Understanding and measuring health literacy among secondary students in Beijing and Melbourne

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Abstract

Background

Health literacy is a personal asset that involves decision-making for healthcare, disease prevention and health promotion in everyday life, contributing to people's health outcomes such as health behaviours and health status. Although there are a range of definitions, health literacy is commonly defined as an individual's ability to find, understand and use health information to promote and maintain good health. From a public health perspective, improving health literacy at an early age is crucial to adolescent health at present and in future. Compared to adult health literacy, adolescent health literacy is under-researched. This is mostly due to a lack of appropriate instruments. Without reliable and valid instruments, it is not possible to quantitatively examine the relationship between health literacy and adolescent health. In addition, due to a lack of theory-driven empirical research, current evidence on adolescent health literacy is limited, especially in terms of our understanding of the mediating role of health literacy. As health literacy is a broad concept, it is necessary for researchers to consider it within a specific culture and context. This PhD research focuses on adolescent health literacy in secondary school settings in China and Australia. Schools were chosen because they are optimal venues for improving adolescent health literacy through a range of health curricula and programs. Given that China has yet to adopt the skills-based health literacy assessment that is widely used in Western countries, this PhD research mainly targets Chinese secondary students. In addition, due to a lack of research on generic health literacy in Australian adolescents and an opportunistic reason for the PhD candidate, a pilot study was conducted in one Australian secondary school to reflect upon the findings of health literacy measurement in Australian school contexts.

Aims

This PhD research aims to measure health literacy in Chinese and Australian secondary students from a health promotion perspective, and to examine the pathways from health literacy influencing factors through to health outcomes.

Method

This PhD research includes a three-phase plan in China and a pilot study in Australia:

- Research Phase 1: A systematic review of health literacy instruments used for adolescents was conducted to identify at least one appropriate instrument.
- Research Phase 2: A validation study was performed to examine whether the selected health literacy instrument was suitable for use in Chinese secondary students.
- Research Phase 3: An empirical study of model testing was carried out to examine Manganello's health literacy framework which postulated pathways from health literacy influencing factors through to health outcomes in Chinese secondary students.
- Finally, a pilot study was conducted in one Australian secondary school to reflect upon the findings of health literacy measurement in Australian school settings.

Results

A total of 15 instruments were included in the systematic review. Adolescent health literacy was mainly measured by the functional domain (i.e. basic skills in reading and writing). Multiple methods existed to measure adolescent health literacy. The review found that most of the 15 included instruments had unknown measurement properties, due to either the poor methodological quality of the studies or a lack of reporting or assessment. Based on the limited evidence from the review, the HLAT-8 was selected to measure adolescent health literacy in this PhD research due to its strong validity, three-domain measurement and quick administration.

The HLAT-8 was translated from English to Chinese (c-HLAT-8) for administration to Chinese secondary students. A total of 650 students in Years 7 to 9 were recruited from four secondary schools in Beijing. The c-HLAT-8 had satisfactory reliability (Cronbach's alpha=0.79; ICC=0.72) and strong validity (translation validity index≥0.95; χ^2/df=3.388, p<0.001; CFI=0.975, TLI=0.945, NFI=0.965, RMSEA=0.061; the c-HLAT-8 had a strong correlation with the HLS-Asia-Q, but a weak correlation with the NVS). The c-HLAT-8 was deemed a valid skills-based instrument for use in Chinese school settings. After the validation, Manganello's health literacy framework was adapted and used for model testing because it explained a full pathway from health literacy influencing factors through to health outcomes. The hypothesised pathway model was tested using data from 650 Chinese secondary students. The proposed pathway model was supported by the data collected, demonstrating the mediating role of health literacy in the relationship between influencing factors and health-related outcomes.

A total of 120 students in Years 7 to 9 were recruited from one secondary school in Melbourne. Consistent with the findings from Beijing students, the NVS result showed a higher proportion of Melbourne students with low health literacy than the HLS-EU-Q result (32.2% for the NVS; 23.7% for the HLS-EU-Q). The pilot study provided new insights (i.e. a shared perspective of health literacy evaluation between the pilot school and the researcher; the feasibility of online data collection; and the possibility of obtaining passive, opt-out consent from parents) into future school-based health literacy research in Australia.

Conclusions

This thesis has generated new knowledge about health literacy measurement and model testing for adolescents in school settings. Specifically, the systematic review demonstrates that there are large differences in the way health literacy is measured in adolescents. Methodological quality frameworks and a consistent set of evaluation principles are recommended to guide health literacy measurement in future. The China-based health literacy research demonstrates a need for a new skills-based instrument for future use and calls for a systems approach (e.g. the '*Health Promoting Schools*' framework) to improving adolescent health literacy at school. Particularly, increasing personal self-efficacy, social support and creating supportive environments are important for promoting health literacy in secondary school settings in China. In Australia, there is a need for further validation of health literacy instruments for adolescents. Changes in school health education policies are required in each culture to better improve adolescent health literacy in school settings.

Declaration

This is to certify that:

i. the thesis comprises only my original work towards the PhD except where indicated in the Preface;
ii. due acknowledgement has been made in the text to all other materials used; and
iii. the thesis is fewer than 100,000 words in length, exclusive of tables, bibliographies and appendices.

Signed: Shuaijun Guo

Date: 10 April 2018

Preface

Ethics

Approval to conduct this research was granted by the University of Melbourne Human Research Ethics Sub-Committee (Ethics number: 1442884), the Department of Education and Training Performance and Evaluation Division (Ethics number: 2015_002665) and the Peking University Health Science Centre Institutional Review Board (Ethics number: IRB00001052-15024). Individuals who participated in surveys provided informed consent after reviewing a plain language statement.

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Publications

Conference presentations

Guo SJ, Armstrong R, Waters E, Sathish T, Alif SM, Browne GR and Yu XM. Measurement properties of health literacy instruments in children and adolescents: a systematic review. The 3rd International Conference on Health Literacy and Healthcare Efficiency, Tainan, Taiwan, 9th to 11th November 2015 (See Appendix A: Poster presentation).

Guo SJ, Davis E, Yu XM, Naccarella L, Armstrong R and Shi YQ. The role of health literacy in the health of school-aged adolescents. The 23rd National Conference of Australian Health Promotion Association, Perth, Australia, 19th to 22nd June 2016 (See Appendix B: Oral presentation).

PhD pending publications

Guo SJ, Davis E, Yu XM, Naccarella L, Armstrong R, Abel T, Browne GR and Shi YQ. Measuring functional, interactive and critical health literacy of Chinese school-aged adolescents: realistic, desirable, or feasible? Global Health Promotion (Accepted, see Appendix C: Accepted Abstract).

Guo SJ, Armstrong R, Waters E, Sathish T, Alif SM, Browne GR and Yu XM. The quality of health literacy instruments used for children and adolescents: a systematic review? (Under review after revision).

Guo SJ, Davis E, Yu XM, Naccarella L, Armstrong R, Shi YQ and Browne GR. An empirical study of health literacy model testing for Beijing secondary students (Under review).

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Abbreviations

ACARA	Australian Curriculum and Assessment Reporting Authority
ACSQHC	Australian Commission on Safety and Quality in Health Care
ALLSS	Adult Literacy and Life Skills Survey
ANOVA	Analysis of Variance
CCSSO	Council of Chief State School Officers
CDC	Centres for Disease Control
CES	Community Environment Scale
CFI	Comparative Fit Index
CHL	Critical Health Literacy
c-HLAT	Chinese version of the Health Literacy Assessment Tool
CI	Confidence Interval
COSMIN	COnsensus-based Standards for the selection of health Measurement INstruments
CSHP	Comprehensive School Health Programs or Coordinated School Health Programs
c-s-TOFHLAd	Chinese version of the short-form Test of Functional Health Literacy in Adolescents
CTT	Classical Test Theory
DALYs	Disability-Adjusted Life Years
DMAIC	Define, Measure, Analyse, Improve and Control
eHEALS	eHealth Literacy Scale
FAS	Family Affluence Scale
FHL	Functional Health Literacy
GSES	General Self-Efficacy Scale
HBSC	Health Behaviour in School-Aged Children
HeLMS	Health Literacy Management Scale
HICs	High-Income Countries
HIPSS	Healthcare Institution of Primary and Secondary School
HIV	Human Immunodeficiency Virus
HLAT	Health Literacy Assessment Tool

HLQ	Health Literacy Questionnaire
HLS-Asia-Q	Health Literacy Study-Asia-Questionnaire
HLS-EU-Q	Health Literacy Survey-European-Questionnaire
HPS	Health Promoting Schools
HRQOL	Health-Related Quality of Life
IALSS	International Adult Literacy and Skills Survey
ICF	International Classification of Functioning, Disability and Health
IHL	Interactive Health Literacy
IMS	Individual Mean Substitution
IOM	Institute of Medicine
IQR	Inter-Quartile Range
IRT	Item Response Theory
LMICs	Low and Middle-Income Countries
LSAC	Longitudinal Study of Australian Children
MSPSS	Multidimensional Scale of Perceived Social Support
NAAL	National Assessment of Adult Literacy
NHES	National Health Education Standards
NVS	Newest Vital Sign
OMIs	Outcome Measurement Instruments
Ophelia	OPtimising HEalth LIterAcy
OR	Odds Ratio
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
REALM	Rapid Estimate of Adult Literacy in Medicine
REALM-Teen	Rapid Estimate of Adolescent Literacy in Medicine
RMSEA	Root Mean Square Error of Approximation
SCASS-HEAP	State Collaborative on Assessment of Student Standards-Health Education Assessment Project
SD	Standard Deviation
SES	School Environment Scale
SHE	School Health Education
SRMR	Standardised Root Mean Square Residual
s-TOFHLA	Short Test of Functional Health Literacy in Adults

STROBE	STrengthening the Reporting of OBservational studies in Epidemiology
TLI	Tucker Lewis Index
TOFHLA	Test of Functional Health Literacy in Adults
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organisation

Glossary

Adolescents refer to those aged between 10 and 19 years (1). In this PhD thesis, I target early adolescents aged 10 to 14 years (2).

Critical health literacy refers to more advanced skills that allow a person to analyse health information critically and use that information to take control over health determinants (3).

Functional health literacy refers to basic skills in reading and writing health information which allow a person to function effectively in everyday life (3).

Health literacy in this thesis represents an individual's ability to find, understand and use health information and services to promote and maintain good health (4, 5). In this PhD thesis, health literacy consists of three domains: functional, interactive and critical.

Interactive health literacy refers to advanced skills that allow a person to extract health information and derive meaning from different forms of communication (3).

Media literacy is defined as one's ability to access, analyse, evaluate and communicate messages in a variety of forms (6).

Mental health literacy refers to the ability to recognise specific disorders; the skills to seek mental health information and the knowledge of risk factors and causes, of self-treatments and of professional help available (7).

Secondary students in this PhD thesis refer to students in Years 7 to 9 in government secondary schools.

Chapter 1 Introduction

The purpose of this chapter is to introduce the rationale and context for this PhD research. Following the problem statement, three research questions of this thesis are posed. Based on these questions, the aim and scope of this study are outlined. Finally, an overview of each chapter is presented.

1.1 Problem statement

Health literacy, a public health priority in the 21st century (8), is commonly defined as an individual's ability to find, understand and use health information successfully to promote and maintain good health (4, 5). The importance of health literacy to public health has been well-documented in the literature (9-11). People with low health literacy are likely to have worse health-compromising behaviours, more healthcare costs and poorer health status (9, 12). In response to low health literacy, many countries have adopted health literacy enhancement as an effective action strategy to improve population health and reduce health inequities (13-15). From a public health perspective, improving health literacy at an early age is crucial to adolescent health at present and in future (16, 17); however, compared to adult health literacy, adolescent health literacy is under-researched (18, 19). Although adolescence is commonly viewed as a healthy time of life (20), this age group faces unprecedented health challenges in the 21st century. As highlighted in the 2016 Lancet report on adolescent health (21), today's adolescents have three main categories of health problems: diseases of poverty (e.g. undernutrition, infectious diseases), injuries (e.g. unintentional injuries, violence) and non-communicable diseases (e.g. physical disorders, mental illness). These health problems may continue into adulthood and may even be passed along to the next generation (21). Therefore, investment in adolescent health should be given priority, including promoting health literacy in adolescents (22). National surveys worldwide have shown that low health literacy is a common and serious problem among adolescents (e.g. 34.0% in the USA; 67.6% in Australia; 93.7% in China) (23-25). Despite evidence showing that adolescent health literacy interventions can bring about better health outcomes, such as improvements in healthy behaviours and decreased use of emergency department services (26, 27), two gaps still exist in current research about health literacy measurement and model testing in adolescents.

Health literacy measurement serves as a solid foundation in the field of health literacy (28). Only by using a reliable and valid measurement tool can the importance of health literacy to public health be identified. Over the past decade, several systematic reviews have been published, particularly for health literacy measurement (29-32), including that for adolescents (33, 34). However, the authors of these reviews did not assess the methodological quality of the included studies, nor did they critically evaluate measurement properties of the included instruments. Therefore, it is still unknown about the overall quality of health literacy instruments used for adolescents. To fill this knowledge gap, one aim of this PhD research has been to identify at least one appropriate instrument to measure health literacy in adolescents by examining both the methodological qualities of relevant studies and the measurement properties of available instruments.

Theoretical models allow researchers to define and understand the construct of health literacy and how health literacy relates to other variables (e.g. socio-economic status) (35). Also, using such a theoretical model can enhance the rigour, clarity and transparency of a research study (28). Owing to a lack of theory-driven empirical research, current understanding of adolescent health literacy is limited; it is mainly in the exploratory stage due either on the relationship between health literacy and influencing factors (32, 36, 37) or on the relationship between health literacy and health outcomes (38-40). Little is known about the mediating role of health literacy in adolescent health. Testing of the mediating role of health literacy can assist researchers in making informed decisions about how to address low health literacy and eventually how to improve distal health outcomes (41). Currently, there are five theoretical models for understanding adolescent health literacy (16, 42-44). Only the causal pathway model proposed by Manganello (i.e. Manganello's health literacy framework) (16) explains a full pathway from health literacy influencing factors through to health outcomes. Therefore, due to the lack of evidence regarding the mediating role of health literacy, the other aim of this PhD research was to work within Manganello's health literacy framework to examine pathways from health literacy influencing factors through to health outcomes.

To fill the above two research gaps, I have developed three research questions for this thesis:

- Is there an instrument which is reliable and valid in measuring health literacy in adolescents, based on a study of high methodological quality?
- If there is such an instrument, is it appropriate for use in adolescents in school settings?
- What are the relationships between health literacy, its influencing factors and health-related outcomes for adolescents based on Manganello's health literacy framework?

1.2 Aim of research

To answer the above three research questions, this thesis had three specific objectives:

- To systematically review the evidence-based health literacy instruments used for adolescents and identify at least one appropriate instrument;
- To validate the selected health literacy instrument in Chinese secondary students; and
- To work within Manganello's health literacy framework to examine pathways from health literacy influencing factors through to health outcomes in Chinese secondary students.

1.3 Scope and settings

Given that health literacy is a broad concept, this term needs to be specific in a particular context, content and culture (5, 45). This means that health literacy may have different meanings in different cultures and contexts. Therefore, researchers must first define health literacy within a specific culture and context. As for this PhD research, I have focused on adolescent health literacy in school settings in China and Australia. Schools were chosen because they are critical venues for improving adolescent health literacy through health curricula and programs (18, 46, 47). Also, schools are the most common gathering places where adolescents spend most of their daytime (48). It is therefore feasible and achievable to recruit large samples in a short time.

There were two reasons why I chose China and Australia as research settings. The first and main reason was the research gaps that existed in both cultures. I will explain this briefly in the following paragraphs. Further details of the rationale for contextualising health literacy in China and Australia will be outlined in Chapter 2.8: Justification of research settings in this PhD research. The second is an opportunistic reason because of my own background and networks in China and Australia. I completed my Master degree at Peking University. There is a strong partnership between government secondary schools in Beijing and my previous research institute (i.e. Institute of Child and Adolescent Health of Peking University). This partnership ensured access to secondary schools and successful recruitment of adolescents for this research project. After my Master study, I came to the University of Melbourne to pursue my PhD. Therefore, Beijing and Melbourne were two accessible cities for me. Given these academic connections in both cities, and the fact that research gaps exist in both Chinese and Australian contexts, this PhD research was an opportunity to explore adolescent health literacy across two cultural settings.

Compared to the skills-based health literacy instruments used in Western countries (33, 34), health literacy measures in mainland China mainly focus on the knowledge or behaviour-based assessment (36-38, 49). Due to a lack of skills-based health literacy assessment and of theory-based empirical research in China, current understanding of adolescent health literacy is limited. Current research on adolescent health literacy is mainly at the exploratory stage (36-38, 50-52). Little is known about the mediating role of health literacy in Chinese adolescents' health; therefore, one intended outcome of this PhD research is to advance health literacy measurement by validating a skills-based instrument in Chinese adolescents. The other intended outcome is to contribute to understanding the role of health literacy in predicting health outcomes by theoretical model testing. 650 students in Years 7 to 9 were selected from four government secondary schools in Beijing, using cluster and convenience sampling. Further details of the recruitment procedures for Chinese students are presented in Chapter 5: Understanding and Measuring Health Literacy among Secondary Students in Beijing, China**.**

In Australia, although adolescent health literacy focuses largely on the domain of health skills (e.g. critical thinking, decision-making and problem-solving), most existing studies focus on mental health literacy (53-57). Mental health literacy specifically refers to an individual's ability to address problems of mental health and illness, rather than addressing general health issues (7). One possible reason for researching mental health literacy is the high prevalence of mental health disorders in Australian adolescents (58). Compared to mental health literacy, general health literacy represents one's ability to deal with general health issues (4, 5), which is more related to people's general health in everyday life. Therefore, attention should also be given to exploring this general health literacy and finding ways to improve it in adolescents. Given that most Australian health literacy research still focuses on the adult population (59-61), particularly from the healthcare perspective (62), little is known about general health literacy for Australian adolescents in school settings. In addition, few appropriate instruments have been developed to measure health literacy in adolescents (23, 63-66); hence this PhD research also included Australian secondary students as its target population.

It should be noted that this PhD research does not focus on a cultural comparison of health literacy between Chinese and Australian adolescents. Instead, it focuses mainly on health literacy measurement and model testing in Chinese secondary students. After conducting health literacy studies in China, I questioned whether the findings on health literacy measurement in Chinese schools could be generalised to Australian schools. This curiosity was triggered by one of Pleasant's (28) recommendations on health literacy measurement: a robust and comprehensive approach to health literacy measurement should allow comparison across cultures. Also, as I was doing my PhD at the University of Melbourne, I had good access to schools in Melbourne, which meant that my research was feasible here. A pilot study was conducted to measure students' health literacy in one secondary school in Melbourne, Australia. This pilot study is an additional component of this thesis. The first intended outcome of the pilot study is to further support the findings of health literacy measurement in Chinese school settings. The second intended outcome is to provide new knowledge about adolescents' general health literacy in Australian schools. Finally, the last intended outcome is to provide new insights into future school-based health literacy research in Australia. 120 students in Years 7 to 9 were recruited from one pilot secondary school. Further details of the recruitment procedures for Australian students are presented in Chapter 6: Health

Literacy Measurement among Australian Adolescents: Pilot testing in an Australian Secondary School.

1.4 Overview of this thesis

This thesis presents empirical work on health literacy measurement and model testing in school-aged adolescents. It consists of nine chapters.

Chapter 1 provides an overview of the thesis, stating the three key research questions and research aims, outlining the scope and research settings, and introducing a synopsis of each chapter.

Chapter 2 reviews what is already known in the field of health literacy, including its definitions, importance and particularly how adolescent health literacy has advanced in terms of its theoretical models, measurement and intervention. Following a critical literature review, I have summarised four gaps in the existing research and justified my focus in this thesis on the first three of those gaps.

Chapter 3 explains the theoretical framework underpinning this thesis and provides an overview of the methodology used in this PhD research. Following the introduction of the theoretical framework, the design of a three-phase research plan in China and a pilot study in Australia are outlined, which were developed to achieve the overall research aims of this PhD research. An overview of the methodology used is then presented. Further details of methods employed in each research phase are outlined in Chapters 4, 5 and 6.

Chapter 4 presents the process of Research Phase 1 in this PhD research, which is a systematic review of health literacy instruments used for adolescents. It examines the methodological quality of each included study and the overall quality of measurement properties for each included instrument. By this step, the 8-item Health Literacy Assessment Tool (HLAT-8) is identified as the most suitable instrument to measure secondary students' health literacy in Research Phase 2 and Research Phase 3.

Chapter 5 has two sections, both of which target Chinese secondary students. Section One details the process of Research Phase 2 in this PhD research, which reports on the culturally-adapted translation and validation process of the c-HLAT-8 in Chinese secondary students. Section Two describes the process of Research Phase 3 in this PhD research, which describes an empirical study of health literacy model testing in Chinese secondary students.

Chapter 6, focusing on Australian secondary students, outlines a pilot study of health literacy measurement in one secondary school in Melbourne. Despite recruitment challenges, this chapter adds to new evidence on students' general health literacy, providing new insights into future school-based health literacy research in Australia.

Chapter 7 presents a synthesis and discussion of the data provided in the preceding Chapters 4, 5 and 6. Five key findings are further discussed to better understand the conceptual definitions, measurement and conceptual models of adolescent health literacy. Also, research contributions and limitations of the whole research are summarised.

Chapter 8 reflects on the main findings from this PhD research based on a knowledge translation framework (i.e. the Interactive Systems Framework), outlining implications for future research, practices and relevant policies.

Chapter 9 provides a conclusion for this PhD research. It includes a summary of findings from each research phase, highlighting the implications of this thesis to the overall field of adolescent health literacy.

Chapter 2 Background

This chapter presents a literature review of adolescent health literacy to justify this PhD research. There are eight sections in this chapter. The first and second sections chronologically summarise the evolving concept of health literacy and highlight the importance of health literacy to population health. The third to sixth sections discuss adolescent health literacy in terms of its significance, conceptual models, measurement and practical interventions. The seventh and eighth sections provide a summary of the main research gaps which inform the research settings of this PhD research.

2.1 What is health literacy?

Health literacy represents an individual's capacity to obtain, understand and use health information and services in ways which promote and maintain personal and community health (67, 68). Differing from the term '*literacy*' (i.e. the ability to read and write) (69), health literacy is a broader and more complex concept (70, 71) which occurs when the skills and abilities of those requiring health information and services are aligned with the demand and complexity of that information and those services. The term '*health literacy*' was first proposed in 1974 in a health education conference proceeding (72) which called for health education as a social policy issue affecting health systems, mass media and educational systems. From then until the early 1990s few studies examining health literacy were conducted (73). Since the 1990s, health literacy has gained momentum regarding its definitions, measurement tools and conceptual frameworks (74). In this section health literacy definitions are chronologically collated.

2.1.1 Health literacy in the first stage (the 1970s to the 1990s)

Although health literacy was introduced in the 1970s, no explicit definition of this concept existed (72). Most health literacy research at this stage was conducted from a clinical perspective, especially in the 1990s (75). In 1993, Murphy *et al.* (76) developed a quick reading test to identify patients with low literacy levels in healthcare settings. Within this context, health literacy represented '*patients' ability to read the usual educational brochures, written instructions, consent forms and prescription labels*.' In 1995, Parker *et al.* (77) proposed another definition of health literacy that was more than being able to read medical words. Health literacy was defined here as '*being able to apply literacy skills to health-related materials such as prescriptions, appointment cards, medicine labels and directions for home health care*.' In this case, health literacy was explained as patients in medical settings having skills to read, comprehend and calculate numbers.

In 1995, the Joint Committee on National Health Education Standards developed the 1st edition '*National Health Education Standards: Achieving Health Literacy*' for primary and secondary school health education. In this document, health literacy was defined as '*the capacity of individuals to obtain, interpret and understand basic health information and services and the competence to use such information and services in ways which enhance health*' (78). This definition put health literacy into the educational setting where health literacy was regarded as a measurable outcome to school health education programs (79, 80). However, there was little information about health literacy in such school programs at this stage.

In 1999, the American Medical Association (AMA) Council on Scientific Affairs convened experts in the field of health literacy to investigate how health literacy research was progressing in the United States. Based on a literature review, the committee concluded health literacy was '*a constellation of skills, including the ability to perform basic reading and numerical tasks required to function in the health care environment*' (81). This definition, like Parker's definition (77), highlighted reading ability and computational skills as core components of health literacy. Also, health literacy was explicitly specified in the healthcare setting for the first time.

In summary, health literacy from the 1970s to the 1990s mainly referred to the ability to handle words and numbers in medical settings. To some extent, health literacy equals '*medical literacy*', '*patient literacy*', or '*clinical literacy*' (74). At this stage, health literacy was perceived as reading, comprehension and numeracy skills required to function in the healthcare environment (i.e. functional health literacy), while the next stage enlarged the focus to include both functional health literacy and interactive and critical health literacy.

2.1.2 Health Literacy in the second stage (the 1990s to the 2000s)

From the 1990s to the 2000s, the concept of health literacy evolved extensively to encompass a broad and interconnected set of skills, including finding and understanding health information, communicating health needs with health professionals, making healthy decisions and so forth (74). Compared with the first stage, there were a number of health literacy definitions developed in the second stage.

Of these definitions, the ones from the World Health Organisation (WHO) and the US Institute of Medicine (IOM) are well-recognised. In 1998, Nutbeam (68) defined health literacy as '*the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health*.' This definition was adopted by the WHO. Health literacy implies the simultaneous use of one's knowledge, attitudes, motivation, personal skills and self-efficacy (3). Specifically, health literacy incorporates three hierarchical levels: functional health literacy refers to basic skills in reading and writing health information that can be used to manage effectively in everyday life; interactive health literacy includes advanced skills that allow individuals to extract health information and derive meaning from different forms of communication; and critical health literacy represents more advanced skills that can be applied to critically evaluate health information and take great control over health determinants (3). The definition of health literacy of the IOM Committee is slightly different from the WHO definition. In 2004, the IOM committee regarded health literacy as '*the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions*' (67). Health literacy was considered an outcome influenced by healthcare systems, education systems and a range of social and cultural settings (e.g. home, workplace, community) (67). From these two well-recognised definitions, health literacy has become known as a concept having four clusters of content: 1) cognitive and social skills, abilities, or capacities; 2) health information and services; 3) objectives such as promoting and maintaining good health; and 4) underlying contexts such as clinics, schools, homes and workplaces. Both the WHO and the IOM health literacy definitions indicate that health literacy is more than the ability to perform basic reading and numerical tasks required to function in the healthcare environment; it also encompasses other personal skills such as communication and evaluation in the broader environment.

In the second stage, there are many different perspectives of health literacy. Some authors saw health literacy from a multi-dimensional perspective. For example, in 2003, Zarcadoolas *et al.* (82) presented health literacy in a diverse and multi-layered framework. Health literacy encompassed fundamental literacy/numeracy, science and technology literacy, community/civic literacy and cultural literacy. Similarly, in 2008, Mancuso (83) used a concept analysis to present another understanding of the multi-dimensional nature of health literacy. Health literacy in Mancuso's view included the attributes of capacity, comprehension and communication. Later on, in 2009, an international collaborative research team reached a consensus that health literacy referred to a range of competencies that included knowledge, skills, abilities and attitudes (84). There were other authors explaining health literacy in different contexts. For instance, both Paasche-Orlow (85) and Adkins (86) concurred that health literacy could only be studied in a particular social and cultural context. The 2009 Calgary Charter on Health Literacy also highlighted the importance of context to health literacy (87), arguing that health literacy applied to both individuals and health systems. Within different cultural contexts, there are slight differences in health literacy definitions between countries. For example, the definition used in the USA (67) is distinct from that those in Canada (88) and China (49) (See **Table 2.1**). Finally, there were also some authors interpreting health literacy in terms of its importance. For example, Kickbusch *et al.* (89) deemed that health literacy was a critical empowerment strategy to improve peoples' health. Adams *et al.* (90) alleged that health literacy and health competency were both crucial in promoting wellness and in optimally managing chronic disease. Further descriptions of these health literacy definitions are presented in **Table 2.1**.

In summary, health literacy in the second stage mainly referred to an individual's ability to obtain, understand and use health information and services to promote and maintain good health in the context of everyday life. Although health literacy definitions were numerous and varied in the second stage, a commonality within these definitions was that the achievement of health literacy required high levels of personal skill and empowerment. Also, it was implicitly acknowledging that health literacy was a shared responsibility of individuals and social contexts.

2.1.3 Health literacy in the third stage (2010 to the present)

In the third stage, health literacy moved beyond focusing on individuals' health skills. Health literacy is increasingly recognised as a key concept at the individual, population and system level (35, 74). In 2014, the Australian Commission on Safety and Quality in Health Care (ACSQHC) separated health literacy into two components: individual health literacy (reflecting personal characteristics) and the health literacy environment (reflecting the social conditions around individuals) (13). In 2015, the WHO also redefined health literacy as '*the personal characteristics and social resources needed for individuals and communities to access, understand, appraise and use information and services to make decisions about health*' (10).

The definition of individual health literacy was provided in the first and second stages. It encompasses a range of components: functional literacy (e.g. reading, writing and calculating) in healthcare settings (76-78, 81); theoretical knowledge (e.g. understanding, identification and acquisition) (49, 67, 68, 82, 88); practical knowledge (e.g. seeking information, goal setting, service navigation and application) (49, 67, 68, 82, 88, 89); attitudes (84); communication (83, 86) and self-efficacy (3). As described in the first and second stages, researchers defined individual health literacy variously according to their research purposes. For example, when researchers aim to examine patients' health literacy in medical settings, individual health literacy often refers to functional health literacy, one's ability to read, write and calculate numbers. This is because functional literacy plays a critical role in patients' healthcare service utilisation such as in reading and signing a consent form.

With the rapid development of health literacy research in the 2000s (73), an international consensus gradually emerged that low health literacy was an issue for both individuals and systems (91-93). The concept of health literacy from the personal characteristics perspective could not meet the demands of health literacy practices and interventions. Therefore, health literacy transformed into a more dynamic concept: an interactive outcome influenced by individuals' health skills and social environments (94). From an ecological perspective, individual health literacy is dependent on the social environment, including families, schools, hospitals, communities and government organisations (16, 44). In such cases, to achieve high levels of health literacy, there is a need to consider health literacy from an individual issue to a broader environment and system issue. As argued by Greenhalgh (95) and Koh *et al.* (96), the problem of low health literacy requires a system-level response, requiring the health literacy environment to be included when addressing low health literacy. The term '*health literacy environment*' refers to all relevant health-related contexts and resources that may have an impact on individual health literacy (13). In recent years, a growing number of studies have used a systems approach to improving people's health literacy (10, 95, 96). For example, the Ophelia (**Op**timising **he**alth **li**ter**a**cy) project recommended by the WHO (97), uses a systems approach that supports the identification of community health literacy needs, aiming to develop effective responses and potential solutions to improving health and equity in locally appropriate ways.

Compared with the first and second stages, health literacy in this stage is more advanced and comprehensive. The third stage highlights the importance of environments and systems to individual health literacy. Health literacy is thus considered as a concept dependent on social conditions and resources.

2.1.4 Health literacy definitions for adolescents

Throughout the above literature review, there are five definitions related to health literacy in adolescents (43, 44, 78, 98, 99) (See definitions with a superscript of '*' in **Table 2.1**). Although these health literacy definitions vary, they share two commonalities. One commonality of the five definitions, well-recognised by researchers, is the skills-based nature of health literacy. Health literacy involves a set of health skills such as finding and using health information. The other commonality is in the objectives of health literacy (e.g. '*to enhance health*', '*to change health determinants*'). Health literacy plays a key role in achieving optimal health in adolescents. These two commonalities indicate that current definitions of adolescent health literacy are in the second stage of the evolving concept of health literacy which focuses on an individual's ability to find, understand and use health information and services to promote and maintain good health in everyday life. This finding is aligned with the definition of adolescent health literacy in the most recent 2017 literature (19, 22). Bröder *et al.* (22) used a systematic review method to identify health literacy in children and young people as '*comprising variable sets of key dimensions, each appearing as a cluster of related abilities, skills, commitments and knowledge that enable a person to approach health information competently and effectively and to derive at health-promoting decisions and actions.*' Peralta *et al.* (19) conceptualised adolescent health literacy as having three components: adolescent learning of capacities, health-literate school organisation, and critical health literacy. Although the interrelatedness of individual health literacy and social determinants is recognised, the conceptualisation of adolescent health literacy largely reflects a set of personal skills in current research.

2.1.5 Summary

In summary, there are essentially three stages in the evolution of the definition of health literacy. A complete list of health literacy definitions in each stage is presented in **Table 2.1**. It should be noted that health literacy definitions in the first and second stages are not outdated in terms of their usefulness for current research and practice. As Berkman *et al.* (100) stated, '*the definition of health literacy that one selects may depend on one's goals*.' As per different research goals, health literacy can be defined as either functional health literacy in healthcare settings, or as an individual's capacity to find, understand and use health information in everyday life, or as a complex construct that encompasses individual health literacy and the health literacy environment. Therefore, health literacy definitions need to be specific to a particular context and to a specific research goal. In this PhD research, I adopted the definition of health literacy from the second stage, the definition which referred to an individual's ability to find, understand and use health information and services to promote and maintain good health. There were two reasons for this definition. One was that this PhD research focused on adolescent health literacy in school settings, rather than clinical settings. The skills-based concept of health literacy was aligned with the current goal of school health education (101) which highlighted developing personal skills for school-aged adolescents. The other reason was that one of my research goals was to examine the mediating role of health literacy in adolescent health within Manganello's health literacy framework, rather than using a systems approach to addressing low health literacy in adolescents. Also, due to the complexity of measuring the health literacy environment, health literacy in this PhD research was defined as a skills-based concept in relation to adolescents.

Box 2.1: Key messages about health literacy definitions

- Health literacy is an evolving and complex concept that has changed over time.
- Health literacy mainly refers to the ability to handle words and numbers in medical settings in the 1970s-1990s.
- Health literacy typically represents an individual's ability to obtain, understand and use health information and services to promote and maintain good health in the 1990s-2000s.
- Health literacy has become a broader concept that comprises both individual health literacy and health literacy environment since 2010.
- Health literacy is an implicit concept that requires authors to give an explicit clarification of its definition and context.
- Adolescent health literacy in this PhD research refers to an individual's ability to find, understand and use health information and services to promote and maintain good health.

Table 2.1: A complete list of health literacy definitions in chronological order

Author/Organisation (Year)	Health literacy definition
In the first stage (the 1970s to the 1990s)	
Murphy *et al.* (1993)	'*Patients' ability to read the usual educational brochures, written instructions, consent forms and prescription labels*' (76)
Parker *et al.* (1995)	'*Being able to apply literacy skills to health-related materials such as prescriptions, appointment cards, medicine labels and directions for home health care*'(77)
The Joint Committee on National Health Education Standards (1995) *	'*The capacity of individuals to obtain, interpret and understand basic health information and services and the competence to use such information and services in ways which enhance health*' (78)
American Medical Association (1999)	'*A constellation of skills including the ability to perform basic reading and numerical tasks required to function in the health care environment*' (81)
In the second stage (the 1990s to the 2000s)	
World Health Organisation (1998)	'*The cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health*' (68)
Fok and Wong (2002) *	'*Being able to perform physical and psycho-social activities with appropriate standards, being able to interact with people and being able to cope with necessary changes and demand reasonable autonomy so as to achieve complete physical, mental and social wellbeing*' (98)
Zarcadoolas, Pleasant and Greer (2003)	'*The evolving skills and competencies needed to find, comprehend, evaluate and use health information and concepts to make educated choices, reduce health risks and improve the quality of life. Health literacy comprises fundamental literacy/numeracy, science and technology literacy, community/civic literacy and cultural literacy*.' (82)
The United States Institute of Medicine (2004)	'*The degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions*' (67)
Kickbusch, Wait and Maag (2005)	'*The ability to make sound health decisions in the context of everyday life – at home, in the community, at the workplace, in the healthcare system, the marketplace and the political arena. It is a critical empowerment strategy to increase people's control over their health, their ability to seek out information and their ability to take responsibility*' (89)

Author/Organisation (Year)	Health literacy definition
Paasche-Orlow and Wolf (2007)	'*An individual's possession of requisite skills for making health-related decisions. This means that health literacy must always be examined in the context of the specific tasks that need to be accomplished*' (85)
Mancuso (2008)	'*A process that evolves over one's lifetime and encompasses the attributes of capacity, comprehension and communication*' (83)
Ministry of Health of the People's Republic of China (2008)	'*An important component of physical constitution, which means individuals' capacity to find, understand and use basic health information and services to make informed decisions in order to promote and maintain good health*' (49)
Rootman and Gordon-El-Bihbety (2008)	'*The ability to access, understand, evaluate and communicate information as a way to promote, maintain and improve health in a variety of settings across the life-course*' (88)
Adams *et al.* (2009)	'*Health literacy is the cognitive ability to understand and interpret the meaning of health information in written, spoken or digital form. It impacts on whether people are able to embrace or disregard actions relating to health and make sound health decisions in the context of everyday life*' (90)
Adkins *et al.* (2009)	'*The ability to derive meaning from different forms of communication by using a variety of skills to accomplish health-related objectives. Health literacy involves a range of practices in the social realm (e.g. language competencies and identity management skills); it is, therefore, a public act rather than an individual act of decoding forms*' (86)
Higgins *et al.* (2009) *	'*The ability to make sound health decisions in the context of everyday life. It is a critical empowerment strategy to increase people's control over their health, their ability to seek out information and their ability to take responsibility. The ability to access, understand, evaluate and communicate information as a way to promote, maintain and improve health in a variety of settings across the life course*' (44)
Yost *et al.* (2009)	'*The degree to which individuals have the capacity to read and comprehend health-related print material, identify and interpret information presented in a graphical format (charts, graphs, tables), and perform arithmetic operations in order to make appropriate health and care decisions*' (102)
Protheroe *et al.* (2009)	'*It may be better to consider health literacy in terms of competencies, which could include such variables as knowledge, skills, abilities and attitudes*' (84)

Author/Organisation (Year)	Health literacy definition
The Calgary Charter on Health Literacy (2009)	'*Health literacy allows the public and personnel working in all health-related contexts to find, understand, evaluate, communicate and use information. Health literacy is the use of a wide range of skills that improve the ability of people to act on information in order to live healthier lives. These skills include reading, writing, listening, speaking, numeracy and critical analysis, as well as communication and interaction skills*' (87)
Paakkari and Paakkari (2012) *	'*Health literacy comprises a broad range of knowledge and competencies that people seek to encompass, evaluate, construct and use. Through health literacy competencies people become able to understand themselves, others and the world in a way that will enable them to make sound health decisions, and to work on and change the factors that constitute their own and others' health chances*' (43)
Massey *et al.* (2012) *	'*A set of skills used to organise and apply health knowledge, attitudes and practices relevant when managing one's health environment*' (99)
In the third stage (2010 to the present)	
Parker and Ratzan (2010)	'*Health literacy occurs when the skills and ability of those requiring health information and services are aligned with the demand and complexity of information and services*' (70)
Greenhalgh (2012)	'*Health literacy is a wider definition that emphasises the complex interdependencies between health understanding, health attitudes and behaviours, social determinants of health and the design and delivery of health services. Even when individual health literacy needs are identified, meeting these needs in particular subpopulations and risk groups requires a system-wide response*' (95)
Sorensen *et al.* (2012)	'*Health literacy is linked to literacy and entails people' s knowledge, motivation and competencies to access, understand, appraise and apply health information in order to make judgments and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life during the life course*' (74)
Koh *et al.* (2013)	'*Health literate organisations integrate health literacy into the organisation's mission and all dimensions of planning, implementation, evaluation and quality improvement activities. A 'health literate' organisation ensures that written materials are understandable and relevant; it also trains the workforce to meet the needs of people with a range of health literacy skills and relieves individuals of the challenge of coordinating their own care*' (96)

Author/Organisation (Year)	Health literacy definition
The Australian Commission on Safety and Quality in Health Care (2014)	'*Health literacy is separated into two components: individual health literacy and the health literacy environment. Individual health literacy is the skills, knowledge, motivation and capacity of a person to access, understand, appraise and apply information to make effective decisions about health and health care and take appropriate action. Health literacy environment is the infrastructure, policies, processes, materials, people and relationships that make up the health system and have an impact on the way that people access, understand, appraise and apply health-related information and services*' (13)
World Health Organisation (2015)	'*The personal characteristics and social resources needed for individuals and communities to access, understand, appraise and use information and services to make decisions about health*' (10)
Poureslami *et al.* (2016)	'*Health literacy is not only multidimensional, but it is also longitudinal, with different foci, priorities and purposes over the life course. These characteristics argued for flexibility and multiplicity in defining health literacy so that definitions could reflect the variable interplay of patients, providers and systems across different health, disease and social contexts*' (103)

Note: * these definitions are related to health literacy for children and adolescents.

2.2 Why is health literacy important?

With the rapid development of health literacy definitions, an increasing number of studies have begun to examine health literacy measurement tools, relationships between health literacy and health outcomes, and the effectiveness of health literacy interventions (31, 73, 104-106). In healthcare settings, health literacy is often seen as a clinical '*risk factor*' for patients who may have difficulties in reading, understanding and using medical information (5). For example, patients with low health literacy are more likely to misunderstand medical prescriptions, experience ineffective communication with health professionals, have poor self-management of chronic disease, and frequently utilise emergency care services (104). From a health promotion perspective, health literacy is usually treated as a '*personal asset*' that protects and improves one's health in a wide range of contexts, including schools, hospitals, workplaces, communities and markets (5). In such contexts, health literacy empowers an individual to understand conditions that determine their health and to know how to change those conditions (107). Given the importance of health literacy, this section reviews the prevalence of low health literacy across countries and explains how low health literacy is associated with a range of adverse health outcomes.

2.2.1 The prevalence of low health literacy across countries

Low health literacy is a global health issue affecting both high-income countries (HICs) and low and middle-income countries (LMICs). In HICs, there have been many national health literacy surveys conducted in the last two decades. In the USA, the 2003 National Assessment of Adult Literacy (NAAL) survey showed that 36.0% of US adults had health literacy scores at basic or below basic levels, which means they could not meet the basic health demands of everyday life (24). In Canada, 55.0% of those aged 16 to 65 were scored as having poor health literacy for the 2003 International Adult Literacy and Skills Survey (IALSS) (88). Similarly, findings from the 2006 Adult Literacy and Life Skills Survey (ALLS) in Australia and New Zealand showed that approximately 59% of Australian adults and 56.2% of New Zealanders had poor health literacy skills (23). In European countries, the 2011 Health Literacy Survey-European-Questionnaire (HLS-EU-Q) found that 47.6% of participants in eight countries were at risk of low health literacy. In each country, the percentage of those demonstrating low health literacy ranged from 28.7% to 62.1% (Austria 56.4%; Bulgaria 62.1%; Germany 46.3%; Greece 44.8%; Spain 58.3%; Ireland 40.0%; Netherlands 28.7% and Poland 44.6%) (108). More recently, national health literacy survey data have also been available in Japan (109) and Israel (110). Results showed the prevalence of low health literacy was 85.4% in Japan and 31.0% in Israel. These figures suggest that low health literacy is a common problem across HICs, ranging from 28.7% to 85.4% in those countries.

Compared with that in HICs, the prevalence of low health literacy is greater in LMICs. Currently, there are few national health literacy surveys conducted in Asian countries. In 2008, the Chinese Resident Health Literacy Scale (CRHLS) was carried out in mainland China. Results showed that only 6.5% of Chinese adults aged 15 to 69 had adequate health literacy, indicating that the majority (93.5%) of citizens would not perform well when they were faced with health-related problems (25). More recently, in 2013 and 2014, a population-based cross-sectional study was conducted in five Asian countries (Indonesia, Kazakhstan, Myanmar, Taiwan and Vietnam). Participants aged over 15 were asked about their health literacy skills, using the Health Literacy Study-Asia-Questionnaire (HLS-Asia-Q). The survey results reported that the prevalence of low health literacy was: 63.1% in Indonesia; 53.5% in Kazakhstan; 58.7% in Myanmar; 44.5% in Taiwan and 66.9% in Vietnam (111, 112).

It is hard to compare the prevalence of low health literacy across countries on a standardised scale because the health literacy surveys used may vary. However, it is common to all of these countries that low health literacy is a serious public health concern. Of particular note is the higher prevalence of low health literacy among immigrants, members of ethnic minorities, minors, elderly people, and people with low educational attainment (23-25, 88, 108). In response to low health literacy, many countries have integrated health literacy into their national health policies and reforms (15). For example, '*Healthy People 2010*' (113) and '*Healthy People 2020*' (14) in the USA; '*National Statement on Health Literacy*' in Australia (13); and '*Health Literacy Promotion Initiatives*' and '*Health Literacy 66*' in mainland China (15). Also, enhancing health literacy has been recommended by the WHO as an effective action strategy to reduce health inequities in the international setting (9-11, 114, 115). Clearly, addressing low health literacy is becoming a public health priority at both national and international levels.

Table 2.2: The prevalence of low health literacy in the overall population across countries

Country	Year	Health literacy survey	Participant age	Prevalence of low health literacy (%)
HICs				
America (24)	2003	NAAL	16+	36.0
Canada (88)	2003	IALSS	16-65	55.0
Australia (23)	2006	ALLSS	15-74	59.5
New Zealand (116)	2006	ALLSS	16-65	56.2
Austria (108)	2011	HLS-EU-Q47	15+	56.4
Bulgaria (108)	2011	HLS-EU-Q47	15+	62.1
Germany (108)	2011	HLS-EU-Q47	15+	46.3
Greece (108)	2011	HLS-EU-Q47	15+	44.8
Spain (108)	2011	HLS-EU-Q47	15+	58.3
Ireland (108)	2011	HLS-EU-Q47	15+	40.0
Netherlands (108)	2011	HLS-EU-Q47	15+	28.7
Poland (108)	2011	HLS-EU-Q47	15+	44.6
Israel (110)	2012-2013	HLS-EU-Q16	18+	31.0
Japan (109)	2013	HLS-EU-Q47	20-69	85.4
LMICs				
China (25)	2008	CRHLS	15-69	93.5
Indonesia (112)	2013-2014	HLS-Asia-Q47	15+	63.1
Kazakhstan (112)	2013-2014	HLS-Asia-Q47	15+	53.5
Myanmar (112)	2013-2014	HLS-Asia-Q47	15+	58.7
Taiwan (112)	2013-2014	HLS-Asia-Q47	15+	44.5
Vietnam (112)	2013-2014	HLS-Asia-Q47	15+	66.9

Note: ALLSS, The Adult Literacy and Life Skills Survey; CRHLS, The Chinese Resident Health Literacy Scale; HICs, High-Income Countries; HLS-Asia-Q, The Health Literacy Study-Asia-Questionnaire; HLS-EU-Q, The Health Literacy Survey-European-Questionnaire; IALSS, The International Adult Literacy and Skills Survey; LMICs, Low and Middle-Income Countries; NAAL, The National Assessment of Adult Literacy.

2.2.2 Impact of low health literacy

Low health literacy leads to a range of adverse health-related outcomes. A few systematic reviews (12, 105, 117, 118) have documented the close relationship between health literacy and health-related outcomes. In the following paragraphs, Nutbeam's health promotion outcome model (3) was employed here to clarify what types of adverse outcomes result from low health literacy (See **Figure 2.1**). Health-related outcomes are classified into two categories: intermediate health outcomes and distal health and social outcomes.

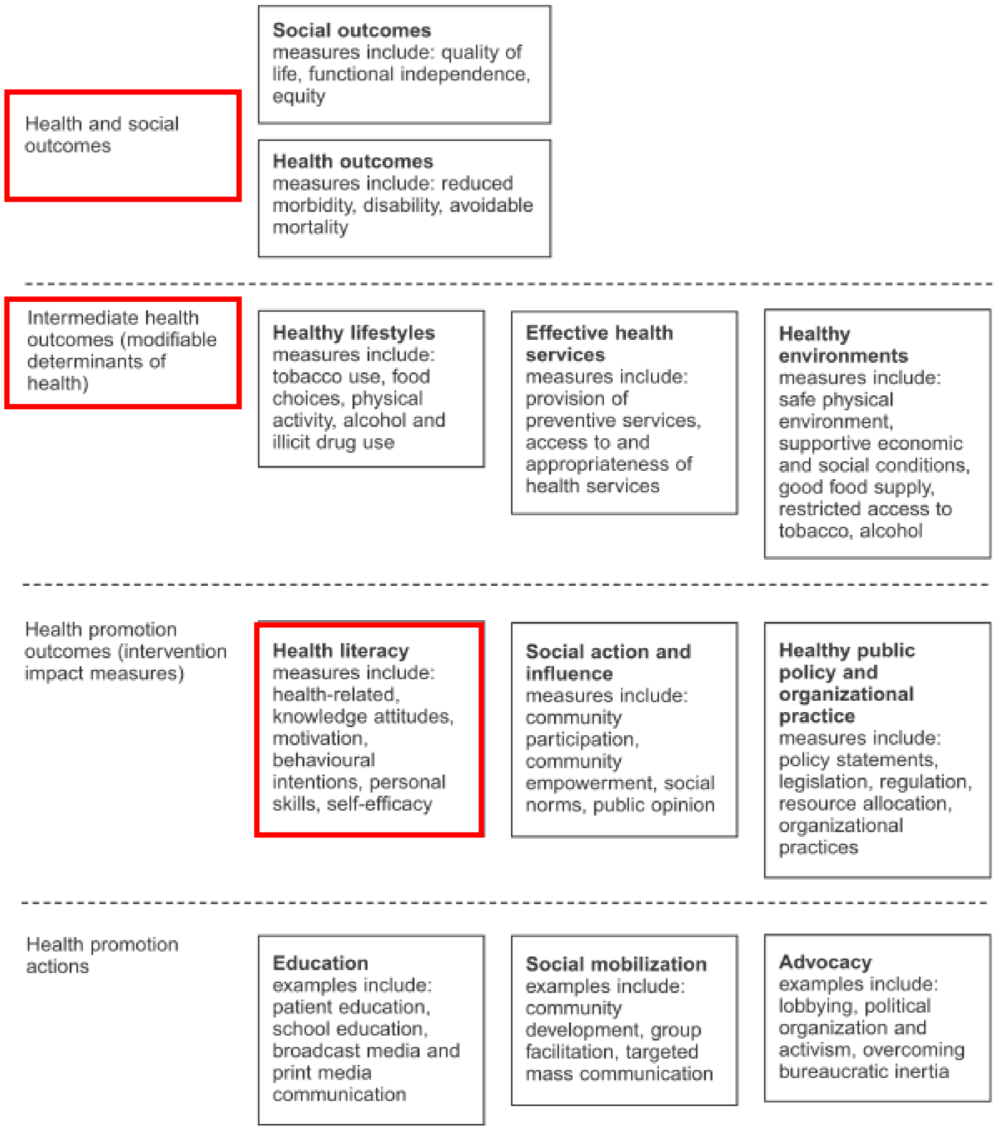

Figure 2.1: A health promotion outcome model proposed by Nutbeam (3)

2.2.2.1 Intermediate health outcomes

Intermediate health outcomes refer to modifiable determinants of health (3). Adverse outcomes resulting from low health literacy include poor health behaviours and lifestyles, ineffective health service utilisation and poor self-management of chronic diseases.

2.2.2.1.1 Poor health behaviours and lifestyles

Health literacy is regarded as a health promotion outcome that affects healthy behaviours and lifestyles (3). Evidence from two relevant studies suggests that the relationship between health literacy and health behaviours only exists in *some* domains of health behaviours, not in all. In a cross-sectional study by Von Wagner *et al.* (119), the association between functional health literacy and health-promoting behaviours was examined in a total of 759 British adults aged 18 to 90. Results showed that people with high health literacy scores were more likely to engage in health-promoting behaviours such as eating at least five portions of fruit and vegetables a day (OR=1.02; 95% CI=1.003 to 1.03), or being a non-smoker (OR=1.02; 95% CI=1.003 to 1.03). However, there was no relationship between health literacy and regular physical activity (OR=1.00; 95% CI=0.98 to 1.02). In a second study conducted by Chang (52), 1601 high school students in Taiwan were recruited to examine the relationship between health literacy and health-promoting behaviours. Again, findings revealed that adolescents with low health literacy were less likely to exhibit health-promoting behaviours, especially in the domain of nutrition (adjusted OR=0.62; 95% CI=0.43 to 0.89) and interpersonal relations (adjusted OR=0.61; 95% CI=0.43 to 0.87), but not in the domain of exercise, stress management and health responsibilities. Both above authors suggested that health literacy was only related to eating patterns, not to physical activity. As explained by Chang (52), the role of health literacy in predicting physical activity was probably neutralised by peer influence or the lack of a supportive environment, which were more predictive of people’s physical activity decisions than health literacy was. Therefore, the role of health literacy in predicting health behaviours may differ between health behaviour domains. However, this evidence should be taken cautiously, because health literacy in the above two studies was only measured by an individual’s ability to understand healthcare materials (i.e. functional health literacy), ignoring other important domains of health literacy such as interactive and critical health literacy. More evidence is needed to confirm the relationship between health literacy and health behaviours, using a more comprehensive measurement.

Low health literacy is also found to be associated with overweight and obesity (38, 39). Body weight is considered as an important indicator of adolescent and adult health (120). With the rapid development of the social economy, the global prevalence of overweight and obesity is increasing in both developing and developed countries (121). Therefore, overweight and obesity have gained increasing attention. As for the relationship between health literacy and overweight and obesity, the literature has shown that low health literacy is a significant contributor to overweight and obesity (38, 39, 122). For instance, using a convenience sample of 239 parent-child dyads from paediatric clinics, Chari *et al.* (39) found that the odds of obesity among adolescents with low health literacy were significantly higher than those with high health literacy (OR=5.00; 96% CI=1.26 to 19.8). Similarly, Lam and Yang (38) examined the association between low health literacy and overweight and obesity among 1035 Chinese high school students. Their findings suggested that students with low health literacy were more likely to be overweight and obese (OR=1.84; 95% CI=1.13 to 2.99). As argued by Zarcadoolas *et al.*(123), strengthening health literacy could be an effective strategy in helping consumers take action to control and prevent obesity in the 21st century.

2.2.2.1.2 Ineffective health service utilisation

In medical settings, low health literacy affects a patient's ability to use health services effectively. Patients with low health literacy would have difficulty in reading/understanding medical information, and would struggle to communicate with health professionals. One of the most common problems for patients is shame and stigma. In an early study by Parikh *et al.* (124), it was found that 67.4% of patients with low health literacy (n=58) admitted having trouble reading and understanding medical information, and almost 40% of patients with low health literacy admitted shame and embarrassment (n=23). As a result of low health literacy, patients are more likely to experience low self-esteem, to feel stigmatised when encountering medical conditions, and even likely to conceal their health needs. Such negative experiences may, in turn, inhibit them from taking help-seeking decisions in the future and from accessing services. Patients' low health literacy levels and their deeply harboured emotions (e.g. shame and stigma) are closely inter-linked. As suggested by Mackert *et al.* (125) in a framework addressing stigma and low health literacy, various factors contribute to the stigma associated with low health literacy, thus leading to infrequent health service utilisation. Therefore, low health literacy and stigma problems should both be considered when seeking to improve access to health service.

Another important negative consequence of low health literacy is reduced utilisation of preventative services (126). In a cross-sectional study conducted by Scott *et al.* (127), 2722 participants aged 65 to 79 were enrolled to examine whether people with low health literacy were less likely to report preventative health service use. Findings showed that participants with low health literacy were less likely to receive influenza vaccination (OR=1.4; 95% CI=1.1 to 1.9) and pneumococcal vaccination (OR=1.3; 95% CI=1.1 to 1.7), after adjustment for demographics, socio-economic status and health status. Female participants were less likely to have mammogram screening (OR=1.5; 95% CI=1.0 to 2.2) or Papanicolaou smears (OR=1.7; 95% CI=1.0 to 3.1). To further examine the relationship between health literacy and preventative service use, DeWalt *et al.* (128) and Berkman *et al.* (104) conducted a systematic review in 2004 and 2011 respectively. Both their findings suggested that low health literacy was associated with less use of preventative services. Of note is that most evidence supporting the above relationship is from cross-sectional studies. Future studies such as cohort studies are needed to further confirm the close relationship between health literacy and use of preventative services.

People with low health literacy are also more likely to use emergency care and hospitalisation services. Due to their inability to read medical messages and comprehend prescriptions, patients probably have a lower rate of medication adherence and/or misunderstand what their practitioners tell them. In a study by Schumacher *et al.* (129), 518 patients in an emergency department were interviewed about their health literacy levels. Results showed that patients with low health literacy reported greater emergency care use (OR=1.57; 96% CI=1.02 to 2.43). Compared to those with high health literacy, patients with poor health literacy preferred to access emergency care because they saw the emergency care service as a source of high-quality care (129). In other similar studies, patients deemed that the emergency care service was an easier or more convenient entry point to the health system (130, 131). Meanwhile, the risk of hospitalisation is higher among individuals with low health literacy than their counterparts. Using a systematic review approach, DeWalt *et al.* (128) found two good quality cohort studies that examined the relationship between low health literacy and hospitalisation. Findings from the two cohort studies showed that the odds of hospitalisation were statistically higher (OR range=1.29 to 1.69) among patients with low health literacy than those with high health literacy.

Finally, it should be noted that ineffective health service utilisation is more frequent among seniors, immigrants, members of ethnic minorities and minors (104, 128). This means that, apart from low health literacy, influential factors inhibiting patients from using health services effectively may include poor cognitive ability (132), using a language other than the patient's first language (133), and cultural differences (134). When considering health literacy interventions that aim to improve the effectiveness and quality of healthcare services, a comprehensive perspective is needed to consider the above influencing factors.

2.2.2.1.3 Poor self-management of chronic diseases

Chronic diseases account for a significant proportion of the global burden of disease in the 21st century. In the 2010 Global Burden of Disease Study, Murray *et al.* (135) compared the disability-adjusted life years (DALYs) of disease and injury burden in 1990, 2005 and 2010. The DALYs of communicable diseases decreased from 47% in 1990 to 35% in 2010, whereas the DALYs of chronic conditions increased from 43% in 1990 to 54% in 2010 (135). This finding suggests an apparent shift in the global disease burden from communicable diseases to chronic diseases. In response to chronic diseases, patients need ongoing self-management to improve health outcomes (136). However, given the complexity of chronic illness (e.g. asymptomatic onset, ongoing management) and the nature of patients (e.g. the elderly, minors) (103), there is a high risk of poor self-management of chronic conditions among people with low health literacy.

Low health literacy is related to poor self-management. That is, patients with low health literacy and chronic diseases such as diabetes, hypertension, or asthma are likely to have less knowledge of their diseases and poorer self-management behaviours (137, 138). In a national survey by Heijmans *et al.* (139) in the Netherlands, communicative and critical health literacy were found to play more important roles in self-management of chronic diseases than functional health literacy, but the impact differed by various self-management contexts (e.g. coping with consequences, having an active role). Similarly, Gallant (140) also found that certain components of health literacy (i.e. communicative health literacy and numeracy) were more relevant for self-management than others (e.g. functional health literacy). The effects of health literacy on self-management behaviours varied among different types of illnesses and ethnic groups.

Therefore, enhancing certain types of health literacy could be an effective strategy in improving certain self-management behaviours.

2.2.2.2 Distal health and social outcomes

Distal health and social outcomes represent those long-term consequences or results at the end-stage of interventions (3). People with low health literacy are more likely to have high healthcare costs, have poor health status, experience poor health-related quality of life, and to have a high likelihood of morbidity and mortality.

2.2.2.2.1 High healthcare costs

Individuals with low health literacy are likely to have higher healthcare expenditure than their counterparts, due to poor comprehension of medical messages, low adherence to prescribed medication regimes, frequent use of emergency care services, and long hospital stays. In an empirical study by Howard *et al.* (141), 3260 participants who were Medicare-managed care enrollees were recruited to examine the impact of low health literacy on medical costs. Their results showed that emergency care costs were significantly higher among people with low health literacy than those with high health literacy (emergency care costs=$108; 98% CI: $62 to $154). Based on the 2003 National Assessment of Adult Literacy (NAAL) survey and the Medical Expenditure Panel Survey (MEPS) in the USA, Vernon *et al.* (142) used Friedland's modelling assumptions to estimate the annual cost resulting from low health literacy. Results showed that the expected annual cost ranged from $106 billion to $238 billion, accounting for 7% to 17% of all personal health care costs. Due to this huge financial burden, many countries have taken actions to address low health literacy at both policy and practice levels. For example, by integrating health literacy into their health policies (13-15) or by adopting health literacy as a national health indicator (143). Nowadays, improving health literacy is becoming a key strategy to reduce the future economic burden and to increase the quality of healthcare.

2.2.2.2.2 Poor health status

Despite the evidence showing the relationship between health literacy and health status, the causal pathway is still unclear. To further explore the causal mechanism, several empirical studies have been conducted using the path analysis approach (41, 144-146).

Some authors found that health literacy was directly related to health status (144, 145). Health literacy was found to be a mediator between educational levels and health status. Mediators are variables that explain why specific outcomes or effects occur (94). For example, Cho *et al.* (145) found that health literacy was a mediator between educational attainment and health status. Educational attainment had an indirect impact on health status, mediated via increased health literacy. Similarly, Heide *et al.* (144) confirmed that health literacy was a mediator between education and self-reported health (i.e. general health, physical health and mental health). Conversely, there are some authors arguing that the causal pathway linking health literacy to health status is more complex (41, 146). That is, the relationship between health literacy and health status is not direct. Instead, the relationship is mediated by other variables such as health behaviours, knowledge and self-efficacy. For example, in 2011, Osborn *et al.* (41) examined the mechanisms linking health literacy to physical behaviours and health status among 330 patients with hypertension. Their findings showed that there were significant paths from health literacy to knowledge, knowledge to self-efficacy, self-efficacy to physical activity, and physical activity to health status. Similarly, in another study by Sun *et al.* (146), health behaviour was also found to partially mediate the relationship between low health literacy and poor health status. In summary, given the above evidence about the impact of health literacy on health status, health literacy can be either a direct factor or an indirect determinant of health status, influenced by a chain of mediating factors.

2.2.2.2.3 ***Poor health-related quality of life***

Health-related quality of life (HRQOL) is viewed as an important, patient-centred outcome in healthcare settings, as well as a comprehensive health indicator in population health studies (147). As proposed by Nutbeam (3) in the health promotion model, HRQOL is a distal outcome that represents people's subjective assessment of their health and wellbeing and ability to perform physical, psychological and social functions (148). There have been several studies examining the relationship between health literacy and health-related quality of life in the last decade (148-153). Findings from these studies suggested that higher health literacy scores were associated with higher scores on health-related quality of life. However, current evidence is mainly from cross-sectional studies among the elderly (154), members of ethnic minorities (149), cancer patients (150) and people with chronic diseases (151, 152). Longitudinal studies and studies among other populations such as children and adolescents are needed in future to further confirm the causal relationship between health literacy and HRQOL.

2.2.2.2.4 High odds of morbidity and mortality

In practice, morbidity and mortality are commonly-used indicators in epidemiology of a population's general health and burden of disease (155). Due to poor self-management of chronic diseases and ineffective health service utilisation, people with low health literacy are likely to be at high risk of morbidity and mortality. Using a longitudinal research design approach, Bostock and Steptoe (156) examined the association between low health literacy and mortality in 7857 older adults. After controlling for socio-demographics and cognitive ability, the authors found that the hazard ratio for all-cause mortality for participants with low health literacy was 1.26 (95% CI=1.02 to 1.55) compared to those with high health literacy. Similarly, in other cohort studies among patients with heart failure (157-159), low health literacy was found to be independently associated with higher morbidity and mortality rates. All this evidence suggests that low health literacy is an independent risk factor for morbidity and mortality outcomes. Improving populations' health literacy would be a useful public health strategy for reducing morbidity and mortality rates.

2.2.3 Summary

In summary, low health literacy is a significant public health problem in both HICs and LMICs. People with low health literacy are likely to have adverse health outcomes, including poor health behaviours and lifestyles, ineffective use of health services, poor self-management of chronic diseases, high healthcare costs, poor health status, poor health-related quality of life, and high morbidity and mortality rates. Although the relationship between health literacy and health outcomes has been well-documented in the literature, most empirical evidence was based on the adult population rather than adolescents. The next section will move on to health literacy in adolescents and explain why health literacy should be highlighted for adolescents.

Box 2.2: Key messages about health literacy significance

- Low health literacy is a common and serious public health problem around the world, with the percentages ranging from 28.7% in the Netherlands to 93.52% in mainland China.
- Low health literacy has an adverse impact on intermediate health outcomes such as poor health behaviours and lifestyles, ineffective health service utilisation and poor self-management of chronic diseases.
- Low health literacy also brings about negative distal health and social outcomes such as high healthcare costs, poor health status, poor health-related quality of life and high odds of morbidity and mortality.

2.3 Why should we study health literacy in adolescents?

Although health literacy is a broad and multidimensional concept (5, 63), there is an agreement that health literacy should be researched with a specific group and in a specific context (45, 100, 107). In other words, health literacy must be clearly defined for a population (e.g. adolescents, the elderly, diabetic patients) in a specific context (e.g. schools, clinics, communities). The increasing importance of health literacy to public health has generated a number of studies about health literacy in different populations and contexts (12, 46, 74, 104, 160). While adolescent health literacy has gained momentum in the last two decades (16, 33, 46), it is still under-researched (16) in comparison with adult health literacy. In this section, the distinction between adolescent health literacy and adult health literacy is explained, and two reasons are given for the importance of health literacy to adolescent health.

2.3.1 What is the difference between adolescent health literacy and adult health literacy?

When conducting health literacy research in adolescents, researchers need to consider their characteristics. Unlike adult health literacy, childhood/adolescent health literacy is a continuum over time, following a trajectory from no health literacy to adult (relatively stable) health literacy (161). Here I used Forrest's '*4D*' model to elaborate the unique characteristics of adolescent health literacy (162, 163) (See **Figure 2.2**). This model was chosen because it is a useful guide in distinguishing adolescent health research from adult health research. Given that the age range of '*children*' (i.e. under the age of 18 years) and '*adolescents*' (i.e. 10 to 19 years) are overlapping (2), I will use the term '*adolescents*' consistently to explain each component of the '*4D*' model.

1. Developmental change	***2. Dependency***
3. Differential epidemiology	***4. Demographic patterns***

Figure 2.2: Forrest's 4D model for health literacy research in adolescents

First, adolescents' developmental ability should be considered. Adolescents are experiencing physical, emotional and cognitive changes during this transitional life stage (16). Compared with adults, they are less capable of processing health information and using reasoning skills by themselves (164). However, this does not mean that adolescents cannot develop their own health literacy skills and become health literate. According to the Piagetian theory of cognitive development (165), children and adolescents experience four critical stages of cognitive development before entering adulthood: sensory motor stage (0 to 2 years), preoperational stage (2 to 7 years), concrete operational stage (7 to 11 years) and formal operational stage (11 to 16 years). Adolescents aged 10 to 19 are typically in the formal operational stage where they can think abstractly and logically by themselves (166). For example, when adolescents face a decision in everyday life (e.g. doing homework or watching a movie), they can think of possible outcomes and subsequent impacts. Therefore, adolescents can use the same '*thinking style*' to understand the '*health-related world*' and make decisions about health. As exemplified by Borzekowski (166), a 9-year-old may not be able to explain why a child has a fever, but he or she would be able to know that such a child needs to stay in bed and rest. Therefore, it is possible and realistic to develop health literacy in adolescents at an early age (167), but such development must be built on the cognitive ability of adolescents because they cannot use information to inform decision-making if they fail to understand that information. In other words, the readability of health materials and instructions should be designed to match adolescents' cognitive development. Currently, most health information for adolescents is written at a level above tenth-grade (117), which is highly demanding. Therefore, it is imperative to design health literacy programs and materials that are aligned with adolescents' cognitive development. In summary, the first major difference between adolescent health literacy and adult health literacy is the level of cognitive ability. When researching adolescent health literacy, researchers should pay attention to the readability of health literacy materials.

The second consideration is that adolescents depend more on their parents, friends and peers than adults do. In other words, adolescents need more social support from families, schools and communities when making a health-related decision (168). For example, family support has been found to be associated with adolescent health literacy. An empirical study by Driessnack *et al.* (169) found a significant relationship between the number of children's books at home and children's health literacy levels. Children who reported having fewer children's books at home were more likely to have low health literacy. Similarly, Chisolm *et al.* (170) found that adolescent health literacy was closely related to parental health literacy and parental education. Although the above two studies did not measure family support, the evidence suggested family environment was an important contributor to the development of health literacy in adolescents. As recommended by Borzekowski (166), conducting health literacy research in younger populations should consider how adolescents perform health-related tasks when helped by parents and peers; that is, adolescent health literacy should be measured in the context of a supportive interaction with families and friends.

Another consideration is that adolescents are experiencing a unique pattern of health, illness and disability, which is different from that of adults. First, the timing of disease occurrence is an important factor that may affect their health literacy (162). For example, an early onset of a mental illness can have a powerful impact on the developing brain, affecting cognitive development (171). As the formulation of health literacy skills depends largely on personal cognitive abilities (166, 172), early disease occurrence is likely to have more impact on the development of health literacy skills than later occurrence. Therefore, it should be considered the timing of disease occurrence and the impact of disease development when conducting health literacy research in different age groups of adolescents with special needs. Second, the requirement for health literacy among adolescents living with chronic disease is higher than that of adults living with chronic disease. Adults mostly rely on their own health literacy to manage health, whereas adolescents rely on their own health literacy and parental health literacy to manage health (170, 173, 174). Therefore, it should also be considered both parental health literacy and adolescent health literacy when targeting adolescents with chronic conditions.

Finally, adolescents' demographic patterns should be considered, especially for those living in poverty. According to a recent analysis based on data from 89 countries (175), there are almost 385 million children and adolescents under the age of 18 living in extreme poverty. Also, the analysis shows that children and adolescents (19.5%) are more than twice as likely as adults (9.2%) to live in extreme poverty. The literature has demonstrated that adolescent health literacy is affected by a set of demographic factors including race/ethnicity and socio-economic status (36, 52, 176, 177). That is, adolescents are more likely to have low health literacy if they come from ethnic minorities or immigrant backgrounds, or from low socio-economic families. Therefore, health literacy research should be inclusive of both mainstream adolescents and those with disadvantaged backgrounds.

2.3.2 The high prevalence of low health literacy among adolescents

Low health literacy is a public health concern for whole populations. As discussed in Chapter 2.2.1, there was a high percentage of low health literacy across many countries (28.7% to 93.5%). Although there have been no national health literacy surveys designed particularly for adolescents, previous national health literacy surveys revealed low health literacy rates in adolescents by using the data in the 15 to 19 and 19 to 24 age groups. Based on the available national health literacy statistics (23-25, 88, 116, 178), the prevalence of low health literacy in adolescents ranged from 34% in the USA to 93.7% in China (See **Table 2.3**). In a systematic review by Sanders *et al.* in 2009 (117), at least one in three adolescents and young adults in the United States showed low health literacy. In 2016, Sansom-Daly *et al.* (179) conducted an updated review of the prevalence of health literacy in adolescents and young adults in an international context. Their results showed that low health literacy was reported in less than 40% of participants aged 10 to 39 years. All this evidence suggests that adolescents in the 21st century have the same problem of low health literacy as adults, or even worse than adults.

Table 2.3: The prevalence of low health literacy among adolescents and youths across countries

Country	Health literacy survey (Year)	Participant age	Prevalence of low health literacy*	
			Total population	Adolescent/ youth
America (178)	NALS (1992)	16+	47 % to 51% of the respondents performed in Level 1 [a] and Level 2 [b].	13% had Level 1 in prose domain in the 16 to 24 age group, whereas 21% had Level 1 in prose domain in the total population.
America (24)	NAAL (2003)	16+	36% had basic and below basic health literacy (Level 1 and Level 2).	34% had basic and below basic health literacy (Level 1 and Level 2) in adolescents aged 16 to 18.
Canada (88)	IALSS (2003)	16-65	55% scored below Level 3[c].	Approximately 50% scored below Level 3 in the 16 to 25 age group.
Australia (23)	ALLSS (2006)	15-74	59.5% scored below Level 3.	67.6% scored below Level 3 in the 15 to 19 age group.
New Zealand (116)	ALLSS (2006)	16-65	56.2% had poor health literacy skills.	The age group of 16 to 18 and 19 to 24 had the poorest health literacy, compared to the rest of the overall population.
China (25)	CRHLS (2008)	15-69	93.52% had low health literacy.	93.7% had low health literacy in the 15 to 24 age group.

Note: ALLSS, The Adult Literacy and Life Skills Survey; CRHLS, The Chinese Resident Health Literacy Scale; IALSS, The International Adult Literacy and Skills Survey; NAAL, The National Assessment of Adult Literacy; NALS, The National Adult Literacy Survey. *a* Level 1 indicates no more than the most simple and concrete literacy skills; *b* Level 2 indicates skills necessary to perform simple and everyday literacy activities; *c* Level 3 indicates skills necessary to perform moderately challenging literacy activities (24). * Level 3 is considered to be the minimum level of proficiency required to meet the demands of everyday life (88).

2.3.3 How is health literacy linked with adolescent health?

Compared with other life stages (e.g. infancy, late adulthood), adolescence is commonly viewed as a healthy time (20). However, adolescents are facing significant health challenges in the 21st century. These challenges include: 1) the shift in disease burden from traditional communicable diseases to non-communicable diseases and conditions (180); 2) the high prevalence of health-compromising behaviours (181, 182) which undermine the present and future health of adolescents; and 3) challenges that adolescents face when using the Internet to access online health information (183-185). As outlined in Chapter 2.2, health literacy is regarded as a '*personal asset*' to protect individual and community health (5). Also, health literacy acts as a precursor to the overall health of a population (8). The next section will explain how health literacy is linked to adolescent health, especially how health literacy might have the potential to address current health challenges among adolescents.

2.3.3.1 Challenge one: The shift in disease burden among adolescents

Disease burden, defined as the impact of a health problem on a given population, can be measured using a variety of indicators such as mortality and the disability-adjusted life years (DALYs) (186). According to the 2014 WHO report '*Health for the world's adolescents*', there were 1.3 billion adolescent deaths in 2012 (180). The top five causes of mortality among adolescents were road injury, HIV, suicide, lower respiratory infections and interpersonal violence. Given that the mortality data do not show the conditions and behaviours that can lead to premature death and future disability (186), the DALYs measure was introduced in the 2014 WHO report as an indicator that considered both death and morbidity. From this perspective, the top five causes of the DALYs lost among adolescents were depression, road injuries, iron-deficiency anaemia, HIV, internal self-harm, back and neck pain (180). More recently, a Lancet commission on adolescent health issued another report on the global disease burden among adolescents and young people aged 10 to 24 (21). Based on available data from 188 countries, the Lancet commission found that the adolescent burden of disease covered three main categories: 1) non-communicable diseases such as physical disorders and mental disorders; 2) injuries such as unintentional injuries and violence; and 3) diseases of poverty such as under-nutrition and infectious diseases. It is apparent that the current disease burden for adolescents is mainly attributed to chronic health conditions, especially injuries and mental disorders.

As defined by Van Cleave *et al.* (187), chronic health conditions in a child or adolescent refer to '*any physical, emotional, or mental condition that prevented him or her from attending school regularly, doing regular school work, or doing usual childhood activities or that required frequent attention or treatment from a doctor or other health professional, regular use of any medication, or use of special equipment*'. Over the past fifty years, chronic illnesses among children and adolescents have steadily risen, especially the chronic conditions of asthma, obesity and mental disorders (188, 189). For example, in the USA, the 1988-2006 Youth-Child Cohort studies (187) revealed that the prevalence of asthma was higher at the end of the study periods compared with that of the baseline (baseline=2.0% vs. end-study=3.6%; $p<0.001$). In 2015, Akinbami *et al.* (190) examined the prevalence of asthma for children aged 0 to 17 using 2001-2013 National Health Interview Survey data and found that childhood asthma prevalence increased from 2001 (8.7%) to 2009 (9.7%), followed by a plateau then a decline in 2013 (8.3%). In China, Song *et al.* (191) used data from five cross-sectional surveys (1985, 1995, 2000, 2005, 2010) of Chinese National Survey on Students' Constitution and Health to examine the trend of obesity prevalence in Chinese children aged 7 to 18. Results showed the standardised prevalence of obesity in Chinese children increased rapidly from 0.1% in 1985 to 5.0% in 2010. Similarly, Australian young people are also facing the significant challenge of chronic conditions. According to the 2014 Report on Australia's Health (192), the most common chronic conditions reported among young people in 2011-2012 were hay fever and allergic rhinitis (18.8%), short-sightedness (18.7%), psychological distress (12.0%) and asthma (11.0%). Chronic illnesses and conditions will always bring about significant stress for children and adolescents which may in turn influence their adherence to medication and eventually affect their health (188). Adolescents with chronic conditions have more opportunities to interact with the healthcare system, such as in communicating with a health professional and engaging in self-management, than their counterparts (16). In these chronic cases, adolescents need to develop their health literacy skills: perform basic reading and numerical tasks, describe symptoms, and communicate with their health providers effectively in the healthcare environment (193). Several empirical studies have demonstrated that adolescents with training in health literacy can improve asthma-related outcomes (e.g. fewer hospitalisations and emergency department visits) (27) and become independent in managing their healthcare (194). Therefore, improving health literacy at an early age is worthy of investment; it will reduce the disease burden resulting from chronic illnesses.

2.3.3.2 Challenge two: The high prevalence of health-compromising behaviours among adolescents

In addition to the change in the pattern of disease burden, adolescents also engage in health behaviours that compromise their health. In the short term, health-compromising behaviours contribute to the leading causes of mortality and morbidity among adolescents. In the 2005-2006 Health Behaviour in School-aged Children (HBSC) survey across 41 countries, Haug *et al.* (181) found that there was a strong negative relationship between overweight and eating patterns and physical activity. In most countries, fewer than 50% of young people reported eating fruit or vegetables daily, and only a third of young people met the guideline of 60 minutes of moderate to vigorous physical activity on five or more days per week (181). In the long term, health-compromising behaviours in adolescence can lead to non-communicable diseases in adulthood, such as cardiovascular diseases and type 2 diabetes mellitus (180). In a longitudinal birth cohort study, Hancox *et al.* (182) explored the associations between childhood and adolescence television viewing and adulthood health conditions including overweight, cardio-respiratory fitness, smoking and raised cholesterol. Their results showed that average week night viewing between the ages of 5 and 15 was associated with higher body mass indices, lower cardio-respiratory fitness, increased cigarette smoking and raised serum cholesterol in adulthood (182). The high prevalence and the adverse impact of health-compromising behaviours clearly pose another significant challenge to adolescent health at present and into future.

Adolescence is a crucial life stage during which long-term health habits and lifestyles develop (195, 196). Therefore, early intervention and prevention are crucial to the change of health-compromising behaviours (16). In the health promotion outcome model proposed by Nutbeam (3), health behaviours and lifestyles were regarded as modifiable by well-designed interventions and programs. In response to health-compromising behaviours among adolescents, many school health programs have been conducted, for example, the Health Promoting Schools (HPS) programs (195, 197-199), the Comprehensive School Health (CSH) programs (200, 201) and the Coordinated School Health Programs (CSHP) (202-204). In the 21st century, as Kolbe (101) argued, school health programs should be designed to achieve four different goals for achieving the optimal health and wellbeing of children and adolescents. These four goals include improving health literacy (e.g. health knowledge, attitudes and skills), improving health behaviours and health outcomes (e.g. increasing physical activity), improving educational achievement (e.g. improving scores on standardised tests), and improving social outcomes (e.g. improving the quality of life). Among these goals, improving health knowledge and attitudes (health literacy) is deemed to be the first step to improve adolescents' health behaviours and other health outcomes. The underlying rationale is supported by health behavioural change models such as the knowledge-attitude-behaviour (KAB) model and the health belief model (205), both of which highlight the role of health knowledge and attitudes in predicting health behaviours. Equipping adolescents with adequate health literacy could be an effective strategy for reducing the high prevalence of health-compromising behaviours and increasing the prevalence of health-promoting behaviours (17). As demonstrated in a pilot study by Diamond *et al.* in 2011 (26), a youth health literacy curriculum was provided to primary and secondary school students from low socio-economic backgrounds in New York and Los Angeles. It focused on improving participants' skills in goal-setting, decision-making, and in functional literacy and numeracy. They found that low-family-income students (n=60) increased their health knowledge and improved their healthy behaviours after participating in that curriculum. Although the sample size was small and the generalisability of the conclusions were limited, the evidence suggested that it was feasible to improve health behaviours through enhancing adolescent health literacy at school.

2.3.3.3 Challenge three: Using the Internet to access online health information

Finally, adolescents face challenges when using the Internet to access online health information. In the 21st century, adolescents rely on technology in everyday life much more than their adult counterparts (176). In the 2010 Report to the Kaiser Family Foundation in the USA, 70% of young people aged 8 to 18 years had access to the Internet on a typical day (206). In China, according to the 2016 Internet Development Statistics Report (207), there were approximately 710 million Internet users across the country, of which adolescents aged 10 to 19 accounted for 20.1%. Due to the popularity, confidentiality and anonymity of the Internet, it is not surprising that adolescents have treated the Internet as a valuable resource for addressing health concerns (184). The most commonly-searched health topics among adolescents are sexual and reproductive health, well-known chronic diseases like diabetes, body image, substance use, mental disorders and violence (184). Due to the complexity and redundancy of online information, studies have suggested that adolescents cannot derive maximum benefit from this information resource (183-185). For example, in a qualitative study by Gray *et al.* (183), 157 adolescents aged 11 to 19 in the UK and the USA were asked about their challenges when using the Internet for online health information. Adolescents reported that it was difficult for them to choose the most credible website and to evaluate the accuracy of online information. Therefore, despite increased access to the Internet, adolescents cannot use online health information effectively, which in turn affects their health decisions and actions, thus leading to poor health outcomes.

In the world of the online information era, adolescents must be able to access, understand, evaluate and apply online health information to make appropriate health decisions; in other words, they must be health literate (183, 208). Health literacy in an electronic context is also known as eHealth literacy (208). To examine whether improving eHealth literacy skills would affect adolescents' reliance on and trust in commercial and brand websites, Hove *et al.* (209) conducted an eHealth literacy intervention among 182 middle school students in Michigan in the USA. Their results showed that, compared to baseline trust in aerobic exercise online information, the odds ratio of choosing the brand websites as the least reliable source of information was 2.45 (OR=2.45, 95%CI=1.24 to 4.84) after the eHealth literacy intervention. This suggested that interventions targeting adolescent health literacy could contribute to their health decision-making. Therefore, to assist the young generation to obtain maximum benefit from using the Internet, improving health literacy could be an effective strategy.

2.3.4 Summary

In summary, there is a close but inter-dependent relationship between health literacy and adolescent health. Health literacy in adolescents is unique because of their developmental limitations, dependency on parents and peers, differential epidemiological characteristics, and demographic patterns. Low health literacy in adolescents is equally as important as that in adults. This uncovers an underlying concern for the population's health in the future. Health literacy can contribute to addressing three main challenges encountered during adolescence by reducing the disease burden of chronic health conditions, improving healthy behaviours, and overcoming challenges that result from accessing accurate online health information. There is a need to develop and improve health literacy at an early age. With an increasing interest in adolescent health literacy, conceptual frameworks and measurement tools of health literacy in adolescents have proliferated over the last decade. In the next section, an overview of conceptual frameworks, measurement tools and practical interventions related to adolescent health literacy is presented.

Box 2.3: Key messages about health literacy and adolescent health

- Childhood/Adolescent health literacy is a continuum over time, following a trajectory from no health literacy to adult health literacy (relatively stable).
- When conducting health literacy research in adolescents, researchers need to consider their developmental limitations, dependency on parents and peers, differential epidemiological characteristics, and demographic patterns.
- Low health literacy in adolescents is similar to that of adults according to previous national health literacy surveys.
- Health literacy, a '*personal asset*' that protects an individual's health, has great potential to address health challenges encountered by adolescents including the increasing burden of chronic diseases, the high prevalence of health-compromising behaviours, and challenges that result from accessing accurate online health information.

2.4 What models and frameworks exist to describe adolescent health literacy?

In the field of health literacy, conceptual models or frameworks allow researchers to understand the construct of health literacy and how health literacy relates to other variables such as socio-economic status and self-efficacy (35). Also, using a conceptual model or framework enhances the rigour, clarity and transparency of a study (28). Currently, there exist more than 12 health literacy conceptual models or frameworks for different populations and contexts (74, 94). Some of the models focus on an explanation of the health literacy construct (3, 83, 210, 211), while others highlight the causal relationship between health literacy and health outcomes (74, 85, 94, 212). As this PhD research focuses on adolescent health literacy, this section presents an overview of conceptual models that are particularly proposed for understanding adolescent health literacy.

2.4.1 The skills-based pyramid model

The skills-based pyramid model was proposed based on the 1995 and 2007 US Joint Committee on National Health Education Standards (78, 213, 214). This model suggests that classroom-based health education is critical for developing health literacy in school-aged children and adolescents (42). Health literacy in this model is defined as '*the capacity of an individual to obtain, interpret and understand basic health information and services and the competence to use such information and services in ways which are health-enhancing*' (78). Specifically, health literacy consists of eight components including health concepts and seven health skills such as accessing valid health information, decision-making, goal-setting, and advocating for personal, family and community health (See **Figure 2.3**) (42). With a priority on nine health education content areas (alcohol and other drug use prevention, injury prevention, nutrition, physical activity, family life and sexuality, smoking prevention, mental health, personal and consumer health, and community and environmental health), students are expected to become health literate as they study and grow in elementary, middle and high schools (215).

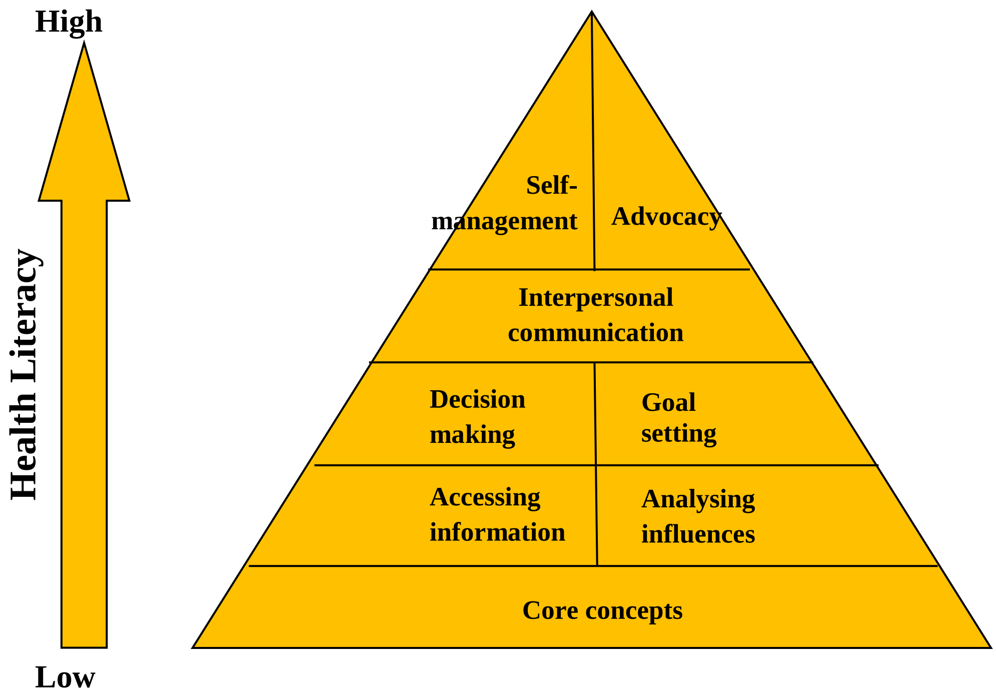

Figure 2.3: The skills-based pyramid model for understanding students' health literacy (214)

The rationale underlying the skills-based pyramid model is aligned with Anderson and Krathwohl's hierarchical learning model (216), which explains that students' learning competencies have six components in a hierarchical order: remembering, understanding, applying, analysing, evaluating and creating. These learning competencies are similar with the eight components within the skills-based pyramid model. Therefore, the skills-based pyramid model can be used as a guiding framework to develop childhood and adolescent health literacy according to their cognitive development and learning process.

Based on the skills-based pyramid model, the Council of Chief State School Officers (CCSSO) in the USA developed a State Collaborative on Assessment of Student Standards Health Education Assessment Project (SCASS-HEAP) to evaluate and promote students' health literacy skills (215). The SCASS-HEAP provides teachers with tools to guide health education instruction for health literacy development. For example, Brey *et al.* (217, 218) demonstrated with two case studies about how to foster students' health literacy in classroom lessons with specific materials and resources. Also, the SCASS-HEAP provides teachers with assessment items for evaluating students' health literacy. For instance, in a cross-sectional study by Tompkins *et al.* (219) in 2005, a 40-item SCASS-HEAP assessment instrument was employed to evaluate students' health literacy in primary and secondary schools. Results showed that students' health literacy decreased as grade level increased. Similarly, in another intervention study by Hubbard and Rainey (220) in 2007, the SCASS-HEAP database items were used to evaluate whether students' health literacy improved after the textbook-based health literacy intervention. Their findings showed that students in the intervention group demonstrated significant improvement in health literacy compared to those in the control group.

The skills-based pyramid model provides school staff with a clear guide for what students should know and do in order to improve their health. Over the past three decades, the skills-based health education approach has made substantial progress in influencing students' health literacy (79). However, this model places more emphasis on the health literacy construct, neglecting health literacy influencing factors and their relationships to health outcomes. Without considering these influencing factors and potential consequences, it is hard to determine the most appropriate and effective way to develop adolescent health literacy at school.

2.4.2 The health promoting schools (HPS) model

In 1986, the term '*Health Promoting Schools (HPS)*' was derived from the Ottawa Charter for Health Promotion (221). A health promoting school is one that constantly strengthens its capacity as a healthy setting for living, learning and working (222). The HPS program has different names in different regions. For example, it is commonly-used in European countries (223), but it is called the '*Comprehensive School Health (CSH)*' program in Canada (224), the '*Coordinated School Health Program (CSHP)*' in the USA (225), and the '*Healthy School*' program in Hong Kong (226). In this thesis, the initials '*HPS*' are consistently used in relation to this model to reduce confusion. Since 1998, the HPS model has been shown to be a useful approach in different school health programs around the world (199, 227-230). The HPS model goes beyond school settings into the broader community, applying a holistic approach to providing a supportive environment for developing students' health literacy (42). Similar to that in the skills-based pyramid model (42), health literacy in the HPS model also consists of eight components. The difference between the skills-based pyramid model and the HPS model is that the HPS model explains how to improve students' health literacy from eight directions (health education, physical education, nutrition services, faculty/staff wellness and health promotion, counselling and psychological services, health services, healthy school environment, family and community involvement) (See **Figure 2.4**).

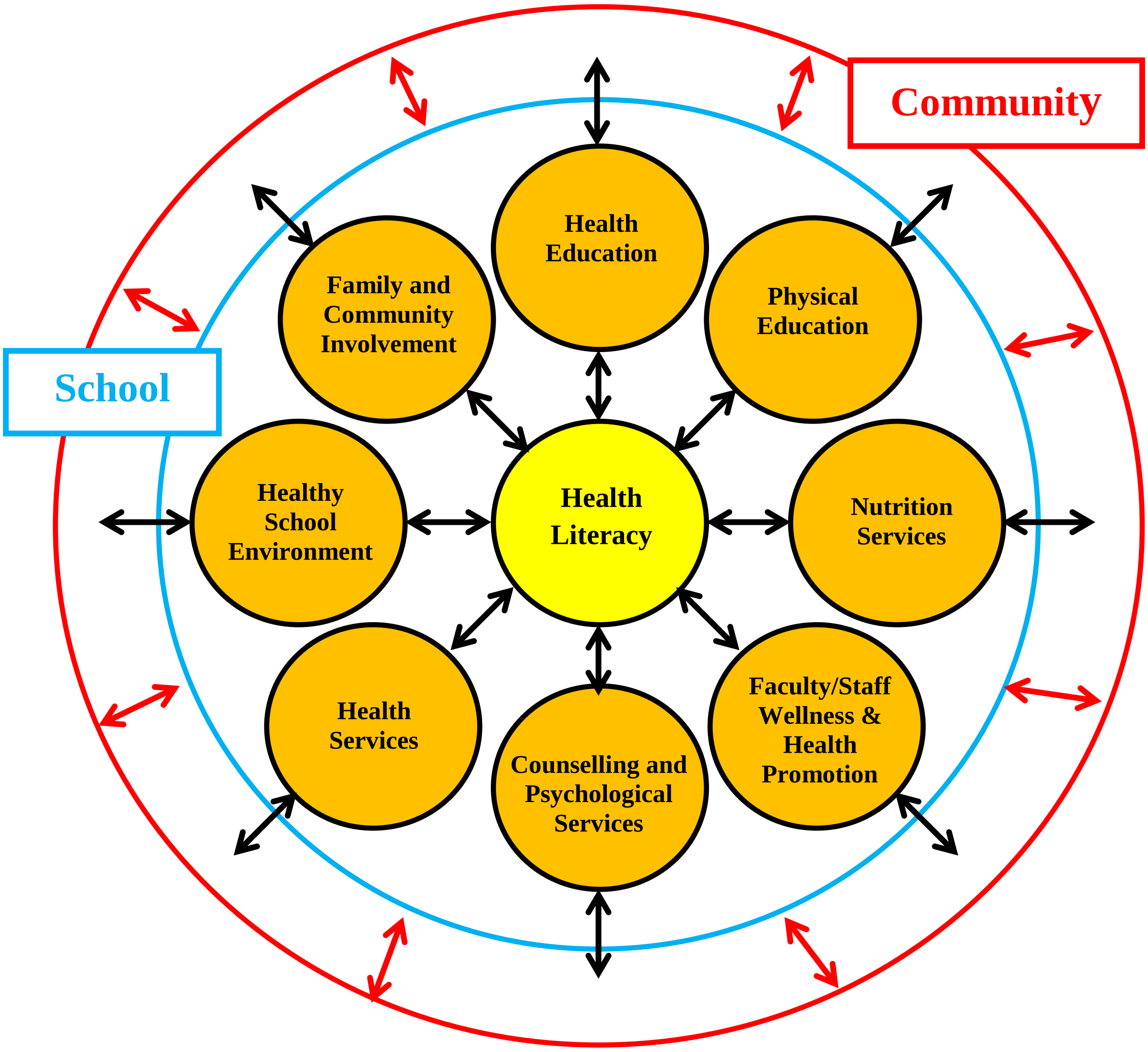

Figure 2.4: The Health Promoting Schools model for improving students' health literacy (42)

The HPS model provides an advanced understanding of how to further foster and support health literate individuals and systems (42). As recommended by Nutbeam (3), health literacy is an outcome of school health education that can be measured at three levels: functional health literacy (the corresponding education outcome is communication of information); interactive health literacy (the corresponding education outcome is the development of personal skills); and critical health literacy (the educational outcome is personal and community empowerment). In the last 30 years, there has been reasonable evidence demonstrating that the HPS model is effective in achieving functional health literacy (e.g. transmitting health knowledge to students) and interactive health literacy (e.g. developing students' refusal skills) (195, 199, 231). However, few empirical studies have demonstrated the achievement of critical health literacy (e.g. changing individual and community practices) for school students (79). More evidence is needed in future to show that students' critical health literacy can be enhanced using the HPS model.

The HPS model is a useful guide for improving adolescent health literacy in school settings. Using the HPS model, it is possible to foster health literacy not only in students but also in parents and schools (195, 230, 232). Although the HPS model serves as a comprehensive intervention framework to enhance students' health literacy and other health outcomes, it is challenging to implement and sustain HPS programs in practice due to lack of funding and resources (233). To address the root cause of this issue, Lee *et al.* (234) called for a new paradigm of thinking for HPS, which could be regarded as a new paradigm of schooling aimed at achieving students' health and education outcomes - rather than HPS being viewed as an add-on program. Such a new paradigm of schooling offers a greater opportunity to sustain the HPS program in practice. To make implementation of this paradigm feasible, the effects of HPS programs on students' learning and health outcomes must be documented and disseminated to both health and education sectors.

2.4.3 The causal pathway model

The causal pathway model of adolescent health literacy, proposed by Manganello in 2008, drew heavily on the IOM report '*Health Literacy: A Prescription to End Confusion*' (See **Figure 2.5**) (16). Health literacy in the causal pathway model is typically defined as '*the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions.*' There are three main modules in the causal pathway model: 1) antecedents of health literacy, including intrapersonal, interpersonal and environmental factors that contribute to health literacy; 2) the construct of health literacy, consisting of functional health literacy, interactive health literacy, critical health literacy and media literacy; 3) consequences of health literacy, including health behaviours, health costs and health service use (16).

In the causal pathway model, adolescent health literacy is understood from an ecological perspective. Intrapersonal factors such as cognitive development contribute to the development of health literacy. According to Piagetian theory of cognitive development (165), adolescents aged 11 to 16 are experiencing 'formal operational' stage of cognitive development. That means adolescents can think logically and abstractly. They can start with a general theory about what produces a particular outcome and then they deduce explanations for what has brought about that outcome. Besides, family environment and peer influence also play important roles in promoting health literacy. In an empirical study by Ghaddar *et al.* (176), they found that American high school students were more likely to have high health literacy levels if they not from Hispanic families, and they had checked health information related to a family member's health online. Similarly, Martin (235) found that friends and peers were particularly important when considering sexual health literacy in this modern and connected information era, given that information and support were exchanged between friends and peers in online and offline. Last but not least, the broader environment and systems are direct and indirect influential factors of adolescent health literacy. As highlighted by Peralta *et al.* (19), the school system is a critical place that can develop adolescent health literacy focusing on three areas: enhancing adolescent learning of capabilities, creating health-literate organisations, and improving critical health literacy.

Compared with the skills-based pyramid model and the HPS model, this causal pathway model is more advanced, not only elaborating the construct of health literacy, but also explaining the pathway from antecedents via the construct of health literacy to health-related outcomes. However, little evidence is known about the degree to which the theoretical model matches empirical data. Empirical research based on this model is needed in future to examine how adolescent health literacy interacts with other variables in practice.

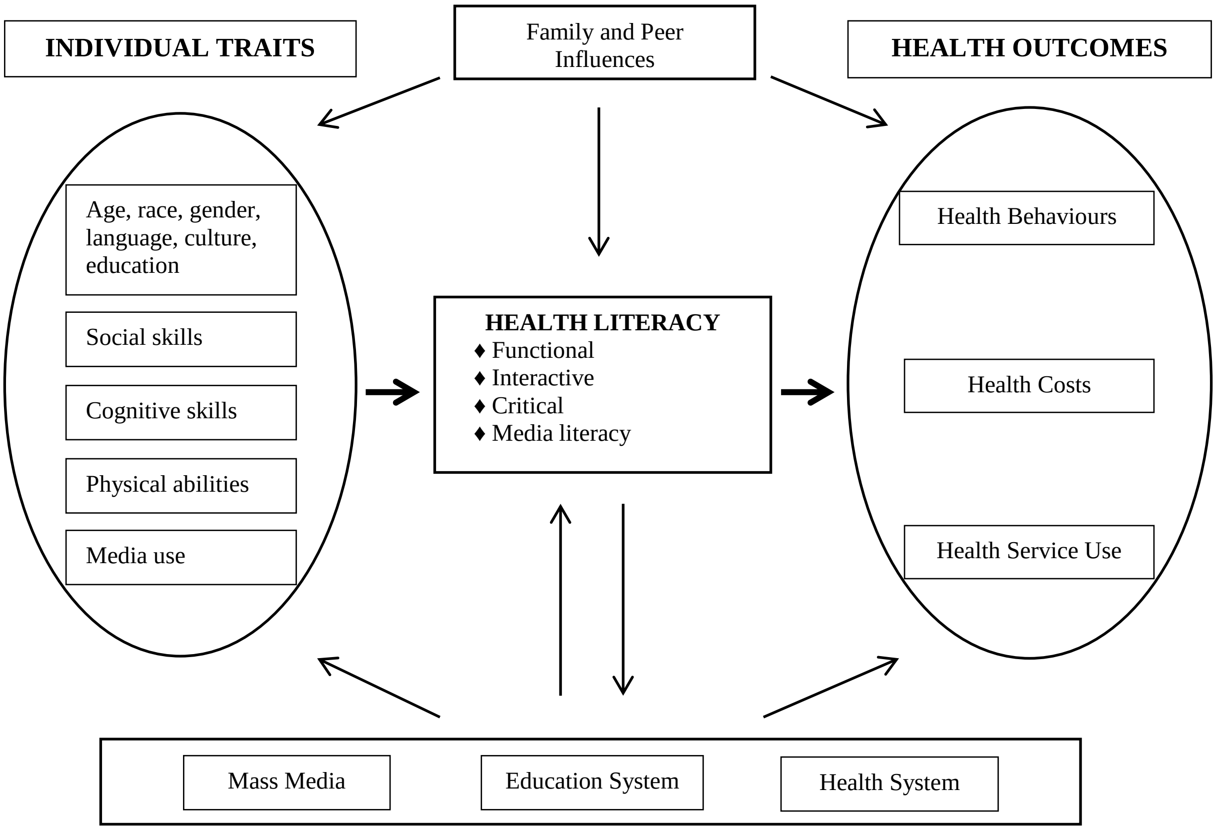

Figure 2.5: The causal pathway model of adolescent health literacy proposed by Manganello (16)

2.4.4 The social ecological model

The social ecological model was put forward by Higgins *et al.* (44) in 2009 (See **Figure 2.6**). Higgins *et al.* (44) tailored the social ecological model for the purpose of exploring and understanding factors that were related to adolescent health literacy. Health literacy in this model refers to '*the ability to make sound health decisions in the context of everyday life. It is a critical empowerment strategy to increase people's control over their health, their ability to seek out information and their ability to take responsibility*' and '*the ability to access, understand, evaluate and communicate information as a way to promote, maintain and improve health in a variety of settings across the life-course*' (44). From a social ecological perspective, there are three levels of influencing factors in health literacy: intrapersonal factors (e.g. age, gender, knowledge); interpersonal factors (e.g. school, family, peers); and environmental and structural factors (e.g. community, culture, media). As explained in the above causal pathway model, these three-level factors contribute to adolescent health literacy via different approaches or pathways.

Using the social ecological model, Higgins *et al.* (44) conducted a qualitative study to understand how a new health education curriculum '*Planning 10 Curriculum*' influenced high school students' health literacy. Results showed that the social ecological model was useful as a theoretical guide in documenting a myriad of factors influencing students' health literacy. Various levels of influencing factors were found such as personal values, school health curriculum, parents, and media. Students themselves reported that '*Planning 10 Curriculum*' helped them make healthy decisions.

In general, the social ecological model assists researchers to understand different levels of influencing factors affecting adolescent health literacy in school settings while providing potential entry points to effectively develop adolescent health literacy. However, this model does not explain how health literacy relates to adolescents' health outcomes such as health behaviours. Compared with the causal pathway model, the social ecological model seems to neglect the role of health literacy in the health of adolescents.

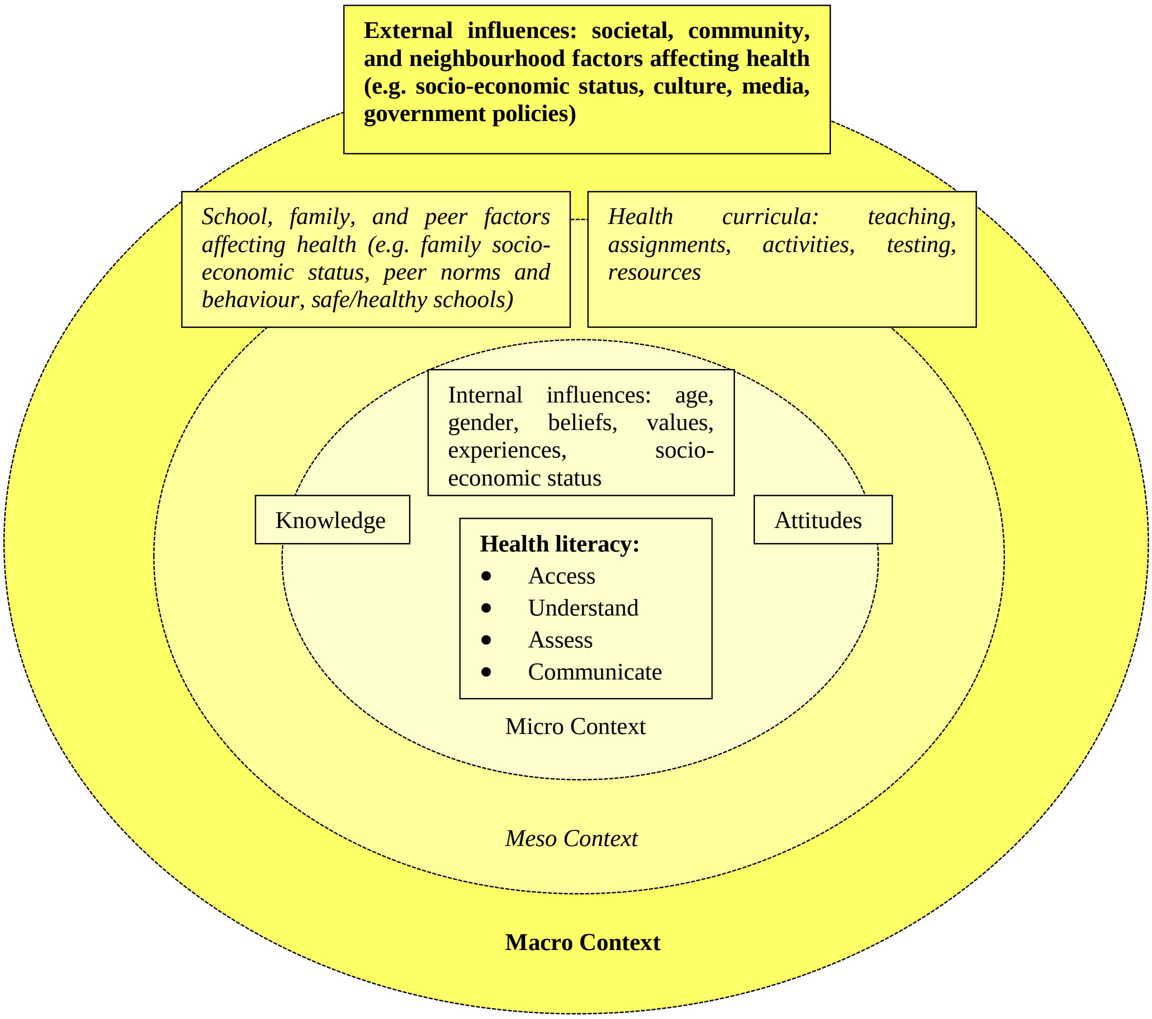

Figure 2.6: Social ecological model applied to health literacy in adolescents (44)

2.4.5 The inclusive hierarchy model

The inclusive hierarchy model is a more recent model proposed by Paakkari *et al.* (43, 46) in 2012. Health literacy in this model is defined as '*a broad range of knowledge and competencies that people seek to encompass, evaluate, construct and use. Through health literacy competencies people become able to understand themselves, others and the world in a way that will enable them to make sound health decisions and to work on and change the factors that constitute their own and others' health chances*' (43). Health literacy, treated as a learning outcome at school, comprises five components (theoretical knowledge, practical knowledge, critical thinking, self-awareness and citizenship) (See **Figure 2.7**). This model identifies two components that are not covered in the previous four adolescent health literacy models: self-awareness and citizenship. Self-awareness refers to one’s ability to reflect on the self as a learner. Citizenship refers to the ability to act in an ethically responsible way and to accept social responsibility. The inclusive hierarchy model highlights these two components because they encourage students to equip themselves with essential skills in preparation for the complex demands of future society (43). Of particular note, the five components partly overlap and are displayed in an inclusive and hierarchical order. Theoretical knowledge is regarded as the foundation which includes principle, theories, and conceptual models of various health phenomena. Given that theoretical knowledge alone is rarely enough to allow people change their health habits, students need to learn practical knowledge (i.e. procedural skills) in order to behave in a health-promoting way. Based on theoretical and practical knowledge, if students want to gain a deeper understanding of health issues and changing conditions that determine health, they need develop a curious and investigative attitude towards the world and critically think about links between health information received and the changing outside world. Compared to the former three components, self-awareness moves towards a higher level of self-reflect ability, which involves the ability to become aware of one’s strengths and weaknesses, the ability to set achievable goals and the ability to self-management. Finally, citizenship focuses on an individual’s rights and responsibility from a social and ethical perspective. In brief, this model highlights that students are encouraged to put theoretical knowledge into practice and to think critically, but also to evaluate their thoughts, feelings and behaviours and become responsible citizens.

As shown in **Figure 2.7**, the inclusive hierarchy model places more emphasis on tackling the health literacy construct through the lens of educational outcomes. As asserted by Paakkari *et al.*(43), ‘*the descriptions of the components … may serve as a tool in planning for the future.*’ In 2016, Paakkari *et al.* (236) developed a subjective measure of students’ health literacy based on this conceptual model, finding that the measure was suitable for school-aged children and adolescents in large-scale studies. The inclusive hierarchy model is thus a useful framework for measuring health literacy in adolescents in school settings.

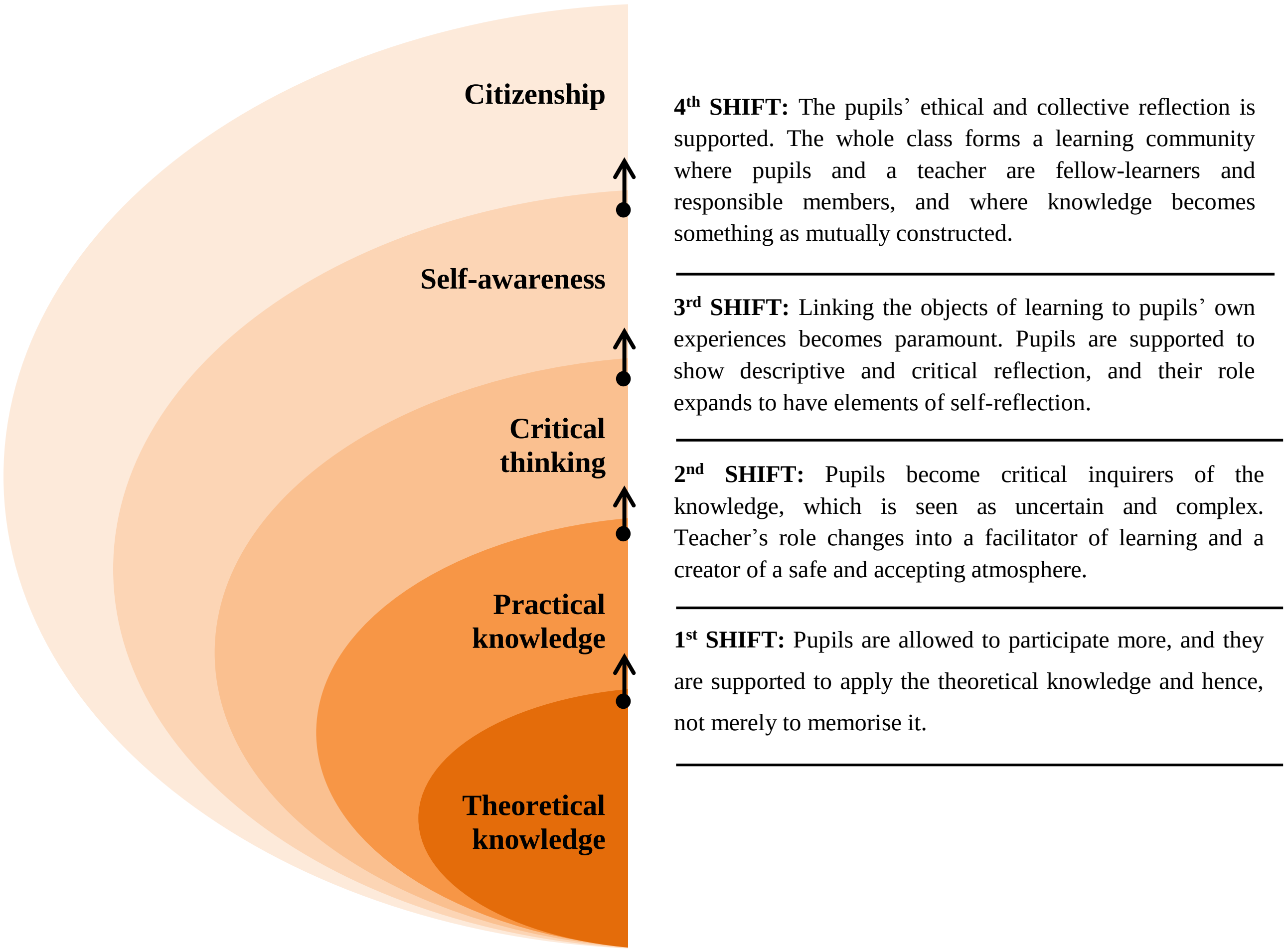

Figure 2.7: The inclusive hierarchy model for learning health literacy in schools (43, 46)

Table 2.4: Summary of conceptual models for adolescent health literacy

	The skills-based pyramid model (214)	The HPS model (42)	The causal pathway model (16)	The social ecological model (44)	The inclusive hierarchy model (43)
Published year	1995; 2007	1998; 2009	2008	2011	2012
Author/Organisation	Joint Committee on NHES	Marx E, Wooley S and Northrop D; CDC	Manganello J	Higgins J	Paakkari L and Paakkari O
Country of origin	USA	USA	USA	Canada	Finland
Target population	Students	Students	Adolescents	Adolescents	Students
Target setting	Elementary, middle and high schools	Elementary, middle and high schools	Not mentioned explicitly	Health education classroom in schools	Basic education or upper secondary schools
Health literacy definition	The capacity of an individual to obtain, interpret and understand basic health information and services and the competence to use such information and services in ways which are health-enhancing	The capacity of an individual to obtain, interpret and understand basic health information and services and the competence to use such information and services in ways which are health-enhancing	The degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions	The ability to make sound health decisions in the context of everyday life. It is a critical empowerment strategy to increase people's control over their health, their ability to seek out information and their ability to take responsibility; the ability to access, understand, evaluate and communicate information as a way to promote, maintain and improve health in a variety of settings across the life-course	Health literacy comprises a broad range of knowledge and competencies that people seek to encompass, evaluate, construct and use. Through health literacy competencies, people become able to understand themselves, others and the world in a way that will enable them to make sound health decisions and to work on and change the factors that constitute their own and others' health chances
Health literacy model					
❖ Antecedents	Not explicitly mentioned	**Eight intervention points:** 1. Health education; 2. Physical education; 3. Nutrition services; 4. Faculty/staff wellness and health promotion; 5. Counselling and psychological services;	**Three-level influences:** 1. Individual traits such as age, race and social skills; 2. Family and peer influences 3. Systemic factors such as mass media and education system	**Three-level influences:** 1. Intrapersonal factors, such as age, gender and knowledge; 2. Interpersonal factors, such as social support from family, school and peers; 3. Community (environment and	Not explicitly mentioned

	The skills-based pyramid model (214)	The HPS model (42)	The causal pathway model (16)	The social ecological model (44)	The inclusive hierarchy model (43)
		6. Health services; 7. Healthy school environment; 8. Community and family involvement		structural) factors, such as health policy, culture and media	
❖ The construct of health literacy	**Eight components:** 1. Comprehending core concepts 2. Accessing valid information 3. Analysing influences 4. Decision-making skill 5. Goal-setting skill 6. Interpersonal communication skill 7. Self-management skill 8. Advocacy skill	**Eight components:** 1. Comprehending core concepts 2. Accessing valid information 3. Analysing influences 4. Decision-making skill 5. Goal-setting skill 6. Interpersonal communication skill 7. Self-management skill 8. Advocacy skill	**Four components:** 1. Functional health literacy 2. Interactive health literacy 3. Critical health literacy 4. Media literacy	**Four components:** 1. Accessing health information 2. Understanding health information 3. Assessing health information 4. Communicating health information	**Five components:** 1. Theoretical knowledge 2. Practical knowledge 3. Critical thinking 4. Self-awareness 5. Citizenship
❖ Health-related outcomes	Not explicitly mentioned	Not explicitly mentioned	**Three primary health outcomes:** 1. Health behaviours 2. Health costs 3. Health service use	Not explicitly mentioned	Not explicitly mentioned
The role of health literacy in the model	Health literacy is an outcome of school health education and promotion.	Health literacy is an outcome of school health education and promotion.	Health literacy is a mediator between antecedents and health outcomes.	Health literacy is a health outcome, which is determined by a myriad of micro, meso and macro factors.	Health literacy is a learning outcome for school students.

Note: CDC, Centres for Disease Control; HPS, Health Promoting Schools; NHES, National Health Education Standards.

2.4.6 Summary

In summary, each conceptual model presents us with a specific understanding of adolescent health literacy for different purposes. A summary of the characteristics of each model is presented in **Table 2.4**. Among the five models, three originated in the United States, one in Canada and one in Finland. Some models (the skills-based pyramid model and the inclusive hierarchy model) provide a more detailed explanation of the health literacy construct, whereas others (the social ecological model, the HPS model and the causal pathway model) provide a better understanding of how to intervene and improve adolescent health literacy using a holistic approach. The role of health literacy in the five models is not the same. Health literacy acts as either a mediator between antecedents and health outcomes, or a school health/learning outcome.

All of the above conceptual models can serve as useful theoretical guides for health literacy measurement and intervention studies. However, there have been few empirical studies based on the above five models so far. Given the importance of conceptual models to empirical research, there is a need for future research to examine and confirm whether empirical data fit these theoretical models. Among the five models, only one illustrates a full understanding of adolescent health literacy from its antecedents through to health outcomes. That is the causal pathway model. Compared with the other four models, this model is more appropriate as a theoretical guide for designing a study that examines the relationships between health literacy, its influencing factors, and health-related outcomes. Further details of the causal pathway model will be presented in Chapter 4: Conceptual Framework and Methodology.

Box 2.4: Key messages about health literacy models for adolescents

- Currently, there have been five conceptual frameworks/models particularly proposed for adolescent health literacy: the skills-based pyramid model, the health promoting schools model, the causal pathway model, the social ecological model and the inclusive hierarchy model.
- Few empirical studies have been found based on these five conceptual frameworks/models of adolescent health literacy.
- Only the causal pathway model illustrates a full pathway from health literacy antecedents to the health literacy construct and health-related outcomes, whereas other conceptual frameworks/models focus on either the health literacy construct or health literacy antecedents.

2.5 How is adolescent health literacy measured in practical settings?

Conceptual models provide a good understanding of the relationship between health literacy and other variables such as socio-economic status, but also explain what components health literacy includes (28, 35). Understanding health literacy components is an initial step for health literacy measurement, which serves as a basic foundation of health literacy research (32, 45). There have been 128 health literacy instruments developed so far for different populations and contexts such as adolescents, the elderly, and people with different types of chronic disease (237). This section explains the importance of health literacy measurement, reviews the methods that are used to measure health literacy, and examines the measurement tools available for adolescents in different cultural settings.

2.5.1 The importance of health literacy measurement

Health literacy measurement is one of the foundations of health literacy research. In the first instance, only from a stable foundation can the importance of health literacy to public health be identified (28, 238), especially for quantitative studies. For example, when researchers examine the association between health literacy and health outcomes of interest (e.g. health behaviours, health status), selecting an accurate health literacy measure is a prerequisite to understanding that relationship without bias. Furthermore, health literacy measurement allows interventions that aim to improve populations' health literacy to be designed, delivered and monitored strategically (10). According to Nutbeam's health promotion outcome model (3), health literacy is regarded as a modifiable contributor to an individual's health - it can be improved through strategic health promotion actions. Therefore, health literacy measurement can provide a solid basis for intervention studies that aim to enhance individuals' health literacy and eventually produce better health outcomes.

2.5.2 Approaches to health literacy measurement

Health literacy is a complex and multi-dimensional concept (5, 63), as reflected by the number of health literacy definitions provided in Chapter 2.1. To some extent, the large number of health literacy definitions leads to a lack of an agreed-upon '*gold standard*' measure (35). As argued by Thomas (107), "*questions on 'how' to measure health literacy are not independent … on 'what' and 'what for' do we want to measure it.*" In other words, health literacy cannot be measured in isolation from its definition and its research purpose. Therefore, health literacy measurement varies according to its research objectives, its study populations and its study contexts. In the following paragraphs, approaches to health literacy measurement in practical settings are summarised according to their measurement elements, administration modes and evaluation methods.

2.5.2.1 Measuring health literacy by different measurement elements

There are two main approaches to measuring health literacy by the number of measurement elements. The first approach is to measure a limited set of health literacy elements. For instance, the Rapid Estimate of Adult Literacy in Medicine (REALM) (76, 239), the Test of Functional Health Literacy in Adults (TOFHLA) (77) and the Newest Vital Sign (NVS) (240). These three tools measure health literacy by focusing on an individual's ability to read, comprehend and calculate numbers. Although they measure only a single dimension or a few dimensions of health literacy, these tools are useful where the research purpose is to measure one or a few elements of health literacy in order to quantify a known issue or identify the relationship between health literacy and outcomes of interest (10). The second approach is to measure a comprehensive range of health literacy elements. In a review of 51 health literacy instruments, Haun *et al.* identified six health literacy tools that measured six or more dimensions of health literacy (32). For example, the Health Literacy Questionnaire (HLQ) (64), and the Health Literacy Survey-European-Questionnaire (HLS-EU-Q) (241). These tools measure health literacy comprehensively. However, their administration time is always burdensome.

2.5.2.2 Measuring health literacy by different administration modes

Based on administration mode, health literacy measurement can be classified into two categories: self-report and performance-based. The self-report approach is used to assess an individual's perceived ability to perform a task, or to evaluate one's confidence and social resources and skills, or to assess one's traditional print and mathematical ability (242). For example, the HLS-EU-Q is a 47-item instrument that asks respondents to self-report difficulties in accessing, understanding, evaluating and using health information in everyday life (241). Self-report measures are easy to administer and more acceptable to respondents than formal testing, especially for those who are ashamed of their limited health literacy (243). However, self-report measures may allow respondents to over-report their health literacy levels. Compared to self-report measures, performance-based measures are objective. They often assess an individual's skills (e.g. word recognition, reading comprehension and calculating numbers) through a single formal test or a series of activities of interest (242). For instance, the Chinese Resident Health Literacy Scale (CRHLS) is an 80-item questionnaire that contains four types of objective questions: true-or-false; only one correct answer to multiple-choice questions; more than one correct answer to multiple-choice questions; and scenario questions that are given following a paragraph of instruction or medical information (244). Performance-based measures provide more objective and more accurate information than self-report measures, but they are always labour intensive, normally taking a longer time to administer.

2.5.2.3 Measuring health literacy by different evaluation methods

Approaches to health literacy measurement can also be divided into two categories: quantitative measurement and qualitative measurement. Currently, most health literacy measurement tools use both qualitative and quantitative methods. The qualitative approach is always the first step to developing a quantitative measure of health literacy. In previous studies (31, 32, 245), researchers often explored the health literacy construct through individual interviews or focus groups. For example, Massey *et al.* (246) developed a multi-dimensional measure of adolescent health literacy in 2013 by conducting 12 focus group discussions with school-aged teenagers and interviewing eight health providers who primarily served young populations. The qualitative approach contributes to an in-depth understanding of the health literacy construct. In addition, qualitative methods allow for the collection of information that is often unobtainable by quantitative surveys (10). As for the quantitative approach, health literacy is often treated as a '*latent construct*' (i.e. one cannot '*see*' health literacy) (28). Quantitative methods aim to quantify the levels of health literacy and provide a total score of health literacy in order to examine relationships between health literacy and other variables of interest. Using this approach, researchers can quickly identify and demonstrate the importance of health literacy to public health.

2.5.3 Health literacy measurement tools in adolescents

In the field of adolescent health literacy, there has been an increasing number of health literacy instruments developed or validated for adolescents in the last decade. Of particular note are two systematic reviews focusing on adolescent health literacy measurement (33, 34). In 2013, Ormshaw *et al.* (33) conducted a systematic review of measures of child and adolescent health literacy. 16 empirical studies were identified as being concerned with childhood or adolescent health literacy measurement. However, only six studies viewed health literacy measurement as their primary research aim, while the remaining studies used measures of health literacy as either a comparison tool when developing other new instruments or as a dependent variable to examine the effect of an intervention program. In the six relevant studies, health literacy instruments used for adolescents were: the KidsHealth KidsPoll of Health Literacy Survey (247), the Chinese short-form Test of Functional Health Literacy in Adolescents (c-sTOFHLAd) (52), a questionnaire that measured mental health literacy (248), a health literacy measure using a set of subscales such as health knowledge and attitudes (249), a vignette-based questionnaire that measured mental health literacy (250) and the Short Test of Functional Health Literacy in Adults (s-TOFHLA) (122). A summary list of these instruments is presented in **Table 2.5**.

In 2014, Perry conducted an integrative review of health literacy instruments used for adolescents (34). In accordance with the inclusion and exclusion criteria, five instruments were identified including the Test of Functional Health Literacy in Adults (TOFHLA) (251), the Rapid Estimate of Adolescent Literacy in Medicine (REALM-Teen) (252), the Chinese short-form Test of Functional Health Literacy in Adults (c-s-TOFHLAd) (50), a health literacy measure using a set of subscales such as health knowledge and attitudes (249), and the Understanding and Evaluating Health Literacy Booklet (177) (See **Table 2.5**). Compared with the review by Ormshaw *et al.* (33), Perry identified another three new health literacy instruments used for adolescents (TOFHLA, REALM-Teen and the Understanding and Evaluating Health Literacy Booklet).

Although the above two reviews provide empirical evidence on health literacy measurement in adolescents, both have limitations. Ormshaw *et al.* (33) did not evaluate the measurement properties of each health literacy instrument. Although Perry (34) summarised the measurement properties of each health literacy instrument, the information provided was limited and mostly descriptive, lacking a critical appraisal of each measurement property (reliability, validity and responsiveness). Another important limitation of both Ormshaw *et al.* (33) and Perry's (34) reviews was that they did not consider the methodological quality of included studies. A lack of quality assessment of studies would raise concerns about the quality of such reviews of health literacy instruments for adolescents. Given that previous reviews have not included a critical assessment of measurement properties and a methodological quality assessment of relevant studies, it is necessary to complement current evidence by examining the methodological quality of their studies as well as examining and comparing the quality of measurement properties for each instrument.

As shown in **Table 2.5**, health literacy measurement for adolescents has gained attention since 2006. Most measurement studies were conducted in Western countries such as the USA, fewer in Asian countries. Only one instrument (c-s-TOFHLAd) was validated in Chinese culture. The c-s-TOFHLAd is a translated tool of the s-TOFHLA from English to Chinese. The s-TOFHLA is often used as a screening tool to identify people with low functional health literacy. Thus it is not comprehensive in capturing the multi-dimensional nature of health literacy (246). Due to the scarcity of health literacy measurement in other cultural settings such as China, more studies are needed to develop or validate health literacy instruments for adolescents from other cultural backgrounds.

Table 2.5: A summary list of health literacy instruments used for adolescents

Study no	Author (Year)	Country	Target population	Sample size	Health literacy instrument	Setting	Measurement properties result
1	Davis *et al.* (2006) (252)	USA	Adolescents aged 10-19 years (mean age=14.8±1.9)	1533	REALM-Teen	Middle schools, high schools, paediatric primary care clinics and summer programs	The Cronbach's alpha was 0.94. Correlation of test and retest after one week was 0.98. Convergent validity was measured between REALM-Teen and the WRAT-3 (r=0.83) and SORT-R (r=0.93).
2	Brown *et al.* (2007) (247)	USA	Students aged 9-13 years in Grades 5-8	1178	KidsHealth KidsPoll	Health education centres from seven states in the USA	Not mentioned clearly.
3	Chisolm and Buchanan (2007) (251)	USA	Young people aged 13-17 years (mean age=14.7)	50	TOFHLA	Children's hospital	The reading comprehension component was significantly collated with the WRAT-3 and the REALM (ρ=0.59, p<0.001; ρ=0.60, p<0.001 respectively), however, no correlation were found with the numeracy component (ρ=0.11, p=0.45; ρ=0.18, p=0.22 respectively).
4	Chang (2010) (52)	Taiwan	High school students	1601	c-s-TOFHLAd	Senior/vocational high schools from six counties in Taiwan	The content validity index was 0.82. Cronbach's alpha was 0.88. The one-week stability was moderate (r=0.576, p<0.001). Confirmatory factor analysis was demonstrated as having a good model fit.
5	Leighton (2010) (250)	UK	High school students aged 11-18	208	A vignette-based questionnaire	Six high schools in one town	An initial reliability test in terms of coding the data and subsequent inter-rater reliability test was conducted before data analysis.
6	Olsson *et al.* (2010) (248)	USA	Middle and high school students in Grades 6-12 (median age=14)	281	Brief, hypothetical, gender-matched scenarios questionnaire	Public school	Not mentioned clearly.
7	Sharif *et al.* (2010)	USA	Children aged 6-19 years	107	s-TOFHLA	A community health centre	The s-TOFHLA was reported by a previous study that it had high

Study no	Author (Year)	Country	Target population	Sample size	Health literacy instrument	Setting	Measurement properties result
	(122)						internal consistency (Cronbach's alpha=0.97) and good correlation with the REALM (r=0.80).
8	Schmidt *et al.* (2010) (249)	Germany	Children aged 9-13 years (mean age=10.4)	852	HKACSS	Primary school	The unidimensional Rasch model for health knowledge domain was not rejected. Cronbach's alpha for the communication scale was 0.73 and 0.57 for the attitude scale.
9	Wu *et al.* (2010) (177)	Canada	Students in Grade 8-12	275	HLAB	Secondary schools	The Cronbach's alpha was 0.92. Inter-rater reliability was assessed for six tests, with a 95% concordance rate.
10	Chang *et al.* (2012) (50)	Taiwan	Students in high school (mean age=16.01±1.02)	300	c-sTOFHLAd	High schools	The Cronbach's alpha was 0.85. Correlation of test and retest after one week was 0.95 (p<0.001). Confirmatory factor analysis resulted in a one-factor solution.

Note: c-s-TOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; HKACSS, Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; REALM, Rapid Estimate of Adult Literacy in Medicine; REALM-Teen, Rapid Estimate of Adolescent Literacy in Medicine; s-TOFHLA, the Short-form Test of Functional Health Literacy in Adults; SORT-R, Slosson Oral Reading Test-Revised; TOFHLA, Test of Functional Health Literacy in Adults; WRAT-3, Wide Range Achievement Test-Revised.

2.5.4 Summary

In summary, health literacy measurement builds a stable foundation for the field of health literacy research. Only by using reliable and valid instruments can the association between health literacy and health outcomes be identified. No matter which approach is being used, health literacy measurement depends on study aims, populations and contexts. Currently, there have been an increasing number of health literacy instruments used for adolescents, especially in the USA. Although previous systematic reviews have been published on health literacy measurement in adolescents, they did not include a critical assessment of measurement properties, nor consider a methodological quality assessment of included studies. There is a need to complement this evidence, thus assisting researchers to select the most appropriate instrument for measuring health literacy in adolescents.

Box 2.5: Key messages about health literacy measurement in adolescents

- Health literacy measurement serves as a stable foundation for the field of health literacy research. Measuring health literacy is a prerequisite to understanding the relationship between health literacy and other variables of interest, but also an initial step for health literacy monitoring and interventions.
- Approaches to health literacy measurement vary by different measurement elements, administration modes and evaluation methods.
- Previous systematic reviews of adolescent health literacy measurement did not provide a critical assessment of measurement properties for each health literacy instrument, nor examine included studies' methodological quality.
- Except for the USA, adolescent health literacy measurement studies are lacking in other cultural settings.

2.6 How to improve adolescent health literacy in practical settings?

Conceptual frameworks can provide new insights into health literacy measurement (35), and also can serve as a useful guide for interventions that aim to enhance people's health literacy (74, 94). As discussed in Chapter 2.4, there are five conceptual models of health literacy for adolescents (the skills-based pyramid model (214), the HPS model (42), the causal pathway model (16), the social ecological model (44) and the inclusive hierarchy model (43)). In practice, these conceptual models can be used to design and guide health literacy intervention studies. This section summarises previous empirical evidence on health literacy interventions for adolescents in order to identify research gaps in health literacy interventions for adolescents, then examines whether these interventions are aligned with the above five conceptual models.

2.6.1 Empirical evidence on health literacy interventions for adolescents

Health literacy interventions for both adults and adolescents are under-researched. While the field of health literacy has experienced rapid growth since 2002, health literacy research is dominated by observational research (73, 253). Using the PubMed database as a searching exercise in 2010, Paasche-Orlow *et al.* (253) found that health literacy interventions accounted for less than 8% of all published papers focused on health literacy. In the field of adolescent health literacy, there were 12 studies identified that were concerned with interventions. A summary of these interventions is presented in **Table 2.6**.

Among these 12 health literacy intervention studies, eight were conducted in the USA (n=8). Only one study was found in each of Canada, Germany, Japan and China (Hong Kong). The target populations involved different socio-demographics: students in primary/middle/high schools; participants in urban/rural schools; adolescents with special health care needs or asthma; students from ethnic minority backgrounds; and disadvantaged adolescents living in under-served areas. Most intervention studies had a sample size of less than 200 (n=8). With respect to recruitment and intervention settings, primary/secondary schools were the most common places (n=11), with clinics (n=1) the least common. Six intervention studies were pre-test/post-test design, two were qualitative studies, two were randomized controlled trials, and two were quasi-experimental design.

Health literacy instruments used in these interventions were the Critical Health Competence (CHC) Test, the eHealth Literacy Scale (eHEALS), the Gilmore Oral Reading Test (GORT), the Rapid Estimation of Adult Literacy in Dentistry-30 items (REALD-30), the Rapid Estimate of Adolescent Literacy in Medicine (REALM-Teen), and other self-designed instruments. Eight studies used an interventional framework as a theoretical guide. These interventional frameworks/models included the skills-based pyramid model, the social ecological model, the persuasion knowledge model, Klarfki's theoretical model, the educational transition planning framework, a model similar to the causal pathway model, and the life course analysis theory. Therefore, three models used in the interventions were aligned with our previous five conceptual models: the skills-based pyramid model, the social ecological model and the causal pathway model. The other four new models (the persuasion knowledge model, Klarfki's theoretical model, the educational transition planning framework and the life course analysis theory) were used either as the intervention's rationale or for the development of curriculum materials. As for the effectiveness of health literacy interventions, 11 studies reported positive evidence of improvement in students' health literacy. Only one study suggested that the intervention had a limited effect on improving health literacy (254).

To sum up, health literacy interventions for adolescents have increasingly gained attention in the last decade, especially in the USA. As the most common intervention setting, schools have become the optimum venues for training adolescents in health literacy. It is important to note that conceptual frameworks/models play an important part in guiding health literacy interventions. Some authors used conceptual models as guides for designing curricula or interventions; others used conceptual models to explain the rationale for interventions. Three of our previous five conceptual models were found in empirical interventions: the skills-based pyramid model, the social-ecological model and the causal pathway model.

Table 2.6: Intervention studies that aim to improve adolescent health literacy

Study no	Author (Year)	Country	Target population	Sample size	Recruitment setting	Health literacy instrument used	Conceptual model used	Study design	Intervention described	Result
1	Hubbard *et al.* (2007) (220)	USA	Middle school and high school students	330 (intervention) 339 (control)	Two middle schools and one high school	A 30-item instrument	The skills-based pyramid model was used for designing textbooks and other curricular materials.	Quasi-experimental design	Textbook-based health literacy instructions and curricular materials were developed to improve students' health-related concepts and skills described in the national health education standards.	• The intervention group middle school students significantly improved their skills scores (by almost 5 points) compared to the control group (less than 1 point). • The intervention group high school students significantly improved their scores from pre- to post-test (almost 2 points) compared to the control group.
2	Naito *et al.* (2007) (255)	Japan	Student aged 11-12 in Grade 6	63	Public elementary school	Pre- and post-program questionnaire survey	None	Pre-test/post-test design	A workshop in a classroom was facilitated by a dentist to increase school children's interactive health literacy. The workshop was 2-hour.	• More than half (76%) of students found the workshop to be useful to increase their awareness of health information and its quality, suggesting the effectiveness and acceptability of the health literacy education program.
3	Robinson *et al.* (2008) (27)	USA	Underserved minority asthmatic children aged 6-14	110	Paediatric allergy clinics	GORT	None	Pre-test/post-test design	A longitudinal intervention over 6 months was conducted to improve asthmatic children's literacy and health outcomes using a Saturday-school format and the asthma reading advocacy camp.	• Results showed there was a significant improvement in children's literacy and self-efficacy, indicating literacy enhancement was an important factor in improving self-efficacy and impacting asthma-related outcomes.

Study no	Author (Year)	Country	Target population	Sample size	Recruitment setting	Health literacy instrument used	Conceptual model used	Study design	Intervention described	Result
4	Begoray *et al.* (2009) (254)	Canada	Students aged 14-15 in Grade 10	33	Four schools	na	A social-ecological and social constructivist framework was used to understand the influence of health education on health literacy.	Qualitative design	A health curriculum called '*Planning 10*' was implemented to improve students' health literacy. This curriculum consisted of four components: health living, health information, healthy relationships and health decision. The total instructional time was 36 hours.	• Students reported mostly negative experiences citing repetitive course content, routinely delivered by teachers and passively received by students. • Findings suggested that the '*Planning 10*' curriculum had limited effect on improving health literacy.
5	Stecklberg *et al.* (2009) (256)	Germany	Secondary school students aged 16-18 in Grade 11	45 (intervention) 218 (control)	Secondary schools	CHC Test	A theoretical model proposed by Klafki was used for curriculum development.	Random controlled trial	According to the concept of evidence-based medicine, a 6-module school curriculum was developed to improve students' critical health literacy.	• Students in the intervention group achieved higher mean person parameters compared with their counterparts in the control group (p<0.01). • Teaching critical health literacy to secondary school students is feasible and is likely to enhance the competence of critical health literacy.
6	Diamond *et al.* (2011) (26)	USA	Minority, low-income, urban students from Grades 3-8	12-64 (longitudinal)	Schools	REALM-Teen	None	Pre-test/post-test design	An after-school program called '*Building Wellness* ^{TM}' was implemented over 6 years to prepare the youth to be active and educated participants in their healthcare. The involved health topics were obesity, asthma,	• There was an increase in knowledge, improved healthy behaviours and enthusiasm from participants and facilitators after interventions.

Study no	Author (Year)	Country	Target population	Sample size	Recruitment setting	Health literacy instrument used	Conceptual model used	Study design	Intervention described	Result
									injury, drug/alcohol use and abuse.	
7	Hess *et al.* (2011) (194)	USA	High school students with special health care needs aged 14-22	137	Five high schools	na	An intervention framework was adopted on the basis of federally mandated educational transition planning by integrating health care transition into school-based transition practice.	Qualitative design	A school-based health care transition education intervention was designed to equip adolescents who had special health care needs with health literacy, self-efficacy and self-determination skills. A 40-hour curriculum was implemented in 13 high school special education classes over 8 weeks.	• All focus group participants said the curriculum was highly relevant and valuable. • This intervention showed promise for empowering adolescents with special health care needs to become more independent in managing their health care.
8	Hove *et al.* (2011) (209)	USA	Rural public school students in Grades 6-8	182	One rural public school	eHEALS	The persuasion knowledge model was used as a theoretical guide for understanding lay people's perception about a message's persuasive intent.	Pre-test/post-test design	Three eHealth literacy training sessions were held in computer classes to develop and improve the level of adolescent eHealth literacy. The intervention topics were nutrition, calorie intake and physical activity.	• The change in eHealth literacy significantly predicted adolescents' perception that the brand website was the least reliable source of information.
9	Katz *et al.* (2011) (257)	USA	Elementary school students in Grades 2-4	628 (intervention) 552 (control)	Five elementary schools	A food label literacy test instrument	The social-ecological model of behaviour	Random controlled trial	The Nutrition Detectives program was conducted to cultivate practical and	• There was a significant increase in nutrition label literacy for students in

Study no	Author (Year)	Country	Target population	Sample size	Recruitment setting	Health literacy instrument used	Conceptual model used	Study design	Intervention described	Result
							change was used to guide the intervention.		actionable skills related to daily physical activity and healthful eating. The program consisted of 5-min lessons, using a community-based participatory research approach.	intervention schools (p<0.01). • There was also a significant increase in nutrition label literacy for parents of intervention group students (p<0.01).
10	Pike *et al.* (2011) (258)	USA	Students in Grades 4 and 5	167 (intervention) 69 (control)	Five schools	An 18-question unit assessment test	None	Quasi-experimental design	A 15-lesson, asthma-based curriculum was developed to improve children's awareness and understanding of asthma and develop health literacy.	• Increases in asthma knowledge occurred between pre-test and post-test among the intervention group (p<0.001). • Scores of the intervention group were higher than comparison classroom scores at the post-test time point (p<0.001), suggesting offering asthma education is an opportunity to build health literacy for students with chronic diseases.
11	Paek *et al.* (2012) (259)	USA	Rural public school students in Grades 6-8	182	One rural public school	eHEALS	The intervention framework was consistent with Manganello's causal pathway model (16).	Pre-test/post-test design	Three eHealth literacy training sessions were held in computer classes to develop and improve the level of adolescent eHealth literacy. The intervention topics were nutrition, calorie intake and physical activity.	• Social cognitive factors (outcome expectations and involvement) significantly improved students' eHealth literacy. • All the perceived social influence variables (injunctive norm, descriptive norm and subjective norm)

Study no	Author (Year)	Country	Target population	Sample size	Recruitment setting	Health literacy instrument used	Conceptual model used	Study design	Intervention described	Result
										significantly improved students' eHealth literacy.
12	Tse *et al*. (2015) (260)	China (Hong Kong)	English-speaking adolescents aged 14-16 in Grades 9-10	22	One English-medium international school	REALD-30	The life course analysis theory was used.	Pre-test/post-test design	Participants received alerts posted daily for five consecutive days requiring online accessing of the oral health literacy education materials through three social media outlets: Twitter, Facebook and YouTube.	• There were significant differences in literacy assessment scores for participants who received oral health education messages via Facebook (*p*=0.02) and YouTube (*p*=0.005).

Note: na, no information available. CHC Test, Critical Health Competence Test; eHEALS, eHealth Literacy Scale; GORT, Gilmore Oral Reading Test; REALD-30, Rapid Estimation of Adult Literacy in Dentistry-30; REALM-Teen, Rapid Estimate of Adolescent Literacy in Medicine.

2.6.2 Gaps in health literacy interventions for adolescents

Although considerable progress has been made in the field of health literacy interventions for adolescents, there are still gaps in current research. These gaps include:

1) **Health literacy interventions for adolescents took place mainly in the USA, and evidence is lacking from other countries.**

   Low health literacy is a global issue for both adults and adolescents (23-25, 88, 116, 178). For example, the prevalence of low health literacy among adolescents was 34% in the USA, 67.6% in Australia and 93.7% in China. Therefore, improving health literacy is a pressing issue around the world. Intervention studies are needed to respond to low health literacy in adolescents in the global context. Health literacy, as a culturally-sensitive concept (261), may have different meanings according to cultural and language backgrounds. The same health literacy intervention framework may not work in another cultural background, thus health literacy interventions for adolescents in other countries are needed to overcome the problem of low health literacy.

2) **Health literacy interventions for adolescents were often conducted with small samples.**

   As summarised in **Table 2.6**, eight intervention studies had a small sample size of fewer than 200 participants. The sample size and sampling method are important factors in the generalisability of a study's results (262). Due to small samples, previous findings may be not generalised to other populations and contexts. There is a need for evidence based on large-scale representative samples to enhance future findings' generalisability.

3) **Health literacy instruments for intervention use were diverse and most of their measurement properties were unknown.**

   Health literacy measurement serves as a solid foundation in the field of health literacy including health literacy interventions (28). There were large discrepancies between studies that employed health literacy instruments for intervention use, with only two studies reporting their instruments' reliability (the eHealth Literacy Scale and a 30-item health literacy instrument). As discussed by Perry (34), one possible factor impeding health literacy interventions is the lack of reliable and valid instruments. Without a high-quality instrument, it is not possible to design and implement an effective intervention. There is a need for future research to establish reliable and valid health literacy instruments for intervention use.

4) Robust designs were lacking for adolescent health literacy interventions.

As shown in **Table 2.6**, there were only two randomised controlled trials (RCT) designed for adolescent health literacy interventions. From the perspective of evidence-based medicine, RCT studies generally provide reliable and robust evidence (263). Focusing on RCT studies enables researchers to draw specific conclusions on the degree of the effectiveness of health literacy interventions for adolescents when conducting systematic reviews or meta-analysis. Thus, RCT studies are an important contribution to evidence-based medicine. Such design studies are needed to provide more reliable findings on the effectiveness of adolescent health literacy interventions.

2.6.3 Summary

In summary, health literacy interventions for adolescents have gained momentum in the last decade, especially in school settings. Conceptual models play a vital role in guiding health literacy interventions for adolescents. However, health literacy interventions for adolescents are still in the explorative stage. More health literacy intervention studies are needed in future, outside of the USA, with large-scale samples, using reliable and valid health literacy instruments, and based on a robust study design such as randomised controlled trials.

Box 2.6: Key messages about health literacy interventions for adolescents

- There has been increasing empirical evidence on health literacy interventions for adolescents over the last decade.
- Conceptual models play a vital part in guiding health literacy interventions for adolescents.
- Health literacy interventions for adolescents take place mainly in the USA, with empirical studies lacking in other countries.
- Few health literacy interventions for adolescents are found to have large-scale representative samples.
- Few health literacy interventions for adolescents are found to use reliable and valid health literacy instruments.
- Robust study designs such as randomised controlled trials are lacking for health literacy interventions for adolescents.

2.7 Addressing gaps in the current research

It is evident from the above literature review that adolescent health literacy has gained increasing attention over the last decade. However, there are still four gaps in current research:

1) Adolescent health literacy studies (e.g. measurement studies, intervention studies) are lacking outside of the USA;
2) Previous systematic reviews of adolescent health literacy measurement have not provided a critical assessment of measurement properties for instruments, nor conducted a methodological quality assessment for included studies;
3) There is limited empirical evidence of the validity of conceptual models of adolescent health literacy; and
4) Few high-quality health literacy interventions for adolescents have been conducted. Health literacy interventions are lacking, especially those with large samples, using a reliable and valid health literacy instrument, and based on robust study designs.

A high-quality health literacy intervention for adolescents must be based on a valid instrument and a practical conceptual framework. Therefore, it is necessary to do some preliminary work to collect such information before conducting interventions. As recommended in a recent WHO document (10), within a successful health literacy response framework, measuring health literacy and examining relationships between health literacy and other health outcomes are initial steps for implementing interventions and informing policy-makers. As per this recommendation, this PhD research focuses on health literacy measurement and health literacy model testing for relationship analysis, because there remain large gaps in these two areas, as discussed in the preceding literature review.

Here I used the '*DMAIC*' (define, measure, analyse, improve and control) framework to explain why I focused on health literacy measurement and model testing in this PhD research (See **Figure 2.8**). The '*DMAIC*' framework is a systematic and fact-based approach that provides a framework for results-oriented project management (264). There are five components of the DMAIC framework. In this PhD research, the '*define*' component refers to identifying and selecting health literacy definitions, target populations, scopes, contexts, and rationales for this study. The ‘*measure*’ component represents how health literacy and other important variables are measured. The ‘*analysis*’ component refers to identifying and examining the key determinants and impacts of health literacy. The ‘*improve*’ component refers to taking action to improve health literacy for adolescents, while the last component ‘*control*’ represents sustaining effective health literacy interventions for adolescents in the long term.

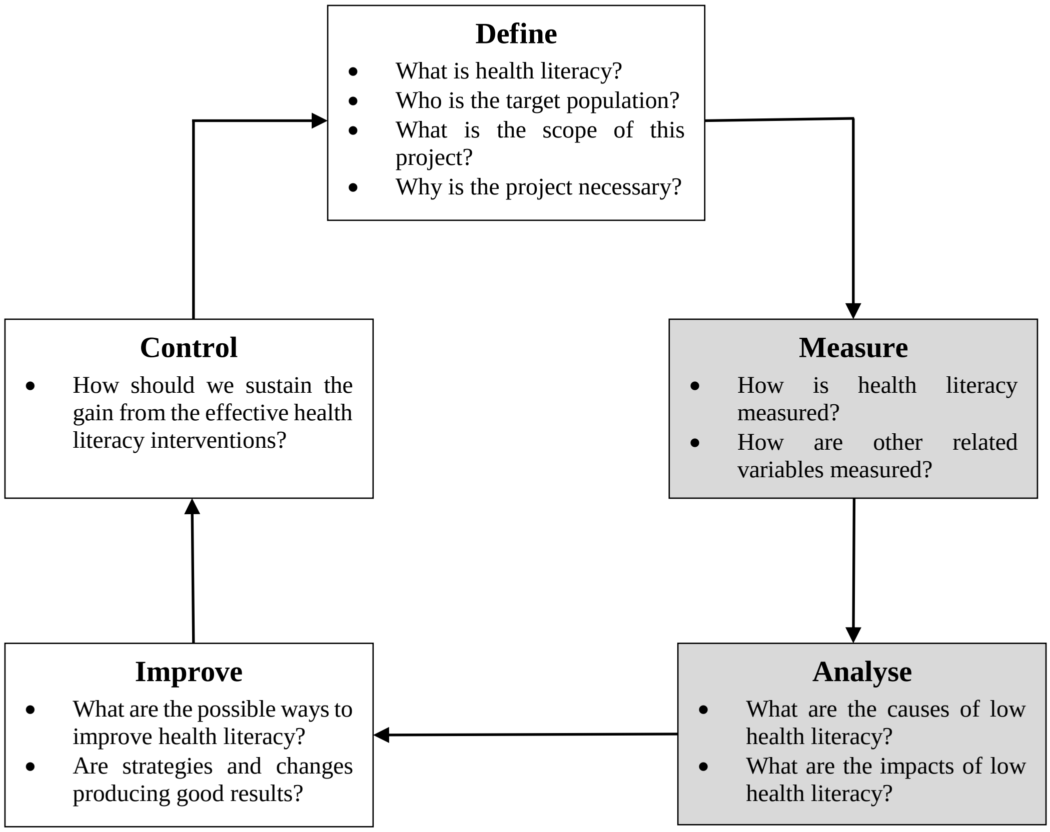

Figure 2.8: The DMAIC cycle as a framework to explain the rationale of this PhD project

As explained earlier in Chapter 2.1, health literacy in this PhD research was defined as a skills-based concept involving an individual’s ability to find, understand and use health information to promote and maintain health. As discovered in the literature review, there remain four gaps in current research about health literacy measurement and intervention. Given that measurement and relationship analysis are solid foundations for health literacy interventions, this PhD research only focused on the second and third component of the DMAIC framework. It did not seek to address all of the four research gaps. Instead, it focused on addressing the first three gaps by measuring and understanding health literacy among secondary students in Beijing and Melbourne, based on a hypothesised model.

1) **Addressing the first gap: Adolescent health literacy studies (e.g. measurement studies, intervention studies) are lacking outside of the USA.**

   Although health literacy studies among adolescents have proliferated in recent years, most of them were conducted in the USA. That means, health literacy research is lacking in other cultures. Given that health literacy is a culturally sensitive concept (261, 265), which may represent different meanings in different cultures, it should be clearly defined in each particular culture and context. In this PhD research, health literacy was contextualised into Chinese and Australian cultures. There were two reasons why I researched adolescent health literacy in these two cultures. The first and main reason was the research gaps in each culture, and the second reason was the feasibility and accessibility of the field work. Further explanation will be offered in the next section Chapter 2.8: Justification of research settings in this PhD research.

2) **Addressing the second gap: Previous systematic reviews lacked a critical assessment of measurement properties for health literacy instruments and a methodological quality assessment for included studies.**

   There have been two systematic reviews of health literacy measures used for adolescents (33, 34); however, neither of them provided a critical assessment of measurement properties for included instruments or performed a methodological quality assessment for included studies. Due to a lack of such information, the authors' conclusions about measurement properties of instruments may be biased. It is still unclear about the overall quality of health literacy instruments used for adolescents. As the first step to understanding the relationships between health literacy, its influencing factors, and health-related outcomes among secondary students, it is necessary to select a reliable and valid instrument to measure adolescent health literacy. Therefore, it is essential to examine and compare measurement properties of previously used health literacy instruments as well as to consider methodological issues of previous health literacy studies, thus assisting researchers to select the most appropriate instrument. To fill this research gap, a systematic review of health literacy instruments used for adolescents was conducted. Further details of this review will be provided in Chapter 4: A Systematic Review of Health Literacy Instruments Used for Adolescents.

3) **Addressing the third gap: Few empirical studies have been found based on a conceptual framework regarding adolescent health literacy.**

To advance the field of health literacy measurement in a consistent way, both McCormack *et al.* (35) and Pleasant *et al.* (28) recommended that health literacy should be measured based on a testable conceptual framework. Using such a theoretical framework would enhance the rigour, clarity and transparency of a study. Although there are five health literacy conceptual models proposed for adolescents, little practical work has been found based on these theoretical models, especially for the mediating role of health literacy in the relationship between antecedents and health-related outcomes. Testing of the mediating role of health literacy can assist researchers to make informed decisions about how to address low health literacy and to improve distal health outcomes (41). Therefore, this PhD research has sought to present an empirical work that is designed on Manganello's health literacy framework. Further discussion of addressing this gap will be offered in Chapter 5: Understanding and Measuring Health Literacy among Secondary Students in Beijing, China.

Box 2.7: Key messages about research gaps for adolescent health literacy

This PhD research focuses on addressing the following three research gaps:

- Adolescent health literacy studies are lacking outside of the USA.
- The overall quality of health literacy instruments used for adolescents is still unknown.
- Little empirical evidence is available about the validity of health literacy conceptual models for adolescents, especially for the mediating role of health literacy.

2.8 Justification of research settings in this PhD research

This PhD research seeks to understand and measure health literacy among secondary students in Beijing, China and Melbourne, Australia. China and Australia were chosen for the following three reasons:

1) **Adolescent health literacy studies in mainland China and Australia are lacking.**

In mainland China, the concept of health literacy was first introduced in 2008 by the Chinese government through a public bulletin entitled '*Basic Knowledge and Skills of People's Health Literacy*' (49). As discussed in a literature review by Tung and Sørensen (266) in 2014, there were only seven peer-reviewed health literacy articles identified from mainland China. Although health literacy research in mainland China has gained increasing attention in recent years, most studies have focused on the adult population (146, 244, 267-271). Compared with adult health literacy, adolescent health literacy is under-researched, with few studies identified for Chinese adolescents (36-38). Therefore, there is little information about adolescent health literacy in Chinese culture.

Of the few studies regarding adolescent health literacy in China, it can be learnt that Chinese adolescents develop their health literacy through three main channels: school health education (37), family resources (36, 38), and online health resources (38). In terms of school health education, Yu *et al.* (36) conducted a national survey that examined primary and secondary students' health literacy gained through school health education. Their results showed students' health literacy in China was limited and unbalanced, showing students from eastern provinces had higher health literacy levels than those from middle and western provinces. The current school health education system is insufficient to improve students' health literacy due to two main reasons: 1) school health education in China mainly focuses on the basic knowledge, rather than encouraging students to adopt healthy behaviours (37). As explained by Lawry (79), the health curriculum in many developing countries including China is characterised by providing information about health topics such as basic hygiene. Therefore, school health education focuses less on interactive communication and equipment of students' health skills; 2) it is the influence of the 'academic stress' culture which limits the development and promotion of health literacy in China educational systems (272, 273). In China, school health education has been delivered through a range of curricula (e.g. physical education, science, history) in primary and secondary schools since the 1990s (274). However, the corresponding class hours are still short, with only 6-7 classes (i.e. 40 minutes) in one semester (275). Besides school health education, Lam and Yang (38) also found that family structure and resources play important roles in promoting adolescent health literacy. Adolescents were more likely to attain low health literacy scores if they came from a low familiar resource environment. Although adolescent health literacy can be developed and promoted via different approaches, the existing evidence is limited and mainly focuses on delivering basic health knowledge, rather than skills training.

The limited evidence on adolescent health literacy in China is probably rooted within the broader political context. The earliest government document calling for developing adolescent health literacy was the Chinese Primary and Secondary School Health Education Guideline (CPSSHEG) (275), which was based on the above public bulletin '*Basic Knowledge and Skills of People's Health Literacy*' and issued by the department of education in 2008. Improving students' health literacy was clearly specified as a goal of primary and secondary school health education. Particularly, health literacy in the CPSSHEG is conceptualised as having three domains: conceptual knowledge and attitudes (71 items), behaviour and lifestyles (48 items) and health-related skills (40 items) (275). Compared to conceptual knowledge and attitudes and behaviour and lifestyles, health-related skills only account for 25% of the total items in the CPSSHEG. Therefore, current evidence on health literacy in China has mainly focused on the domain of health knowledge and behaviours, rather than health skills. There is a lack of skills-based measurement tools for adolescent health literacy. Also, due to a lack of theory-based empirical research, current understanding of adolescent health literacy is limited either on the relationship between health literacy and influencing factors, or the relationship between health literacy and health outcomes. Little is known about the mediating role of health literacy. Therefore, this PhD research seeks to fill these gaps by conducting both a validation study of a skills-based instrument and an empirical study of model testing for adolescent health literacy in mainland China.

In Australia, the term '*health literacy*' was first used in 1993 in a national health report entitled '*Goals and targets for Australia's health in the year 2000 and beyond*' (276). Since then, considerable work has been done on health literacy in Australia (59-61). However, although there is an increasing number of studies of adolescent health literacy in Australia, most of them focus on mental health literacy (54, 56, 57) rather than general health literacy. Mental health literacy refers to '*knowledge and beliefs about mental disorders which aid their recognition, management or prevention*' and '*the ability to recognise specific disorders; knowing how to seek mental health information; knowledge of risk factors and causes, of self-treatments and of professional help available*' (7), which is a separate and distinct term from general health literacy. Developing general health literacy skills is essential for children and adolescents who will become future health literate citizens (46). As outlined in the 2014 Australian Commission on Safety and Quality in Health Care (ACSQHC) report (62), the national health and physical education curriculum was developed to build students' general health literacy skills. Health literacy was included in the rationale and aims of the national health and physical education curriculum. Despite this, there is a scarcity of empirical research on general health literacy in school settings. Two reasons may explain this research gap. One probable reason is a lack of appropriate instruments for measuring students' health literacy, as current instruments are mainly designed for adults. The other probable reason is the broad context of health literacy research in Australia. Currently, health literacy is mostly conducted from the healthcare perspective. Therefore, there is a need to complement the current evidence on general health literacy in Australian school settings.

2) **Low health literacy among adolescents is prevalent in both mainland China and Australia.**

The prevalence of low health literacy among adolescents is high in mainland China and Australia. For example, in the 2008 national health literacy survey in mainland China, 93.7% of the 15 to 24 age group had low health literacy (25). Similarly, 67.6% of the 15 to 19 age group were scored as having low health literacy in the 2006 national health literacy survey in Australia (23). More attention should be paid to this young population in order to prepare them to be health literate in the future.

3) **My own background and networks ensured a rather high geographic accessibility and feasibility to achieve the research aim.**

The last reason is an opportunistic reason. I completed my Master degree at the Institute of Child and Adolescent Health at Peking University in 2013. There is a strong partnership between government secondary schools and my previous research institute. After my Master study, I came to the University of Melbourne to pursue my PhD degree. Therefore, Beijing and Melbourne are two accessible cities for me.

Finally, I should highlight that this PhD research does not provide a cultural comparison of health literacy in China and Australia; instead, it seeks to understand and measure health literacy separately in each culture. Specifically, this PhD research treats health literacy research in Chinese culture as its main component, including health literacy measurement and model testing for Beijing secondary students. On the other hand, health literacy research in Australian culture is treated only as an additional component of this thesis, which is a pilot study of health literacy measurement in one secondary school in Melbourne. There are two intended aims for this pilot study. Due to a lack of school-based health literacy research, one aim is to explore the feasibility of data collection on health literacy in Australian school settings. The other aim, arising from the lack of appropriate health literacy instruments for Australian adolescents, is to further support the use of the selected health literacy instruments in the Australian culture, not only in the Chinese culture.

Box 2.8: Key messages about contexts and rationales of this PhD research

This PhD research focuses on adolescent health literacy in China and Australia for the following three reasons:

- Large gaps exist in current research on adolescent health literacy in both China and Australia.
- Low health literacy is prevalent in Chinese and Australian young people.
- There is a high geographic accessibility and feasibility in place for the researcher due to personal background and networks.

Chapter 3 Conceptual Framework and Methodology

3.1 Introduction

This chapter introduces a hypothesised theoretical framework and the methodology used in this thesis. It has two sections. The first section outlines a conceptual framework underpinning this thesis, and explains how each component of the framework applies to this PhD research. The second section presents an overview of the methodology used in the whole research. A three-phase research design is discussed with a brief introduction to each research phase. Methods in each phase will be presented in detail in Chapters 4, 5 and 6.

3.2 Conceptual framework underpinning this thesis

3.2.1 Which conceptual model might be the most appropriate?

In Chapter 2.4, there are five conceptual models of adolescent health literacy identified: the skills-based pyramid model, the inclusive hierarchy model, the health promoting schools (HPS) model, the social ecological model and the causal pathway model (16, 42-44, 214). The skills-based pyramid model (214) and the inclusive hierarchy model (43) focus explaining the health literacy construct. This means that these two models are useful when developing health literacy instruments because they can provide a detailed guide to the domains of health literacy. The HPS model (42) offers a comprehensive intervention framework for improving health literacy in school-aged children and adolescents. It is therefore suitable for use when designing intervention studies. When looking back to the overarching research aim of this thesis (i.e. to work within a theoretical model to examine relationships between health literacy, its influencing factors and health-related outcomes), the social ecological model (44) and the causal pathway model (16) might be considered appropriate. The social ecological model is useful when understanding the relationship between health literacy and its influencing factors; however, it does not speculate on the relationship between health literacy and health-related outcomes (44). Compared with the social ecological model, the causal pathway model illustrates a full pathway between adolescent health literacy, its influencing factors, and health-related outcomes (16). Therefore, the causal pathway model has great potential to underpin this thesis.

3.2.2 The hypothesised framework underlying this thesis

The original causal pathway model was proposed by Manganello (16) in 2008. I will refer to this model as Manganello's health literacy framework. It has three main modules (see **Figure 3.1**): 1) factors that may influence health literacy; 2) components that comprise the health literacy construct; and 3) health-related outcomes that may attribute to health literacy. In each module, there are several components. As suggested by Manganello (16), the causal pathway model can be adapted according to a study's aim and priorities. In the following paragraphs, components of each module are discussed and several changes are made to formulate the final, hypothesised theoretical framework underlying this thesis (see **Figure 3.2**).

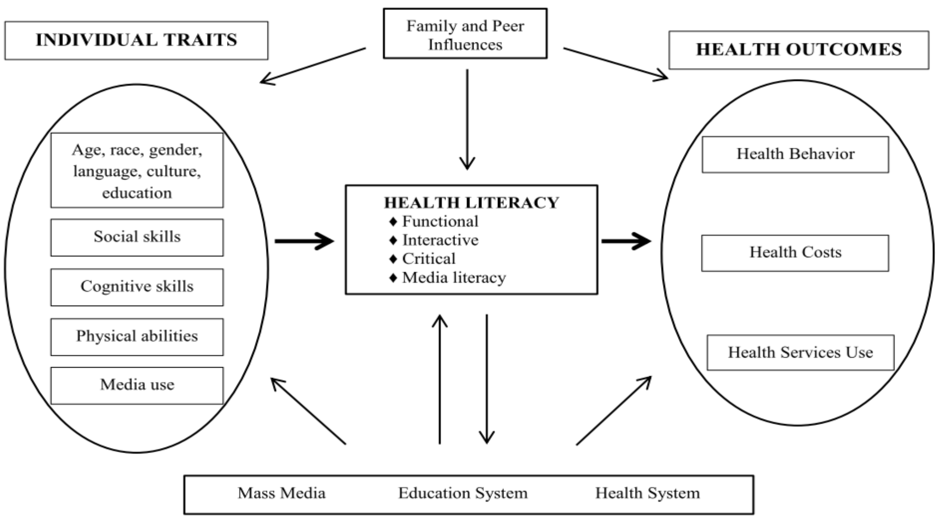

Figure 3.1: Manganello's health literacy framework for adolescents (16)

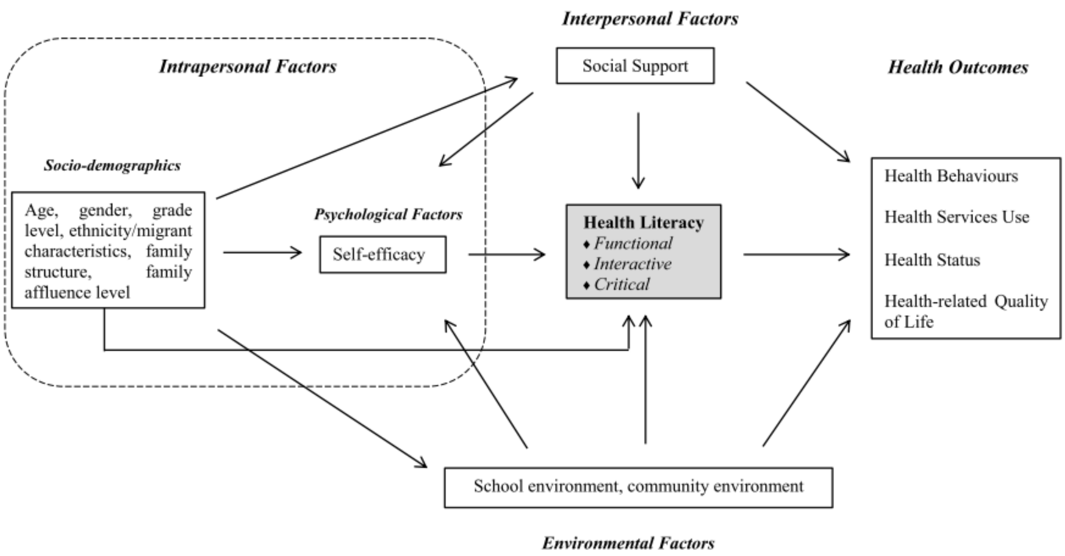

Figure 3.2: The hypothesised framework underpinning this thesis

3.2.2.1 Module 1: Factors that may influence adolescent health literacy

3.2.2.1.1 <u>Intrapersonal factors</u>

Intrapersonal factors are defined as personal demographics, biological factors and psychological factors that may underlie one's health literacy (44, 277). In the original causal pathway model, Manganello (16) included five individual characteristics that may predict one's health literacy: socio-demographics (e.g. age, gender and culture), social skills, cognitive skills, physical abilities and media use. In this PhD research, only socio-demographics were measured, together with personal self-efficacy added. The reasons for these changes are explained below.

The relationship between socio-demographics and adolescent health literacy has been well-documented in previous empirical studies (36, 52, 176, 177). However, there are inconsistencies in their results. For example, Wu *et al.* (177) conducted a cross-sectional study that examined the influencing factors of health literacy among Canadian high school students. Their results showed that students were likely to have lower health literacy scores if they were males, came from other countries, and skipped school more often, but showed no relationship between health literacy and students' grade level and socio-economic status. Another study by Ghaddar *et al.* (176) in America also examined whether individual characteristics influenced health literacy in high school students. Their findings suggested that health literacy was not associated with gender and socio-economic status. Instead, they found statistical differences in health literacy by grade level and ethnicity. In Asian adolescents, Chang (52) and Ye *et al.* (36) identified that students were at risk of low health literacy if they were boys and from lower grades, came from ethnic minorities, and had parents with lower education levels. In the above studies, although they had the same target population (i.e. high school students), findings were inconsistent in terms of gender, grade level and socio-economic status. There might be many reasons for this discrepancy. For example, health literacy measurement tools used (the NVS, the TOFHLA, or self-designed), sample size (small, medium, or large), methods for statistical analysis (univariate, bivariate, or multivariate), and potential confounders (controlled or not). Using an assessment framework is a rigorous way to reduce the degree of discrepancy, to control potential confounders, and to clarify how socio-demographics relate to health literacy (35). Therefore, based on previous empirical evidence, this PhD research seeks to employ Manganello's health literacy framework to examine the relationship between adolescent health literacy and socio-demographics (e.g. age, gender, grade level).

Manganello's health literacy framework includes '*social skills*' and '*cognitive abilities*'. Social skills are defined as '*the abilities necessary for effective interpersonal functioning*' (278, 279), while cognitive abilities refer to '*individual differences in the capacity to perform tasks that require the manipulation, retrieval, evaluation or processing of information*' (280, 281). These two concepts were also mentioned in the health literacy framework proposed in the 2004 American Institute of Medicine (IOM) report, which viewed social skills and cognitive abilities as intrapersonal factors to health literacy (67). In previous empirical research, Serper *et al.* (132) and Wolf *et al.* (282) examined the associations between health literacy and cognitive abilities among English-speaking adults aged 55 to 74 in the USA. Using the TOFHLA, REALM and NVS as health literacy measurement tools, they found that all health literacy measures were strongly correlated with participants' cognitive function. While there is evidence supporting the view that social skills and cognitive abilities are intrapersonal factors of health literacy, some researchers contrarily consider them essential components of health literacy. As shown in the health literacy definition from the WHO, health literacy represents '*the cognitive and social skills which determine the motivation and ability of* *individuals to gain access to understand and use information in ways which promote and maintain good health*' (68). Further, Nutbeam (3, 71) explained health literacy as a concept involving different levels of social skills and cognitive abilities. Health literacy was classified into three categories: functional, interactive and critical. Functional health literacy referred to basic skills in reading and writing, whereas interactive and critical health literacy involved advanced cognitive and social skills such as communication and advocacy. When looking back to the health literacy definition adopted in this thesis (i.e. an individual's ability to find, understand and use health information and services to promote and maintain good health: see Chapter 2.1), the concept '*health literacy*' includes functional, interactive and critical domains. Therefore, I treated '*social skills*' and '*cognitive abilities*' as parts of health literacy. '*Social skills*' and '*cognitive abilities*' were not considered to be intrapersonal factors in the final adapted model.

'*Physical abilities*' refers to basic abilities needed to perform physical tasks (283). According to the International Classification of Functioning, Disability and Health (ICF) (284), physical disability is a broad concept that involves any impairment of body structure, any restriction, or lack of ability to perform an activity in life situations. As the term '*physical disabilities*' is more frequently used to measure an individual's physical abilities (284-287), I used this term to discuss its relationship with health literacy. People with physical disabilities are limited in their access to education, healthcare services, and social activities (287, 288). In 2015, Omariba and Ng (289) examined the relationship between immigrant generation and physical disability in Canada, and the role of health literacy in this relationship. Using data from the 2003 International Adult Literacy and Skills Survey (IALSS), the research team found that first-generation immigrants were less likely to report disability. Health literacy was found to negatively correlate with disability among immigrant Canadians, a relationship largely accounted for by individuals' socio-economic status. There is little evidence about the relationship between physical disability and health literacy in adolescents. In the 2015 Mission Australia's Youth Survey, 6% of respondents aged 15 to 19 indicated that they had a disability such as physical disability (290). In mainland China, the percentage of adolescents aged 15 to 24 with a physical disability accounted for 2.2%-6.34% (286, 287). In other words, the proportion of adolescents with a physical disability is small (approximately 2.2%-6.3%). Given that this PhD research targets school-aged Chinese and Australian adolescents who are deemed to be '*healthy*' populations, this study does not treat '*physical disability*' as a research priority. Therefore, the intrapersonal factor 'physical abilities' was not included in the final adapted model.

Manganello (16) also added '*media use*' as the fifth intrapersonal factor in the original model. As today's adolescents are frequent users of mass media (291, 292), it is reasonable to speculate on a close relationship between media use and health literacy. In empirical research, Paek *et al.* (293) found that middle school students in the USA were likely to obtain higher health literacy scores if they read magazines or newspapers more often (r=0.12, p<0.01). Similarly, Ghaddar *et al.* (176) found that the use of reliable and valid online health information was positively associated with health literacy for American high school students (OR=2.1; 95% CI=1.1 to 4.1). These two empirical studies supported '*media use*' as an intrapersonal factor of adolescent health literacy. However, the challenge of measuring '*media use*' should be noted. First, several studies have documented the problem of self-report media use (294-296). For example, Prior (294) found that respondents were more likely to overstate their exposure to television news. The primary reason for over-reporting was an imperfect recall. Most respondents could not recall all episodes of news exposure, so they estimated their exposure, a strategy that tended to generate higher incidence than is the case. Second, media use is a broad term that includes various media activities. As defined in the 2010 US media use report (206), media activities among children and adolescents included watching television and movies, playing video games, listening to music, using computers, and reading newspapers, magazines and books. This highlights the further challenge of measuring '*media use*' comprehensively, a time-consuming and burdensome administrative task. Therefore, '*media use*' was not included as a measurable intrapersonal factor in the finally determined model.

Self-efficacy is another important psychological factor affecting adolescent health literacy (44, 176). The term '*self-efficacy*' stems from Bandura's social cognitive theory (297). Self-efficacy represents an individual's belief in his/her ability to successfully execute a specific task within a given context (298). The literature has documented socio-demographics such as gender affecting personal self-efficacy (299-302). For example, Singh and Udainiya (299) found that male adolescents and those belonging to joint families had higher self-efficacy scores than female adolescents and those from nuclear families. Also, studies have suggested that self-efficacy is an independent predictor of health literacy (176, 303, 304). In 2012, Ghaddar *et al.* (176) conducted a cross-sectional study that examined the relationship between self-efficacy and adolescent health literacy. After controlling for confounders (e.g. ethnicity and grade level), their findings showed that students with high self-efficacy were more likely to have high health literacy (OR=1.07; 95% CI=1.02 to 1.12). Based on these empirical findings, this PhD research postulates '*self-efficacy*' as a mediator between socio-demographics and health literacy in the final adapted model.

*3.2.2.1.2 **Interpersonal factors***

In Manganello's health literacy framework, interpersonal factors refer to family and peer influences that may affect the health literacy of adolescents (16). Similarly, in the social ecological model of adolescent health literacy proposed by Higgins *et al.* (44), interpersonal factors were defined as social support and the quality of human interactions with families, friends and significant others. In this study, I focused on investigating social support because adolescents are heavily dependent on their families and friends for health-seeking in everyday life (166). While the literature has documented social support as a crucial factor influencing adolescent physical and mental health (305-307), few empirical studies have been conducted on the relationship between social support and health literacy, especially in adolescents. In the adult population, findings of the relationship between social support and health literacy are inconsistent. In 2013, Kamimura *et al.* (308) conducted a cross-sectional study that examined the relationship between health literacy, social support and physical and mental health among 187 American patients utilising a free clinic. Their findings showed that health literacy was not positively related to social support. Another empirical study by Stewart *et al.* (309), examining whether social support acted as a mediator between health literacy and depression among American smokers with low socio-economic status, showed that social support mediated the effect of health literacy on depression. Specifically, low health literacy was associated with low social support, which predicted high depression symptoms. Due to these inconsistent findings and little evidence from adolescents, this PhD research postulates '*social support*' as an interpersonal factor of health literacy for school-aged adolescents in the final adapted model.

3.2.2.1.3 Environmental factors

Environmental factors represent system-level influences on adolescent health literacy. In Manganello's health literacy framework, three environmental factors were included: health systems, educational systems and the mass media.

The health system plays a significant but not sole role in the development of health literacy. As highlighted in the seminal report '*Health Literacy: A Prescription to End Confusion*' from the American Institute of Medicine (67), many factors associated with health systems affect an individual's health literacy. These factors include complex and confusing health systems, partly arising from the increased use of information technology (310, 311), too high a level readability of health-related materials for patients (312, 313), poor patient-provider communication skills among clinicians (314, 315), low cultural competence of health providers (316, 317), and so forth. In the 2014 Health Literacy National Statement, the Australian Commission on Safety and Quality in Health Care stipulated that health systems could make it easier or more difficult for patients to understand and use health information (13); hence intervening in health systems has become a critical strategy for improving patients' health literacy (95, 96, 318). As for adolescents, given the increasing prevalence of chronic illnesses, they are likely to have more interaction with the health system than previously (189, 319, 320). However, due to their less well-developed cognitive skills, adolescents are more dependent on parents for using health systems than adults are. When measuring the impact of health systems on adolescent health literacy, parental health literacy should be measured and controlled (166). In this PhD research, I did not include '*health systems*' as a measurable component of '*environmental factors*'. One reason is that this thesis focuses on secondary schools rather than healthcare settings. The other reason is the challenge and burdensome administration for data collection if both adolescent and parent health literacy were to be studied. Therefore, the environmental factor '*health systems*' was not measured in this thesis.

The education system is another important system-level factor that contributes to adolescent health literacy (44). In many countries (e.g. the United States, Australia and

China), national health education guidelines stipulate that school health education should aim to develop students' knowledge, understanding and skills, thus fostering health-literate students (215, 275, 321). Health literacy is often used as a measurable outcome of school health education in evaluating health-related knowledge, attitudes, behavioural intentions and personal skills (3, 43, 45). A large body of evidence has demonstrated that students' knowledge, attitudes, skills and behaviours can be improved through school health education (79, 322-324). School health education thus plays a crucial role in developing adolescent health literacy. In addition to school health education, the school environment may also have an impact on students' health literacy. As highlighted in the Health Promoting Schools (HPS) model (42), establishing healthy school environments is an essential strategy in fostering health literate individuals and communities. Although it is well known that the school environment has an impact on students' physical and mental health (79, 325-328), little is known about the relationship between health literacy and the school environment. This PhD research hypothesised '*school environment*' as a potential environmental factor affecting students' health literacy. Therefore, the original factor '*education systems*' was altered to '*school environment*'.

The third environmental factor in Manganello's health literacy framework was '*mass media*'. The term '*mass media*' here is distinct from the term '*media use*' in '*intrapersonal factors*'. '*Media use*' refers to an individual's specific media use, covering behaviours such as frequency of TV watching, whereas '*mass media*' describes the various means of communication through television, radio, newspapers and so forth, which focus on the media environment and its content (16). In 2011, Paek *et al.* (293) conducted an empirical study that examined the impact of mass media on adolescent health literacy. Their findings showed that adolescents were more likely to have high health literacy if they heard about health information from mass media more frequently. Even after controlling for variables of media use (i.e. the frequency of TV watching, magazine reading and Internet use), there was still a positive relationship between accessing health information from mass media channels and health literacy ($r=0.10$, $p<0.05$). In the final adapted model, I did not include '*mass media*' as an environmental factor. The reason is that it is complex and challenging to measure '*mass media*' comprehensively, as explained earlier.

In the final adapted model, I introduced '*community environment*' as another environmental factor. Previous research has demonstrated that neighbourhood characteristics such as physical environment, social environment, and provision of services are associated with adolescents' learning, behavioural and emotional outcomes (329-334). In the Longitudinal Study of Australian Children (LSAC), Edwards (333) found that children were more likely to have low scores on learning, social and emotional outcomes if they were from disadvantaged neighbourhoods. Jenkin *et al.* (334) also found that neighbourhood contextual factors such as accessibility of green spaces had a protective effect on sugar-sweetened beverage consumption. However, little is known about the relationship between the community environment and health literacy. Using focus group and environmental scan methods, Higgins *et al.* (44) conducted a qualitative study that explored whether neighbourhood features might affect students' health literacy. Their findings suggested that convenient access to fast food outlets impeded students' capacity to make healthy eating decisions. Despite a lack of quantitative evidence, this PhD research postulates that neighbourhood environment can contribute to adolescent health literacy. Therefore, '*community environment*' was added as a potential component of '*environmental factors*'.

3.2.2.2 Module 2: Health literacy construct

Health literacy consists of four domains in Manganello's health literacy framework (16). That is, functional, interactive, critical and media literacy. The first three domains were fully explained in the three-level health literacy model proposed by Nutbeam (3). Functional health literacy refers to basic skills in reading and writing health information that can be used to effectively manage everyday situations; interactive health literacy refers to advanced skills that allow individuals to extract health information and derive meaning from different forms of communication; and critical health literacy represents more advanced skills that can be used to critically evaluate health information and to take control over health determinants. The three-level health literacy model has been well accepted in current research since its inception (4, 74, 94, 303). While Manganello included '*media literacy*' as an integral component of health literacy, some researchers argued that '*media literacy*' should be considered as a separate construct (335-339) referring to one's ability to access, analyse, evaluate and communicate messages in a variety of forms (6). An interesting approach to distinguishing '*media literacy*' from '*health literacy*' can be demonstrated in an empirical study by Levin-Zamir *et al.* (6). After examining health literacy theory and media literacy theory, the authors found that neither the concept '*health literacy*' nor '*media literacy*' seemed comprehensive enough to explain how adolescents interpreted health-related content in mass media. Based on the theoretical foundations of definitions for both health literacy and media literacy, they developed a new concept '*media health literacy*' which reflected a continuum of skills including identifying health-related content in the media, recognising its influence on health behaviours, critically analysing the content, and expressing the intention to respond through actions. In this study, I agreed with Levin-Zamir's viewpoint and treated '*media literacy*' as a separate construct from '*health literacy*'. Therefore, the health literacy construct in this PhD research only included the first three domains (functional, interactive and critical).

3.2.2.3 Module 3: Health outcomes that may result from health literacy

3.2.2.3.1 Health behaviour

In Manganello's health literacy framework, health behaviour is considered a dependent outcome of health literacy. Health behaviour refers to '*any activity undertaken by an individual, regardless of actual or perceived health status, for the purpose of promoting, protecting or maintaining health, whether or not such behaviour is objectively effective towards that end*' (68). The relationship between health behaviour and health literacy has been well documented in theoretical and empirical research (3, 41, 52, 74, 94, 146). For example, in Nutbeam's health promotion outcome model (3), health behaviour was regarded as an intermediate outcome of health literacy. In 2011, Osborn *et al*. (41) conducted a cross-sectional path analysis that examined the impact of health literacy on physical activity and health status among patients with hypertension. Their results suggested significant paths from health literacy to physical activity, and physical activity to health status. However, little is known about whether the relationship is apparent in adolescents. Therefore, '*health behaviour*' was included as an outcome in this PhD research and used to examine the mechanisms linking health literacy to health behaviour among adolescents using the adapted Manganello's health literacy framework.

3.2.2.3.2 ***Health cost***

In the original model, Manganello also hypothesised '*health cost*' as an outcome of health literacy. Health cost represents expenditure related to diagnosis, treatment, prevention and rehabilitation of disease (340). As outlined in Chapter 2.2.2, the literature suggested that low health literacy was positively correlated with high health expenditure (141, 142). Although little is known about the relationship between adolescents' health costs and health literacy, '*health cost*' was not included in the final adapted model in this PhD research. The reason is that adolescents are dependent on their guardians for healthcare expenditure. Adolescents probably do not know how much their guardians spend when they use a certain type of health service, thus making it difficult to measure adolescents' health costs accurately.

3.2.2.3.3 ***Health service use***

The last health outcome in Manganello's model is '*health service use*', which refers to the utilisation of all services that deal with the diagnosis and treatment of disease, or the promotion, maintenance and restoration of health (341). People with low health literacy are more likely to have ineffective health service utilisation, including less use of preventative services (126, 127), more frequent use of emergency care (129) and longer hospital stays (128). However, this conclusion is mostly drawn from the adult population. Although there are two systematic review examining the relationship between health literacy and the use of health care services among children and adolescents (12, 117), all the included studies focused on assessing caregiver/parental health literacy, rather than child or adolescent health literacy. In addition, the evidence is inconsistent about the relationship between caregiver health literacy and children's health service utilisation including emergency department visits and hospitalisations. The relationship between health literacy and health service use in adolescents is still unclear. In 2016, Berens *et al.* (342) conducted a cross-sectional health literacy survey among a representative national sample across Germany. Using multivariate logistic regression, they found that low health literacy was associated with a high frequency of doctor visits (OR=2.14; 95% CI=1.22 to 3.75) for all age groups, including the youth group aged 15 to 29. This finding indicates a negative relationship between adolescent health literacy and use of doctors' services. More recently, Levine *et al.* (343) examined associations between low health literacy and health services utilisation (i.e. emergency department visits, hospitalisations and length of stay in the hospital) among adolescents and young adults with chronic or end-stage kidney disease. Their results showed no differences between low and high health literacy groups on health services utilisation outcomes after adjusting for demographics and disease type. Due to a lack of empirical evidence for younger adolescents aged 10-15, this PhD research targeted secondary students in Year 7 to Year 9 (approximately 13-15 years) and included '*health service use*' as a distal outcome in the final adapted model.

Although access to and use of preventive health care services has become the norm in primary care for adolescents (99), they are not likely to seek or use health services even they have significant health problems due to various reasons (e.g. knowledge of services; structural factors; concerns about accessing services) (344-346). Given that adolescents usually depend on their parents for using health services (168, 347, 348), it is challenging to measure adolescents' health service use accurately. This PhD research used two approaches to ensure the reliability and validity of its measurement. First, measurement items were selected from a previous well-established questionnaire: the 2013 Health Literacy Study-Asia-Questionnaire (HLS-Asia-Q) (349). Five-item questions about health service utilisation were asked: emergency service use, general practitioner service use, hospital service use, other health professionals service use, and patient-provider communication. Second, the selected five items were piloted on a small sample (n=10) of secondary school students to ensure their clarity and readability (See **Appendix 5.6**: Questionnaire pilot test results).

3.2.2.3.4 ***Health status***

In the final adapted model, '*health status*' was considered as a dependent outcome, referring to '*a description and/or measurement of the health of an individual or population at a particular point in time against identifiable standards*' (68). '*Health status*' was included because growing evidence has supported the close relationship between health literacy and health status (41, 144-146). To examine the association between adolescent health literacy and health status, Chang (52) conducted a cross-sectional survey among 1601 high school students in Taiwan. The results showed that adolescents with low health literacy levels were less likely to have good health status (adjusted OR=0.59; 95% CI=0.41 to 0.86). Despite the clear relationship between adolescent health literacy and health status, the causal mechanism linking health literacy to health status in a theoretical framework is still unknown. In this PhD research, I added '*health status*' as a distal outcome in Manganello's health literacy framework in order to examine the mediating role of health literacy in adolescents' health status.

3.2.2.3.5 Health-related quality of life

In addition to '*health status*', '*health-related quality of life (HRQOL)*' was also considered in the final adapted model, referring to '*an individual's perception and subjective evaluation of their health and wellbeing within their unique cultural environment*' (350, 351). While the literature has suggested that health literacy is positively related to HRQOL among populations such as cancer patients and diabetic patients (352, 353), it is unknown whether this positive relationship holds true for school-aged adolescents. Due to little research to date, this PhD research adds on HRQOL as an outcome of interest, hypothesising that students with high health literacy are likely to have better HRQOL.

3.2.3 Summary

In summary, several changes were made to the original causal pathway model in the development of the final adapted model, thus making it suitable for use in this PhD research.

3.2.3.1 Change of Module 1: Factors that may influence adolescent health literacy

In the final adapted model, only '*socio-demographics*' and '*self-efficacy*' were included as '***intrapersonal factors***', while '*social skills, cognitive skills, physical abilities and media use*' were excluded for different reasons (e.g. measurement issues, research priorities). As for '***environmental factors***', '*school environment*' and '*community environment*' were considered as potential contributors to students' health literacy. '*Mass media*' and '*health system*' were not included because their measurement would prove too challenging and complex.

3.2.3.2 Change of Module 2: Health literacy construct

Health literacy in the final adapted model consists of three domains: functional, interactive and critical. The component '*media literacy*' was excluded because this term has been widely accepted as a separate concept.

3.2.3.3 Change of Module 3: Health outcomes that may result from health literacy

Health outcomes were adapted to include '*health behaviour, health service use, health status and health-related quality of life*'. '*Health cost*' was excluded because adolescents were dependent on their guardians for healthcare, which made it difficult to measure accurately.

3.2.3.4 Change of model pathways

There were two changes of pathways from the original model to the final adapted model. First, '*self-efficacy*' was hypothesised as a mediator between '*socio-demographics*' and '*health literacy*'. This hypothesis was formulated on the basis of previous research on self-efficacy and health literacy. Self-efficacy has been found to be associated with both socio-demographics (299-301) and health literacy (44, 176). Second, the pathway between '*health literacy*' and '*environmental factors*' was changed from a bi-directional arrow to a uni-directional arrow. In the original model, Manganello (16) strengthened the bi-directional path because '*health literacy*' interacts with '*environmental factors*'. On the one hand, environmental factors can have a direct impact on health literacy, which was explicitly discussed in Module 1: Factors that may influence health literacy. On the other hand, the level of an individual's health literacy can also affect the success of a system-level health literacy intervention. That is, a health literacy intervention focusing on changing systems may fail if the target population has limited health literacy (e.g. limited skills in understanding the information provided). As this PhD research focuses on the influence of environmental factors on health literacy, rather than examining the success of system-level interventions, a uni-directional path was adopted.

Box 3.1: Key messages about the conceptual framework underpinning this PhD research

- The causal pathway model proposed by Manganello was considered to be the most appropriate framework to underpin this PhD research, because it explained a full pathway from influencing factors through health literacy to health-related outcomes for adolescents.
- Manganello's health literacy framework was adapted according to the research aim and priorities of this PhD research when putting it into practice.

3.3 Methodology used in the thesis

A three-phase research plan was designed to achieve the aims of this PhD thesis. An overview of this research is provided in **Figure 3.3**, together with the methodology used in each research phase. Specifically, the three research phases included:

1) A systematic review of health literacy instruments used for adolescents;
2) A validation study of psychometric testing for the selected health literacy instrument in Chinese secondary students; and
3) A model testing study of Manganello's health literacy framework in Chinese secondary students.

These three research phases represent the major components of this PhD research which was conducted in Chinese secondary schools. After assessing the findings from research with Chinese secondary students, I also conducted a pilot study of health literacy measurement in one Australian secondary school. Due to a lack of appropriate instruments and a lack of school-based health literacy research in Australian adolescents, one aim of this pilot study was to pilot three health literacy instruments and to provide new knowledge about adolescents' general health literacy in Australian schools. Given that a robust and comprehensive approach to health literacy measurement should allow comparison across cultures (28), the other aim of this pilot study was to reflect upon the findings of health literacy measurement in both Chinese and Australian school settings.

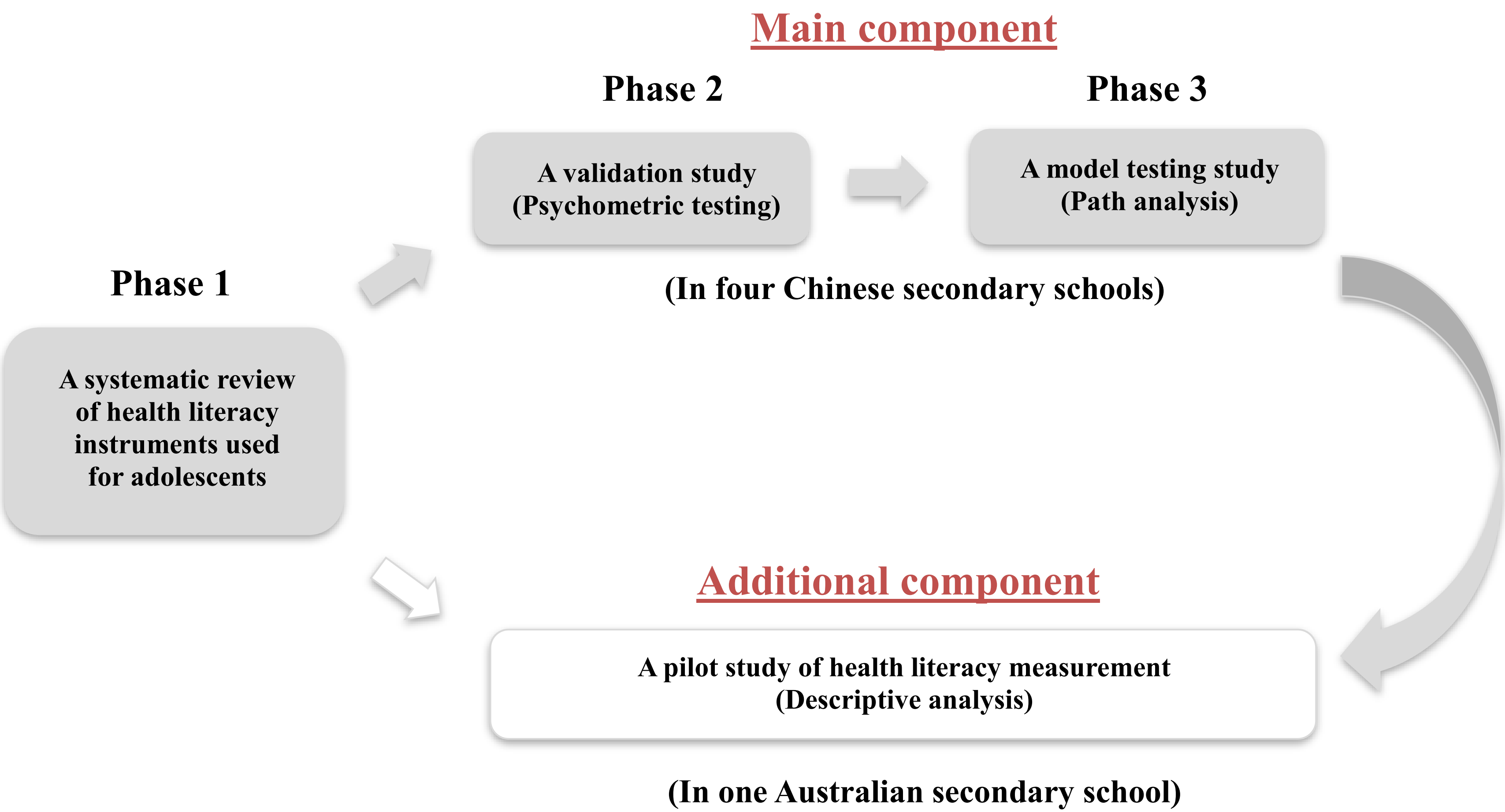

Figure 3.3: An overview of this PhD research

3.3.1 Research Phase 1: A systematic review of health literacy instruments used for adolescents

The first research phase was to conduct a systematic review of health literacy instruments used for adolescents. The aim of this review was to identify at least one appropriate instrument to measure adolescent health literacy for next-step use. Details of the method rationale and study design are presented in the following paragraphs.

3.3.1.1 Choice of research method

Literature reviews (or narrative reviews) and systematic reviews are both common means of gathering available information and current evidence on a topic (354). A literature review typically uses an implicit process that aims to provide a broad overview of relevant information on a certain subject (355), whereas a systematic review is a more rigorous process that aims to collate evidence that fits pre-specified eligibility criteria in order to answer a specific and focused question (356). As summarised by Rys *et al.* (357) and Cook *et al.* (358), literature reviews and systematic reviews vary in terms of questions, sources and search, selection, appraisal, synthesis, and inferences. In brief, systematic reviews often have a specific question, use comprehensive sources and an explicit search strategy, have pre-specified eligibility criteria, include rigorous critical appraisal, give a quantitative summary, and provide evidence-based inferences. The choice between completing a literature review or a systematic review is usually determined by the research purpose and research question.

In this PhD research, a systematic review was employed. There were two reasons for this. First, this PhD research had a specific research question about health literacy instruments used for adolescents. As outlined in the literature review of Chapter 2.5.3, there have been two systematic reviews published on health literacy measurement in adolescents (33, 34). However, knowledge about the overall quality of health literacy instruments used for adolescents is still limited. Due to a lack of methodological quality assessment for included studies, and a lack of critical evaluation of psychometric properties for health literacy instruments, it is difficult for researchers to select the most appropriate instrument for field use. When conducting health literacy research that needs to measure health literacy quantitatively, it is necessary for researchers to select at least one instrument. So, which health literacy instrument has good validity and reliability based on a study of high methodological quality? To answer this question, this PhD research sought to identify at least one suitable health literacy instrument by conducting a systematic review. Second, systematic reviews can provide more rigorous, replicable and transparent evidence than narrative reviews (354). A systematic review follows a standard scientific protocol that identifies the research objectives, concepts and detailed methods for evaluating literature. A systematic review can also minimise subjective bias because at least two independent reviewers are needed for screening literature and extracting data (354). Based on these considerations, Research Phase 1 of this thesis was to conduct a systematic review that aimed to identify at least one appropriate instrument to measure adolescent health literacy for next-step use.

3.3.1.2 Study design

Following the guidelines outlined in the Cochrane Handbook (356), a systematic review protocol was developed (See **Appendix 3.1**: A systematic review protocol). There are eight stages in conducting a systematic review (356): 1) defining the review question; 2) developing eligibility criteria for included studies; 3) searching for studies; 4) selecting studies; 5) extracting data; 6) assessing methodological quality of included studies; 7) analysing and synthesising data; and 8) interpreting results and drawing conclusions.

During the process of conducting this systematic review, the PRISMA checklist and the COSMIN checklist were both considered as tools for controlling the quality of the review. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist, developed by Moher *et al.* (359) in 2009, is an evidence-based minimum set of items for reporting systematic reviews. The PRISMA checklist can be used for reporting reviews of randomised controlled trials, but also for reporting other types of systematic reviews. Therefore, the PRISMA checklist was used to ensure the reporting quality of the review of health literacy instruments used for adolescents (See **Appendix 3.2**: PRISMA checklist for reporting systematic review).

The '***CO****nsensus-based* ***S****tandards for the selection of health status* ***M****easurement* ***IN****struments*' (COSMIN) checklist was developed by Mokkink *et al.* (360) in 2010 based on an international Delphi study. The COSMIN checklist, a consensus-based checklist to evaluate the methodological quality of studies on measurement properties, can assist researchers to select valid and reliable health measurement instruments. The COSMIN checklist was developed because previous standards and criteria for evaluating the methodological quality of a study on measurement properties were not operationalised into user-friendly and easily applicable checklists (360). In 2012, a scoring system for the COSMIN checklist was developed to calculate quality scores per measurement property for health instruments, especially for systematic reviews of measurement properties (361). Although the focus of the COSMIN checklist is health-related patient-reported outcomes, the checklist can be also used for evaluating studies on other kinds of health measurement instruments such as performance-based tests (362). Currently, the COSMIN checklist has been widely used in 569 systematic reviews of measurement properties for different types of health measurement instruments (362). Therefore, the COSMIN checklist was used to evaluate the methodological quality of included studies in the systematic review of measurement properties for health literacy instruments in adolescents (See **Appendix 3.3**: COSMIN checklist for examining studies' quality). Further details of how to use this checklist will be given in Chapter 4: A Systematic Review of Health Literacy Instruments Used for Adolescents.

3.3.2 Research Phase 2: A validation study of the selected health literacy instrument in Chinese adolescents

As one of the overarching research aims of this thesis was to examine Manganello's health literacy framework using empirical data, it was necessary to measure health literacy as an initial step in examining the relationship between health literacy and other variables in the model. Following Research Phase 1, the second research phase involved conducting a validation study of the selected health literacy instrument in Chinese school-aged adolescents to ensure that the selected instrument was appropriate for field use.

3.3.2.1 Choice of research method

There are three commonly-used research methods: qualitative methods, quantitative methods, and mixed methods that combine both qualitative and quantitative methods (363). Qualitative methods focus on words, aiming to capture the lived experiences of the social world and the meanings people give these experiences from their own perspectives, whereas quantitative methods focus on numbers and aim to measure things in an objective and structured way, avoiding any bias that could influence the findings (364). Mixed methods involve gathering both numeric information and text information (365). In this PhD research, quantitative methods were more suitable because the overall research aims were to measure adolescent health literacy and examine the hypothesised framework, rather than understanding the meanings and subjective experiences of individuals. Therefore, a quantitative approach was adopted.

Before examining the hypothesised model, it is necessary to ensure the validity and reliability of the selected health literacy instrument. Using a high-quality instrument is a prerequisite to understanding the relationship between health literacy and other variables such as influencing factors (28, 366). Therefore, psychometric methods were used in the second research phase.

Psychological assessment is a commonly-used method in the field of psychometrics, education and health (367). This is where most measurement theories have originated. A measurement theory is a theory about how the scores generated by items represent the construct to be measured (368). There are two well-known measurement theories: classical test theory (CTT) and item response theory (IRT) (369). The CTT is a conventional strategy to measure constructs that are not directly observable, which represent observed scores as being equal to the true score for an individual plus an error term (368). The IRT, on the other hand, refers to modern test theory that encompasses a group of models designed to represent the relation between an individual's item response and an underlying latent trait (370). Compared with the CCT, the IRT needs stronger assumptions (requiring uni-dimensional scales, and items must be locally independent) and is more complex mathematically (369, 371). In this PhD research, I employed the CTT as the measurement theory for psychometric assessment because it met the research needs of this study and it was easy to apply in practice.

Due to wide variation in the names of measurement properties (e.g. reliability, validity and responsiveness), it might be confusing for researchers if the definitions were not consistently used. To avoid such confusion, this PhD thesis used the taxonomy and definitions of measurement properties developed by the COSMIN checklist research team. In 2010, Mokkink *et al.* (372) clarified and standardised terminology and definitions of measurement properties by conducting an international Delphi study to address the lack of consensus on taxonomy, terminology and definitions which could lead to confusion about which measurement properties were relevant and which concepts they represented. Currently, the taxonomy, terminology and definitions from the COSMIN checklist are widely used not only in systematic reviews of measurement properties (373) but also in validation studies (374-377). Therefore, to reduce disparities between definitions, the taxonomy and terminology from the COSMIN checklist were adopted in Research Phase 2 (See **Figure 3.4**).

COSMIN definitions of domains, measurement properties, and aspects of measurement properties

Term			Definition
Domain	**Measurement property**	**Aspect of a measurement property**	
Reliability			The degree to which the measurement is free from measurement error
Reliability (extended definition)			The extent to which scores for patients who have not changed are the same for repeated measurement under several conditions: e.g. using different sets of items from the same health related-patient reported outcomes (HR-PRO) (internal consistency); over time (test-retest); by different persons on the same occasion (inter-rater); or by the same persons (i.e. raters or responders) on different occasions (intra-rater)
	Internal consistency		The degree of the interrelatedness among the items
	Reliability		The proportion of the total variance in the measurements which is due to 'true'† differences between patients
	Measurement error		The systematic and random error of a patient's score that is not attributed to true changes in the construct to be measured
Validity			The degree to which an HR-PRO instrument measures the construct(s) it purports to measure
	Content validity		The degree to which the content of an HR-PRO instrument is an adequate reflection of the construct to be measured
		Face validity	The degree to which (the items of) an HR-PRO instrument indeed looks as though they are an adequate reflection of the construct to be measured
	Construct validity		The degree to which the scores of an HR-PRO instrument are consistent with hypotheses *(for instance with regard to internal relationships, relationships to scores of other instruments, or differences between relevant groups)* based on the assumption that the HR-PRO instrument validly measures the construct to be measured
		Structural validity	The degree to which the scores of an HR-PRO instrument are an adequate reflection of the dimensionality of the construct to be measured
		Hypotheses testing	Idem construct validity
		Cross-cultural validity	The degree to which the performance of the items on a translated or culturally adapted HR-PRO instrument are an adequate reflection of the performance of the items of the original version of the HR-PRO instrument
	Criterion validity		The degree to which the scores of an HR-PRO instrument are an adequate reflection of a 'gold standard'
Responsiveness			The ability of an HR-PRO instrument to detect change over time in the construct to be measured
	Responsiveness		Idem responsiveness
Interpretability*			Interpretability is the degree to which one can assign qualitative meaning - that is, clinical or commonly understood connotations – to an instrument's quantitative scores or change in scores.

† The word 'true' must be seen in the context of the CTT, which states that any observation is composed of two components – a true score and error associated with the observation. 'True' is the average score that would be obtained if the scale were given an infinite number of times. It refers only to the consistency of the score, and not to its accuracy (ref Streiner & Norman)
** Interpretability is not considered a measurement property, but an important characteristic of a measurement instrument*

Figure 3.4: The COSMIN taxonomy and definitions of measurement properties (372)

3.3.2.2 Study design

Due to a lack of skills-based measurement of adolescent health literacy in China, Research Phase 2 targeted Chinese adolescents. Based on the findings from the systematic review in Research Phase 1, the selected health literacy instrument was then translated from English to Chinese according to Beaton's cross-cultural adaptation guidelines (378). A cross-sectional study was designed to validate the selected instrument in Beijing secondary students. To ensure the quality of this validation study, the COSMIN checklist (360), the STROBE statement (379), and Pleasant's evaluation principles for health literacy measurement (28) were employed.

- As explained earlier in Chapter 3.3.1.2, the COSMIN checklist can be used not only to evaluate the methodological quality of studies on measurement properties for systematic reviews, but also as a guide for designing and reporting a study on measurement properties (360).
- The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement was developed by Von Elm *et al.* (379) in 2007. This statement was generated because important information from the previous observational research was often missing or unclear, hampering the quality assessment of studies. The STROBE statement consists of 22 items describing matters that should be included in an accurate and complete report of an observational study (379). Further information about how to use the STROBE statement in Research Phase 2 is presented in **Appendix 3.4**: STROBE statement for reporting validation study.
- There were seven evaluation principles proposed by Pleasant *et al.* (28) for health literacy measurement in 2011. As health literacy is a complex and multi-dimensional concept, difficult to measure (5, 63), Pleasant *et al.* (28) developed these principles through an online discussion and consensus-gauging process with over 100 experts from a broad range of research areas related to health literacy (380). Specifically, these evaluation principles included (28): 1) measure health literacy on a conceptual framework; 2) consider multi-dimensionality in content and methodology; 3) measure health literacy on a continuous basis; 4) treat health literacy as a latent construct; 5) honour the principle of compatibility; 6) allow comparison across different contexts

including populations and cultures; and 7) prioritise public health applications versus clinical screening. Given that health literacy is a broad concept, which makes its measurement complex and various (35, 45, 212), Pleasant's evaluation principles could be a rigorous framework to employ in standardising the field of health literacy measurement. Further details of how to use these seven principles are presented in **Appendix 3.5**: Pleasant's evaluation principles for health literacy measurement.

Using the above three methodological guides, Research Phase 2 sought to translate and validate the selected health literacy instrument in Chinese adolescents. The study design and methods are outlined in detail in Chapter 5.2 Section One: Health literacy measurement in Chinese secondary students.

3.3.3 Research Phase 3: A cross-sectional study of model testing in Chinese adolescents

The third research phase sought to examine the fit between Manganello's health literacy framework and empirical data in Chinese adolescents, using the validated health literacy instrument in Research Phase 2.

3.3.3.1 Choice of research method

There are three commonly-used methods for investigating relationships between multiple variables: regression analysis, path analysis and structural equation modelling (381). Regression analysis is a statistical method used to examine the relationship between more than one independent variable and only one dependent variable (382). This method is particularly used for testing the relationship between a dependent variable and a set of independent variables (381). Compared with regression analysis, path analysis and structural equation modelling are more advanced methods which can examine the relationships between dependent variables as well as between independent variables (381). Path analysis is considered to be one special form of structural equation modelling (381) which includes all observed variables, not using latent variables. In this PhD research, path analysis was considered more appropriate than structural equation modelling to test Manganello's health literacy framework for three reasons (16): 1) path analysis can specify directionality in relationships between variables and allow the testing of a theory of causal order (383-386). However, it should be noted that path analysis was not used to establish causal relationships; it was only used to estimate the effect size of the relationships in a causal model (387); 2) due to a high number of outcome variables, employing a structural equation model was complex; 3) path analysis is still widely used in behavioural science (388). Therefore, path analysis was the method of choice for the model testing in Research Phase 3.

In accordance to the hypothesised framework mentioned in Chapter 3.2.2, health literacy was regarded as a mediator between a series of independent variables (i.e. intrapersonal factors, interpersonal factors, and environmental factors) and dependent variables (i.e. health behaviours, health services us, health status, and health-related quality of life).

3.3.3.2 Study design

Due to a lack of theory-based empirical research for adolescent health literacy in China, and lack of knowledge about the mediating role of health literacy in health outcomes for adolescents, a cross-sectional study of model testing was conducted in Chinese adolescents. This empirical study was designed based on an adapted version of Manganello's health literacy framework (16) which was explained in Chapter 3.2.2. The STROBE statement was also used to ensure the study's reporting quality (379) (See **Appendix 3.6**: STROBE statement for reporting model testing study). Further details of the study design and methods are explained in Chapter 5.3 Section Two: Health literacy model testing in Chinese secondary students.

3.3.4 Additional Research Phase: A pilot study of health literacy measurement in Australian adolescents

After considering the findings of health literacy measurement from Chinese secondary schools, I questioned whether the selected health literacy instrument could also be used in Australian school settings. Due to an opportunistic reason and a lack of school-based health literacy research and a lack of appropriate health literacy instruments for Australian adolescents, a pilot study was conducted to explore the feasibility of data collection on health literacy in Australian schools, and to provide further support for the findings of health literacy measurement in Chinese secondary schools.

3.3.4.1 Choice of research method

Due to the small sample size of Australian students (n=120) in this pilot study, I did not conduct the validation and model testing of health literacy for Australian adolescents, because the small sample size did not meet the statistical requirements for psychometric testing and path analysis. Therefore, only descriptive statistics (i.e. mean, median, frequency and percentage) was conducted to examine participants' socio-demographics, their health literacy scores, and the prevalence of low health literacy among students in this pilot study.

3.3.4.2 Study design

A cross-sectional study was designed to pilot three health literacy instruments for adolescents in one secondary school in Melbourne, Australia. To control the quality of this pilot study, the STROBE statement was used to ensure the study's reporting quality (379) (See **Appendix 3.7**: STROBE statement for reporting pilot study). Also, Pleasant's evaluation principles for health literacy measurement were used to guide the design of this pilot study (28). Further details of the study design and methods are outlined in Chapter 6: Health Literacy Measurement among Australian Adolescents: Pilot testing in an Australian Secondary School.

Box 3.2: Key messages about methodology used in this PhD research

This PhD research includes a three-phase plan for exploring health literacy in Chinese secondary schools, which is the main component of this PhD thesis. After considering the findings from Chinese students, a pilot study is conducted in an Australian secondary school as an additional component of this PhD thesis:

- Research Phase 1 is a systematic review of health literacy instruments used for adolescents.
- Research Phase 2 is a validation study of the selected health literacy instrument in Chinese secondary students.
- Research Phase 3 is an empirical study of model testing of health literacy in Chinese secondary students.
- An additional component of this PhD research is a pilot study of health literacy measurement in an Australian secondary school.

Future details of methods in each research phase are outlined in later chapters.

3.4 Summary

In summary, this chapter outlined the hypothesised model underpinning this PhD research. Manganello's health literacy framework was identified as the most suitable framework, because it explained a full pathway from health literacy through to health-related outcomes for adolescents. This framework was adapted in accordance with the study's aims and priorities. To achieve the overarching research aims of this thesis (i.e. to measure adolescent health literacy and examine whether the hypothesised model fits empirical data), this PhD research included a three-phase plan for exploring health literacy in Chinese culture and a pilot study in Australian culture. An overview of the methodology used in this PhD research was summarised and presented. Further details of methods used in each research phase will be given in the next three chapters.

Chapter 4 A Systematic Review of Health Literacy Instruments Used for Adolescents

Declarations for Chapter 4

The following declaration outlines my contribution to Chapter 4:

Details of contribution	Extent of contribution
I led the development of the protocol and conduct of this systematic review. Literature screening, data collection and synthesis process were conducted by two independent authors.	70%

The contribution of co-authors is outlined below:

Name	Details of contribution
Dr Rebecca Armstrong	Provided guidance on the development of the protocol and process of conducting the review. Provided feedback on the writing process.
Professor Elizabeth Waters	Provided guidance on the development of the protocol and process of conducting the review.
PhD candidate Thirunavukkarasu Sathish	Assisted with data collection and synthesis.
PhD candidate Sheikh Alif	Assisted with literature screening.
PhD candidate Geoffrey Browne	Provided feedback on the writing process.
Professor Xiaoming Yu	Provided feedback on the writing process.
Dr Elise Davis	Provided feedback on the writing process.
Dr Lucio Naccarella	Provided feedback on the writing process.

Candidate's signature: Shuaijun Guo Date: 14 September 2017

4.1 Introduction

As summarised in Chapter 2.5.3, there are two systematic reviews of health literacy measurement in adolescents (33, 34). Although they provide empirical evidence in the field of health literacy measurement for adolescents, their evidence is limited due to either a lack of critical evaluation of measurement properties of health literacy instruments, or a lack of methodological quality assessment of health literacy measurement studies. Therefore, the overall quality of health literacy instruments used for adolescents is still unknown. This impedes researchers' understanding of which instrument is valid and reliable for field use and makes it difficult to select an appropriate health literacy instrument. To fill this research gap, this chapter presents Research Phase 1 of this PhD research. A systematic review was conducted in this phase to identify the most appropriate tool to measure health literacy in adolescents for next-step use.

4.2 Aim and objectives

This review aimed to summarise the evidence and identify at least one appropriate health literacy instrument for use in adolescents for the next step in the overall research plan of this PhD thesis. Specifically, the objectives were:

- To examine the methodological quality of included health literacy measurement studies for adolescents;
- To examine the measurement properties of health literacy instruments used for adolescents;
- To compare the overall rating of measurement properties between health literacy instruments used for adolescents;
- To identify which instrument was reliable and valid to measure health literacy in adolescents for the next-step research plan.

4.3 Working definitions of relevant terms

The working definitions of relevant terms used in this review are presented in **Table 4.1** and **Table 4.2**. I used the COSMIN checklist to define the measurement properties of a health literacy instrument (372) because it was commonly used to reduce inconsistency in the terminology and definitions of measurement properties for a health-related instrument (373-377). Also, the Scientific Advisory Committee of the Medical Outcome Trust checklist (SAC checklist) (389) was used as a complementary guide to define other important characteristics of a health literacy instrument, such as administrative burden and forms of administration.

Table 4.1: Definitions of measurement properties of a health literacy instrument

Domain	Category	Definition	Source
Reliability		The degree to which the measurement is free from measurement error	COSMIN checklist (372)
	Internal consistency	The degree of the inter-relatedness among items	COSMIN checklist (372)
	Reliability	The extent to which scores for respondents who have not changed are the same for repeated measurement under several conditions. It includes test-retest reliability, inter-rater reliability and intra-rater reliability	COSMIN checklist (372)
	Measurement error	The systematic and random error of a respondent's score that is not attributed to true changes in the construct to be measured	COSMIN checklist (372)
Validity		The degree to which a test measures what it claims to measure	COSMIN checklist (372)
	Content validity	The degree to which the content of an instrument is an adequate reflection of the construct to be measured	COSMIN checklist (372)
	Structural validity	The degree to which the scores of an instrument are an adequate reflection of the dimensionality of the construct to be measured	COSMIN checklist (372)
	Hypotheses testing	The degree to which the scores of an instrument are consistent with hypotheses based on the assumption that the instrument validly measures the construct to be measured. Hypotheses testing contains convergent validity, which refers to the strength of association between two measures of a similar construct	COSMIN checklist (372)
	Cross-cultural validity	The degree to which the performance of the items on a translated or culturally adapted instrument is an adequate reflection of the performance of the items of the original version of the instrument	COSMIN checklist (372)
	Criterion validity	The degree to which the scores of an instrument are an adequate reflection of a '*gold standard*'	COSMIN checklist (372)
Responsiveness	Responsiveness	The ability of an instrument to detect change over time in the construct to be measured	COSMIN checklist (372)

Note: COSMIN, COnsensus-based Standards for the selection of health Measurement Instruments.

Table 4.2: Definitions of other important characteristics of a health literacy instrument

Category	Definition	Source
Generalisability	The degree to which the items in an instrument or its psychometric properties are relevant to populations other than those in which the instrument was devised	COSMIN manual (262)
Interpretability	The degree to which one can assign qualitative meaning to an instrument's quantitative scores or change in scores	COSMIN checklist (372)
Burden	The time, effort and other demands placed on those to whom the instrument is administered (i.e. respondent burden) or on those who administer the instrument (i.e. administrative burden)	SAC checklist (389)
Forms of administration	These include interviewer-administered, trained observer rating, computer-assisted interviewer-administered, self-report and performance-based measures	SAC checklist (389)

Note: COSMIN, COnsensus-based Standards for the selection of health Measurement Instruments; SAC, Scientific Advisory Committee.

4.4 Methods

This review used the methods for conducting systematic reviews outlined in the Cochrane Handbook (356). A review protocol was developed prior to commencing the study (**Appendix 3.1**: A systematic review protocol). To improve the reporting quality of this review, the PRISMA statement was used (359). Further details about how the PRISMA checklist was used are given in **Appendix 3.2**: PRISMA checklist for reporting systematic review.

4.4.1 Search strategy

Given that the term '*health literacy*' was first used in 1974 in a paper entitled '*health education as social policy*' (72), seven electronic databases were used to search for articles published between 1st January 1974 and 30th May 2014: Medline via Web of Science, PubMed, Embase via Ovid, PsycINFO via EBSCO, CINAHL via EBSCO, ERIC via EBSCO and Cochrane Library. The search strategy was first designed on the basis of previous reviews (30, 31, 33, 104), and then following consultation with two librarian experts from the University of Melbourne. After consultation, three types of search terms were used:

- **Construct-related terms**: '*health literacy*' OR '*health and education and literacy*';
- **Outcome-related terms**: '*health literacy assess**' OR '*health literacy measure**' OR '*health literacy evaluat**' OR '*health literacy instrument**' OR '*health literacy tool**';
- **Age-related terms**: '*child**' OR '*adolescent**' OR '*student**' OR '*youth*' OR '*young people*' OR '*teen**' OR '*young adult.*'

No language restriction was applied. The detailed search strategy for each database is available in **Appendix 4.1**: Search strategy for seven databases. As per the PRISMA flow diagram (359), reference tracking was also conducted as a secondary source from included studies and from six previously published systematic reviews on health literacy (12, 30, 31, 33, 104, 117).

4.4.2 Eligibility criteria

Studies had to fulfil the following criteria to be included:

- The stated aim of the study was to develop or validate a health literacy instrument;
- Participants were children or adolescents aged 6 to 24. This broad age range was determined because the age range for '*children*' (i.e. under the age of 18) and '*adolescents*' (i.e. aged 10 to 24) overlap (2), and also because Erikson (390) and Fok *et al.* (98) argued that children aged 6 to 12 were able to learn and develop their own health literacy;
- The term '*health literacy*' was explicitly defined (i.e. an individual's ability to read, access, understand, communicate and use health information and services successfully), although studies assessing health numeracy (i.e. the ability to understand and use numbers in healthcare settings) were also considered; and
- At least one measurement property (i.e. reliability, validity and responsiveness) was reported in the outcomes.

Studies were excluded if: a) the full paper was not available (e.g. conference abstracts); b) they were not peer-reviewed (e.g. dissertations, government reports); c) they were qualitative studies.

4.4.3 Selection process

All references were imported into EndNote X7 software (Thomson Reuters, New York, NY). First, all duplicate records were removed before screening. Second, all irrelevant references were screened and excluded based on their titles and abstracts. Third, all relevant full-text papers were downloaded. Each paper was screened by two independent authors (myself and another PhD student SA). At each major step of this systematic review, discrepancies between authors were resolved through discussion.

4.4.4 Data extraction

Data were extracted from full-text papers by two independent authors (myself and another PhD student TS). As per the COSMIN checklist manual (262) and previously published systematic reviews (366, 391, 392), a data extraction template was developed. The extracted data included: characteristics of included studies (e.g. first author, published year and country), general characteristics of included instruments (e.g. health topics, components and scoring systems), methodological quality of included studies (e.g. internal consistency, reliability and measurement error), ratings of measurement properties of included instruments (e.g. internal consistency, reliability and measurement error) and other important characteristics of included instruments (e.g. interpretability, administrative burden and forms of administration).

4.4.5 Methodological quality assessment of included studies

The methodological quality of included studies was assessed using the COSMIN checklist (361). The COSMIN checklist is a critical appraisal tool containing standards for evaluating the methodological quality of studies on measurement properties of health measurement instruments (393) (**Appendix 3.3:** COSMIN checklist for examining studies' quality). The COSMIN checklist has been widely used in 569 systematic reviews of measurement properties for different types of health measurement instruments (362). Specifically, nine measurement properties (i.e. internal consistency, reliability, measurement error, content validity, structural validity, hypotheses testing, cross-cultural validity, criterion validity and responsiveness) were assessed (262). Since there is no agreed-upon '*gold standard*' for health literacy measurement (28, 35), criterion validity was not assessed in this review. Each measurement property section contains 5 to 18 evaluating items. For example, *internal consistency* is evaluated against 11 items. Each item is scored using a four-point scoring system ('*excellent*', '*good*', '*fair*' or '*poor*'). The overall methodological quality of a study is obtained for each measurement property separately, by taking the lowest rating of any item in that section (i.e. '*worst score counts*'). Two authors (myself and TS) independently assessed the methodological quality of included studies.

4.4.6 Evaluation of measurement properties for included instruments

Except for using the COSMIN checklist to examine studies' quality, there was also a need to evaluate the quality of instruments on each measurement property. The quality of each measurement property of an instrument was evaluated using quality criteria proposed by Terwee *et al.* (394) who belonged to the COSMIN checklist developer group (See **Table 4.3**). Each measurement property was given a rating result ('+' positive, '-' negative, '?' indeterminate and '*na*' no information available). This evaluation process was conducted by two independent authors (myself and TS).

Table 4.3: Quality criteria for measurement properties of health literacy instruments (394)

Property	Rating	Quality criteria
Reliability		
Internal consistency	+	(Sub)scale uni-dimensional AND Cronbach's alpha(s) ≥ 0.70
	?	Dimensionality not known OR Cronbach's alpha not determined
	-	(Sub)scale not uni-dimensional OR Cronbach's alpha(s) < 0.70
Measurement error	+	MIC > SDC OR MIC outside the LOA
	?	MIC not defined
	-	MIC ≤ SDC OR MIC equals or inside LOA
Reliability	+	ICC/weighted Kappa ≥ 0.70 OR Pearson's r ≥ 0.80
	?	Neither ICC/weighted Kappa nor Pearson's r determined
	-	ICC/weighted Kappa < 0.70 OR Pearson's r < 0.80
Validity		
Content validity	+	The target population considers all items in the questionnaire to be relevant AND considers the questionnaire to be complete
	?	No target population involvement
	-	The target population considers items in the questionnaire to be irrelevant OR considers the questionnaire to be incomplete
Construct validity		
Structural validity	+	Factors should explain at least 50% of the variance
	?	Explained variance not mentioned
	-	Factors explain < 50% of the variance
Hypotheses testing	+	(Correlation with an instrument measuring the same construct ≥ 0.50 OR at least 75% of the results are in accordance with the hypotheses) AND correlation with related constructs is higher than with unrelated constructs
	?	Solely correlations determined with unrelated constructs
	-	Correlation with an instrument measuring the same construct < 0.50 OR < 75% of the results are in accordance with the hypotheses OR correlation with related constructs is lower than with unrelated constructs
Responsiveness		
Responsiveness	+	(Correlation with an instrument measuring the same construct ≥ 0.50 OR at least 75% of the results are in accordance with the hypotheses OR AUC ≥ 0.70) AND correlation with related constructs is higher than with unrelated constructs
	?	Solely correlations determined with unrelated constructs
	-	Correlation with an instrument measuring the same construct < 0.50 OR < 75% of the results are in accordance with the hypotheses OR AUC < 0.70 OR correlation with related constructs is lower than with unrelated constructs

Note: AUC, Area Under the Curve; ICC, Intra-class Correlation Coefficient; LOA, Limits of Agreement; MIC, Minimal Important Change; SDC, Smallest Detectable Change. + positive rating; ? indeterminate rating; - negative rating.

4.4.7 Best evidence synthesis: levels of evidence

According to the COSMIN checklist developer group (362), '*a best evidence synthesis*' was used to synthesise all the evidence on measurement properties of different instruments. This synthesis procedure was similar to the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) framework (395). The GRADE framework, a commonly-used and transparent approach to rating quality of evidence, is often used in reviews of clinical trials (396). Given that this review did not target clinical trials, the adapted GRADE framework by the COSMIN checklist developer group was used (391). As seen in **Table 4.4**, the possible overall rating for a measurement property is ‘*positive*’, ‘*negative*’, ‘*conflicting*’ or ‘*unknown*’, accompanied by levels of evidence (‘*strong*’, ‘*moderate*’ or ‘*limited*’). Specifically, three steps were taken to obtain the overall rating for a measurement property. First, the methodological quality of a study on each measurement property was assessed using the COSMIN checklist. Measurement properties from ‘*poor*’ methodological quality studies did not contribute to ‘*the best evidence synthesis*’. Second, the quality of each measurement property of an instrument was evaluated using Terwee’s quality criteria (394). Third, the rating results of measurement properties in different studies on the same instrument were examined whether consistent or not. This best evidence synthesis was performed by one author (myself) and then checked by a second author (TS).

Table 4.4: Levels of evidence for the overall rating of measurement properties (391)

Level	Rating	Criteria
Strong	+++ or ---	Consistent findings in multiple studies of good methodological quality OR in one study of excellent methodological quality
Moderate	++ or --	Consistent findings in multiple studies of fair methodological quality OR in one study of good methodological quality
Limited	+ or -	One study of fair methodological quality
Conflicting	±	Conflicting findings
Unknown	?	Only studies of poor methodological quality

Note: + positive result; - negative result; ±conflicting result; ? unknown result.

4.5 Results

The search identified 1804 studies. After duplicates and initial title/abstract screening, 303 full-text articles were identified and obtained. As per the eligibility criteria, 15 studies were included (4, 6, 50, 169, 177, 208, 246, 249, 251, 252, 397-401), yielding 15 health literacy instruments used for adolescents (See **Figure 4.1**). The main reasons for exclusions included: 1) the study aim was not aligned (n=51); 2) the target population was not aligned (n=44); and 3) multiple reasons, including that they were qualitative studies, reviews, commentaries or a combination of at least two reasons mentioned above (n=189).

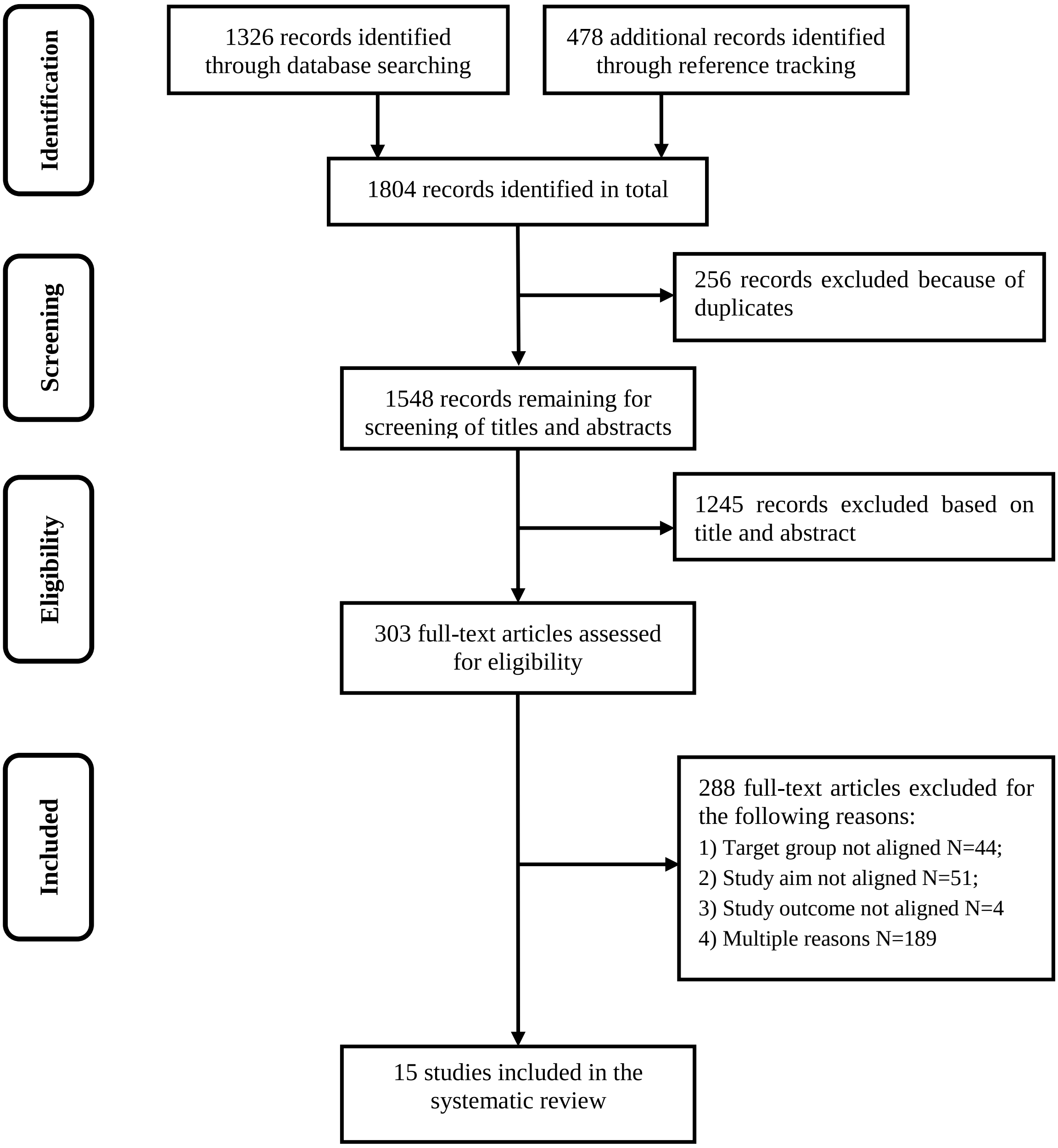

Figure 4.1: Flowchart of search and selection process according to PRISMA flow diagram (359)

4.5.1 Characteristics of included studies

Among the 15 studies identified, 11 were published in the last five years (2010 to 2014) (see **Table 4.5**). Most included studies were conducted in Western countries (n=13), with seven studies carried out in the USA. The target population aged 7 to 25 could be roughly classified into three subgroups: children aged 7 to 12 (n=3), adolescents aged 13 to 17 (n=10) and young adults aged 18 to 25 (n=2). The sample size ranged from 50 to 7428, with gender evenly distributed in most studies (n=10). Convenience sampling was used in three studies (n=3). Schools (n=9) were the most common recruitment settings, compared to clinical settings (n=4) and communities (n=2).

Table 4.5: Characteristics of included studies

Study no	Author (Year)	Country	Target population	Health literacy instrument	Sample size (% male)	Sampling method	Recruitment setting
1	Davis *et al.* (2006) (252)	USA	Adolescents aged 10-19 years (mean age=14.8±1.9)	REALM-Teen	1533 (47.4)	na	Middle schools, high schools, paediatric primary care clinics and summer programs
2	Norman and Skinner (2006) (208)	Canada	Adolescents aged 13-21 years (mean age=14.95±1.24)	eHEALS	664 (55.7)	Sampling from one arm of a randomised controlled trial	Secondary schools
3	Chisolm and Buchanan (2007) (251)	USA	Young people aged 13-17 years (mean age=14.7)	TOFHLA	50 (48.0)	na	Children's hospital
4	Steckelberg *et al.* (2009) (399)	Germany	Students in Grades 10-11 and university	CHC Test	Sample 1: 322 (36.6) Sample 2: 107 (32.7)	na	Secondary schools, university
5	Schmidt *et al.* (2010) (249)	Germany	Children aged 9-13 years (mean age=10.4)	HKACSS	852 (52.9)	na	Primary school
6	Wu *et al.* (2010) (177)	Canada	Students in Grades 8-12	HLAB	275 (48.0)	Convenience sampling	Secondary schools
7	Levin-Zamir *et al.* (2011) (6)	Israel	Adolescents in Grades 7, 9, 11 (approximately age 13, 15 and 17)	MHL	1316 (52.0)	Probability sampling and random cluster sampling	Public schools
8	Chang *et al.* (2012) (50)	Taiwan	Students in high school (mean age=16.01±1.02)	c-sTOFHLAd	300 (52.6)	Multiple-stage stratified random sampling	High schools
9	Hoffman *et al.* (2013) (400)	USA	Youth aged 14-19 years (mean age=17)	REALM-Teen; NVS; s-TOFHLA	229 (61.6)	na	Private high school
10	Massey *et al.* (2013) (246)	USA	Adolescents aged 13-17 years (mean age=14.8)	MMAHL	1208 (37.6)	Sampling from a large health insurance network	Publicly health insurance network
11	Mulvaney *et al.* (2013) (401)	USA	Adolescents aged 12-17 years (Sample 1: mean age=13.92; Sample 2: mean age=15.10)	DNT-39 and DNT-14	Sample 1: 61 (52.5) Sample 2: 72 (55.6)	na	Diabetes clinics

Study no	Author (Year)	Country	Target population	Health literacy instrument	Sample size (% male)	Sampling method	Recruitment setting
12	Abel *et al.* (2014) (4)	Switzerland	Young adults aged 18-25 years (male mean age: 19.6; female mean age=18.8)	HLAT-8	7428 (95.5)	Sampling from compulsory military service for males and two-stage random sampling for females	Compulsory military service, communities
13	Driessnack *et al.* (2014) (169)	USA	Children aged 7-12 years	NVS	47 (53.0)	Convenience sampling	The science centre
14	Harper (2014) (398)	New Zealand	Students aged 18-24 years	HLAT-51	144 (41.0)	Purposeful sampling	College
15	Warsh *et al.* (2014) (397)	USA	Children aged 7-17 years (median age=11)	NVS	97 (46.0)	Convenience sampling	Paediatric clinics

Note: na, no information available. CHC Test, the Critical Health Competence Test; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; DNT, the Diabetes Numeracy Test; eHEALS, the eHealth Literacy Scale; HKACSS, the Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; HLAT-8, the 8-item Health Literacy Assessment Tool; HLAT-51, the 51-item Health Literacy Assessment Tool; MHL, the Media Health Literacy; MMAHL, the Multidimensional Measure of Adolescent Health Literacy; NVS, the Newest Vital Sign; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; s-TOFHLA, the short-form Test of Functional Health Literacy in Adults; TOFHLA, the Test of Functional Health Literacy in Adults.

4.5.2 General characteristics of included instruments

This systematic review identified 15 health literacy instruments used for adolescents (See **Table 4.6**). Depending on whether the instrument was developed bespoke for the study or not (33), the 15 included health literacy instruments were classified into three groups:

1) Newly-developed instruments for adolescent health literacy (n=9), including the Rapid Estimate of Adolescent Literacy in Medicine (REALM-Teen) (252, 400), the Health Literacy Assessment Booklet (HLAB) (177), the Multidimensional Measure of Adolescent Health Literacy (MMAHL) (246), the Media Health Literacy (MHL) (6), the eHealth Literacy Scale (eHEALS) (208), the Critical Health Competence Test (CHC Test) (399), the Health Knowledge; Attitudes, Communication and Self-efficacy Scale (HKACSS) (249), the 51-item Health Literacy Assessment Tool (HLAT-51) (398) and the 8-item Health Literacy Assessment Tool (HLAT-8) (4);
2) Adapted instruments that were based on previous instruments for adult health literacy (n=3), including the Chinese version of the short-form Test of Functional Health Literacy in Adolescents (c-sTOFHLAd) (50), the Diabetes Numeracy Test-39 (DNT-39) (401) and the Diabetes Numeracy Test-14 (DNT-14) (401);
3) Original instruments that were developed for adult health literacy (n=3), including the Newest Vital Sign (NVS) (169, 397, 400), the Test of Functional Health Literacy in Adults (TOFHLA) (251) and the short-form Test of Functional Health Literacy in Adults (s-TOFHLA) (400).

Table 4.6: General characteristics of included instruments used for adolescents

No	Health literacy instrument	Health literacy definition	Health literacy component (item number)	Health topic and content (readability level)	Response category	Scoring system
1	NVS (169, 397, 400)	Health literacy was defined as '*the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health-related decisions.*' (IOM, 2004) (67)	1. Reading comprehension (2) 2. Numeracy (4)	Nutrition-related information about the label of an ice cream container (na)	Open-ended	Score: 0-6; Ordinal category: 0-1: high likelihood of limited literacy; 2-3: possibility of limited literacy; 4-6: adequate literacy
2	TOFHLA (251)	Health literacy was defined as '*the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health care decisions.*' (IOM, 2004) (67)	1. Reading comprehension (50) 2. Numeracy (17)	Instruction for preparation for an upper gastrointestinal series (4.3 grade), a standard informed consent form (10.4 grade), patients' rights and responsibilities section of a Medicaid application form (19.5 grade), actual hospital forms & labelled prescription vials (9.4 grade)	4 response options	Score: 0-100; Ordinal category: 0-59: inadequate health literacy; 60-74: marginal health literacy; 75-100: adequate health literacy
3	s-TOFHLA (400)	Health literacy was defined as '*the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health-related decisions.*' (IOM, 2004) (67)	Reading comprehension (36)	Instruction for preparation for an upper gastrointestinal series (4^{th} grade), patients' rights and responsibilities section of a Medicaid application form (10^{th} grade)	4 response options	Score: 0-36; Ordinal category: 0-16: inadequate literacy; 17-22: marginal literacy; 23-36: adequate literacy
4	c-sTOFHLAd (50)	Health literacy refers to '*a capacity of an individual to obtain, interpret and understand basic health information products and services and the competence to use such information and services in ways that are health enhancing.*' (WHO, 1998) (68)	Reading comprehension (36)	Instruction for preparation for an upper gastrointestinal series (4^{th} grade), patients' rights and responsibilities section of a Medicaid application form (10^{th} grade)	4 response options	Score: 0-36; Ordinal category: 0-16: inadequate literacy; 17-22: marginal literacy; 23-36: adequate literacy
5	REALM-Teen (252, 400)	Health literacy refers to '*an individual's capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions.*' (IOM, 2004) (67)	Reading recognition (66)	66 health-related words such as weight, prescription and tetanus (6^{th} grade)	Open-ended	Score: 0-66; Ordinal category: 0-37: $\leq 3^{rd}$; 38-47: 4^{th}-5^{th}; 48-58: 6^{th}-7^{th}; 59-62: 8^{th}-9^{th}; 63-66: $\geq 10^{th}$

No	Health literacy instrument	Health literacy definition	Health literacy component (item number)	Health topic and content (readability level)	Response category	Scoring system
6	HLAB (177)	Health literacy refers to '*the ability to access, understand, evaluate and communicate information as a way to promote, maintain and improve health in a variety of settings across the life-course.*' (Rootman and Gordon-El-Bihbety, 2008) (88)	1. Understanding health information (30) 2. Evaluating health information (17)	A range of topics such as nutrition and sexual health (pilot-tested)	Open-ended	Score: 0-107; Continuous category
7	MMAHL (246)	'*Health literacy occurs when the skills and ability of those requiring health information and services are aligned with the demand and complexity of information and services.*' (Parker and Ratzan, 2010) (70)	1. Patient-provider encounter (4) 2. Interaction with the health care system (5) 3. Rights and responsibilities (7) 4. Confidence in using health information from personal source (3) 5. Confidence in using health information from media source (3) 6. Health information seeking competency using the Internet (2)	Experiences of how to access, navigate and manage one's health care and preventive health needs (6^{th} grade)	5-point Likert scale	Score: na; Continuous category
8	MHL (6)	Media health literacy is conceptualised as a continuum, ranging from the ability to identify health-related content in the media; recognise its influence on health behaviour; critically analyse the content and to express intention to respond through action (Levin-Zamir, 2011) (6)	1. Content identification (6) 2. Perceived influence on behaviour (6) 3. Critical analysis (6) 4. Action/reaction (6)	Nutrition/dieting, physical activity, body image, sexual activity, cigarette smoking, alcohol consumption, violent behaviours, safety habits and/or friendship and family connectedness (pilot-tested)	Open-ended & multiple choice	Score: 0-24; Continuous category
9	DNT-39 (401)	Numeracy was defined as '*the ability to understand and use numbers in daily life.*' (Rothman *et al.*, 2008) (402)	Health numeracy (39)	Nutrition, exercise, blood glucose monitoring and insulin administration (na)	Open-ended	Score: 0-100; Continuous category
10	DNT-14 (401)	Numeracy was defined as '*the ability to understand and use numbers in daily life.*' (Rothman *et al.*, 2008) (402)	Health numeracy (14)	Nutrition, exercise, blood glucose monitoring and insulin administration (na)	Open-ended	Score: 0-100; Continuous category
11	eHEALS (208)	eHealth literacy was defined as '*the ability to read, use computers, search for information, understand health information and put it into context.*' (Norman, 2008) (208)	1. Accessing health information (4) 2. Evaluating health information (2) 3. Applying health information (2)	General health topics about online health information (pilot-tested)	5-point Likert scale	Score: na; Continuous category

No	Health literacy instrument	Health literacy definition	Health literacy component (item number)	Health topic and content (readability level)	Response category	Scoring system
12	CHC Test (399)	Health literacy represents '*the cognitive and social skills, which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health.*' (WHO, 1998) (68)	1. Understanding medical concepts (15) 2. Searching literature skills (22) 3. Basic statistics (18) 4. Design of experiments and sampling (17)	Echinacea and common cold, magnetic resonance imaging in knee injuries, treatment of acne, breast cancer screening (pilot-tested)	Open-ended & multiple choice	na
13	HKACSS (249)	Health literacy was defined as '*personal, cognitive and social skills which determine the ability of individuals to gain access to, understand and use information to promote and maintain good health.*' (WHO, 1998) (68)	1. Health knowledge (3) 2. Health attitudes (4) 3. Health communication (3) 4. Self-efficacy (3)	Physical activities, nutrition, smoking, vaccination, tooth health and general health (na)	2 response options; 5-point Likert scale; 4-point Likert scale	Score: na; Continuous category
14	HLAT-51(398)	Health literacy is beyond the ability to read health information. Health literacy includes comprehension, health numeracy, media literacy, digital literacy and Internet health information-seeking skills (WHO, 1998; the Calgary Charter on Health Literacy, 2009) (68, 87)	1. Comprehension skill (20) 2. Health numeracy (11) 3. Media literacy (8) 4. Digital literacy (12)	Health topics such as gout and uric acid, high cholesterol and triglyceride levels, health-information-seeking skills (na)	Yes/no; multiple choice	na
15	HLAT-8 (4)	Health literacy refers to '*individuals' knowledge and skills to prevent disease and to promote health in everyday life.*' (Nutbeam, 2008; Peerson and Saunders, 2009) (5, 403)	1. Understanding health information (2) 2. Finding health information (2) 3. Communicating health information (2) 4. Evaluating health information (2)	General health topics in people's daily life (na)	5-point Likert scale; 4-point Likert scale	Score: 0-37; Continuous category

Note: na, no information available. CHC Test, the Critical Health Competence Test; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; DNT, the Diabetes Numeracy Test; eHEALS, the eHealth Literacy Scale; HKACSS, the Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; HLAT-8, the 8-item Health Literacy Assessment Tool; HLAT-51, the 51-item Health Literacy Assessment Tool; IOM, the Institute of Medicine; MHL, the Media Health Literacy; MMAHL, the Multidimensional Measure of Adolescent Health Literacy; NVS, the Newest Vital Sign; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; s-TOFHLA, the short-form Test of Functional Health Literacy in Adults; TOFHLA, the Test of Functional Health Literacy in Adults; WHO, the World Health Organization.

4.5.2.1 Health literacy definitions

As summarised in **Table 4.6**, more than half (n=8) of the 15 included studies used health literacy definitions from the WHO or the IOM. Almost all studies (n=14) regarded health literacy as a skills-based concept that reflected an individual's ability to access, understand and use health information and services. Only one study defined health literacy as an interactive outcome influenced by an individual's ability and the broad environment (246). Particularly, there were two studies defining health literacy in the context of eHealth (i.e. eHealth literacy) (208) or media health (i.e. media health literacy) (208), while most studies defined health literacy in the general health context, such as in clinics and schools. There was one study about health numeracy which referred to the ability to understand and use numbers in daily life (401).

4.5.2.2 Health literacy components

Health literacy component was defined as a dimension of health literacy (43) which may involve different kinds of knowledge, skills, capabilities and competencies. Health literacy is such a broad concept (5, 45) that makes its measurement complex and various (35, 45, 212). To understand and capture the commonly used components of health literacy, I employed Nutbeam's three-domain health literacy model to classify the 15 included instruments (3). As shown in **Table 4.7**, seven instruments measured only functional health literacy and one instrument measured only critical health literacy. Five instruments measured health literacy by three domains.

Table 4.7: Health literacy instruments based on Nutbeam's three-domain health literacy model

Domain	Health literacy instrument
Functional health literacy	The REALM-Teen (252, 400), the TOFHLA (251), the s-TOFHLA (400), the c-sTOFHLAd (50), the NVS (169, 397, 400), the DNT-39 (401) and the DNT-14 (401)
Critical health literacy	The CHC Test (399)
Functional and interactive health literacy	The HKACSS (249)
Functional and critical health literacy	The HLAB (177)
Functional, interactive and critical health literacy	The MMAHL (246), the MHL (6), the eHEALS (208), the HLAT-51 (398) and the HLAT-8 (4)

Note: CHC Test, the Critical Health Competence Test; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; DNT, the Diabetes Numeracy Test; eHEALS, the eHealth Literacy Scale; HKACSS, the Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; HLAT-8, the 8-item Health Literacy Assessment Tool; HLAT-51, the 51-item Health Literacy

Assessment Tool; MHL, the Media Health Literacy; MMAHL, the Multidimensional Measure of Adolescent Health Literacy; NVS, the Newest Vital Sign; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; s-TOFHLA, the short-form Test of Functional Health Literacy in Adults; TOFHLA, the Test of Functional Health Literacy in Adults.

When comparing health literacy definitions used in the study with health literacy components used in each instrument, only seven instruments (the DNT-39, the DNT-14, the MMAHL, the MHL, the eHEALS, the HLAT-51 and the HLAT-8) were found to measure health literacy in accordance with its particular definition. As for the other eight instruments, although health literacy was defined as a three-domain concept, health literacy was measured only by one domain or two domains. Specifically, five instruments measured only the functional domain (the REALM-Teen, the TOFHLA, the s-TOFHLA, the c-sTOFHLAd and the NVS); one instrument measured only the critical domain (the CHC Test); one instrument measured functional and interactive domains (the HKACSS); while one instrument measured functional and critical domains (the HLAB).

4.5.2.3 Health topics, contents and readability levels

Health literacy instruments for adolescents covered a range of health topics such as nutrition, sexual health and patients' rights. Most instruments (n=12) measured health literacy in healthcare settings or health promotion contexts, while only three instruments (the eHEALS, the MHL and the HLAT-51) measured health literacy in the specific context of eHealth or media health (6, 208). In relation to the readability of tested materials, only five health literacy instruments reported their readability levels, ranging from 6 to 19.5 grade. In addition, there were another four instruments that used pilot tests before their large-scale administration.

4.5.2.4 Total items, response options and scoring systems

The number of items included in health literacy instruments ranged from 6 to 72, with an average of 31. With respect to response options, the open-ended response option was included in five instruments; the multiple-choice response option was displayed in four instruments; the Likert-scale format was designed in three instruments; and the combined format was shown in the other three instruments (e.g. a combination of open-ended and multiple-choice response options). Scoring systems of instruments were introduced in ten studies, with six studies using the continuous scoring system and four studies using the categorical scoring system.

4.5.3 Evaluation of methodological quality of included studies

According to the COSMIN checklist (361), the methodological quality of each study as per each measurement property for each health literacy instrument is presented in **Table 4.8**. All studies (n=15) were available for an examination of their methodological quality based on content validity; 12 studies were available for checking internal consistency and hypotheses testing; six studies for structural validity; five studies for reliability; and only one study for cross-cultural validity.

Table 4.8: Methodological quality of each study for each measurement property according to the COSMIN checklist

Health literacy instrument (Author, year)	Internal consistency	Reliability	Measurement error	Content validity	Structural validity	Hypotheses testing	Cross-cultural validity	Responsive-ness
NVS (Hoffman *et al.*, 2013) (400)	Poor	na	na	Poor	na	Fair	na	na
NVS (Driessnack *et al.*, 2014) (169)	Poor	na	na	Poor	na	Poor	na	na
NVS (Warsh *et al.*, 2014) (397)	na	na	na	Poor	na	Fair	na	na
TOFHLA (Chisolm and Buchanan, 2007) (251)	na	na	na	Poor	na	Fair	na	na
s-TOFHLA (Hoffman *et al.*, 2013) (400)	Poor	na	na	Poor	na	Fair	na	na
c-sTOFHLAd (Chang *et al.*, 2012) (50)	Fair	Fair	na	Good	Fair	Fair	Fair	na
REALM-Teen (Davis *et al.*, 2006) (252)	Poor	Fair	na	Good	na	Fair	na	na
REALM-Teen (Hoffman *et al.*, 2013) (400)	Poor	na	na	Poor	na	Poor	na	na
HLAB (Wu *et al.*, 2010) (177)	Fair	Poor	na	Good	na	Fair	na	na
MMAHL (Massey *et al.*, 2013) (246)	Good	na	na	Good	Good	na	na	na
MHL (Levin-Zamir *et al.*, 2011) (6)	Poor	na	na	Good	na	Good	na	na
DNT-39 (Mulvaney *et al.*, 2013) (401)	Fair	na	na	Poor	na	Fair	na	na
DNT-14 (Mulvaney *et al.*, 2013) (401)	Fair	na	na	Poor	na	Fair	na	na
eHEALS (Norman and Skinner, 2006) (208)	Fair	Fair	na	Good	Fair	Fair	na	na
CHC Test (Steckelberg *et al.*, 2009) (399)	na	Poor	na	Good	Poor	na	na	na
HKACSS (Schmidt *et al.*, 2010) (249)	Excellent	na	na	Good	na	Good	na	na
HLAT-51 (Harper, 2014) (398)	Poor	na	na	Good	Poor	na	na	na
HLAT-8 (Abel *et al.*, 2014) (4)	Excellent	na	na	Poor	Excellent	Good	na	na

Note: na, no information available. CHC Test, the Critical Health Competence Test; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; DNT, the Diabetes Numeracy Test; eHEALS, the eHealth Literacy Scale; HKACSS, the Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; HLAT-8, the 8-item Health Literacy Assessment Tool; HLAT-51, the 51-item Health Literacy Assessment Tool; MHL, the Media Health Literacy; MMAHL, the Multidimensional Measure of Adolescent Health Literacy; NVS, the Newest Vital Sign; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; s-TOFHLA, the short-form Test of Functional Health Literacy in Adults; TOFHLA, the Test of Functional Health Literacy in Adults.

4.5.4 Evaluation of measurement properties of included instruments

After the methodological quality assessment of included studies, measurement properties of each health literacy instrument were examined according to Terwee's quality criteria (394). The rating results of measurement properties of each instrument are summarised in **Table 4.9**. Further details of rating results are presented in **Appendix 4.2**: Reliability and validity results for included instruments.

Table 4.9: Evaluation of measurement properties for included instruments according to Terwee's quality criteria

Health literacy instrument (Author, year)	Internal consistency	Reliability	Measurement error	Content validity	Structural validity	Hypotheses testing	Cross-cultural validity	Responsive-ness
NVS (Hoffman *et al.*, 2013) (400)	-	na	na	?	na	-	na	na
NVS (Driessnack *et al.*, 2014) (169)	+	na	na	?	na	-	na	na
NVS (Warsh *et al.*, 2014) (397)	na	na	na	?	na	+	na	na
TOFHLA (Chisolm and Buchanan, 2007) (251)	na	na	na	?	na	+ (TOFHLA-R) -(TOFHLA-N)	na	na
s-TOFHLA (Hoffman *et al.*, 2013) (400)	+	na	na	?	na	-	na	na
c-sTOFHLAd (Chang *et al.*, 2012) (50)	+	+	na	+	?	+	?	na
REALM-Teen (Davis *et al.*, 2006) (252)	+	+	na	+	na	+	na	na
REALM-Teen (Hoffman *et al.*, 2013) (400)	+	na	na	?	na	-	na	na
HLAB (Wu *et al.*, 2010) (177)	+	+	na	+	na	-	na	na
MMAHL (Massey *et al.*, 2013) (246)	+	na	na	+	-	na	na	na
MHL (Levin-Zamir *et al.*, 2011) (6)	+	na	na	+	na	+	na	na
DNT-39 (Mulvaney *et al.*, 2013) (401)	+	na	na	?	na	-	na	na
DNT-14 (Mulvaney *et al.*, 2013) (401)	+	na	na	?	na	-	na	na
eHEALS (Norman and Skinner, 2006) (208)	+	-	na	+	+	-	na	na
CHC Test (Steckelberg *et al.*, 2009) (399)	na	+	na	+	+	na	na	na
HKACSS (Schmidt *et al.*, 2010) (249)	+ (Health communication) - (Health attitude)	na	na	+	na	+	na	na
HLAT-51 (Harper, 2014) (398)	?	na	na	+	?	na	na	na
HLAT-8 (Abel *et al.*, 2014) (4)	-	na	na	?	+	+	na	na

Note: na, no information available; + positive rating; ? indeterminate rating; - negative rating. CHC Test, the Critical Health Competence Test; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; DNT, the Diabetes Numeracy Test; eHEALS, the eHealth Literacy Scale; HKACSS, the Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; HLAT-8, the 8-item Health Literacy Assessment Tool; HLAT-51, the 51-item Health Literacy Assessment Tool; MHL, the Media Health Literacy; MMAHL, the Multidimensional Measure of Adolescent Health Literacy; NVS, the Newest Vital Sign; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; s-TOFHLA, the short-form Test of Functional Health Literacy in Adults; TOFHLA, the Test of Functional Health Literacy in Adults; TOFHLA-N, the Numeracy part of the Test of Functional Health Literacy in Adults; TOFHLA-R, the Reading part of the Test of Functional Health Literacy in Adults.

4.5.5 The synthesised evidence for the overall rating of measurement properties

Finally, a synthesis was conducted for the overall rating of measurement properties for each instrument according to '*the best evidence synthesis*' guidelines recommended by the COSMIN checklist developer group (362). This synthesis result was derived from information presented in **Table 4.8** and **Table 4.9**. Results were combined for two health literacy instruments (the NVS and the REALM-Teen) that were examined by different authors. The overall rating of each measurement property for each health literacy instrument is presented in **Table 4.10**. In summary, most information (70.8%, 85/120) on measurement properties was unknown due to either poor methodological quality of studies or a lack of information on reporting or assessment. Despite the limited information, the c-sTOFHLAd was found to have positive evidence on four measurement properties. Two instruments (the REALM-Teen and the eHEALS) had positive evidence on three measurement properties. Six instruments (the HLAB, the MMAHL, the MHL, the HKACSS and the HLAT-8) showed positive evidence on two measurement properties.

Table 4.10: The overall rating of measurement properties for each health literacy instrument used for adolescents

Health literacy instrument	Internal consistency	Reliability	Measurement error	Content validity	Structural validity	Hypotheses testing	Cross-cultural validity	Responsive-ness
NVS (169, 397, 400)	?	na	na	?	na	±	na	na
TOFHLA (251)	na	na	na	?	na	+ (TOFHLA-R) - (TOFHLA-N)	na	na
s-TOFHLA (400)	?	na	na	?	na	-	na	na
c-sTOFHLAd (50)	+	+	na	++	?	+	?	na
REALM-Teen (252, 400)	?	+	na	++	na	+	na	na
HLAB (177)	+	?	na	++	na	-	na	na
MMAHL (246)	++	na	na	++	--	na	na	na
MHL (6)	?	na	na	++	na	++	na	na
DNT-39 (401)	+	na	na	?	na	-	na	na
DNT-14 (401)	+	na	na	?	na	-	na	na
eHEALS (208)	+	-	na	++	+	-	na	na
CHC Test (399)	na	?	na	++	?	na	na	na
HKACSS (249)	+++ (Health communication) --- (Health attitude)	na	na	++	na	++	na	na
HLAT-51 (398)	?	na	na	++	?	na	na	na
HLAT-8 (4)	---	na	na	?	+++	++	na	na

Note: na, no information available; +++ or --- strong evidence and positive/negative result; ++ or -- moderate evidence and positive/negative result; + or - limited evidence and positive/negative result; ± conflicting evidence; ? unknown, due to poor methodological quality or indeterminate rating of a measurement property. CHC Test, the Critical Health Competence Test; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; DNT, the Diabetes Numeracy Test; eHEALS, the eHealth Literacy Scale; HKACSS, the Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; HLAT-8, the 8-item Health Literacy Assessment Tool; HLAT-51, the 51-item Health Literacy Assessment Tool; MHL, the Media Health Literacy; MMAHL, the Multidimensional Measure of Adolescent Health Literacy; NVS, the Newest Vital Sign; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; s-TOFHLA, the short-form Test of Functional Health Literacy in Adults; TOFHLA, the Test of Functional Health Literacy in Adults; TOFHLA-N, the Numeracy part of the Test of Functional Health Literacy in Adults; TOFHLA-R, the Reading part of the Test of Functional Health Literacy in Adults.

4.5.6 Other important characteristics of included instruments

Other important characteristics of included instruments are presented in **Table 4.11**. These important characteristics included interpretability (372), burden (respondent burden and administrative burden) (389), and forms of administration (self-administered or interviewer-administered; self-report or performance-based) (389).

4.5.6.1 Interpretability

According to the COSMIN checklist manual (262), the extracted information about interpretability included percentages of missing items, description of how missing items were handled, distribution of the total scores, and percentages of respondents who had the lowest possible score and the highest possible score. In this systematic review, only one study reported percentages of missing items for the HKACSS (249), while three studies mentioned how they addressed missing items for instruments of the MMAHL, the HKACSS and the HLAT-8 (4, 246, 249). Eight studies described the distribution of total scores for health literacy.

4.5.6.2 Burden

The burden of an instrument is classified into the respondent burden and the administrative burden (389). Among the 15 instruments, the time to administer was reported in seven instruments, with the administration time ranging from 3 to 90 minutes. With respect to the administrative burden, the ease of scoring was examined for each instrument. According to the quality criteria proposed by Bot *et al.* (285), there were three rating levels for administrative burden: easy (summing up of the items), moderate (visual analogue scale or single formula) and difficult (visual analogue scale in combination with formula or complex formula). This review found that six instruments were rated as '*easy*' and four instruments as '*moderate*'.

4.5.6.3 Forms of administration

There were three forms of administration when measuring adolescent health literacy: seven interviewer-administered instruments (n=7), seven self-administered instruments (n=7), and one video-assisted, interviewer-administered instrument (n=1). As for the method of assessment, ten instruments were performance-based, three instruments were self-report, and two included both performance-based and self-report items.

Table 4.11: Other important characteristics of health literacy instruments used for adolescents

No	Health literacy instrument	Interpretability	Respondent burden	Administrative burden	Administration form	Instrument design
1	NVS (169, 397, 400)	• Non-normative distribution (169) • Median scores=2 (IQR=1-4) (397) • Total scores: 4.8±1.5 (169)	No longer than 3 minutes	Summing up of the items	Interviewer-administered & Performance-based	Original
2	TOFHLA (251)	• Negatively skewed distribution • Total scores: 28.27±3.36	12.9 minutes (8.9-17.3 minutes)	Simple formula	Interviewer-administered & Performance-based	Original
3	s-TOFHLA (400)	na	na	Summing up of the items	Interviewer-administered & Performance-based	Original
4	c-sTOFHLAd (50)	na	20-minute class period	Summing up of the items	Self-administered & Performance-based	Adapted
5	REALM-Teen (252, 400)	• Mean score:56.8±10.7 (252) • Median score=61 (252)	2-3 minutes	Summing up of the items	Interviewer-administered & Performance-based	Newly-developed
6	HLAB (177)	• Normal distribution • Total scores: 41.8±17.3	Two regular classroom sessions	Simple formula	Self-Administered & Performance-based	Newly-developed
7	MMAHL (246)	• Missing data were assessed by multiple imputations using chained equations	na	na	Self-administered & Self-report	Newly-developed
8	MHL (6)	• Normal distribution • Total scores: 10.12±3.43	na	Summing up of the items	Video-assisted interviewer-administered & Performance-based	Newly-developed
9	DNT-39 (401)	• Total scores: 69.25±16.99	na	Simple formula	Interviewer-administered & Performance-based	Adapted
10	DNT-14 (401)	• Negatively skewed distribution • Total scores: 75.56±22.00	na	Simple formula	Interviewer-administered & Performance-based	Adapted
11	eHEALS (208)	na	na	na	Self-Administered & Self-report	Newly-developed
12	CHC Test (399)	na	Less than 90 minutes	na	Interviewer-administered & Performance-based	Newly-developed
13	HKACSS (249)	• Percentages of missing items ranged 3.1%-14.7% • Probabilistic multiple imputation was conducted to avoid excess missing values	na	na	Self-Administered & Performance-based & Self-report	Newly-developed

No	Health literacy instrument	Interpretability	Respondent burden	Administrative burden	Administration form	Instrument design
14	HLAT-51 (398)	na	30-45 minutes	na	Self-administered & Performance-based & Self-report	Newly-developed
15	HLAT-8 (4)	• Respondents who had one/more missing values were excluded • Normal distribution • Total scores in men: 25.54±5.38 • Total scores in women: 27.57±4.87	na	Summing up of the items	Self-administered & Self-report	Newly-developed

Note: na, no information available. CHC Test, the Critical Health Competence Test; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; DNT, the Diabetes Numeracy Test; eHEALS, the eHealth Literacy Scale; HKACSS, the Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; HLAT-8, the 8-item Health Literacy Assessment Tool; HLAT-51, the 51-item Health Literacy Assessment Tool; IQR, interquartile range; MHL, the Media Health Literacy; MMAHL, the Multidimensional Measure of Adolescent Health Literacy; NVS, the Newest Vital Sign; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; s-TOFHLA, the short-form Test of Functional Health Literacy in Adults; TOFHLA, the Test of Functional Health Literacy in Adults.

4.6 Discussion

4.6.1 Summary of main results

This systematic review identified and examined 15 health literacy instruments used for adolescents. Results showed that health literacy was mainly defined as a skills-based concept for this population group. There was a large variety of methods to measure adolescent health literacy. Health literacy measurement in adolescents generally focused on the functional domain, and less on the interactive and critical domains. The methodological quality of included studies as per each measurement property varied from poor to excellent. Most information (70.8%) on measurement properties was unknown due to either the poor methodological quality of studies or a lack of reporting or assessment. It is difficult to draw a robust conclusion about which instrument is the most reliable and valid for adolescents.

4.6.2 Health literacy definitions for adolescents

This review found that adolescent health literacy was a skills-based concept in 14 of 15 included studies which defined health literacy as an individual's ability to find, understand and use health information and services to protect health. Only one study defined adolescent health literacy as an interactive outcome influenced by individuals' skills and complex health environments (246). This finding is similar to that from Bröder's systematic review in 2017 (22) which suggests that the currently-used health literacy definitions for adolescents are mainly consistent with the second stage of the evolving concept of health literacy (See Chapter 2.1.2). Health literacy is regarded as a range of health skills to deal with health information successfully. From a public health perspective, health literacy is a personal asset to promote health, requiring a high level of personal skills and empowerment (5, 107). In school settings, the skills-based concept of health literacy is aligned with the goal of school health education (101) which aims to improve students' health knowledge and skills. Given that children and adolescents can empower themselves to become active participants in developing their own health literacy skills (404, 405), more attention should be given in schools to promoting health literacy skills for adolescents at an early age. On the other hand, an increasing number of studies have acknowledged that health literacy is not only an individual issue, but also an interactive outcome influenced by an individual's skills, the broader environment, and the resources available (91, 95-97, 238). This is not only the case for understanding health literacy in adults, but also for understanding health literacy in different population including adolescents. For instance, Peralta *et al.* (19) proposed a new approach conceptualising adolescent health literacy. Three areas of focus (adolescent development and capability learning, health-literate organisation, and critical health literacy) are regarded as key components to conceptualise adolescent health literacy in the school setting. Particularly, the component of 'health-literate organisation' recommends using a whole school approach to change for health such as planning for school development and providing organisational support. The importance of the broader environment to adolescent health literacy will be further discussed in Chapter 7.2: Adolescent health literacy is mainly a skills-based concept.

This review also identified that the concept '*health literacy*' was context-specific for adolescents, as is the case for adult health literacy (29, 32, 45, 245). Most included studies (n=13) contextualised health literacy in the general health context such as in schools and clinics, while two studies defined health literacy either in the eHealth context (eHealth literacy) or in the media health context (media health literacy). There might be two reasons for the adoption of the terms '*eHealth literacy*' and '*media health literacy*'. One reason reflects the challenges that adolescents face when using the Internet to access online health information (183-185). As discussed in Chapter 2.3.3.3, adolescents use the Internet as a valuable resource for addressing their health concerns due to the popularity, confidentiality and anonymity of the Internet. However, their low health literacy means they cannot derive maximum benefit from this information resource (406, 407). Therefore, it is essential to integrate health literacy into the eHealth context or media health context. The other reason for generating '*eHealth literacy*' and '*media health literacy*' arises from the difference between eHealth/media contexts and general contexts. The common sources of health information for adolescents were families, friends, and medical professionals in general contexts (406). In such contexts, young people can have interactions with others and seek more support when dealing with difficult health information. By comparison, finding and using health information in eHealth/media contexts is always a solitary exercise for adolescents. That is, they evaluate health information mainly by themselves, requiring them to have higher levels of health literacy in eHealth/media contexts than in general contexts. Therefore, health literacy in eHealth/media contexts is different from that in general contexts. It is necessary to re-define health literacy in the specific context of eHealth or media health. In summary, the rise of these new terminologies (‘*eHealth literacy*’ and ‘*media health literacy*’) requires a new understanding of health literacy in different contexts and presents new opportunities for future measurement and intervention studies in these new contexts.

4.6.3 Health literacy measurement in adolescents

This review identified only seven instruments that measured health literacy in accordance with their particular definitions. Consistent with Pleasant’s finding (193), this suggests that a large gap exists between the conceptual definitions and the operational definitions (i.e. measurement) of health literacy in current research. The main reason for this mismatch is that health literacy measurement in adolescents still focuses on the functional domain rather than three domains (functional, interactive and critical). Unlike health literacy research for patients in clinics (5, 408), health literacy research for adolescents should be from a health promotion perspective (16, 44, 247), rather than a health care or disease management perspective. As recommended in the Bangkok Charter (409) and the HPS framework (42), building capacity for health literacy is necessary to promote health in adolescents. The focus of health literacy for this young population should be not only on the functional domain (i.e. aiming for communication of information), but also on the interactive (i.e. aiming for the development of personal skills) and critical domains (i.e. aiming for personal and community empowerment) (3). Given that current evidence is limited to measuring functional health literacy, ignoring the interactive and critical domains, there is a need for future research to use the three-domain instrument to measure adolescent health literacy.

This review revealed that there was a large variety of methods used to measure health literacy for adolescents. Health literacy measurement varied in terms of components, health topics, response options, scoring systems, burden and forms of administration. There were several reasons for this disparity. First, definitions of health literacy were inconsistent. Some researchers measured health literacy using general health topics (4, 177), while others measured eHealth literacy or media health literacy using specific health topics (6, 208). Second, researchers had different research purposes for their studies. Some researchers tried to use what were originally adult instruments to measure adolescent health literacy (169, 251, 397), whereas others wanted to develop a new or an adapted instrument (177, 252, 398, 401). Third, the research settings affected the measurement process. As clinical settings were busy, short surveys were more appropriate than long surveys (246, 252, 397). On the other hand, health literacy in school settings was often measured by long and comprehensive surveys (177, 398, 399). Due to the complex and broad nature of health literacy, it is challenging to measure adolescent health literacy using a unified approach. However, it should be noted that there are key evaluation principles for guiding health literacy measurement research. In 2011, Pleasant *et al.* (28) proposed seven evaluation principles for health literacy measurement, including: 1) using a conceptual model; 2) considering multi-dimensions; 3) measuring on a continuous basis; 4) treating health literacy as a latent construct; 5) honouring the principle of compatibility; 6) allowing comparisons across contexts and populations; and 7) prioritising public health research. When looking through the 15 included measurement studies, few researchers have put these evaluation principles into practice. There is clearly a need for future researchers to use such evaluation principles to reduce disparities in health literacy measurement.

4.6.4 The methodological quality of included studies

This review included a methodological quality assessment of included studies, which was missing in previous reviews on this subject (33, 34). Methodological quality assessment is important because strong conclusions about the measurement properties of instruments can only be drawn from high-quality studies. In this review, the COSMIN checklist was shown to be a useful framework for critically appraising the methodological quality of studies as per each measurement property (361). Findings suggested that there was a wide variation in the methodological quality of studies for each instrument. The poor methodological quality of studies was often seen in the original or adapted health literacy instruments (the NVS, the TOFHLA, the s-TOFHLA, the DNT-39 and the DNT-14). Studies were rated as poor quality for three main reasons. The first reason was the unclear description of the target population involved, making evaluating content validity difficult. This suggested that researchers were less likely to consider an instrument's content validity when using the original adult instrument for adolescents. Given that adolescents have less well-developed cognitive abilities, it is essential to assess whether all items within an instrument are understandable and relevant for adolescents. As recommended by Velardo and Drummond (167), one essential step to contribute to child health literacy is that the delivery of information can be easily accessed and understood by younger age groups. This is the same case for adolescent health literacy. There is a need for future research to consider different characteristics of populations when using the same instrument in different populations. The second reason was a lack of uni-dimensionality analysis for internal consistency. As explained in the COSMIN checklist manual (262), uni-dimensionality and internal consistency are not the same. Internal consistency refers to the degree of inter-relatedness among items (372). Given that a set of items can be inter-related and multi-dimensional (410), uni-dimensionality was a prerequisite for a clear interpretation of the internal consistency statistics (Cronbach's alpha) (262). Future research needs to include both the internal consistency statistics and uni-dimensionality analysis (e.g. factor analysis) for describing internal consistency. Finally, the last reason was the small sample size for validation studies. Four studies were found to be of poor quality in their evaluation of internal consistency, reliability, structural validity or hypotheses testing (169, 398-400). Further discussion of the sample size requirement will be given in Chapter 7.4.1: Reflections of using the COSMIN checklist.

In summary, current evidence was limited on methodological quality due to a scarcity of rigorous literature reporting sufficient information on measurement properties. In order to enhance the methodological quality of future studies on all measurement properties, researchers need to use the COSMIN checklist when developing or validating a health literacy instrument, as '*the COSMIN checklist can be used as guidance for designing or reporting a study on measurement properties*' (393).

4.6.5 The overall rating of reliability for included instruments

This review demonstrated that only the c-sTOFHLAd showed positive evidence of both internal consistency and test-retest reliability. The c-sTOFHLAd was a translated tool of the s-TOFHLA from English to Chinese (50). Compared to the overall rating of reliability of the s-TOFHLA (400), the c-sTOFHLAd showed better results. The reason for this positive evidence was probably the different methodological quality of included studies for the s-TOFHLA and the c-sTOFHLAd. The c-sTOFHLAd study had fair methodological quality in terms of internal consistency and test-retest reliability, whereas the original s-TOFHLA study had poor methodological quality for internal consistency and unknown information for test-retest reliability. Given the large disparity of rating results between the original and translated instrument, further evidence on a rigorous methodology is needed to confirm whether the s-TOFHLA has the same or a different reliability within different cultures, thus assisting researchers to understand the generalisability of the s-TOFHLA's reliability results.

Our review also showed that a large gap existed between the methodological quality of studies and the rating results of instruments for internal consistency. Although 10 instruments had positive rating results for internal consistency, only six of them were found to be based on good methodological quality studies. Without high-quality study design and reporting, it is difficult to draw a strong conclusion on internal consistency. Therefore, future researchers who assess internal consistency should ensure their studies' quality. Test-retest reliability was less commonly examined than internal consistency. Only two instruments (the c-sTOFHLAd and the REALM-Teen) showed positive evidence of test-retest reliability. One possible reason for this limited, positive evidence was the complexity of administration. For example, the MMAHL, the DNT-39 and the DNT-14 were administered in busy clinical settings - it was difficult to recruit the same respondent for a second round of administration (246, 401). However, despite the difficulty of administration, it is still worthwhile to examine test-retest reliability because it can indicate whether consistent results can be reproduced, or whether the generalisation is limited (411). Due to a lack of assessment of test-retest reliability for current instruments, there is a need for future research to fill this gap.

4.6.6 The overall rating of validity for included instruments

There were six instruments (the c-sTOFHLAd, the REALM-Teen, the MHL, the eHEALS, the HKACSS and the HLAT-8) found to show positive evidence of both content validity and construct validity (including structural validity, hypotheses testing and cross-cultural validity). In this review, I focused on examining construct validity for two reasons. First, construct validity is seen as the core of an instrument's validity in the field of psychometrics. It determines whether operational variables adequately represent theoretical constructs underlying an instrument (412, 413). Second, the overall rating results of content validity for included instruments were similar (i.e. either moderate, positive evidence '++' or unknown '?'). Therefore, construct validity was determined to be the key to examining the overall rating of validity for included instruments in this review. In this context, only the HLAT-8 showed positive evidence of structural validity and hypotheses testing (i.e. the degree to which the scores of an instrument are consistent with hypotheses based on the assumption that the instrument validly measures the construct to be measured, which includes known-group validity and convergent validity). However, in the original paper (4), the HLAT-8 was only tested for its known-group validity (i.e. health literacy varied between groups of gender, education and health values), not for convergent validity (i.e. the strength of association between two health literacy measures). Examination of convergent validity is also important because it assists researchers in understanding the extent to which two examined measures' constructs are theoretically and practically related, especially when researchers develop a new measure (414). Therefore, the HLAT-8 needs further evidence of its convergent validity to support its strong construct validity in the future.

It should be noted that structural validity was less commonly examined than content validity and hypotheses testing for the 15 included instruments, especially for the original and adapted instruments (e.g. the NVS, the TOFHLA, the DNT-39) that were initially developed for measuring adult health literacy (169, 251, 397, 400, 401). This suggests that researchers may have been overlooking the examination of construct validity when measuring adolescent health literacy using an instrument that was developed for adults. As a result, researchers may have misunderstood that construct validity of an instrument would be the same for adults and adolescents. In this review, one study showed that the two-factor structure of the s-TOFHLA for measuring adult health literacy turned to one-factor structure when measuring adolescent health literacy (50). Possible reasons for the changing structure might be different characteristics of populations (adults versus adolescents) or different cultural contexts (Western culture versus Chinese culture). Therefore, an instrument's structural validity may change if it targets a different population. This suggests that when measuring adolescent health literacy using an adult health literacy instrument, researchers need to confirm its structural validity before conducting large-scale surveys, thus enabling stronger conclusions to be drawn from the survey findings.

4.6.7 The overall rating of responsiveness for included instruments

As was the case in a previous study by Jordan *et al.* (31), this research demonstrated that none of the 15 studies contained evidence of instruments' responsiveness. Responsiveness is the ability of an instrument to detect change over time in the construct to be measured, and it is particularly important for longitudinal studies (361). However, most included studies in this review were cross-sectional studies, with only one study discussing the potential to measure health literacy over time using the MMAHL (246). Studies that measure health literacy over time in populations are needed, not only because this is a prerequisite for longitudinal studies, but also so that the responsiveness of instruments can be monitored and improved.

4.6.8 Feasibility issues for included instruments

This review also showed that feasibility aspects of included instruments varied in practice. This included interpretability (e.g. percentage of missing items, distribution of total scores), ease of administration (e.g. administration time, ease of score calculation), administration forms (e.g. self-administered, interviewer-administered, self-report, performance-based). The focus here is on discussing forms of administration because they are more likely to be considered when selecting an appropriate instrument in practice. In relation to the mode of administration, this review identified seven self-administered instruments and eight interviewer-administered instruments (including face-to-face interviewer-administered and video-assisted, interviewer-administered). This suggests that both administration modes are well accepted for measuring adolescent health literacy. Self-administered instruments are cost-effective and efficient, but may bring about respondent bias (415, 416), whereas interviewer-administered instruments, while able to ensure high response rates, are always resource intensive and expensive to administer (417, 418). Although the literature showed that there was no significant difference between these two administration modes (415-417, 419-421), the relevant studies mostly concerned health-related quality of life instruments. It is still not known whether differences exist between self-administered and interviewer-administered instruments for health literacy. Among adolescents, health literacy research is more likely to be conducted through large-scale surveys in school settings. Therefore, the more cost-effective self-administered mode seems to have great potential for future research. To further support the wide use of self-administered instruments, there is a need for future research to confirm the same effect of administration between self-administered and interviewer-administered instruments for adolescent health literacy.

With regard to the type of assessment method, this review revealed that ten instruments were performance-based; three instruments were self-report; and two instruments included both performance-based and self-report items. This suggests that most health literacy instruments are performance-based for adolescents. There might be two reasons for this. First, it is due to the characteristics of adolescents. Compared with adults, they have less well-developed cognitive ability and are dependent on their parents for health-related decisions (162). Measurement error is more likely to occur when adolescents answer self-report items (422). Therefore, performance-based assessment is often selected to avoid such inaccuracy. Second, performance-based instruments are objective, whereas self-report instruments are subjective and may bring about over-estimated results (4, 245). However, the frequent use of performance-based instruments does not suggest that they are more appropriate than self-report instruments when measuring adolescent health literacy. Compared with performance-based instruments, self-report instruments are always time-efficient and less embarrassing for respondents (193, 423). The only challenge in using self-report instruments is to consider the readability of tested materials. If adolescents can understand what a health literacy instrument measures, then they are more able to self-assess their own health literacy skills (167). The difference between self-report and performance-based instruments of health literacy has been discussed in the literature (242, 412), but the evidence is still limited due to either a lack of specifically-designed studies for exploring the difference or the complex nature of health literacy. Further studies are needed to fill this knowledge gap, for example, quantitative studies that examine the relationship between these two types of assessment methods, as well as qualitative studies on adolescents' preferences for each type.

4.6.9 Generalisability issues for included instruments

This review identified three gaps in the generalisability of findings from the 15 included instruments: 1) limited cultural contexts, mainly in North America and Europe; 2) a narrow age range of samples' demographics, mainly in adolescents aged 13 to 17; and 3) small samples and convenience sampling.

With regard to health literacy measurement in different cultural contexts, this review found that most instruments (12/15) were examined in North America and Europe. Adolescent health literacy measurement is under-researched in Asia and other parts of the world. When researchers use a health literacy instrument in a different culture, they should pay attention to the country of use and its cultural and language differences (378). As shown in the study by Chang *et al.* (50), there were large discrepancies between the overall rating of measurement properties for the s-TOFHLA and the c-sTOFHLAd. Therefore, it is necessary to confirm the generalisability of findings for included instruments across different cultural contexts.

This review showed that only two instruments targeted children aged 7 to 12. By contrast, most included instruments (11/15) were conducted among adolescents aged 13 to 17. This finding is aligned with Bröder's finding (22), suggesting that evidence is lacking for children's health literacy measurement. A possible reason for this is the different cognitive development ability between of children and adolescents (166). Compared to adolescents (13 to 17 years), children (7 to 12 years) have less well-developed cognitive abilities, thus making it more challenging to measure childhood health literacy. Given that health literacy is an important concept for both children and adolescents (19, 167, 404), there is a need for future research with more attention paid to childhood health literacy. A possible means of exploring this could be by validating health literacy instruments used for adolescents aged 13 to 17in children aged 7 to 12.

As for the sample size and sampling method, this review found that four instruments (the TOFHLA, the NVS, the DNT-39 and the DNT-14) used a sample size less than 100. As discussed in the original papers (169, 251, 397, 401), due to their small samples their findings may be not generalised to other populations. Therefore, these four instruments need further validation in a larger population. The sampling method is another factor that influences the generalisability of an instrument's results. This review showed that only one instrument (the c-sTOFHLAd) was administered in a multiple-stage stratified random sample (50). Two instruments (the HLAB and the NVS) were found to be using convenience sampling methods; five instruments (the eHEALS, the

MHL, the MMAHL, the HLAT-8 and the HLAT-51) were reported to use other sampling methods such as purposeful sampling and probability sampling; while the sampling procedures of seven instruments were unknown. This suggests that representative samples are needed in future research to ensure the generalisability of included instruments' results.

4.6.10 Recommendations for future research

This systematic review recommends five main directions for future studies:

- Health literacy measurement for adolescents has been focusing on the functional domain. More attention is needed in future research to integrate interactive and critical domains into health literacy measurement for adolescents.
- There is a large variety of methods in health literacy measurement for adolescents. To reduce disparities in health literacy measurement, there is a need for future research to use agreed-upon evaluation principles to standardise the field of health literacy measurement for adolescents.
- The methodological quality of health literacy measurement studies varies from poor to excellent. There is a need for future research to use a methodological quality control framework to improve the quality of health literacy measurement studies. The COSMIN checklist can be used as a rigorous guide to ensure the quality of studies when developing new instruments or validating existing instruments in different populations.
- Although there is growing evidence about adolescent health literacy measurement covered in this review, no instruments have been evaluated with respect to all measurement properties. More evidence based on a rigorous methodology is needed to examine and report measurement properties of health literacy instruments.
- Large-scale and representative samples are needed in future to generalise the findings of adolescent health literacy instruments' reliability and validity across different cultures.

4.6.11 Recommendations for next-step research plan

Although it is challenging to draw a robust conclusion about which instruments are reliable and valid, there is still important evidence from this review. It offers useful information for researchers regarding the most suitable instrument to employ when measuring health literacy for adolescents in the next-step plan of this PhD thesis.

This review identified ten instruments (the REALM-Teen, the NVS, the s-TOFHLA, the c-sTOFHLAd, the eHEALS, the CHC Test, the HKACSS, the HLAB, the MHL, the HLAT-51) that were used to measure health literacy in school settings. Among these instruments, four tested functional health literacy (the REALM-Teen, the NVS, the s-TOFHLA and the c-sTOFHLAd); one examined critical health literacy (the CHC Test); one measured functional and interactive health literacy (the HKACSS); one examined functional and critical health literacy (the HLAB); and three tested health literacy comprehensively focusing on functional, interactive and critical domains (the eHEALS, the MHL and the HLAT-51); however, none of these comprehensive instruments were considered appropriate for use in schools. This was due to the fact that they focused on non-general health literacy or were burdensome to administer. As shown in **Table 4.7**, to ensure a three-domain nature focus, only the MMAHL and the HLAT-8 were available for consideration. After comparing measurement contexts and measurement purpose, the HLAT-8 was identified as the most suitable instrument for measuring adolescent health literacy in school settings, because it was developed to measure health literacy in the health promotion context (4) which was aligned with the school setting in this PhD thesis.

Although the HLAT-8 was initially developed for young adults aged 18 to 25, it has great potential for field use in adolescents aged 10 to 17. First, this tool is particularly useful for measuring health literacy in the context of family and friends. This is highly important for school-aged adolescents because they often seek support for health decisions from parents and peers (16, 162, 168). The HLAT-8 can assess students' knowledge and skills that relate to health conversations in their family and among peers (e.g. '*When you come up with questions concerning health issues, how often can you get information and advice from family, friends, or teachers?*'). Second, the HLAT-8 is a short but comprehensive tool that captures the three-domain nature of health literacy:

functional, interactive and critical. This is aligned with Nutbeam's three-domain model (3) and the hypothesised model of this thesis. Third, the HLAT-8 showed satisfactory structural validity (RMSEA=0.03; CFI=0.99; TLI=0.97; SRMR=0.03) (4). Fourth, it has good feasibility (e.g. it is self-administered and time-efficient) for large-scale samples in school-based studies. For the above reasons, the HLAT-8 was selected as a suitable instrument for measuring adolescent health literacy in school settings in the next-step research plan of this thesis. However, there are still two main aspects that need to be considered in future. One aspect is its use in the target population. Given the HLAT-8 has not been tested for children and adolescents under 18, its readability and measurement properties need to be evaluated. The other aspect is that its convergent validity (the strength of association between two measures of a similar construct, an essential part of construct validity), has not been examined. Testing convergent validity of the HLAT-8 is important because high convergent validity assists researchers to understand the extent to which two examined measures' constructs are theoretically and practically related.

4.6.12 Limitations

This review was not without limitation. First, we restricted searched studies aiming to develop or validate a health literacy instrument. Thus we may miss out relevant instruments in other types of studies (220, 293) or newly-developed instruments in the last two years (236, 424, 425). Second, mental health literacy instruments were not included in this review. This was due in part to the separate and independent definition of mental health literacy in current research and practice (7, 53, 57, 248, 426). Third, although the COSMIN checklist provided us with rigorous evidence of the methodological quality of a study, this quality assessment tool cannot evaluate a study's overall methodological quality. Instead, it evaluates only a study's quality as per each measurement property. Reporting the information on each measurement property is very demanding for researchers. This also explains why the COSMIN checklist provides limited evidence on the methodological quality of included studies. Further reflections of using the COSMIN checklist are presented in Chapter 7.4.1: Reflections on using the COSMIN checklist. Fourth, individual subjectivity plays a part in every stage of a systematic review such as the screening stage or data synthesis stage. To reduce this subjectivity as much as possible, two authors independently managed the major stages (screening, data extraction, quality assessment of studies and data synthesis) of this systematic review.

4.7 Conclusion

Based on the findings from this review, there is a lack of consistency in health literacy measurement in adolescents in terms of measurement domains and measurement methods. There is a need for future research to use agreed-upon evaluation principles to standardise the field of health literacy measurement. Also, there is a scarcity of rigorous literature reporting sufficient information on measurement properties, especially responsiveness. Rigorous and high-quality studies are needed to fill the knowledge gap in relation to health literacy measurement in adolescents. This will, in turn, provide strong confidence in the field use of health literacy instruments in future health promotion programs. Although none of the 15 included instruments reported evidence on all measurement properties, the HLAT-8 showed strong construct validity and captured the three-domain nature of health literacy. The HLAT-8 was selected as the most suitable instrument to measure adolescent health literacy in the next-step research plan of this PhD thesis. Further details of its applicability will be presented in Chapter 5: Understanding and Measuring Health Literacy among Secondary Students in Beijing, China.

Box 4.1: Key messages about the systematic review of health literacy instruments used for adolescents

The systematic review in Research Phase 1 found that:

- Health literacy measurement in adolescents was still focusing on the functional domain, rather than three domains (functional, interactive and critical).
- Multiple methods existed to measure health literacy in adolescents.
- Most information on measurement properties was not known, due to either the poor methodological quality of studies, or a lack of reporting or assessment.
- Although it is challenging to draw a robust conclusion about which instrument is the most reliable and valid, this review provides important evidence that supports the use of the HLAT-8 to measure adolescent health literacy in the next-step research phase.

Future information on the applicability of the HLAT-8 will be outlined in the next chapter.

Chapter 5 Understanding and Measuring Health Literacy among Secondary Students in Beijing, China

5.1 Introduction

Findings from the systematic review in Chapter 4 suggested that the HLAT-8 had great potential for measuring adolescent health literacy in school settings. Due to a lack of skills-based instruments for adolescent health literacy in China (36-38, 51), I translated the HLAT-8 from English to Chinese and then examined whether it was appropriate for use in Chinese secondary students in Beijing. This chapter has two sections. Section One explains Research Phase 2 of this PhD project, which reported the cross-cultural translation process and the evaluation of reliability and validity of the HLAT-8 in 650 Chinese secondary students. Section Two outlines Research Phase 3 of this PhD project, which examined four path models of health literacy based on Manganello's health literacy framework in 650 Chinese secondary students.

5.2 Section One: Validation of the selected health literacy instrument in Chinese secondary students

5.2.1 Background: Health literacy in Chinese adolescents

While health literacy is an increasingly important topic in the global context (73, 84, 427, 428), health literacy research in China is relatively new, especially health literacy measurement in adolescents (266). As I explained earlier in Chapter 2.8: Justification of research settings in this PhD research, adolescent health literacy in China is under-researched. Currently, the understanding of adolescent health literacy in China focuses on health knowledge and health behaviours (36-38), rather than health skills. Given that the skills-based health literacy assessment has been widely used in Western countries (4, 6, 177, 208, 246), it seems logical for researchers to use a skills-based health literacy instrument with Chinese adolescents.

In mainland China, the concept '*health literacy*' was first introduced in 2008 by the Chinese government through a public bulletin entitled '*Basic Knowledge and Skills of*

People's Health Literacy' (49). Since then, health literacy research in China has gained attention. However, most studies focus on the adult population (244, 267-269), rather than adolescents. Focusing on adolescent health literacy is of critical importance because: 1) low health literacy is a prevalent and serious problem among Chinese adolescents (25). As shown in the 2008 national health literacy survey, 93.7% of participants aged 15 to 24 had low health literacy (25); 2) the literature has suggested that low health literacy is a risk factor for adolescents' health outcomes, including poor health status (52, 429), overweight and obesity (38), and health-compromising behaviours (52, 430). In this section, the focus is specifically on the measurement of adolescent health literacy in school settings. There are two reasons for this. One reason is that '*measurement*' provides a stable foundation for health literacy research (28, 35). Only based on reliable and valid measurement can the importance of health literacy to adolescent health be identified. The other reason is that health literacy is a broad concept that requires researchers to clarify its definition in specific populations and contexts (5, 107). Schools are not only the place where adolescents spend most of their day time, but also critical venues for promoting health literacy of adolescents through various health curricula and programs (18, 46, 47).

Currently, health literacy measures in China mainly focus on knowledge or behaviour-based assessment, or the functional domain, rather than skills-based assessment. For example, the first national health literacy survey, which was developed in 2008 (25), focused mainly on testing health knowledge. Later on, the Chinese Resident Health Literacy Scale (CRHLS) was developed with an emphasis on basic reading ability and understanding health information, which was used for the second national health literacy survey in 2012 (244). Although the CRHLS is widely-used in Chinese culture, it targets people aged 15 and over, rather than adolescents, and especially not those aged 11 to 14. In the last five years, several studies have been specifically conducted on adolescent health literacy in China (36-38, 51). Health literacy instruments used in these studies included the s-TOFHLA (38), knowledge-based or behaviour-based questionnaires (36, 37), and the Health Literacy Questionnaire (HLQ) (51). However, when measuring health literacy in Chinese adolescents aged 10 to 19, all these instruments have limitations. The s-TOFHLA is a screening tool to identify adolescents with low functional health literacy; it is not sufficiently comprehensive to capture the multi-dimensional nature of health literacy. Although health knowledge and health behaviours are good indicators of health literacy, they are distinct from health literacy. The literature has suggested that health knowledge is more likely to be a precursor of health literacy (74), whereas health behaviour is an outcome of health literacy (249). Lastly, although the HLQ is a valid, reliable and comprehensive instrument to measure health literacy, it has not been used in early adolescents aged 10 to 14. There is still a huge gap in health literacy measurement in early adolescents in China.

The findings from the systematic review in Research Phase 1 concluded that the Health Literacy Assessment Tool (HLAT-8) was the most appropriate instrument for measuring adolescent health literacy with large samples in school settings. Also, the construct of health literacy underlying the HLAT-8 was aligned with the definition of health literacy adopted in this thesis, which referred to a skills-based concept involving personal ability to access, understand and apply health information (3, 67). Owing to a lack of skills-based health literacy instruments for early adolescents in mainland China, this study hypothesised that the HLAT-8 would be an appropriate skills-based instrument for measuring health literacy in Chinese secondary students. This study aimed to translate the HLAT-8 into Chinese and to further examine its reliability and validity in Chinese adolescents.

5.2.2 Methods

This validation study was designed in two parts. The purpose of the first part was to translate the HLAT-8 from English to Chinese (c-HLAT-8). The purpose of the second part was to examine reliability (internal consistency and test-retest reliability) and validity (content validity, structural validity and convergent validity) of the c-HLAT-8.

5.2.2.1 Ethical considerations

Ethics approval to conduct this study was obtained from The University of Melbourne (Ethics number: 1442884, see **Appendix 5.1**) and Peking University Institutional Review Board (Ethics number: IRB00001052-15024, see **Appendix 5.2**). This study was approved as '*low-risk*' research in Chinese school settings. Therefore, passive, opt-out consent was obtained from both parents and students. All students and their parents were given a copy of the Plain Language Statement prior to data collection.

5.2.2.2 Translation procedures

First, contacts were made with the developers of the HLAT-8, and permission to translate the scale was obtained. Second, the translation process was conducted based on Beaton's cross-cultural adaptation guidelines (378). These guidelines ensured the maximum attainment of translation equivalence between the HLAT-8 and the c-HLAT-8. There were six steps in the translation process (See **Figure 5.1**): 1) forward translation: the HLAT-8 was translated from English to Chinese by three independent translators who met Beaton's criteria (378). These criteria were: their native language was Chinese, they were fluent in spoken and written English, and their expertise was from different backgrounds; 2) synthesis of forward translation: a group meeting was held between the above three translators to discuss any discrepancies and to reach a consensus on the first Chinese version; 3) backward translation: the first Chinese version was then back-translated into English by two independent English-native translators. Both spoke fluent Chinese and were naïve to the outcome measurement; 4) translation committee review: a translation committee was established by the above five translators to discuss any inconsistencies between the four versions of the HLAT-8 (the English version, the first Chinese version, backward translation A, and backward translation B). The second Chinese version was derived from the discussion; 5) expert panel evaluation of the translation validity index (TVI): an expert group was established to compare the translation equivalence between the original HLAT-8 and the second Chinese version of the HLAT-8 (431). The expert panel consisted of five native Chinese bilingual speakers from different expertise backgrounds (i.e. public health, nutrition, linguistics, adolescent health and epidemiology). Experts were asked to judge the equivalence of each item by comparing two versions using a four-point scale (1='*totally different*'; 2='*needs major item modification to be equivalent*'; 3='*equivalent but needs minor modification*'; 4='*equivalent*'). After two rounds of expert evaluation, the pre-final Chinese version was formed; and 6) pilot test: a pilot test was conducted for the pre-final Chinese version among ten secondary school students in Years 7 and 8. The readability and clarity of each item of the c-HLAT-8 were explored in a group interview with students. Any unclear issues were resolved to form the final version of the c-HLAT-8.

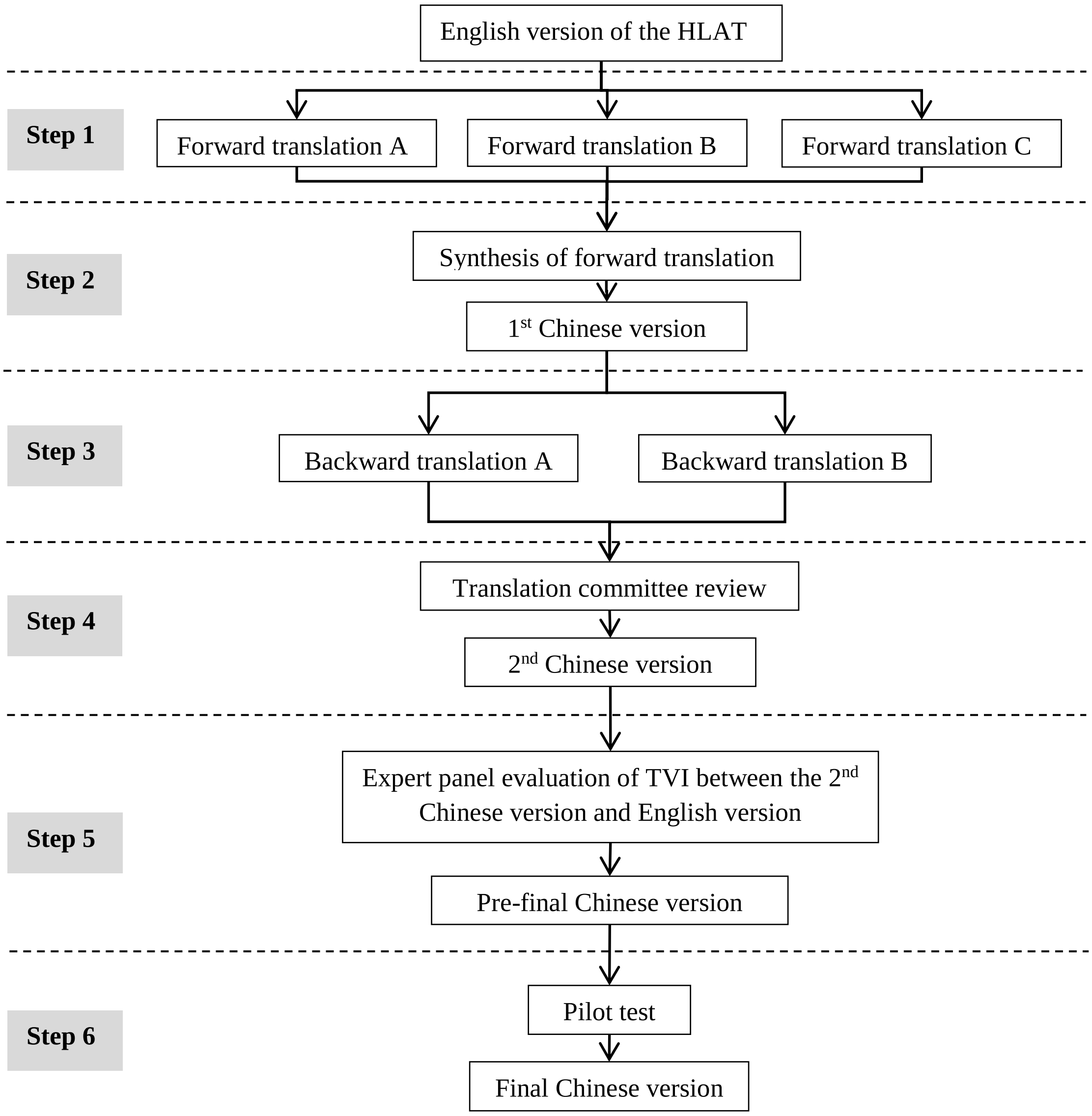

Figure 5.1: Translation procedures of the c-HLAT-8

(Note: c-HLAT-8: the Chinese version of the Health Literacy Assessment Tool; TVI: Translation Validity Index)

5.2.2.3 Validation procedures

Following the translation process, a cross-sectional study was conducted to examine the reliability and validity of the c-HLAT-8. Three methodological frameworks were used to control the quality of this validation study: 1) as summarised in the systematic review of Research Phase 1, most of the existing health literacy measurement studies had poor or unknown methodological quality. In order to ensure the methodological quality of this validation study, the COSMIN checklist (393) was used as a quality guide

(See **Appendix 3.3**); 2) given that health literacy is a multi-dimensional concept and thus difficult to measure, Pleasant's evaluation principles (28) were used to guide the design of this validation study (See **Appendix 3.5**); 3) as this validation study was cross-sectional, the STROBE statement (379) was used to ensure the reporting quality of observational studies (See **Appendix 3.4**).

5.2.2.3.1 Sampling and recruitment

5.2.2.3.1.1 Sampling method

Convenience sampling was used in the present study. Participants were selected from Years 7 to 9 (approximate age range: 11 to 15) in government secondary schools located in two districts of Beijing, China: Xi-Cheng District (an urban district) and Tong-Zhou District (a suburban district). In each district, two secondary schools were selected conveniently based on previous research partnerships with schools and the appropriateness of survey timing. Thereafter, two whole classes in each year level (Years 7, 8 and 9) were conveniently chosen.

5.2.2.3.1.2 Sampling size

The sample size of this validation study was determined by two issues. First, the sample size was decided on the basis of previous psychometric theory and practice. Charter (432) recommends a minimum of 400 subjects for precise estimates of reliability coefficients in reliability studies, while much larger samples are necessary to provide precise estimates of the population validity coefficients. In a literature review of publications on self-report measures by Anthoine *et al.* (433), it was found that the sample size determination for validation studies was hardly ever justified a priori, and there were no clear and sound recommendations on sample size determination for validation studies. However, their findings showed that, among 114 validation studies, about 92% reported a subject to item ratio greater than or equal to 2, and 90% had a sample size greater than or equal to 100. Based on psychometric theory and previous empirical practice, a minimum sample size of 400 was determined for this validation study, because this sample size met the requirements of Charter's recommendations and the empirical findings from Anthoine's review.

Second, the sample size was also considered by path analysis in Research Phase 3 of this PhD thesis because the Chinese sample for the model testing was the same sample in this validation study. As summarised by Golob (434), several recommendations were proposed for a sufficient sample size for path analysis: 1) a minimum sample size of at least 200 was needed to reduce biases to an acceptable level for any type of structural equation modelling estimation; 2) sample size for maximum likelihood estimation should be at least 15 times the number of observed variables; 3) sample size should be at least 10 times the number of free parameters for strongly kurtotic data. In the model testing study of Research Phase 3, the number of observed variables was ten, and the number of estimated parameters was 48. As such, a minimum sample size of 480 was required. Therefore, it was decided that the final sample size should be at least 480.

5.2.2.3.1.3 Recruitment of participants

Secondary students in Years 7 to 9 were approached using the following recruitment strategies:

- First, ethics approval was obtained from the Institutional Review Board of The University of Melbourne (Ethics number: 1442884, see **Appendix 5.1**: Ethics from University of Melbourne) and The Peking University Health Science Centre (Ethics number: IRB00001052-15024, see **Appendix 5.2**: Ethics from Peking University Health Science Centre).
- Second, a research protocol (See **Appendix 5.3**: Research protocol in Beijing schools) was sent to a government organisation called the '*Healthcare Institution of Primary and Secondary School (HIPSS)*' located in each district (Xi-Cheng District and Tong-Zhou District). This organisation belongs to the Department of Education and assists the department in planning, deploying staff and implementing work related to school health (435). The HIPSS directors gave their approval for this study.
- Third, four secondary schools were approached with the support of the HIPSS directors. School principals gave verbal permission for the survey to be conducted in their schools.
- Fourth, two whole classes in each year level (Years 7, 8 and 9) from participating schools were conveniently selected if the survey timing was

appropriate. Passive, opt-out consent was sought from parents prior to data collection. A plain language statement (See **Appendix 5.4**: Plain Language Statement for Beijing students) was sent to all parents through their children accompanied by a letter requesting that the parent could contact the research team or school if they wanted their children to withdraw from the study.

- Fifth, a paper-based questionnaire (See **Appendix 5.5**: Questionnaire for Beijing students) was sent to students on the survey date. Students voluntarily completed the survey.

1. To obtain ethics approval from the Institutional Review Board of The University of Melbourne and The Peking University Health Science Centre

↓

2. To approach the directors of the Healthcare Institution of Primary and Secondary School in Xicheng District and Tongzhou District, Beijing, China

↓

3. To seek school principals' approval and arrange survey timing with each participating school

↓

4. To seek passive, opt-out consent from parents prior to data collection

↓

5. To invite students in Years 7 to 9 to voluntarily complete a paper-based questionnaire

Figure 5.2: Flow chart of recruitment strategies for Chinese students

5.2.2.3.2 __Data collection procedures__

The field survey was conducted between November and December 2015. Ten Master students in public health from Peking University were recruited as investigators for the field survey. Prior to data collection, the principal researcher (myself) gave brief training to each investigator to ensure consistency of the administration. On the survey date, all students in participating classes were invited to complete a self-administered questionnaire in class time or in break time after lunch. An investigator was present during the completion of the questionnaire and available to answer students' questions.

5.2.2.3.3 Questionnaire

Information about participants' characteristics, psychological factors, interpersonal factors, environmental factors, health literacy assessment and health-related outcomes was collected using an anonymous questionnaire. As the purpose of this section was to validate the c-HLAT-8, I have reported only the information regarding health literacy assessment at this point. Other information about health literacy and its influencing factors and health-related outcomes will be outlined in Section Two of this chapter: Health literacy model testing in Chinese secondary students.

5.2.2.3.3.1 Participants' characteristics

Participants' characteristics included age, gender (male or female), ethnicity (Han or ethnic minorities), year level (Years 7, 8 or 9), family structure (intact families[1] or other types of families[2]) (436), self-report academic performance (very poor or poor, average, good or very good) (437), self-report interest in learning about health (not interested, unsure, or interested) (293), self-report health status (poor or fair, good, very good or excellent) (438) and socio-economic status (low, medium or high) (439).

The Family Affluence Scale (FAS)

Adolescents' socio-economic status was assessed using the FAS developed by Currie *et al.* (439) in 2008. The FAS comprises four items measuring family affluence in terms of number(s) of cars, computers, bedrooms and family holidays. According to the FAS scoring system, a composite score is classified into three groups: low (0-3); medium (4-5); and high (6-7) family affluence (439). In 2012, Liu *et al.* (440) examined reliability and validity of the Chinese version of the FAS in a total of 5876 primary and secondary students in Beijing. Their results showed that the FAS had satisfactory test-retest

[1] Intact families were defined as those in which participants indicated residing in a household with both biological parents.
[2] Other types of families were defined as those in which participants indicated residing in a household with either one of their parents, foster parents, step parents, a relative or who were living in a shared care institution.

reliability (intra-class correlation coefficient>0.75), relatively low internal reliability (Cronbach's alpha=0.58) and moderate convergent validity (the FAS was correlated with parental education level and perceived family wealth, with coefficients ranging from 0.48 to 0.51, $p<0.001$). Given that the FAS is a widely-used socio-economic status indicator in the Health Behaviour in School-Aged Children (HBSC) survey (441) which has been conducted in over 30 countries, the Chinese version of the FAS was used in this study.

5.2.2.3.3.2 Health literacy assessment

Three health literacy assessment tools were employed: the c-HLAT-8, the Newest Vital Sign (NVS) and the Health Literacy Study-Asia-Questionnaire (HLS-Asia-Q). The NVS and the HLS-Asia-Q were chosen as comparison tools to test convergent validity of the c-HLAT-8. Further information is outlined below regarding an *a priori* statement on the expected strength of associations between the c-HLAT-8, the NVS and the HLS-Asia-Q.

The Chinese version of the Health Literacy Assessment Tool (c-HLAT-8)

The HLAT-8 is a short health literacy instrument developed by Abel *et al.* (4) in 2014. It is an 8-item Likert scale that measures an individual's ability to access, understand, evaluate and communicate health information in everyday life. The HLAT-8 measures health literacy in three domains: functional health literacy (4 items); interactive health literacy (2 items); and critical health literacy (2 items). Respondents answer each item on a 5-point scale (1=strongly disagree, 4=strongly agree; 0=I do not have such experiences) or a 6-point scale (1=very bad, 5=very good; 0=there have never been any questions). The HLAT-8 total score range is 0-37, with higher scores indicating higher levels of health literacy (4). In the present study, the HLAT-8 was selected for use because the systematic review in Research Phase 1 of this PhD project suggested it was the most suitable instrument for measuring adolescent health literacy. The HLAT-8 was translated from English to Chinese (c-HLAT-8).

The Chinese version of the Newest Vital Sign (NVS)

The NVS was originally developed by Weiss *et al.* (240) in 2005 as a quick screening test for limited functional health literacy in clinical settings. It consists of six questions that test both reading comprehension and numeracy after respondents read a nutrition label from an ice-cream container. The answer to each question is scored as either correct or incorrect. The total score of the NVS ranges from 0 to 6. Scores of 4 to 6 suggest '*adequate health literacy*', whereas scores of 0 to 3 are categorised as indicating the '*possibility of low health literacy*' (240).

The literature (169, 397) has shown that the NVS has satisfactory internal consistency (Cronbach's alpha=0.71) and strong convergent validity (the NVS score was strongly correlated with the Gray Silent Reading Test score, correlation coefficient=0.71, $p<0.001$) in adolescents in the health promotion context. In 2013, Guo (442) validated the NVS in 1451 high school students in Beijing and found that the Chinese version of the NVS had satisfactory structural validity (exploratory factor analysis indicated a two-factor construct and explained 53.67% of the total variance, with factor loadings greater than 0.40 on all items), moderate test-retest reliability (correlation coefficient between test and re-test was 0.46, $p<0.01$), and relatively low internal consistency (Cronbach's $\alpha=0.58$). In the present study, the NVS was used to test convergent validity of the c-HLAT-8. As the NVS only tests the functional domain of health literacy (reading comprehension and numeracy), it was expected that the NVS had a stronger correlation with the functional domain of the c-HLAT-8 than the correlation with the interactive and critical domains of the c-HLAT-8.

The Health Literacy Study (HLS)-Asia-Questionnaire

The HLS-Asia-Q is a health literacy instrument derived from the Health Literacy Survey-European-Questionnaire (HLS-EU-Q) (111). It is a long but comprehensive health literacy survey with 47 items, covering three domains (healthcare, disease prevention and health promotion) and four competencies to manage health information (obtain, understand, evaluate and use health information) (241). Respondents are asked to rate their perceived difficulty for each item using a 4-point Likert scale ranging from '*very difficult*' to '*very easy*.' The general health literacy index is calculated to obtain a total score ranging from 0 to 50. Scores below 26 indicate '*inadequate health literacy*'; scores of 26 to 33 suggest '*problematic health literacy*'; scores of 33 to 42 are categorised as indicating ‘*sufficient health literacy*’; and scores of 42 to 50 suggest ‘*excellent health literacy*’ (111).

In 2015, the HLS-Asia-Q was translated from English to Chinese and showed high internal consistency (Cronbach’s α=0.96) for the whole scale and satisfactory construct validity for each of the three domains (χ^2/df=20.78-26.70; RMSEA=0.08-0.09) in respondents aged 15 and over (111). In the present study, the HLS-Asia-Q was piloted on ten secondary students in Years 7 and 8. Several changes were made to ensure its readability and clarity for secondary school students (See **Appendix 5.6**: HLS-Asia-Q item change after the pilot test). Its Cronbach α of 0.96 indicated that the HLS-Asia-Q exhibited high internal consistency. As the HLS-Asia-Q captures a more comprehensive nature of health literacy than the NVS, it was expected that the c-HLAT-8 had a stronger correlation with the HLS-Asia-Q than with the NVS.

5.2.2.3.4 __Statistical analysis__

5.2.2.3.4.1 Dealing with missing values

The individual mean substitution was used prior to data analysis. This step was conducted to avoid excess missing data due to item non-response in a self-report scale (443). A missing total score was assigned if more than half of the total items on a scale were missing. If one-half or fewer items were missing, a person-specific estimate (mean of the non-missing items) was substituted for the missing items (444). The percentage of missing items for the c-HLAT-8 (n=649) and the HLS-Asia-Q (n=603) ranged from 0% to 0.5% and 0% to 1.2% respectively.

5.2.2.3.4.2 Statistical methods

The SPSS 22.0 (IBM Corp., US, 2013) and AMOS 23.0 (IBM Corp., US, 2015) were used to conduct all statistical analysis. Descriptive statistics such as percentages were calculated for participants’ characteristics. Scores of the c-HLAT-8, the NVS and the HLS-Asia-Q were calculated as per each scale scoring system. Five measurement properties were examined according to the COSMIN checklist (393) and Terwee’s quality criteria (394) (See **Table 5.1**).

Table 5.1: Statistical methods for each measurement property of the c-HLAT-8

Measurement property	Statistical method	Quality criteria
1. Internal consistency	Internal consistency was examined by calculating Cronbach's α.	A Cronbach's α score above 0.7 was considered satisfactory (394).
2. Test-retest reliability	Test-retest reliability was evaluated via the ICC by administering the questionnaire twice, two weeks apart.	Sufficient test-retest reliability was assumed if the ICC was greater than 0.7 (394).
3. Content validity	Content validity of the c-HLAT-8 was reviewed by the TVI.	A TVI was considered good when a maximal level of 80% of item comparisons was rated as 4 ('*equivalent*'), and 100% of item comparisons was rated as either 3 or 4 ('*equivalent but needs minor modification*' or '*equivalent*') (431).
4. Structural validity	Structural validity was tested by the CFA using the maximum likelihood estimation in the AMOS. The original four-factor CFA model without correlated errors was first assessed. When there was a model misfit, error covariance with the largest modification index and substantive rationale was incorporated (445).	A CFA model was considered as an adequate model when the CFI value was $\geq$ 0.90, the TLI was $\geq$ 0.90, the NFI was $\geq$ 0.90, and the RMSEA was $\leq$ 0.10 (446).
5. Hypotheses testing	• Convergent validity was examined by Spearman rank correlation between the c-HLAT-8 and the NVS and the HLS-Asia-Q. • Known-group validity was examined by comparing health literacy scores between groups of gender (expecting higher scores in girls than boys), ethnicity (expecting higher scores in Han than ethnic minorities), self-report academic performance (expecting higher scores in students having good academic performance), self-report interest in learning about health (expecting higher scores in students having high health interest), self-report health status (expecting higher scores in students with good health status) and socio-economic status (expecting higher scores in students with high socio-economic status). Anticipated associations were tested using independent t-test and one-way ANOVA with a Bonferroni correction for the *post hoc* test (4).	• Strong convergent validity was considered when correlation coefficient was above 0.7 (394). • Known-group validity was satisfactory when the expectation was aligned with empirical data (177).

Note: CFA, Confirmative Factor Analysis; CFI, Comparative Fit Index; c-HLAT-8, the Chinese version of the Health Literacy Assessment Tool; HLS-Asia-Q, Health Literacy Study-Asia-Questionnaire; ICC, Intra-class Correlation Coefficient; NFI, Normed Fit Index; NVS, Newest Vital Sign; RMSEA, Root Mean Error of Approximation; TLI, Tucker and Lewis's Index of Fit; TVI, Translation Validity Index.

5.2.3 Results

5.2.3.1 Translation results

After translation, two major changes were made to the c-HLAT-8 to ensure that it was appropriate to Chinese culture. In Item 1 (c-HLAT1) and Item 2 (c-HLAT2), the response option '*I have not used such information*' was culturally adapted to '*I have not read such information*' in the Chinese version. This was changed to ensure that these two items tested students' ability to understand information, rather than using information. In Item 2 (c-HLAT2), the question '*how well do you understand information brochures on health issues (e.g. nutrition, addictive drugs)*' was culturally adapted to '*How well do you understand information presented in health pamphlets (e.g. good nutrition, prevention of addictive drug abuse)*' in the Chinese version. This was because, in Chinese culture, the phrases '*nutrition*' and '*addictive drugs*' are used in a normative way in educational settings. Further details of the translation process are outlined in **Appendix 5.7**: Translation details of the c-HLAT-8. The pilot test showed the c- HLAT-8 was understood by ten students in Years 7 and 8.

5.2.3.2 Validation results

Participant characteristics

In total, 650 students participated in the validation study. No students in attendance refused participation. The average age of participants was 13.42 ± 1.01 (age range: 11 to 17). The distribution of gender, ethnicity, year level, family structure, family affluence level, self-report academic performance, self-report interest in learning about health and self-report health status are shown in **Table 5.2**.

Table 5.2: Participants' characteristics of Chinese secondary students (n=650)

Participant characteristic	No. of missing data (%)	Mean ± SD or frequency (%)
Age	2 (0.3)	13.42 ± 1.01
Gender	0	
Male		357 (54.9)
Female		293 (45.1)
Ethnicity	0	
Han		617 (94.9)
Ethnic minorities		33 (5.1)
Year level	0	
Year 7		232 (35.7)
Year 8		215 (33.1)
Year 9		203 (31.2)
Family structure [a]	1 (0.2)	
Intact families		553 (85.1)
Other types of families		96 (14.8)
Family affluence level	6 (0.9)	
Low		179 (27.5)
Medium		296 (45.5)
High		169 (26.0)
Self-report academic performance	2 (0.3)	
Poor or very poor		208 (32.1)
Average		197 (30.4)
Good or very good		243 (37.5)
Self-report interest in learning about health	0	
Not interested		88 (13.5)
Unsure		85 (13.1)
Interested		477 (73.4)
Self-report health status	0	
Fair or poor		224 (34.5)
Good		227 (34.9)
Excellent or very good		199 (30.6)

Note: *a* intact families were defined as those in which participants indicated residing in a household with both biological parents, whereas other types of families were defined as those in which participants indicated residing in a household with either one of their parents, foster parents, step parents, a relative or who were living in a shared care institution. SD, Standard Deviation.

5.2.3.2.1 Descriptive results of the c-HLAT-8

The mean score of the c-HLAT-8 was 26.37 ± 5.89. The average score for each item is presented in **Table 5.3**.

Table 5.3: Descriptive results of the c-HLAT-8 in Chinese secondary students

Item	Question	Mean ± SD (missing item)
c-HLAT1 [a]	How well do you understand the written information that comes with medication?	3.83 ± 1.04 (0.2%)
c-HLAT2 [a]	How well do you understand information presented in health pamphlets?	3.55 ± 1.22 (0.6%)
c-HLAT3 [b]	How often can you help your family members or a friend if they had questions concerning health issues?	3.29 ± 1.33 (0.2%)
c-HLAT4 [b]	When you come up with questions concerning health issues, how often can you get information and advice from others?	3.14 ± 1.36 (0.3%)
c-HLAT5 [a]	There is much advice and many suggestions for health in daily life. How well can you choose the advice and suggestions that suit you the most?	3.51 ± 1.13 (0.2%)
c-HLAT6 [c]	When I have questions on diseases or health problems, I know where I can find information on these issues.	3.03 ± 1.03 (0.2%)
c-HLAT7 [c]	When I am not ill, but want to do something to further improve my health, I know where I can find information on these issues.	3.14 ± 0.91 (0.2%)
c-HLAT8 [c]	When looking for health information on the Internet, I can determine which sources are of high and which are of poor quality.	2.88 ± 1.14 (0.3%)

Note: *a* response options were: very bad, bad, moderate, good, very good and I have not read such information/I have not been interested in these issues; *b* response options were: never, hardly ever, sometimes, often, always and there have never been any questions; *c* response options were: strongly disagree, disagree, agree, strongly agree and I do not have experiences with these issues. c-HLAT-8, the Chinese version of the Health Literacy Assessment Tool; SD, Standard Deviation.

5.2.3.2.2 Reliability of the c-HLAT-8

A Cronbach's α of 0.79 showed satisfactory internal consistency for the c-HLAT-8. The item-total correlation ranged from 0.57 to 0.69. Test-retest reliability was evaluated in 39 students to whom the questionnaire was administered twice, two weeks apart. The intra-class correlation coefficient (ICC) was 0.72 (95% CI=0.46 to 0.85), suggesting sufficient test-retest reliability.

5.2.3.2.3 Validity of the c-HLAT-8

The TVI examination showed that 95% of items of the c-HLAT-8 were rated as score 4 ('*equivalent*'), while 100% of all items achieved ratings of score 3 or 4 ('*equivalent but needs minor modification*' or '*equivalent*'), indicating the c-HLAT-8 had excellent content validity.

In terms of structural validity, the four-factor model (model 1) showed that three fit indices were good (χ^2/df=7.365, p<0.001; CFI=0.922, NFI=0.911, RMSEA=0.099) and one index was unsatisfactory (TLI=0.854<0.90). To modify the model, I used the largest modification indices (MI) to identify possible correlations between errors (See **Table 5.4**). First, the errors between items c-HLAT6 and c-HLAT8 were correlated because the MI between e3 and e8 was largest (MI=23.298). A review of these two items in the questionnaire revealed that the c-HLAT6 and the c-HLAT8 had the same format and response options, different from the previous five items (c-HLAT1-c-HLAT5). When students answered these two questions, they might be replicating the thinking style and process between the first and second, thus resulting in a high correlation between these items. Similarly, the errors between items c-HLAT7 and c-HLAT8 were also correlated (e4 and e8: MI=27.715). After modifications, model 3 demonstrated good data fit: χ^2/df=3.388, p<0.001; CFI=0.975, TLI=0.945, NFI=0.965, RMSEA=0.061 (See **Figure 5.3**).

Table 5.4: Fit indices for the confirmatory factor analysis model of the c-HLAT-8

Measure	**Recommended cut-off value for good fit**	**Model 1: four-factor model without correlated errors**	**Model 2: four-factor model with correlated errors (e3 and e8)**	**Model 3: four-factor model with correlated errors (e3 and e8; e4 and e8)**
χ^2/df	-	7.365	5.917	3.388
CFI	≥ 0.90	0.922	0.944	0.975
TLI	≥ 0.90	0.854	0.887	0.945
NFI	≥ 0.90	0.911	0.934	0.965
RMSEA	≤ 0.10	0.099	0.087	0.061

Note: CFA, Confirmative Factor Analysis; CFI, Comparative Fit Index; NFI, Normed Fit Index; RMSEA, Root Mean Error of Approximation; TLI, Tucker and Lewis's Index of Fit; TVI, Translation Validity Index.

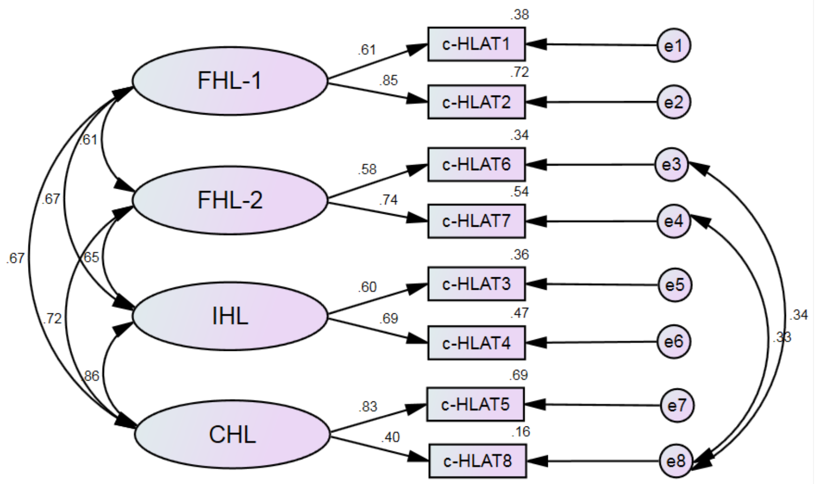

Figure 5.3: Standardised parameter estimates for the four-factor model of the c-HLAT-8

(Note: c-HLAT-8, the Chinese version of the Health Literacy Assessment Tool; CFA, Confirmatory Factor Analysis; CHL, Critical Health Literacy; FHL-1, Functional Health Literacy-Understanding health information; FHL-2, Functional Health Literacy-Finding health information; IHL, Interactive Health Literacy.)

The assessment of convergent validity showed a strong correlation between the c-HLAT-8 and the HLS-Asia-Q (r=0.53, *p*<0.01). However, there was a weak correlation between the c-HLAT-8 and the NVS, with a Spearman correlation coefficient of 0.18 (*p*<0.01). Specifically, correlations between the NVS and the c-HLAT-8 varied by sub-domains: functional domain (r=0.20, *p*<0.01); interactive domain (r=0.09, *p*<0.05) and critical domain (r=0.13, *p*<0.01) (See **Table 5.5**).

Table 5.5: Spearman correlation between the c-HLAT-8, the NVS and the HLS-Asia-Q in Chinese secondary students

	NVS	HLS-Asia-Q
c-HLAT-8	0.181**	0.533**
❖ Functional domain (FHL-1 & FHL-2)	0.204**	0.496**
❖ Interactive domain (IHL)	0.087*	0.413**
❖ Critical domain (CHL)	0.134**	0.435**

Note: ** *p*<0.01; * *p*<0.05. c-HLAT-8, the Chinese version of the Health Literacy Assessment Tool; CHL, Critical Health Literacy; FHL-1, Functional Health Literacy-Understanding health information; FHL-2, Functional Health Literacy-Finding health information; HLS-Asia-Q, Health Literacy Study-Asia-Questionnaire; IHL, Interactive Health Literacy; NVS, Newest Vital Sign.

Known-group validity results showed that positive and anticipated associations existed for groups of family affluence level, self-report academic performance, self-report interest in learning about health and self-report health status in Chinese secondary students (See **Table 5.6**), but no difference in health literacy was found in gender and ethnicity.

Table 5.6: Known-group validity results of the c-HLAT-8 in Chinese secondary students

Participant characteristic	Health literacy score	
	Mean ± SD	*P* value
Gender		
Male	26.40 ± 6.16	0.881
Female	26.33 ± 5.56	
Ethnicity		
Han	26.37 ± 5.89	0.926
Ethnic minorities	26.27 ± 5.96	
Family affluence level [a]		
Low	25.30 ± 5.51 [A]	
Medium	26.72 ± 5.95 [B]	**0.012**
High	26.96 ± 5.82 [B]	
Self-report academic performance [a]		
Poor or very poor	24.77 ± 5.96 [A]	
Average	26.42 ± 5.81 [B]	**<0.001**
Good or very good	27.63 ± 5.58 [C]	
Self-report interest in learning about health [a]		
Not interested	22.01 ± 7.16 [A]	
Unsure	24.27 ± 5.94 [B]	**<0.001**
Interested	27.53 ± 5.11 [C]	
Self-report health status [a]		
Fair or poor	25.07 ± 5.54 [A]	
Good	25.84 ± 5.59 [A]	**<0.001**
Excellent or very good	28.42 ± 6.09 [B]	

Note: *a* post hoc test was calculated using Fisher's Least Significant Difference (LSD): there was no statistical difference between two groups with the same letter. SD, Standard Deviation.

5.2.3.2.4 Descriptive results of health literacy

The mean score of health literacy for each instrument is shown in **Table 5.7**. Based on the cut-off value of the NVS, 45.5% of participating students had low health literacy, whereas 29.0% of students had low health literacy under the HLS-Asia-Q scoring system.

Table 5.7: Descriptive results of health literacy in Chinese secondary students

	c-HLAT-8 (n=649)	NVS (n=633)	HLS-Asia-Q (n=603)
Mean ± SD	26.37 ± 5.89	3.65 ± 1.64	36.80 ± 9.59
Low health literacy (%)	-	45.5	29.0 [a]
High health literacy (%)	-	54.5	71.0 [b]

Note: *a* the category of '*inadequate health literacy*' and '*problematic health literacy*' were combined into '*low health literacy*'; *b* the category of '*sufficient health literacy*' and '*excellent health literacy*' were combined into '*high health literacy*'. c-HLAT-8, the Chinese version of the Health Literacy Assessment Tool; HLS-Asia-Q, Health Literacy Study-Asia-Questionnaire; NVS, Newest Vital Sign; SD, Standard Deviation.

5.2.4 Discussion

This study reported the cross-cultural translation process and evaluated five measurement properties of the c-HLAT-8. There are four key findings from this validation study: 1) the c-HLAT-8 has high internal consistency and sufficient test-retest reliability when measuring health literacy in Chinese secondary students; 2) the c-HLAT-8 is a skills-based instrument that captures a four-dimensional nature of health literacy; 3) the c-HLAT-8 is strongly associated with the HLS-Asia-Q, but weakly with the NVS. The anticipated mean differences in health literacy are shown among most groups; and 4) the proportion of students with low health literacy varies by measurement tools: 45.5% for the NVS and 29.0% for the HLS-Asia-Q.

5.2.4.1 Discussion on the c-HLAT-8's reliability

Findings from this validation study suggest that the c-HLAT-8 has satisfactory internal consistency and test-retest reliability. Compared with the original version of the HLAT-8 in Swiss samples (4), the c-HLAT-8 has a higher coefficient of Cronbach's α (Cronbach's α=0.79 versus Cronbach's α=0.64) in Chinese secondary students. Also, this study examined test-retest reliability of the c-HLAT-8 (ICC=0.72), which was not tested in Swiss samples. All this evidence indicates that the c-HLAT-8 has sufficient reliability for use in accreditation and for quality assurance purposes. The c-HLAT-8 is suitable for future data collection that contributes to outcomes research on health literacy. Specifically, there are two directions for the wide use of the c-HLAT-8 in China: 1) for the purpose of measuring health literacy: the c-HLAT-8 can be used as an outcome measure for health literacy research such as examining health literacy in a single population, or monitoring health literacy over time, or testing health literacy in an intervention study, or comparing health literacy between groups; 2) for the purpose of examining the role of health literacy in health outcomes: the c-HLAT-8 can be integrated into a health assessment battery to examine the association between health literacy and other outcome variables of interest.

5.2.4.2 Discussion on the c-HLAT-8's validity

The confirmatory factor analysis results showed that the c-HLAT-8 was supportive of the hypothesised four-factor structure, which was consistent with the original version of the HLAT-8 in Swiss samples (4). The c-HLAT-8 was shown to be a skills-based instrument that captured a four-dimensional nature of health literacy. However, there were some modifications to the confirmed model with correlations between errors. That is, the error of Item 8 (c-HLAT8) was correlated with that of Item 6 (c-HLAT6) and Item 7 (c-HLAT7) respectively. The reason for these correlations was probably the systematic measurement error in item responses. Items 6 to 8 (c-HLAT6, c-HLAT7 and c-HLAT8) had same response options ('*strongly disagree, disagree, agree, strongly agree*'), which were different from those of previous items (Items 1 to 5). Therefore, students may have applied the same thinking rationale and process when answering Items 6 to 8. As to whether it is necessary to change response options of Items 6 to 8 into similar response options of Items 1 to 5 ('*very bad, bad, moderate, good, very good*'), more evidence is needed before deciding how to reduce such systematic measurement errors in future.

Consistent with *a priori* expectation, the convergent validity results showed that the c-HLAT-8 was strongly associated with the HLS-Asia-Q, but weakly with the NVS. The difference of correlation can be explained by the different construct of health literacy measured within these instruments. As shown in the further analysis of the correlation between each domain of the c-HLAT-8 and the NVS, the NVS had a stronger correlation with the functional domain than with the interactive and critical domains. This finding confirms that the NVS only assesses a rather narrow range of what are mostly cognitive skills (i.e. functional health literacy), whereas the c-HLAT-8 and the HLS-Asia-Q capture a more comprehensive nature of health literacy (including functional, interactive and critical domains). The underlying construct of health literacy in the c-HLAT-8 is theoretically and practically related to that in the HLS-Asia-Q.

Known-group validity results showed that the anticipated mean differences in health literacy were found among most groups (e.g. socio-economic status, self-report academic performance), but not in relation to gender and ethnicity. There might be two reasons for this. The first reason was probably the gender difference in self-report health literacy. As demonstrated by Lee *et al.* (447) in a national survey of health literacy in Taiwan, Chinese males were more likely than Chinese females to over-report their health literacy. The difference in health literacy between genders is probably explained by male students' over-estimated health literacy. The second reason was probably the homogeneity of samples. It was difficult to identify the difference in health literacy between ethnic groups because most participating students had the same ethnicity (i.e. 94.9% came from Han ethnicity). Therefore, further evidence is needed to confirm the known-group validity of the c-HLAT-8 between gender and ethnic groups, with consideration given to controlling for the over-estimation effect between genders and the evenly-distributed participants' cultural backgrounds.

5.2.4.3 Discussion on low health literacy in Chinese secondary students

This study also examined Chinese secondary students' health literacy using three instruments (the c-HLAT-8, the NVS and the HLS-Asia-Q). The mean score of the c-HLAT-8 for Chinese students was 26.37 ± 5.89 (26.40 ± 6.16 in boys; 26.33 ± 5.56 in girls), which was similar to that of Swiss young people (25.54 ± 5.38 in men; 27.57 ± 4.87 in women) (4). As there was no cut-off value for the c-HLAT-8, it was not possible to determine the prevalence of low health literacy using this instrument in Chinese secondary students. Hence, the NVS and the HLS-Asia-Q were used to examine the prevalence of low health literacy. Results showed that the proportion of students with low health literacy varied by instruments: 45.5% for the NVS and 29.0% for the HLS-Asia-Q. There might be two reasons for this difference. One reason was that the NVS and the HLS-Asia-Q were based on different constructs of health literacy, thus resulting in different outcomes. The other reason was the different forms of administration of instruments. The NVS was a performance-based instrument, whereas the HLS-Asia-Q was a self-report instrument. It was conceivable that students were likely to overestimate their health literacy skills using the HLS-Asia-Q.

Although the measurement outcome varied among the above three instruments, they provided a comprehensive understanding of Chinese students' health literacy from multiple perspectives. Also, the three instruments used in this study had different administration modes: the NVS was a performance-based instrument whereas the c-HLAT-8 and the HLS were self-report tools. First, we looked at health literacy results using the NVS. In our study, 54.5% of middle school students were scored as adequate health literacy. Compared to their counterparts in other cultures, Chinese adolescents were likely to have lower health literacy. In the USA, Driessnack *et al.* (169) found the NVS was valid to assess health literacy in children aged 7 to 12 years and showed 80.9% (38/47) of children had adequate health literacy (NVS scores ≥4). Similarly, Linnebur (448) examined health literacy using the NVS in 167 sixth graders in a middle school. Results showed 62.9% of the sixth graders were scored as adequate health literacy. Based on this cultural comparison, we can learn that almost half of middle students in China may need further education to improve their health literacy, particularly functional health literacy. As the NVS has been used a commonly-used tool to screen functional health literacy in the nutrition context for children and adolescents (169, 397), students with limited functional health literacy are less likely to read and comprehend health information, thus leading to less chance to master health skills and less motivation to adopt healthy practices. As supported by the health behaviour theory (73, 449), it is important to improve students' functional health literacy to prevent the occurrence of negative health outcomes such as unhealthy eating and sedentary lifestyles. Given school health education in China is the main channel for equipping students with health knowledge and skills (274), the educational system could play a key role in helping students with low functional health literacy improve their knowledge and skills. For example, the Chinese Primary and Secondary School Health Education Guideline (CPSSHEG) (275) specifies a range of health topics on healthy eating such as how to read food packaging information and how to select healthy food.

Second, we discussed health literacy results using self-report tools. The findings of our study indicated Chinese adolesents had higher self-report health literacy using both the c-HLAT-8 and the HLS. Compared to German young males (25.54 ± 5.38) (4), Chinese male students had slightly higher health literacy levels (26.40 ± 6.16) using the HLAT-8. Similarly, the HLS results revealed that 71.0% of Chinese students had adequate health literacy, which was higher than that of Portuguese secondary students (40.0%-63.2%) (450, 451). The higher proportion of Chinese students with adequate health literacy might have two reasons. The first reason was probably the cultural difference in self-report health literacy. The literature has suggested that respondents in Asian cultures including China, have higher levels of over-confidence than their counterparts in Western cultures such as the USA (452-454). The reasons for over-confidence could be a tendency to favour positive above negative evidence (455), or a lack of immediate and accurate feedback (456), or the differences in educational traditions (453). For instance, in an empirical study by Li *et al.* (453), they found Chinese students were more likely to exhibit higher degrees of over-confidence than Singaporean students due to the differences of educational traditions, even after adjusting for ethnicity and linguistic and culture heritage. The second reason was probably the sampling bias. The samples in this study were recruited from schools in a metropolitan city where students had more opportunities to access high quality education and therefore a greater likelihood of having high health literacy. Therefore, Chinese students were likely to overestimate their health literacy levels using self-report tools. To determine the '*true*' prevalence of low health literacy in Chinese secondary students, future research needs to recruit representative samples with wider demographics and to explore the over-estimation effect of self-report measures.

5.2.4.4 Implications for health literacy research in Chinese adolescents

Compared to existing health literacy instruments in China (36-38), the c-HLAT-8 has three advantages for field use in future: 1) it is a skills-based instrument for measuring health literacy, rather than a knowledge-based or behaviour-based instrument (36, 37). Therefore, the c-HLAT-8 would allow researchers to move towards a skills-based perspective of health literacy for future research, and allow them to compare adolescent health literacy between China and other cultures, thus contributing to a better understanding of Chinese health literacy in an international setting; 2) it measures three domains of health literacy: functional, interactive and critical. Given that previous studies mainly focused on the functional domain (38, 50, 52), the evidence gained so far is limited and may be biased. The c-HLAT-8 can not only provide a new opportunity to measure students' health literacy comprehensively, but also offer an opportunity to explore the role of three-domain health literacy in health outcomes such as health-promoting behaviours, thus assisting researchers to better design and implement effective health interventions in future; and 3) it is useful and easy to administer in early adolescents aged 10 to 14. Compared with the Chinese Resident Health Literacy Scale

(CRHLS) (244) and the HLQ (51), the c-HLAT-8 is time-efficient and feasible for use in large-scale samples in school-based studies. The c-HLAT-8 can allow students to directly assess the mismatch between their capacities and the complex demands of the health environment. While the self-report approach has been considered an appropriate method to measure health literacy accurately (212), there is a need to further explore the relationship between self-report and performance-based measures due to the subjectivity of self-report measures. This also poses a challenge for developing performance-based and three-domain health literacy instruments in future, because there have been no such instruments for Chinese adolescents developed so far. In summary, all of these positive characteristics ensure the great potential of the c-HLAT-8 as a useful instrument for measuring health literacy in Chinese adolescents.

5.2.4.5 Strengths and limitations

This validation study has two main strengths. The first is that by using the COSMIN checklist to examine and report five important measurement properties of the c-HLAT-8, the present study's rigour, clarity and transparency are ensured. The second strength is the low percentages of missing items for the c-HLAT-8. As Schafer and Graham argued (457), high percentages and inappropriate handling of missing values can lead to bias in results. As explained by Shrive *et al.* (458), when less than 10% of values are missing from a scale (whether randomly or not randomly), the individual mean substitution is preferred for accuracy and computational simplicity compared to other methods such as multiple imputations. In the present study, percentages of missing items ranged from 0.2% to 0.6%. Therefore, the individual mean substitution was the method of choice.

Several limitations should be noted as well. The convenience sampling of this study may limit the generalisability of the findings. For example, most of the participating students had the same cultural background (94.9% came from Han ethnicity) and had a similar family structure (85.1% of students were from intact families in which students indicated residing in a household with both biological parents). All of the students were also recruited from secondary schools in a metropolitan city where the ability of the subjects to access good education might be higher than that of the broader population. Therefore, the c-HLAT-8 should be tested in populations with a wider range of socio-demographics. The second limitation is that respondents may have over-estimated their health literacy in self-report items. As shown in a study by Chew *et al.* (423), respondents with high self-efficacy were likely to rate highly in perceived competence with health. As this study did not focus on the comparison of self-report and performance-based measures, this over-estimation effect needs to be explored in future research. Third, the use of qualitative research was limited in the validation process of the c-HLAT-8. Only a preliminary analysis was conducted to test the instrument's understandability and readability among ten students in Years 7 and 8. Further use of qualitative methods can be complementary to explain the cause of systematic measurement errors found in this study. Finally, this study did not examine measurement error and responsiveness which are important measurement properties for longitudinal studies. Given that the c-HLAT-8 had satisfactory reliability, validity and practicability in this study, it is worth assessing its ability to detect health literacy change over time in future research.

5.2.5 Conclusion

In conclusion, the validation study demonstrated that the c-HLAT-8 was a reliable and valid instrument for measuring adolescent health literacy in Chinese school settings. As a skills-based and three-domain health literacy instrument, the c-HLAT-8 can assist researchers to ascertain the health literacy levels of Chinese adolescents, and allow health literacy comparisons between China and other cultures. Also, the c-HLAT-8 would be useful in further exploring the role of three-domain health literacy in health outcomes in future research in China.

Box 5.1: Key messages about the validation study in Chinese secondary students

The validation study in Research Phase 2 of this PhD project found that:

- The Chinese version of the HLAT-8 (c-HLAT-8) was understandable for Chinese secondary students after a cross-cultural translation process and a pilot test.
- The c-HLAT-8 had high internal consistency (Cronbach's alpha=0.79) and satisfactory test-retest reliability (Intra-class correlation coefficient=0.72). It is stable to measure adolescent health literacy over time.
- The c-HLAT-8 had sufficient content validity (translation validity index ≥0.95), strong structural validity (χ^2/df=3.388, P<0.001; CFI=0.975, TLI=0.945, NFI=0.965, RMSEA=0.061) and satisfactory convergent validity (the c-HLAT-8 had a strong correlation with the HLS-Asia-Q (r=0.53, P<0.01), but a weak correlation with the NVS (r=0.18, P<0.01)). It is valid to measure adolescent health literacy in Chinese secondary schools.
- The proportion of students with low health literacy varied by instruments: 45.5% for the NVS and 29.0% for the HLS-Asia-Q.

Future information on the application of the c-HLAT-8 will be given in the next section: Health literacy model testing in Chinese secondary students.

5.3 Section Two: Health literacy model testing in Chinese secondary students

The findings from Section One of this chapter suggest that c-HLAT-8 is a reliable and valid instrument for measuring health literacy in Chinese secondary students. In Section Two, the c-HLAT-8 was used to measure students' health literacy and examine the role of health literacy in a hypothesised model. This section focuses on health literacy model testing in Chinese secondary students. Following discussion of the background and rationale for the investigation, methods and results are outlined.

5.3.1 Background

In mainland China, there is not only a lack of skills-based health literacy measurement, but also a lack of theory-driven empirical research in relation to health literacy. Most health literacy research among Chinese adolescents has been conducted in the absence of a theoretical model as a guide, thus resulting in an incomplete understanding of the use of health literacy models in practice. As shown in previous theoretical models (16, 74, 85, 94, 459), health literacy is regarded as an intermediate variable between its influencing factors and health-related outcomes. However, in practice, health literacy is rarely examined. Without a theoretical model as a guide, previous studies only had a unilateral understanding of the relationships between health literacy and either its influencing factors or its health-related outcomes, rather than attempting to create a more holistic understanding of health literacy from its influencing factors through to health outcomes. For example, Yu *et al.* (37), Ye *et al.* (36), Chang *et al.* (50) and Zhang *et al.* (51) examined the influencing factors of health literacy among Chinese adolescents, and found that the level of health literacy varied by gender, socio-economic status, parental educational level and school types (prestigious schools/non-prestigious schools or senior high schools/vocational high schools). On the other hand, there were two studies that investigated the relationships between health literacy and health outcomes (overweight/obesity, health status or health behaviours) among Chinese high school students (38, 52). Findings from these two studies showed that low health literacy was positively correlated with overweight/obesity, poor health status and poor health behaviours. The role of adolescent health literacy (i.e. the mediating effect) between its influencing factors and health outcomes, however, has not been revealed by previous empirical research.

Theoretical models allow researchers to define the parameters of a construct (e.g. health literacy) and can assist researchers in understanding what health literacy is, and how it relates to other variables of interest (35). As described earlier in Chapter 2.4, there are five theoretical models available for understanding adolescent health literacy: the skills-based pyramid model (214), the health promoting schools model (42), the causal pathway model (i.e. Manganello's health literacy framework) (16), the social ecological model (44) and the inclusive hierarchy model (43). Among these five models, only Manganello's health literacy framework postulated the mediating effect of health literacy on its influencing factors and health-related outcomes. Manganello's health literacy framework was informed by ecological theory (460) and Nutbeam's three-domain health literacy model (3). Although it has been well-documented that intrapersonal, interpersonal and environmental factors affect the overall health of adolescents (461, 462), the pathways from these factors through health literacy to health-related outcomes are still unknown in practice. Testing of theoretical models is needed to inform effective responses to low health literacy in adolescents (41). Therefore, this section aims to work within Manganello's health literacy framework to examine the associations between health literacy, its influencing factors and health-related outcomes in Chinese secondary students.

5.3.2 Methods

5.3.2.1 Study design and hypotheses

This section details Research Phase 3 of this PhD project, which aims to test Manganello's health literacy framework using empirical data. To ensure this framework is applicable, I adapted the framework, explaining my rationale for doing so in Chapter 3.2: Conceptual framework underpinning this thesis. A cross-sectional study was designed based on the final adapted framework (See **Figure 5.4**). To ensure the reporting quality of this cross-sectional study, the STROBE statement was used as a methodological guide (379). Based on a path analytic approach, the present study formulated five hypothesised paths between variables:

1) **Hypothesis 1:** socio-demographics predicted self-efficacy, health literacy, social support and perceptions of school and community environment;
2) **Hypothesis 2:** self-efficacy predicted health literacy;
3) **Hypothesis 3:** social support predicted self-efficacy, health literacy and health-related outcomes (health behaviours, health service use, health status and health-related quality of life);
4) **Hypothesis 4:** perceptions of school and the community environment predicted personal self-efficacy, health literacy and health-related outcomes (health behaviours, health service use, health status and health-related quality of life);
5) **Hypothesis 5:** health literacy predicted health-related outcomes (health behaviours, health service use, health status and health-related quality of life).

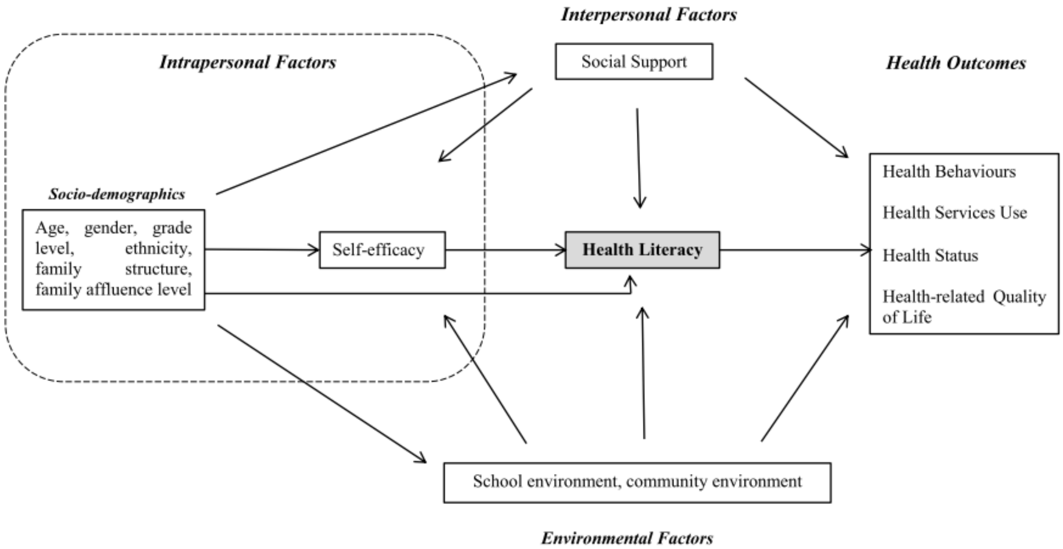

Figure 5.4: The adapted Manganello's health literacy framework used in Chinese secondary students

5.3.2.2 Ethical considerations

The ethics application process for this study was the same as that in Section One of this chapter. Ethics approval was obtained from The University of Melbourne (Ethics number: 1442884, see **Appendix 5.1**) and Peking University Institutional Review Board (Ethics number: IRB00001052-15024, see **Appendix 5.2**). This study was approved as '*low-risk*' research in Chinese school settings. Therefore, passive, opt-out consent was obtained from both parents and students.

5.3.2.3 Sampling and recruitment

The sampling method, sample size and recruitment procedures for this study were the same as those in Section One of this chapter. The sample size of 650 met the requirement of path analysis in this study.

5.3.2.4 Data collection procedures

The data collection procedures were the same as those in Section One of this chapter.

5.3.2.5 Questionnaire

A self-administered questionnaire was designed based on the adapted Manganello's health literacy framework. A summary of questionnaire structure and indicators is provided in **Table 5.8**. Further details of the origin of each indicator are given in **Appendix 5.8**: Summary of questionnaire structure and indicators.

Table 5.8: A summary of questionnaire structure and indicators for Chinese secondary students

Domain	Indicator
Intrapersonal factors	Age Gender Ethnicity Year level Family structure Family affluence level Self-efficacy
Interpersonal factors	Social support
Environmental factors	School environment Community environment
Health literacy assessment	c-HLAT-8 NVS *a* HLS-Asia-Q *a*
Health-related outcomes	Health behaviours ✓ Regular breakfast eating ✓ Physical activity ✓ Cigarette smoking ✓ Alcohol drinking ✓ Teeth brushing Health service use ✓ Emergency service use ✓ General practitioner service use ✓ Hospital service use ✓ Other health professionals' service use ✓ Patient-provider communication Self-report health status Health-related quality of life

Note: *a* the measure was used as a comparison tool to examine convergent validity of the c-HLAT-8; the measure result was reported in Section One of this chapter. c-HLAT-8, the Chinese version of the Health Literacy Assessment Tool; HLS-Asia-Q, the Health Literacy Study-Asia-Questionnaire; NVS, the Newest Vital Sign.

5.3.2.5.1 Intrapersonal factors

Intrapersonal factors were assessed by socio-demographics and personal self-efficacy. Socio-demographics included age (continuous), gender (male or female), ethnicity (Han or ethnic minorities), year level (Years 7, 8 or 9), family structure (intact families or other types of families), and socio-economic status (low, medium or high). The information collected here was the same as that in the validation study, which was fully explained in Section One of this chapter.

5.3.2.5.1.1 General self-efficacy scale (GSES)

Personal self-efficacy was measured by the General Self-Efficacy Scale (GSES) developed by Schwarzer and Jerusalem (463). The GSES is a 10-item scale to assess personal beliefs to cope with a variety of difficult demands in life. Respondents indicate their level of agreement on a 4-point scale (1=not at all true, 4=exactly true). The total score of the GSES ranges from 10 to 40, with higher scores reflecting higher levels of self-efficacy.

Currently, the GSES is available in 32 languages, including the Chinese version (http://userpage.fu-berlin.de/health/selfscal.htm). In 1997, Schwarzer *et al.* (464) validated the Chinese version of the GSES in 293 first-year university students and found that it had excellent internal consistency (Cronbach's α=0.91) and strong structural validity (confirmatory factor analysis confirmed the uni-dimensional nature of the scale, with the first factor accounting for 55% of the total variance). In the present study, Cronbach's α for the GSES was 0.89, and the uni-dimensional structure of the GSES was confirmed by one factor accounting for 50.5% of the total variance, with factor loadings greater than 0.50 on all items.

5.3.2.5.2 ***Interpersonal factors***

As explained earlier in Chapter 3.2: Conceptual framework underpinning this thesis, adolescent health literacy in everyday life relies heavily on young people's families and friends. In this study, social support from families, friends and significant others was measured as an important interpersonal factor of adolescent health literacy.

5.3.2.5.2.1 Multi-dimensional Scale of Perceived Social Support (MSPSS)

Perceived social support was assessed using the Multi-dimensional Scale of Perceived Social Support (MSPSS) developed by Zimet *et al.* (465) in 1988. The MSPSS is a 12-item scale that measures an individual's perceived support from three sources: family (4 items), friends (4 items) and significant others (4 items). Respondents answer each item on a 7-point Likert scale (1=very strongly disagree, 7=very strongly agree). The MSPSS total score ranges from 12 to 84, with higher scores indicating higher levels of social support.

Previous studies suggested that the MSPSS was psychometrically sound in adolescents with high internal consistency (Cronbach's α=0.86-0.93), and strong construct validity (three factors were extracted accounting for 79.3% of the total variance, which coincided with the three domains of the MSPSS scale) (466, 467). In 2000, Chou (468) validated the MSPSS scale in 475 Chinese high school students and found that the

Chinese version of the MSPSS scale had high internal consistency (Cronbach's α=0.89), satisfactory concurrent validity (the MSPSS subscales were positively correlated with the Lubben Social Network Scale, with correlation coefficients ranging 0.25 to 0.40, $p<0.01$), and good construct validity (the MSPSS subscales were negatively correlated with the Anxiety subscale and the Depression subscale of the General Health Questionnaire, with correlation coefficients ranging 0.11 to 0.16, $p<0.05$). In the present study, Cronbach's α for the MSPSS was 0.93, while exploratory factor analysis showed that three factors were extracted accounting for 73.3% of the total variance.

5.3.2.5.3 Environmental factors

The environmental factors were measured using the school environment scale and the community environment scale.

5.3.2.5.3.1 The School Environment Scale (SES)

The School Environment Scale (SES) was derived from the school domain of the Communities That Care Youth Survey (CTCYS) developed by Glaser *et al.* (469) in 2005. The CTCYS is a self-report instrument that assesses protective and risk factors associated with health and behavioural outcomes for adolescents aged 11 to 18 in five domains: community, school, family, peer and individual (437, 470). The school domain of the CTCYS consists of 17 items in 4 sub-domains: opportunities for pro-social involvement (5 items), rewards for pro-social involvement (4 items), academic performance (2 items) and commitment to school (6 items) (469). In American and Australian adolescents, Bond *et al.* (471) and Glaser *et al.* (469) both found that the school domain of the CTCYS had high internal consistency (Cronbach's α=0.70-0.76) and strong construct validity (confirmatory factor model provided a good data fit: RMSEA=0.057,TLI=0.956, SRMR=0.040). In the present study, the original 17-item scale was reduced to a short version that included 10 items. There were two reasons for this change. First, this study focuses on testing students' feelings and experience of school environments and interactions with school activities, rather than personal commitment to school (e.g. commitment to homework), so six items of the sub-domain '*commitment to school*' were deleted. Second, only one item of the sub-domain '*academic performance*' has the same layout and format (4-point Likert-scale) as the other nine items in sub-domains '*opportunities for pro-social involvement*' and '*rewards for pro-social involvement*'. Therefore, the final SES consists of 10 items in three domains: opportunities for pro-social involvement (5 items), rewards for pro-social involvement (4 items) and academic performance (1 item).

Respondents indicate their level of agreement on a 4-point Likert scale (1=strongly disagree, 4=strongly agree). The SES total score ranges from 10 to 40, with higher scores indicating a better feeling about the school environment. In this study, the SES was translated into Chinese using a translation and back-translation technique (378). Its Cronbach's α was 0.88. Also, confirmatory factor analysis showed that each domain had a good data fit: opportunities domain (χ^2/df=2.391, p=0.067, CFI=0.996, RMSEA=0.048); rewards domain (χ^2/df=2.744, p=0.064, CFI=0.995, RMSEA=0.053).

5.3.2.5.3.2 The Community Environment Scale (CES)

The Community Environment Scale (CES) was derived from the Longitudinal Study of Australian Children '*Growing up in Australia*' which was specifically designed to assess neighbourhood effects on children' health (472). The CES is a 9-item scale designed to measure respondents' subjective feelings about their neighbourhood environment, such as feelings of its cleanliness and safety (473). The CES consists of three domains: neighbourhood livability (5 items), neighbourhood facilities (3 items) and traffic on the street (1 item). Respondents answer each item on a 5-point scale (1=strongly disagree, 4=strongly agree; 0=do not know). A total score of the CES is obtained by reversing the score on the item of '*traffic on the street*' (i.e. 1=4, 2=3, 3=2, 4=1 and 0=0) and then summing scores across all nine items. The CES total score ranges from 0 to 36, with higher scores indicating more livable and supportive neighbourhoods. In the present study, the CES was translated from English to Chinese according to Beaton's cross-cultural adaptation guidelines (378). The CES showed adequate internal consistency (Cronbach's α=0.84) and satisfactory construct validity (exploratory factor analysis indicated a three-factor construct and explained 67.78% of the total variance, with factor loadings greater than 0.48 on all items).

5.3.2.5.4 Health literacy assessment

Health literacy was assessed using the Health Literacy Assessment Tool (HLAT-8) that was developed by Abel *et al.* (4) in 2014. The HLAT-8 is an 8-item Likert scale that measures an individual's ability to access, understand, evaluate and communicate health information in everyday life. It consists of three domains: functional health literacy (4 items), interactive health literacy (2 items) and critical health literacy (2 items). Respondents answer each item on a 5-point scale (1=strongly disagree, 4=strongly agree; 0=I do not have such experiences) or a 6-point scale (1=very bad, 5=very good; 0=There have never been any questions). The HLAT-8 total score range is from 0 to 37, with higher scores indicating higher levels of health literacy. In Section One of this chapter, the Chinese version of the HLAT-8 (c-HLAT-8) was shown to have satisfactory internal consistency (Cronbach's α=0.79) and strong construct validity (χ^2/df=3.388, p<0.001; CFI=0.975, TLI=0.945, NFI=0.965, RMSEA=0.061) in Chinese secondary students.

5.3.2.5.5 ***Health behaviours***

Health behaviours were measured by the frequency of breakfast eating ('*during the past 7 days, how often did you have breakfast?*'; 1=0 days, 8=7 days), physical activity ('*during the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?*'; 1=0 days, 8=7 days), cigarette smoking ('*on how many occasions have you smoked cigarettes in the last 30 days?*'; 1=never, 7=40 times or more), alcohol drinking ('*on how many occasions have you drunk alcohol in the last 30 days?*'; 1=never, 7=40 times or more) and teeth brushing ('*how often do you brush your teeth?*'; 1=never, 5=more than once a day). These five items were derived from previously well-established student health and wellbeing surveys (474, 475). A total score of health behaviour is obtained by reversing the scores on '*cigarette smoking*' and '*alcohol drinking*' (1=7, 2=6, and so on) and then summing scores across all five items. Health behaviour scores range from 5 to 35, with higher scores indicating more health-protecting behaviours. This continuous scoring system was used for path analysis. Meanwhile, each health behaviour item was also recoded in a binary form. That is, the item '*breakfast eating*' was recoded to either '*not eating breakfast daily (≤ 6 days/week)*' or '*eating breakfast daily (7 days/week)*' (476), the item '*physical activity*' was recoded to either '*physically inactive ≤ 4 or less days/week*' or '*physically active ≥ 5 or more days/week*' (477), the item '*cigarette smoking*' was recoded to either '*no smoking*' or '*ever smoking*' (475), the item '*alcohol drinking*' was recoded to either '*no drinking*' or '*ever drinking*' (475) and the item '*teeth brushing*' was recoded to either '*≤ once/day*' or '≥ *2 times/day*' (478). This binary scoring system was only used for univariate analysis which examined the relationship between each type of health behaviour and health literacy.

5.3.2.5.6 ***Health service use***

Health service use was assessed by the frequency of emergency service use ('*how many times have you used the emergency service in the last 12 months?*'; 1=0 times, 4=6 times or more; 0=do not know), general practitioner service use ('*how many times have you been to see a general practitioner in the last 12 months?*'; 1=0 times, 4=6 times or more; 0=do not know), hospital service use ('*how many times have you used a hospital service in the last 12 months?*'; 1=0 times, 4=6 times or more; 0=do not know), other health professionals' service use ('*how many times have you used service from other health professionals such as dentists in the last 12 months?*'; 1=0 times, 4=6 times or more; 0=do not know) and patient-provider communication ('*how many times have you raised a question during your doctor's appointment in the last 12 months?*'; 1=0 times, 4=6 times or more; 0=do not know). A total score of health service use is obtained by reversing the score on each item (1=4, 2=3, 3=2, 4=1, 0=0) and then summing scores across all five items. Health service use scores range from 0 to 20, with higher scores indicating less use of health services. This continuous scoring system was used for path analysis. Meanwhile, all health service use items were recoded into a binary form (i.e. '*0 times*' or '≥ *1 times*'). This binary scoring system was only used for univariate analysis which examined the relationship between each type of health service use and health literacy.

5.3.2.5.7 ***Health status***

Health status was assessed using a widely-used general self-report health question ('*in general, would you say your health is?*'; 1=poor, 5=excellent) (438, 479). This single question has demonstrated strong predictive validity with objective indicators of health and mortality (480, 481).

5.3.2.5.8 ***Health-related quality of life (HRQOL)***

Health-related quality of life (HRQOL) was measured by the KIDSCREEN-10 developed by Ravens-Sieberer *et al.* (351) in 2010. The KIDSCREEN-10 is a short version of the KIDSCREEN-52 that assesses the health-related quality of life of healthy and chronically ill children and adolescents aged 8 to 18. Respondents answer each item on a 5-point Likert scale (1=not at all/never, 5=extremely/always). The KIDSCREEN-10 score is obtained by reversing the scores on two items (1=5, 2=4, and so on) and then summing scores across all 10 items. The total score ranges from 10 to 50, with higher scores indicating higher levels of health-related quality of life. In 2015, the Chinese version of the KIDSCREEN full version (KIDSCREEN-52) was used with 1379 Chinese primary and secondary students, showing good psychometric properties (482): high internal consistency (Cronbach's α ranged 0.74-0.95 for all subscales), satisfactory test-retest reliability (ICCs were above 0.70 for all subscales) and adequate construct validity (confirmatory factor analysis showed that fit indices supported the 10-factor structure: CFI=0.91, TLI=0.90, RMSEA=0.07). In the present study, the Chinese version of the KIDSCREEN-10 was extracted from the Chinese version of the KIDSCREEN-52. Cronbach's α for the KIDSCREEN-10 was 0.79, indicating satisfactory internal consistency. Confirmatory factor analysis showed that the KIDSCREEN-10 had an acceptable data fit (χ^2/df=2.877, p<0.001, CFI=0.959, RMSEA=0.055).

5.3.2.6 Data input and quality control

Data were input using EPI Data 3.1 software. 15% (n=104) of the total sample (n=650) was randomly selected for double entry to check the quality of data input. As only 0.11% of data were found to have input errors during the double entry, a high-quality dataset was assumed, and there was no need for double data entry.

5.3.2.7 Data management

Data were exported from EPI Data 3.1 (The EpiData Association, Denmark, Europe) to SPSS 22.0 (IBM Corp., US, 2013). Only researchers associated with this PhD project have access to the database. In addition, paper-based questionnaires were kept separately from each other in locked cabinets. These questionnaires will be destroyed in accordance with ethics requirements when appropriate.

5.3.2.8 Statistical analysis

5.3.2.8.1 Dealing with missing values

The individual mean substitution was used prior to data analysis. This step was conducted to avoid excess missing data due to item non-response in a self-report scale (443). A missing total score was assigned if more than half of the total items on a scale were missing (444). If one-half or fewer items were missing, a person-specific estimate (mean of the non-missing items) was substituted for the missing items. The percentages of missing items for the GSES, MSPSS, SES, CES, c-HLAT-8, health behaviours, health service use and KIDSCREEN-10 ranged from 0.9% to 1.8%, 0.9% to 2.0%, 0.9% to 1.7%, 2.5% to 2.9%, 0.2% to 0.6%, 0.2% to 0.5%, 2.3% to 2.8% and 0% to 0.3% respectively.

5.3.2.8.2 Statistical methods

The methods of statistical analysis are described in three stages:

5.3.2.8.2.1 Statistical analysis stage 1

Descriptive statistics were conducted using SPSS 22.0 (IBM Corp., US, 2013) for participants' socio-demographics and other intermediate or outcome variables.

5.3.2.8.2.2 Statistical analysis stage 2

Univariate analysis (independent T-test, one-way ANOVA test and nonparametric test) and correlation analysis (Pearson correlation analysis and Spearman correlation analysis) were conducted using SPSS 22.0 (IBM Corp., US, 2013) for examination of the relationship between health literacy, its influencing factors, and health-related outcomes. All statistical tests were 2-sided, and a significant level was set at $p<0.05$.

5.3.2.8.2.3 Statistical analysis stage 3

Path analysis was conducted using AMOS 23.0 (IBM Corp., US, 2015) for examinations of the fit between the hypothesised model and empirical data, using the maximum likelihood method. Given that there is no single statistical test of significance for model fit (41, 383, 483), four statistical indicators were used to assess the fit between the model and the sample data. These indicators included:

a. The relative chi-square goodness-of-fit statistic (χ^2/df): The χ^2 statistic is often used to examine the overall fit of a hypothesised model to the empirical data. A non-significant result (i.e. p>0.05) indicates a good fit (484). Due to the sensitivity of the χ^2 statistic to sample size (i.e. the probability of rejecting the hypothesised model increases with increased sample size), the relative chi-square goodness-of-fit statistic (χ^2/df) was considered. As recommended by Kline (485), the χ^2/df statistic should be ≤ 3 for an acceptable model.
b. Root Mean Square Error of Approximation (RMSEA): An acceptable model was considered when the RMSEA value was below 0.08 (486).
c. Comparative Fit Index (CFI): An adequate model was considered when the CFI value was exceeding 0.95 (486).
d. Tucker and Lewis's Index of Fit (TLI): An adequate model was considered when the TLI value was exceeding 0.95 (486).

In Stage 3, an acceptable model fit was considered when the above four indicators met criteria. The model modification was performed based on suggested modification indices (MI). The strength of relationships between variables in the final modified model was shown as standardised path coefficients and their significance. After model testing as per each health outcome, the total sample was also split into two parts (boys and girls) to present a more elaborate and robust approach and to explain the findings from path analysis.

5.3.2.8.3 Statistical analysis assumptions

All statistical analysis assumptions (e.g. sample size, normality, univariate and multivariate outliers) were examined for each statistical method prior to final analysis.

In Stage 2, independent T test and ANOVA were conducted for normally distributed variables (i.e. age, self-efficacy, school environment, health literacy and health-related quality of life), whereas Mann-Whitney U test and Kruskal-Wallis test were conducted for non-normally distributed variables (i.e. social support, community environment, health behaviours and health service use). Pearson correlation analysis was used for normally distributed variables, and Spearman correlation analysis was used for non-normally distributed variables.

In Stage 3, path analysis using maximum likelihood estimation method was conducted because: 1) the sample size of this study was larger (n=650) than the recommended minimum (n=480); 2) all intermediate and dependent variables in the model were continuous variables or ordinal variables with 5 or more categories. This met the statistical requirements for path analysis (487-489). Specifically, four variables (self-efficacy, school environment, health literacy and health-related quality of life) were normally distributed, and four variables (social support, school environment, health behaviours and health service use) were moderately non-normally distributed (skewness<2 and kurtosis<7). As recommended by West *et al.* (490), non-normality is a concern if skewness>2 and kurtosis>7 for path analysis. All variables in this study satisfied this recommendation; 3) the relationships between variables in the model were linear and causal; and 4) missing data were addressed by either individual mean substitution method or deletion (i.e. 3.8%-5.5% of cases were deleted due to missing values for the four tested models). In addition, path analysis results with bootstrapping and without bootstrapping were compared for the estimation of standard errors for each path model. This procedure was to check how robust was the maximum likelihood estimation used in this study because bootstrapping is a commonly-used way to cope with non-normality and to correct standard errors, especially for sample sizes of 200 or less (491).

5.3.3 Results

5.3.3.1 Participant characteristics

In total, 650 students participated in the present study. No students in attendance refused participation. Students' characteristics were the same as those in Section One of this chapter (See **Table 5.2**).

5.3.3.2 Descriptive statistics of intermediate and outcome variables

5.3.3.2.1 ***<u>Descriptive statistics of continuous variables</u>***

Means and standard deviations, and medians and interquartile ranges of eight continuous variables are described in **Table 5.9**. The mean score of self-efficacy, health literacy, school environment and health-related quality of life was 26.85 ± 6.37, 26.37 ± 5.89, 30.48 ± 5.59 and 37.49 ± 5.78 respectively. The median score of social support, community environment, health behaviours and health service use was 65.73, 26.00, 31.00 and 18.00 respectively.

Table 5.9: Descriptive statistics of continuous variables in Chinese secondary students

Continuous variable (measure)	Mean± SD /Median (IQR)
Self-efficacy (GSES) [a]	26.85 ± 6.37
Social support (MSPSS) [b]	65.73 (54.00, 73.00)
School environment (SES) [a]	30.48 ± 5.59
Community environment (CES) [b]	26.00 (24.00, 30.00)
Health literacy (c-HLAT-8) [a]	26.37 ± 5.89
Health behaviours [b]	31.00 (28.00, 33.00)
Health service use [b]	18.00 (16.00, 19.00)
Health-related quality of life (KIDSCREEN-10) [a]	37.49 ± 5.78

Note: *a* variables were distributed normally; *b* variables were distributed non-normally. CES, the Community Environment Scale; c-HLAT-8, the Chinese version of the Health Literacy Assessment Tool; GSES, the General Self-Efficacy Scale; IQR, Interquartile Range; MSPSS, the Multi-dimensional Scale of Perceived Social Support; SD, Standard Deviation; SES, the School Environment Scale.

5.3.3.2.2 Descriptive statistics of categorical variables

Frequencies and percentages of categorical variables are presented in **Table 5.10**. It was notable that 34.5% of students reported fair/poor health status. As to health-compromising behaviours, 49.4% of students reported that they had not eaten breakfast daily in the past week; 42.8% of students were not physically active in the past week; 2.8% of students had smoked in the last 30 days; 14.9% of students had drunk in the last 30 days; and 53.4% of students brushed their teeth once or fewer times each day. In terms of health service use, the percentage of emergency service use, general practitioner service use, hospital service use, other health professionals' service use and patient-provider communication was 17.5%, 49.5%, 54.2%, 31.1% and 44.9% respectively.

Table 5.10: Descriptive statistics of categorical variables in Chinese secondary students

Categorical variable	Frequency (%)
Health status	
Fair or poor	224 (34.5)
Good	227 (34.9)
Excellent or very good	199 (30.6)
Breakfast eating	
Not eating breakfast daily (≤ 6 days/week)	321 (49.4)
Eating breakfast daily (7 days/week)	327 (50.3)
Missing values	2 (0.3)
Physical activity	
Not physically active	278 (42.8)
Physically active	369 (56.8)
Missing values	3 (0.5)
Cigarette smoking	
Ever smoking	18 (2.8)
No smoking	630 (96.9)
Missing values	2 (0.3)
Alcohol drinking	
Ever drinking	97 (14.9)
No drinking	552 (84.9)
Missing values	1 (0.2)
Teeth brushing	
≤ once/day	347 (53.4)
≥ 2 times/day	302 (46.5)
Missing values	1 (0.2)
Emergency service use	
0 times	511 (78.6)
≥ 1 times	114 (17.5)
Missing values	25 (3.8)
General practitioner service use	
0 times	302 (46.5)
≥ 1 times	322 (49.5)
Missing values	26 (4.0)
Hospital service use	
0 times	273 (42.0)
≥ 1 times	352 (54.2)
Missing values	25 (3.8)
Other health professionals' service use	
0 times	424 (65.2)
≥ 1 times	202 (31.1)
Missing values	24 (3.7)
Patient-provider communication	
0 times	332 (51.1)
≥ 1 times	292 (44.9)
Missing values	26 (4.0)

5.3.3.3 Relationships between health literacy and its influencing factors

5.3.3.3.1 Health literacy and categorical influencing factors

Health literacy was examined by gender, year level, ethnicity, family structure and family affluence level. Results showed that only family affluence level was found to be related to health literacy (See **Table 5.11**). Students from medium or high family affluence were more likely to have high health literacy than those from low family affluence.

Table 5.11: Relationships between health literacy and its influencing factors (categorical variables) in Chinese secondary students

Categorical variable	Health literacy [a]	
	Mean ± SD	*P* value
Gender		
Male	26.40±6.16	0.881
Female	26.33±5.56	
Year level [b]		
Year 7	26.78±5.75	
Year 8	26.59±5.41	0.117
Year 9	25.67±6.48	
Ethnicity		
Han	26.37±5.89	0.926
Ethnic minorities	26.27±5.96	
Family structure		
Intact families	26.49±5.79	0.215
Other types of families	25.68±6.47	
Family affluence level [b]		
Low	25.30±5.51 [A]	
Medium	26.72±5.95 [B]	**0.012**
High	26.96±5.82 [B]	

Note: *a* health literacy was examined by independent T-test and ANOVA test; *b* post hoc test was calculated using Fisher's Least Significant Difference (LSD): there was no statistical difference between two groups with the same letter. SD, Standard Deviation.

5.3.3.3.2 Health literacy and continuous influencing factors

As presented in **Table 5.12**, health literacy was found to positively correlate with self-efficacy, social support, school environment and community environment (r=0.25-0.43, $p<0.01$). Students with high scores of self-efficacy, social support, school environment and community environment were more likely to have high health literacy.

Table 5.12: Relationships between health literacy and its influencing factors (continuous variables) in Chinese secondary students

Variable	Age	Self-efficacy	Social support	School environment	Community environment	Health literacy
Age	1.000					
Self-efficacy	-0.133**	1.000				
Social support	-0.048	0.446**	1.000			
School environment	-0.122**	0.475**	0.572**	1.000		
Community environment	-0.047	0.283**	0.375**	0.389**	1.000	
Health literacy	-0.064	0.319**	0.432**	0.427**	0.253**	1.000

Note: ** $p<0.01$.

5.3.3.4 Relationships between health literacy and health outcomes

5.3.3.4.1 <u>Health literacy and categorical health outcomes</u>

As shown in **Table 5.13**, students with high health literacy were more likely than their counterparts to perceive good health status, eat breakfast daily, be physically active, brush teeth frequently, use general practitioner service, and communicate with health providers. Conversely, students with low health literacy were more likely to be drinking alcohol.

Table 5.13: Relationships between health literacy and health outcomes (categorical variables) in Chinese secondary students

Categorical variable	Health literacy	*T/F* value	*P* value
Health status [a]			
Fair or poor	25.07±5.54 [A]		
Good	25.84±5.59 [A]	19.374	**<0.001**
Excellent or very good	28.42±6.09 [B]		
Breakfast eating			
Not eating breakfast daily (≤ 6 days/week)	25.81±5.64	-2.377	**0.018**
Eating breakfast daily (7 days/week)	26.91±6.10		
Physical activity			
Not physically active	25.30±5.20	-4.193	**<0.001**
Physically active	27.19±6.24		
Cigarette smoking [b]			
Ever smoking	25.50 (22.75, 28.25)	-1.131	0.258
No smoking	27.00 (23.00, 31.00)		
Alcohol drinking			
Ever drinking	24.58±7.15	-3.266	**0.001**
No drinking	26.68±5.59		
Teeth brushing			
≤ once/day	25.56±6.16	-3.759	**<0.001**
≥ 2 times/day	27.29±5.43		
Emergency service use			
0 times	26.26±6.03	-1.098	0.273
≥ 1 times	26.93±5.38		
General practitioner service use			
0 times	25.72±6.66	-2.581	**0.010**
≥ 1 times	26.96±5.11		
Hospital service use			
0 times	25.96±6.61	-1.371	0.171
≥ 1 times	26.63±5.31		
Other health professionals' service use			
0 times	26.09±6.20	-1.643	0.101
≥ 1 times	26.87±5.28		
Patient-provider communication			
0 times	25.25±6.49	-5.223	**<0.001**
≥ 1 times	27.64±4.89		

Note: *a* post Hoc Test was calculated using Fisher's Least Significant Difference (LSD): there was no statistical difference between two groups with the same letter; *b* Mann-Whitney U test was conducted due to a small sample size of '*ever smoking*' (n=18). SD, Standard Deviation.

5.3.3.4.2 Health literacy and continuous health outcomes

As seen in **Table 5.14**, health literacy was found to positively correlate with health behaviours (r=0.29, p<0.01) and health-related quality of life (r=0.29, p<0.01), but negatively correlated with scores of health service use (r=-0.09, p<0.05).

Table 5.14: Relationships between health literacy and health outcomes (continuous variables) in Chinese secondary students

Variable	Health literacy	Health behaviours	Health service use	Health-related quality of life
Health literacy	1.000			
Health behaviours	0.293**	1.000		
Health service use	-0.092*	-0.015	1.000	
Health-related quality of life	0.288**	0.328**	0.016	1.000

Note: ** p<0.01; * p<0.05.

5.3.3.5 Other relationships between health literacy influencing factors and health outcomes

As shown in the hypothesised model (See **Figure 5.4**), there were also relationships between socio-demographics, self-efficacy, social support, environmental factors and health outcomes. This section adds further information necessary for next-step path analysis.

5.3.3.5.1 Socio-demographics and health literacy influencing factors

Health literacy influencing factors (self-efficacy, social support, school environment and community environment) were examined by participants' characteristics. As shown in **Table 5.15**, there were statistical differences in **self-efficacy** in terms of gender, year level, family structure and family affluence level. Students were more likely to have high self-efficacy if they were male, came from lower year levels, lived with two biological parents, and came from high affluence families. **Social support** was found to associate with family structure and family affluence level. That is, students who lived with two biological parents and those with high family affluence were more likely to have high scores in social support. With regard to the perceived **school environment**, students had a higher score if they were from lower year levels, lived with two biological parents, and had high socio-economic status. As for the perceived **community environment**, only family affluence level was found to be an influencing factor. Students with a high level of family affluence were more likely to perceive a better community environment.

5.3.3.5.2 Health outcomes and health literacy influencing factors

The relationships between health literacy influencing factors (social support, school environment and community environment) and health outcomes (health behaviours, health service use, health-related quality of life and health status) were also examined. Students with high social support and high perception of school and community environments were more likely to score highly on health behaviours, health-related quality of life and health status (r=0.20-0.60, $p<0.01$), whereas students with high social support were more likely to have low scores on health service use (r=-0.09, $p<0.05$) (See **Table 5.16**).

Table 5.15: Relationships between socio-demographics and health literacy influencing factors in Chinese secondary students

Participant characteristic	Self-efficacy		Social support		School environment		Community environment	
	Mean ± SD [a]	*P* value	Median (IQR) [b]	*P* value	Mean ± SD [a]	*P* value	Median (IQR) [b]	*P* value
Gender								
Male	27.49±6.24	**0.004**	65.00 (54.00, 73.00)	0.954	30.39±5.72	0.646	26.00 (23.00, 31.00)	0.569
Female	26.06±6.44		66.00 (53.00, 74.00)		30.60±5.44		26.00 (24.00, 29.25)	
Year level *								
Year 7	27.96±6.43 [A]	**0.003**	66.77 (56.00, 75.00)	0.132	31.40±5.38 [A]	**<0.001**	26.00 (23.00, 31.00)	0.622
Year 8	26.54±6.61 [B]		66.00 (55.25, 73.00)		30.65±5.82 [A]		26.00 (23.90, 30.00)	
Year 9	25.91±5.86 [B]		62.50 (50.00, 73.00)		29.27±5.38 [B]		26.00 (24.00, 29.00)	
Ethnicity								
Han	26.89±6.28	0.595	65.23 (54.00, 73.00)	0.985	30.55±5.54	0.213	26.00 (24.00, 30.00)	0.399
Ethnic minorities	26.13±7.91		67.00 (52.25, 74.25)		29.28±6.36		28.50 (23.75, 30.00)	
Family structure								
Intact families	27.09±6.36	**0.023**	66.00 (56.00, 74.00)	**0.002**	30.67±5.54	**0.045**	26.00 (24.00, 30.00)	0.105
Other types of families	25.47±6.29		59.00 (49.00, 72.00)		29.43±5.79		26.00 (22.00, 29.00)	
Family affluence level *								
Low	25.20±6.27 [A]	**<0.001**	60.00 (49.00, 69.50) [A]	**<0.001**	29.41±5.68 [A]	**<0.001**	25.00 (22.00, 27.00) [A]	**<0.001**
Medium	26.96±6.17 [B]		67.00 (56.00, 74.00) [B]		30.45±5.43 [B]		26.00 (24.00, 30.00) [B]	
High	28.47±6.50 [C]		69.00 (57.61, 78.00) [B]		31.83±5.48 [C]		28.00 (25.00, 32.00) [C]	

Note: *a* continuous variables were examined by independent T-test and ANOVA test; *b* continuous variables were examined by Mann-Whitney U test and Kruskal-Wallis test; * post hoc test was calculated using Fisher's Least Significant Difference (LSD) or Mann-Whitney U test by adjusting *p* value: there was no statistical difference between two groups with the same letter. SD, Standard Deviation, IQR, Interquartile Range.

Table 5.16: Relationships between health outcomes and health literacy influencing factors in Chinese secondary students

Variable	Social support	School environment	Community environment	Health behaviours	Health service use	Health-related quality of life	Health status
Social support	1.000						
School environment	0.572**	1.000					
Community environment	0.375**	0.389**	1.000				
Health behaviours	0.284**	0.327**	0.197**	1.000			
Health service use	-0.085*	-0.075	-0.028	-0.015	1.000		
Health-related quality of life	0.604**	0.504**	0.390**	0.328**	0.016	1.000	
Health status	0.266**	0.212**	0.210**	0.180**	0.088*	0.358**	1.000

Note: ** $p<0.01$; * $p<0.05$.

5.3.3.6 Structural models

Based on the univariate analysis and correlation analysis results, all significant independent variables (i.e. $p<0.05$) related to '*health literacy*', or '*health behaviours*', or '*health service use*', or '*health status*', or '*health-related quality of life*' were considered for next-step path analysis. Path analysis was conducted separately for each type of health outcome: health behaviours, health service use, health status and health-related quality of life.

5.3.3.6.1 Health behaviour path model

As shown in **Figure 5.5**, the original health behaviour path model demonstrated poor data fit: χ^2/df (23, N=625)=14.163, $p<0.001$, CFI=0.630, TLI=0.277, RMSEA=0.145 (90%CI: 0.131-0.159), but the path from health literacy to health behaviour was significant (r=0.11, $p=0.008$). Examination of modification indices (MI) provided by the AMOS suggested that the model fit could be improved by connecting errors between '*social support*' and '*school environment*', errors between '*school environment*' and '*community environment*', and errors between '*social support*' and '*community environment*' (See **Table 5.17**). These correlated errors are represented by the double-headed arrows in the modified model (See **Figure 5.6**). These modifications were made based on the ecological theory (44, 460) which suggests that '*social support*', '*school environment*' and '*community environment*' are all external influencing factors for students' health literacy. Therefore, they were all connected. Also, the preceding correlation analysis in this study suggested that these variables were correlated with each other. The final trimmed health behaviour path model demonstrated excellent data fit: χ^2/df (26, N=625)=1.275, $p=0.158$, CFI=0.991, TLI=0.985, RMSEA=0.021 (90%CI: 0.000-0.040).

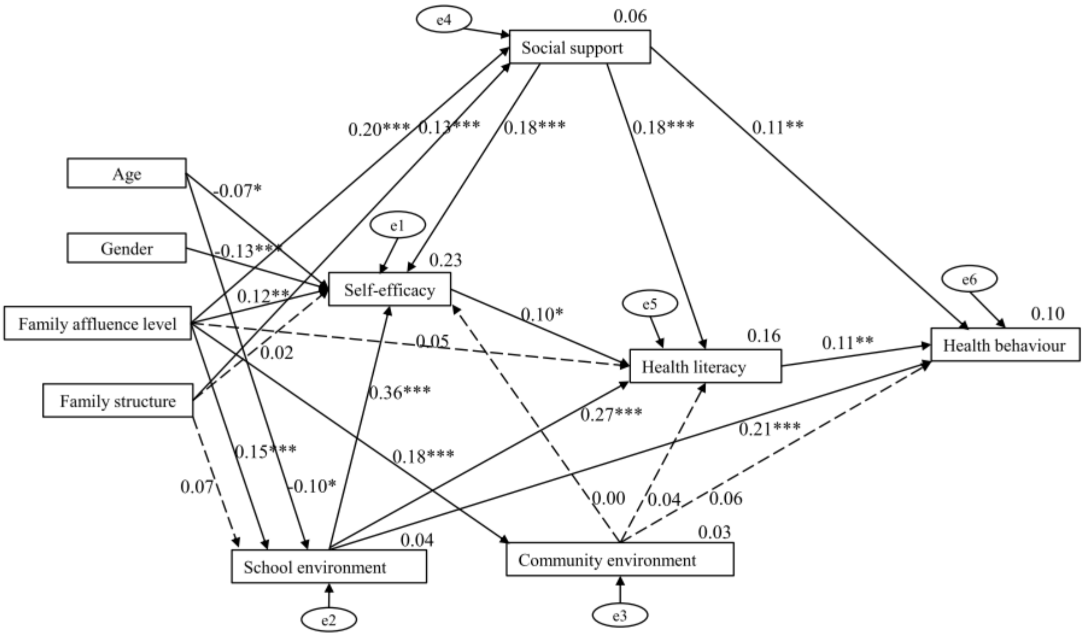

Figure 5.5: The original health behaviour path model in Chinese secondary students

(Note: Coefficients are standardised path coefficients. Dashed lines indicate non-significant relationships, whereas solid lines indicate statistically significant relationships. Overall model fit, χ^2/df (23, N=625)=14.163, p<0.001, CFI=0.630, TLI=0.277, RMSEA=0.145 (90%CI: 0.131-0.159). For tests of significance of individual paths, * p<0.05, ** p<0.01 and *** p<0.001.)

Table 5.17: Modifications for the health behaviour path model in Chinese secondary students

Model	χ^2	*df*	χ^2/df	*P* value	CFI	RMSEA (90%CI)
Original model	325.747	23	14.163	<0.001	0.630	0.145 (0.131, 0.159)
Remove non-significant paths	333.904	29	11.514	<0.001	0.628	0.130 (0.117, 0.143)
Modification 1 (Path e2←→e4)	113.996	28	4.071	<0.001	0.895	0.070 (0.057, 0.084)
Modification 2 (Path e2←→e3)	88.964	27	3.295	<0.001	0.924	0.061(0.047, 0.075)
Modification 3 (Path e3←→e4)	33.156	26	1.275	0.158	0.991	0.021 (0.000, 0.040)
Final model	33.156	26	1.275	0.158	0.991	0.021 (0.000, 0.040)

Note: χ^2=conventional chi-square fit statistic (under maximum likelihood estimate). CFI, Comparative Fit Index; CI, Confidence Interval; RMSEA, Root Mean Square Error of Approximation. Path e2←→e4: path was made between the error of school environment and the error of social support; Path e2←→e3: path was made between the error of school environment and the error of community environment; Path e3←→e4: path was made between the error of community environment and the error of social support.

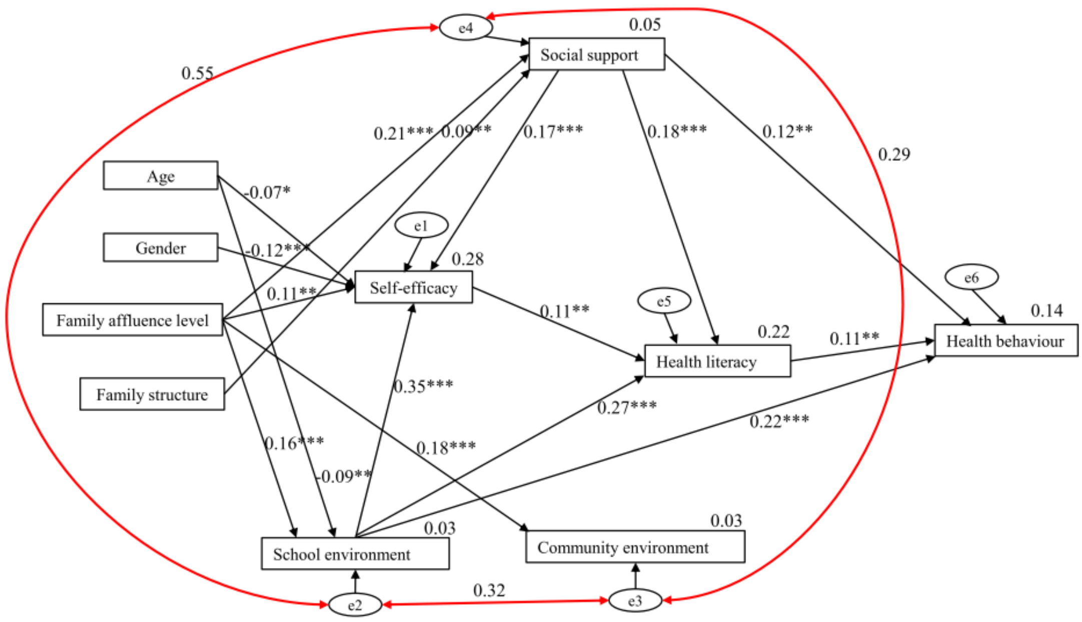

Figure 5.6: The final health behaviour path model in Chinese secondary students

(Note: Coefficients are standardised path coefficients. Overall model fit, χ^2/df (26, N=625)=1.275, p=0.158, CFI=0.991, TLI=0.985, RMSEA=0.021 (90%CI: 0.000-0.040). For tests of significance of individual paths, *p<0.05, **p<0.01 and ***p<0.001.)

In the final trimmed health behaviour path model, there were significant and direct paths from self-efficacy (r=0.11, p=0.007), social support (r=0.18, p<0.001) and school environment (r=0.27, p<0.001) to health literacy. Additional significant paths are shown in **Table 5.18**. Based on the squared multiple correlation coefficients (R^2), the final trimmed model explained 28% of the variance in self-efficacy, 22% of the variance in health literacy, and 14% of the variance in health behaviour.

As seen in the **Table 5.19**, the bootstrapping estimates of standard errors were similar to the maximum likelihood (ML) estimates of standard errors in the health behaviour path model. There were no significant changes in '*p values*' between bootstrapping estimates and ML estimates. This suggests that using the ML estimate method was robust for path analysis in this study.

Table 5.18: Individual parameter estimation for the health behaviour path model in Chinese secondary students

Parameter	Coefficient	Standardised coefficient	Standard error	*P* value
School environment ← age	-0.525	-0.095	0.179	0.003
School environment ← family affluence level	0.558	0.157	0.140	<0.001
Social support ← family affluence level	1.994	0.206	0.378	<0.001
Social support ← family structure	3.800	0.090	1.367	0.005
Self-efficacy ← school environment	0.395	0.347	0.047	<0.001
Self-efficacy ← social support	0.072	0.172	0.017	<0.001
Self-efficacy ← age	-0.455	-0.072	0.216	0.035
Self-efficacy ← family affluence level	0.459	0.113	0.141	0.001
Self-efficacy ← gender	-1.558	-0.122	0.434	<0.001
Health literacy ← self-efficacy	0.099	0.109	0.037	0.007
Health literacy ← school environment	0.277	0.268	0.047	<0.001
Health literacy ← social support	0.070	0.184	0.016	<0.001
Health behaviour ← school environment	0.141	0.219	0.030	<0.001
Health behaviour ← social support	0.029	0.121	0.011	0.008
Community environment ← family affluence level	0.694	0.181	0.151	<0.001
Health behaviour ← health literacy	0.071	0.113	0.026	0.007

Table 5.19: Comparison of ML estimates and bootstrapping estimates of standard errors for the health behaviour path model in Chinese secondary students

Parameter	ML estimate		Bootstrapping estimate[a]	
	SE	*P* value	SE	*P* value
School environment ← age	0.179	0.003	0.171	0.005
School environment ← family affluence level	0.140	<0.001	0.140	0.005
Social support ← family affluence level	0.378	<0.001	0.377	0.004
Social support ← family structure	1.367	0.005	1.593	0.026
Self-efficacy ← school environment	0.047	<0.001	0.054	0.003
Self-efficacy ← social support	0.017	<0.001	0.021	0.004
Self-efficacy ← age	0.216	0.035	0.211	0.025
Self-efficacy ← family affluence level	0.141	0.001	0.148	0.005
Self-efficacy ← gender	0.434	<0.001	0.430	0.005
Health literacy ← self-efficacy	0.037	0.007	0.044	0.032
Health literacy ← school environment	0.047	<0.001	0.053	0.005
Health literacy ← social support	0.016	<0.001	0.020	0.004
Health behaviour ← school environment	0.030	<0.001	0.032	0.003
Health behaviour ← social support	0.011	0.008	0.012	0.013
Community environment ← family affluence level	0.151	<0.001	0.144	0.005
Health behaviour ← health literacy	0.026	0.007	0.028	0.008

Note: *a* bootstrap was performed by 500 bootstrap samples with 95% bias-corrected confidence level. ML, Maximum Likelihood; SE, Standard Error.

In the context of the final trimmed health behaviour path model, each type of health behaviour was also examined, including breakfast eating, physical activity, cigarette smoking, alcohol drinking and teeth brushing. Results from this sub-analysis showed that only the physical activity model and the teeth brushing model were found to be a good fit for both the overall model assessment and individual parameter estimation. As presented in **Table 5.20**, there were significant paths from health literacy to physical activity (r=0.14, p=0.002) and teeth brushing (r=0.10, p=0.018), whereas paths from health literacy to breakfast eating, cigarette smoking and alcohol drinking were not significant (i.e. p>0.05).

Table 5.20: The path from health literacy to each type of health behaviour in Chinese secondary students

Path to:	Path from health literacy			
	Coefficient	Standardised coefficient	SE	*P* value
Eating breakfast daily	-0.002	-0.004	0.016	0.920
Physically active	**0.052**	**0.136**	**0.017**	**0.002**
No smoking	0.001	0.014	0.004	0.756
No drinking	0.006	0.058	0.005	0.187
Teeth brushing	**0.013**	**0.103**	**0.005**	**0.018**

Note: SE, Standard Error.

5.3.3.6.2 Health service use path model

Similarly, the health service use path model was examined by overall health service use and by each type of health service use respectively. As shown in **Figure 5.7**, the original path model for the overall health service use demonstrated poor data fit: χ^2/df (23, N=614)=13.834, p<0.001, CFI=0.591, TLI=0.199, RMSEA=0.145 (90%CI: 0.131-0.159). Also, individual parameter estimation showed that the path from health literacy to overall health service use was non-significant (r=-0.06, p=0.157). Therefore, the overall health service use path model was not established.

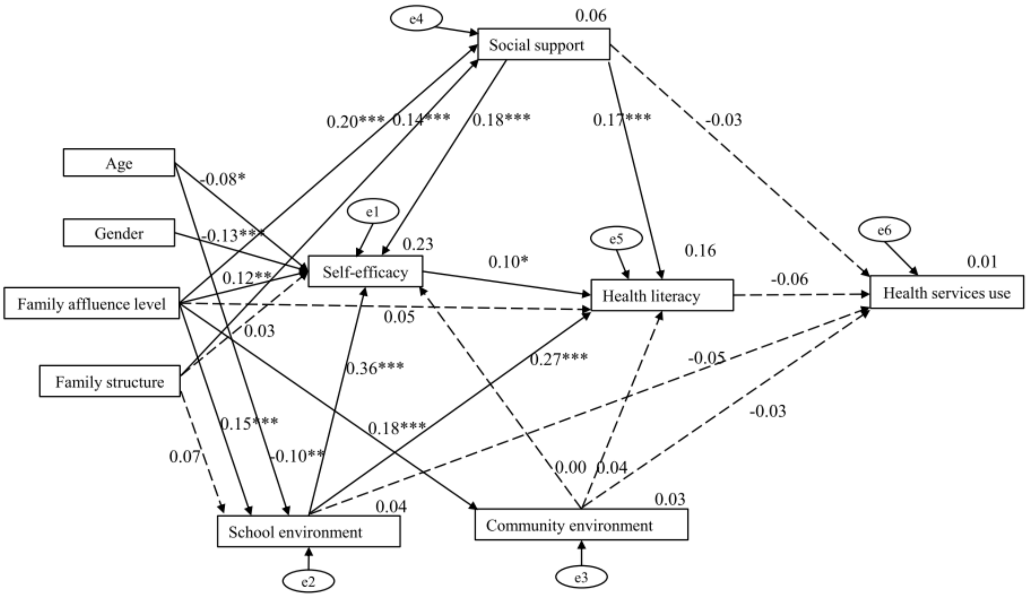

Figure 5.7: The original health service use model in Chinese secondary students

(Note: Coefficients are standardised path coefficients. Dashed lines indicate non-significant relationships, whereas solid lines indicate statistically significant relationships. Overall model fit, χ^2/df (23, N=614)=13.834, p<0.001, CFI=0.591, TLI=0.199, RMSEA=0.145 (90%CI: 0.131-0.159). For tests of significance of individual paths, *p<0.05, **p<0.01 and ***p<0.001.)

When examining each type of health service use, however, only the patient-provider communication path model was found to be a good fit for the individual parameter estimation. That is, there was a significant path from health literacy to patient-provider communication (r=-0.14, p=0.002) (See **Table 5.21**). Therefore, the patient-provider communication path model was established.

Table 5.21: The path from health literacy to each type of health service use in Chinese secondary students

Path to:	Path from health literacy			
	Coefficient	Standardised coefficient	SE	*P* value
Emergency service use	-0.000	-0.005	0.004	0.909
General practitioner service use	-0.010	-0.068	0.006	0.122
Hospital service use	-0.003	-0.023	0.006	0.591
Other health professionals' service use	-0.001	-0.010	0.005	0.821
Patient-provider communication	**-0.019**	**-0.136**	**0.006**	**0.002**

Note: SE, Standard Error.

The patient-provider communication path model showed poor data fit for the overall model assessment: χ^2/df (23, N=614)=13.990, p<0.001, CFI=0.593, RMSEA=0.146 (90%CI: 0.132-0.160). Consistent with the modification process of the health behaviour path model, **Table 5.22** shows each step for the model modification.

Table 5.22: Modifications for the patient-provider communication path model in Chinese secondary students

Model	χ^2	*df*	χ^2/df	*P* value	CFI	RMSEA (90%CI)
Original model	321.781	23	13.990	<0.001	0.593	0.146 (0.132, 0.160)
Remove non-significant paths	330.640	31	10.666	<0.001	0.592	0.126 (0.114, 0.138)
Modification 1 (Path e2←→e4)	115.351	30	3.845	<0.001	0.884	0.068 (0.055, 0.082)
Modification 2 (Path e2←→e3)	90.006	29	3.104	<0.001	0.917	0.059 (0.045, 0.073)
Modification 3 (Path e3←→e4)	32.260	28	1.152	0.264	0.994	0.016 (0.000, 0.036)
Final model	32.260	28	1.152	0.264	0.994	0.016 (0.000, 0.036)

Note: χ^2=conventional chi-square fit statistic (under maximum likelihood estimate). CFI, Comparative Fit Index; CI, Confidence Interval; RMSEA, Root Mean Square Error of Approximation. Path e2←→e4: path was made between the error of school environment and the error of social support; Path e2←→e3: path was made between the error of school environment and the error of community environment; Path e3←→e4: path was made between the error of community environment and the error of social support.

As shown in **Figure 5.8**, the final trimmed patient-provider communication path model demonstrated satisfactory data fit: χ^2/df (28, N=614)=1.152, p=0.264, CFI=0.994, TLI=0.991, RMSEA=0.016 (90%CI: 0.000-0.036). There were significant and direct paths from self-efficacy (r=0.11, p=0.009), social support (r=0.17, p<0.001) and school environment (r=0.27, p<0.001) to health literacy. Additional significant paths are shown in **Table 5.23**. Based on the squared multiple correlation coefficients (R^2), the final trimmed model explained 28% of the variance in self-efficacy, 21% of the variance in health literacy, and 3% of the variance in patient-provider communication.

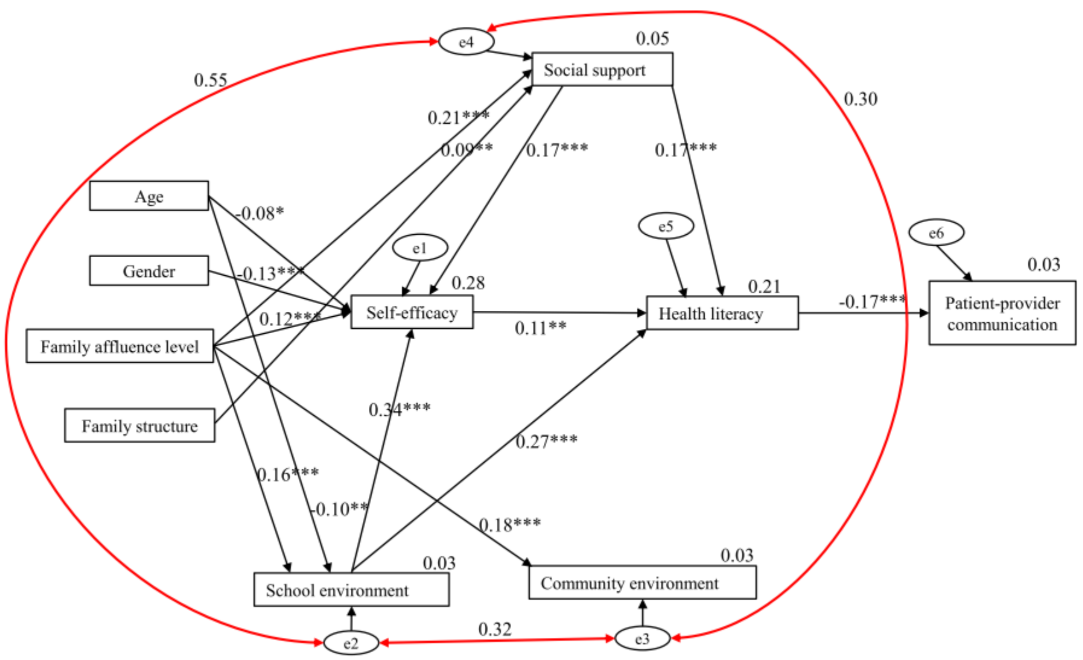

Figure 5.8: The final patient-provider communication path model in Chinese secondary students

(Note: Coefficients are standardised path coefficients. Dashed lines indicate non-significant relationships, whereas solid lines indicate statistically significant relationships. Overall model fit, χ^2/df (28, N=614)=1.152, p=0.264, CFI=0.994, TLI=0.991, RMSEA=0.016 (90%CI: 0.000-0.036). For tests of significance of individual paths, *p<0.05, **p<0.01 and ***p<0.001.)

Table 5.23: Individual parameter estimation for the patient-provider communication path model in Chinese secondary students

Parameter	Coefficient	Standardised coefficient	Standard error	*P* value
School environment ← family affluence level	0.562	0.157	0.142	<0.001
Social support ← family affluence level	1.994	0.206	0.381	<0.001
School environment ← age	-0.558	-0.100	0.181	0.002
Social support ← family structure	3.992	0.094	1.382	0.004
Self-efficacy ← school environment	0.392	0.344	0.047	<0.001
Self-efficacy ← social support	0.073	0.174	0.018	<0.001
Self-efficacy ← family affluence level	0.470	0.116	0.143	<0.001
Self-efficacy ← age	-0.477	-0.075	0.219	0.029
Self-efficacy ← gender	-1.628	-0.127	0.440	<0.001
Health literacy ← self-efficacy	0.098	0.108	0.037	0.009
Health literacy ← school environment	0.282	0.274	0.047	<0.001
Health literacy ← social support	0.066	0.175	0.017	<0.001
Patient-provider communication ← health literacy	-0.023	-0.168	0.005	<0.001
Community environment ← family affluence level	0.691	0.179	0.153	<0.001

Path analysis with bootstrapping was also conducted to compare the maximum likelihood estimates and bootstrapping estimates of standard errors. As the path analysis results with bootstrapping were similar to those without bootstrapping for the patient-provider communication path model, the maximum likelihood estimation method was considered as appropriate for path analysis in the patient-provider communication path model.

5.3.3.6.3 Health status path model

As shown in **Figure 5.9**, the original health status path model demonstrated poor data fit: χ^2/df (23, N=625)=15.043, p<0.001, CFI=0.597, TLI=0.211, RMSEA=0.150 (90%CI: 0.136-0.164), and the path from health literacy to health status was significant (r=0.12, p=0.006). Similar to the modification process of the health behaviour path model, **Table 5.24** shows path changes for each step. These path changes were consistent with the ecological theory (44, 460) which explains how external environments interact with each other. After three steps of modification, the final trimmed health status path model demonstrated good data fit: χ^2/df (26, N=625)=2.049, p=0.001, CFI=0.966, TLI=0.941, RMSEA=0.041 (90%CI: 0.025-0.057) (See **Figure 5.10**).

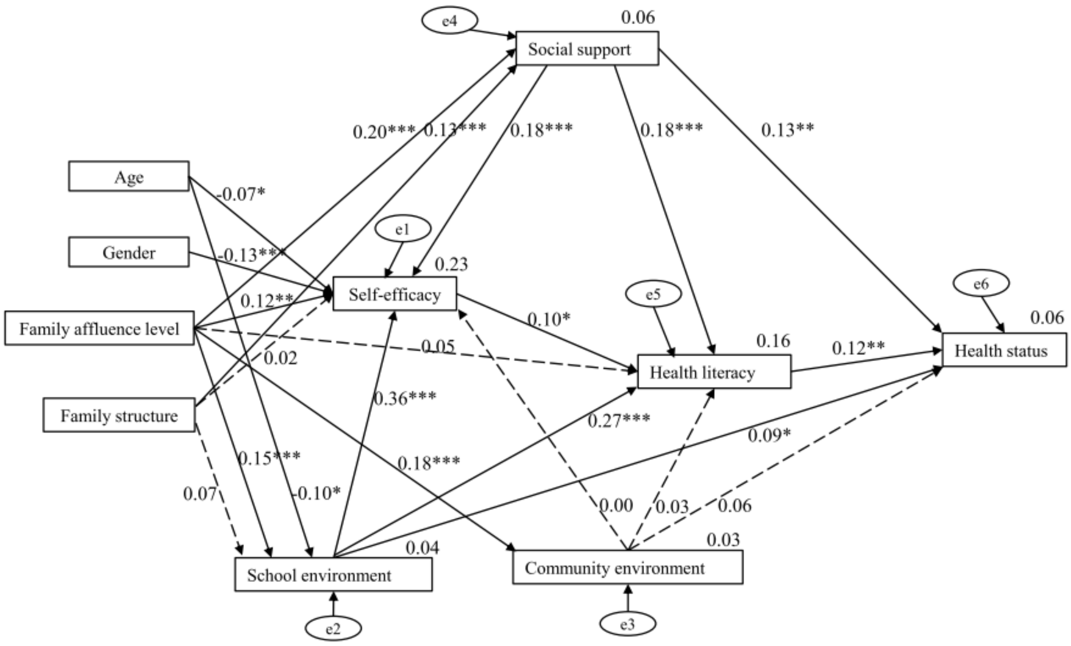

Figure 5.9: The original health status path model in Chinese secondary students

(Note: Coefficients are standardised path coefficients. Dashed lines indicate non-significant relationships, whereas solid lines indicate statistically significant relationships. Overall model fit, χ^2/df (23, N=625)=15.043, p<0.001, CFI=0.597, TLI=0.211, RMSEA=0.150 (90%CI: 0.136-0.164). For tests of significance of individual paths, *p<0.05, **p<0.01 and ***p<0.001.)

Table 5.24: Modifications for the health status path model in Chinese secondary students

Model	χ^2	*df*	*P* value	CFI	RMSEA (90%CI)
Original model	345.987	23	<0.001	0.597	0.150 (0.136, 0.164)
Remove non-significant paths	354.022	29	<0.001	0.594	0.134 (0.122, 0.147)
Modification 1 (Path e2←→e4)	134.114	28	<0.001	0.868	0.078 (0.065, 0.091)
Modification 2 (Path e2←→e3)	109.082	27	<0.001	0.898	0.070 (0.056, 0.084)
Modification 3 (Path e3←→e4)	53.274	26	0.001	0.966	0.041 (0.025, 0.057)
Final model	53.274	26	0.001	0.966	0.041 (0.025, 0.057)

Note: χ^2=conventional chi-square fit statistic (under maximum likelihood estimate). CFI, Comparative Fit Index; CI, Confidence Interval; RMSEA, Root Mean Square Error of Approximation. Path e2←→e4: path was made between the error of school environment and the error of social support; Path e2←→e3: path was made between the error of school environment and the error of community environment; Path e3←→e4: path was made between the error of community environment and the error of social support.

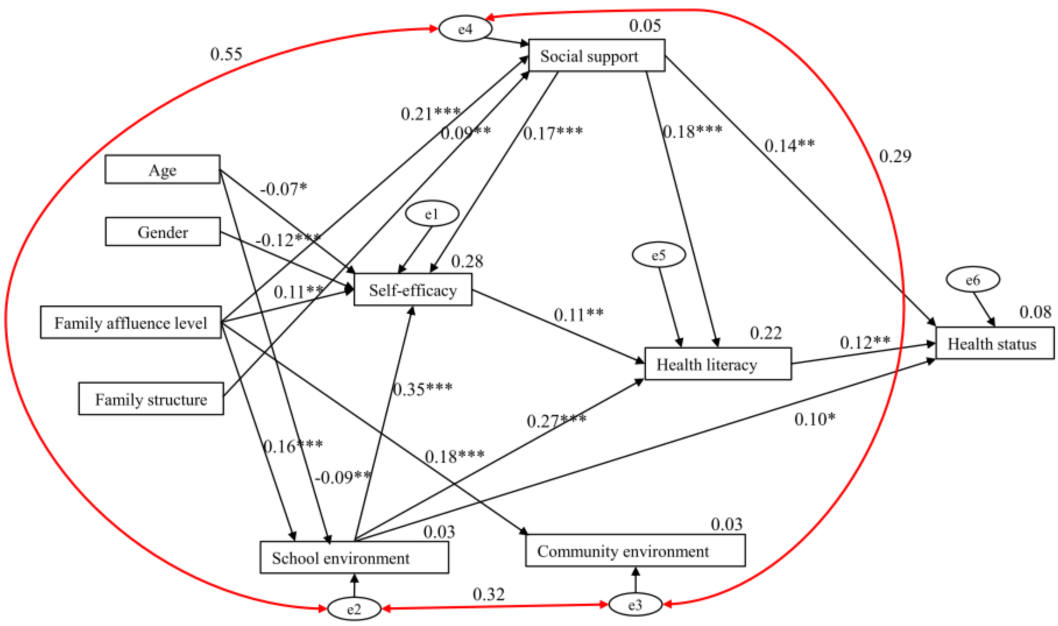

Figure 5.10: The final health status path model in Chinese secondary students

(Note: Coefficients are standardised path coefficients. Overall model fit, χ^2/*df* (26, N=625)=2.049, p=0.001, CFI=0.966, TLI=0.941, RMSEA=0.041 (90%CI: 0.025-0.057). For tests of significance of individual paths, *p<0.05, **p<0.01 and ***p<0.001.)

In the final trimmed health status path model, there were significant and direct paths from self-efficacy (r=0.11, p=0.007), social support (r=0.18, p<0.001) and school environment (r=0.27, p<0.001) to health literacy. Additional significant paths are shown in **Table 5.25**. Based on the squared multiple correlation coefficients (R^2), the final trimmed model explained 28% of the variance in self-efficacy, 22% of the variance in health literacy and 8% of the variance in health status.

Table 5.25: Individual parameter estimation for the health status path model in Chinese secondary students

Parameter	Coefficient	Standardised coefficient	Standard error	***P* value**
Social support ← family structure	3.800	0.090	1.367	0.005
Social support ← family affluence level	1.994	0.206	0.378	<0.001
School environment ← age	-0.525	-0.095	0.179	0.003
School environment ← family affluence level	0.558	0.157	0.140	<0.001
Self-efficacy ← school environment	0.395	0.347	0.047	<0.001
Self-efficacy ← social support	0.072	0.172	0.017	<0.001
Self-efficacy ← age	-0.455	-0.072	0.216	0.035
Self-efficacy ← gender	-1.558	-0.122	0.434	<0.001
Self-efficacy ← family affluence level	0.459	0.113	0.141	0.001
Health literacy ← self-efficacy	0.099	0.109	0.037	0.007
Health literacy ← school environment	0.277	0.268	0.047	<0.001
Health literacy ← social support	0.070	0.184	0.016	<0.001
Health status ← school environment	0.018	0.099	0.009	0.038
Health status ← social support	0.009	0.137	0.003	0.004
Health status ← health literacy	0.021	0.122	0.008	0.005
Community environment ← family affluence level	0.694	0.181	0.151	<0.001

Path analysis with bootstrapping was also conducted to compare the maximum likelihood estimates and bootstrapping estimates of standard errors. As the path analysis results with bootstrapping were similar to those without bootstrapping for the health status path model, the maximum likelihood estimation method was considered as appropriate for path analysis in the health status path model.

5.3.3.6.4 __Health-related quality of life path model (HRQOL)__

As shown in **Figure 5.11**, the original HRQOL path model demonstrated poor data fit: χ^2/df (23, N=625)=14.650, p<0.001, CFI=0.711, TLI=0.434, RMSEA=0.148 (90%CI:

0.134-0.162), and the path from health literacy to health-related quality of life was non-significant (r=0.004, *p*=0.905).

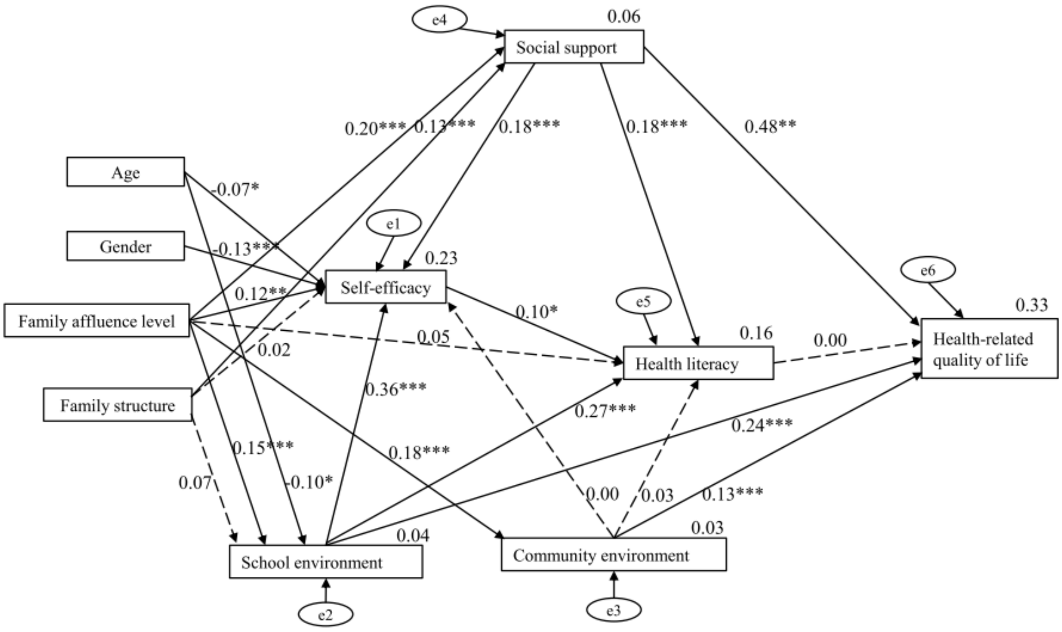

Figure 5.11: The original HRQOL path model in Chinese secondary students

(Note: HRQOL, Health-related Quality of Life. Coefficients are standardised path coefficients. Dashed lines indicate non-significant relationships, whereas solid lines indicate statistically significant relationships. Overall model fit, χ^2/df (23, N=625)=14.650, *p*<0.001, CFI=0.711, TLI=0.434, RMSEA=0.148 (90%CI: 0.134-0.162). For tests of significance of individual paths, **p*<0.05, ***p*<0.01 and ****p*<0.001.)

Although the path from health literacy to HRQOL was not significant in the above model, there were significant relationships between other variables. Based on theoretically consistent modification indices provided by the AMOS (44, 460), the HRQOL path model was modified step by step (See **Table 5.26**). The final trimmed HRQOL path model showed satisfactory data fit: χ^2/df (26, N=625)=1.624, *p*=0.023, CFI=0.985, TLI=0.974, RMSEA=0.032 (90%CI: 0.012-0.048) (See **Figure 5.12**).

Table 5.26: Modifications for the HRQOL path model in Chinese secondary students

Model	χ^2	*df*	*P* value	CFI	RMSEA (90%CI)
Original model	336.946	23	<0.001	0.711	0.148 (0.134, 0.162)
Remove non-significant paths	342.975	29	<0.001	0.711	0.132 (0.119, 0.144)
Modification 1 (Path e2←→e4)	123.067	28	<0.001	0.912	0.074 (0.061, 0.087)
Modification 2 (Path e2←→e3)	98.034	27	<0.001	0.935	0.065 (0.051, 0.079)
Modification 3 (Path e3←→e4)	42.226	26	0.023	0.985	0.032 (0.012, 0.048)
Final model	42.226	26	0.023	0.985	0.032 (0.012, 0.048)

Note: χ^2=conventional chi-square fit statistic (under maximum likelihood estimate). CFI, Comparative Fit Index; CI, Confidence Interval; HRQOL; Health-related Quality of Life; RMSEA, Root Mean Square Error of Approximation. Path e2←→e4: path was made between the error of school environment and the error of social support; Path e2←→e3: path was made between the error of school environment and the error of community environment; Path e3←→e4: path was made between the error of community environment and the error of social support.

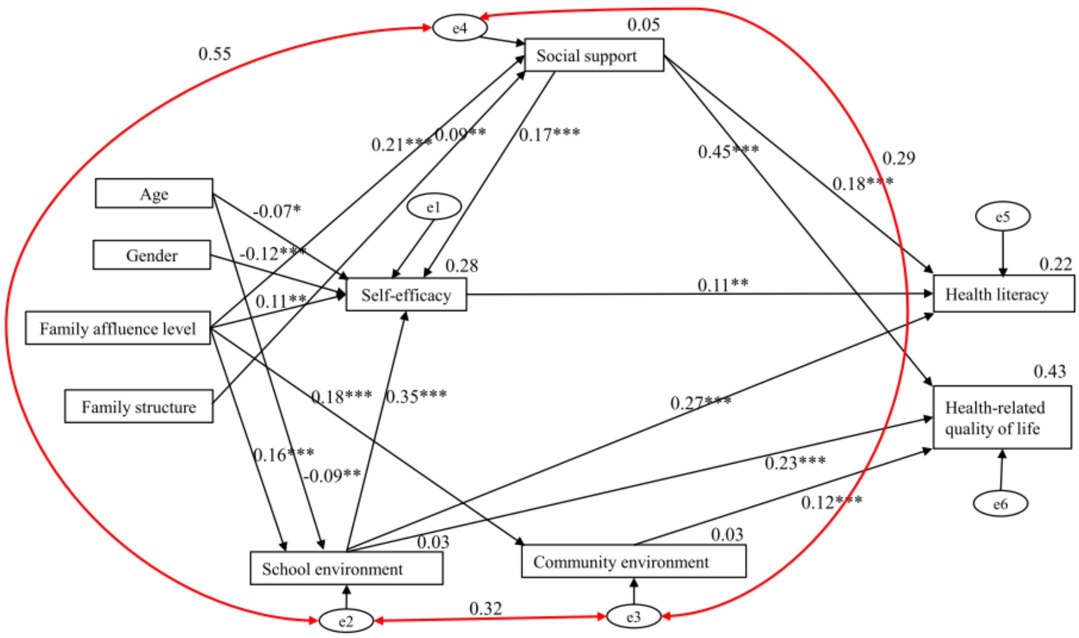

Figure 5.12: The final HRQOL path model in Chinese secondary students

(Note: HRQOL, Health-related Quality of Life. Coefficients are standardised path coefficients. Overall model fit, χ^2/df (26, N=625)=1.624, p=0.023, CFI=0.985, TLI=0.974, RMSEA=0.032 (90%CI: 0.012-0.048). For tests of significance of individual paths, *p<0.05, **p<0.01 and ***p<0.001.)

In the final trimmed HRQOL path model, there were significant and direct paths from self-efficacy (r=0.11, p=0.007), social support (r=0.18, p<0.001) and school environment (r=0.27, p<0.001) to health literacy. Additional significant paths are presented in **Table 5.27**. Based on the squared multiple correlation coefficients (R^2), the final trimmed model explained 28% of the variance in self-efficacy, 22% of the variance in health literacy, and 43% of the variance in health-related quality of life.

Table 5.27: Individual parameter estimation for the HRQOL path model in Chinese secondary students

Parameter	Coefficient	Standardised coefficient	Standard error	***P* value**
School environment ← age	-0.525	-0.095	0.179	0.003
Social support ← family affluence level	1.994	0.206	0.378	<0.001
School environment ← family affluence level	0.558	0.157	0.140	<0.001
Social support ← family structure	3.800	0.090	1.367	0.005
Community environment ← family affluence level	0.694	0.181	0.151	<0.001
Self-efficacy ← social support	0.072	0.172	0.017	<0.001
Self-efficacy ← school environment	0.395	0.347	0.047	<0.001
Self-efficacy ← age	-0.455	-0.072	0.216	0.035
Self-efficacy ← gender	-1.558	-0.122	0.434	<0.001
Self-efficacy ← family affluence level	0.459	0.113	0.141	0.001
Health literacy ← self-efficacy	0.099	0.109	0.037	0.007
Health literacy ← school environment	0.277	0.268	0.047	<0.001
Health-related quality of life ← community environment	0.110	0.116	0.031	<0.001
Health-related quality of life ← school environment	0.231	0.225	0.038	<0.001
Health-related quality of life ← social support	0.168	0.446	0.014	<0.001
Health literacy ← social support	0.070	0.184	0.016	<0.001

Note: HRQOL, Health-related Quality of Life.

Path analysis with bootstrapping was also conducted to compare the maximum likelihood estimates and bootstrapping estimates of standard errors. As the path analysis results with bootstrapping were similar to those without bootstrapping for the HRQOL path model, the maximum likelihood estimation method was considered as appropriate for path analysis in the HRQOL path model.

5.3.3.6.5 Path model results by gender

In order to examine whether path model results were stable in Chinese secondary students, I also reported the results of health behaviour path model and health status path model by gender, because these two models showed promising evidence of the mediating role of health literacy. As shown in **Table 5.28** and **Table 5.29**, both health behaviour path model and health status path model show better results for girls than for boys. Health literacy still plays a mediating role in the relationship between its influencing factors and health behaviours/health status. However, there are no direct paths from self-efficacy to health literacy (r=0.01, p=0.787), or from health literacy to health behaviours (r=0.05, p=0.150) in boys.

Table 5.28: Health behaviour path model by gender

Parameter	Boy		Girl	
	Coefficient	*P* value	Coefficient	*P* value
Health literacy ← self-efficacy	0.014	0.787	0.198	**<0.001**
Health literacy ← school environment	0.262	**<0.001**	0.279	**<0.001**
Health literacy ← social support	0.121	**<0.001**	0.016	0.469
Health behaviour ← health literacy	0.050	0.150	0.090	**0.024**

Table 5.29: Health status path model by gender

Parameter	Boy		Girl	
	Coefficient	*P* value	Coefficient	*P* value
Health literacy ← self-efficacy	0.014	0.787	0.099	**0.007**
Health literacy ← school environment	0.262	**<0.001**	0.277	**<0.001**
Health literacy ← social support	0.121	**<0.001**	0.070	**<0.001**
Health status ← health literacy	0.024	**0.018**	0.021	**<0.001**

5.3.4 Discussion

The present study tested cross-sectional path models linking health literacy to four different health-related outcomes, including health behaviours, health service use, health status and health-related quality of life (HRQOL). All these models included examples of intrapersonal, interpersonal and environmental factors that may contribute to an individual's health literacy. Most results were consistent with the hypotheses proposed earlier in this study. In brief, there were five main findings from this study.

1) Three path models (health behaviour path model, patient-provider communication path model and health status path model) fitted empirical data, but the HRQOL path model did not.
2) Unexpectedly, socio-demographics (e.g. age, gender and family affluence level) did not directly predict students' health literacy.
3) Self-efficacy predicted students' health literacy.
4) Students' health literacy was affected by self-efficacy, social support and school environment, with school environment the most significant influencing factor.
5) Health literacy was shown to be a mediating variable between its influencing factors and health-related outcomes.

5.3.4.1 Health literacy does not predict students' HRQOL

Findings from this study showed that health literacy did not predict HRQOL in the path model. Compared with earlier, similar studies (150, 151, 492, 493), this finding was unexpected. One possible explanation could be that the target population (secondary students) in this study is different from those in previous studies. While previous studies supported the finding that health literacy was positively and independently associated with HRQOL (150, 151, 492, 493), they targeted adults with chronic diseases. The role of health literacy in predicting HRQOL is marked for this population group because adults with chronic diseases need long-term self-care management and regular interaction with health systems, both of which require certain levels of health literacy (151). By contrast, school-aged adolescents are a relatively '*healthy*' population with peaks in strength and fitness (20). It is arguable that the requirement for health literacy in adolescents is not as high as that for adults with chronic diseases. Therefore, the role of health literacy in predicting HRQOL is likely to be less apparent in '*healthy*' adolescents. Given that this study did not consider students' disease characteristics (i.e. the presence or absence of chronic diseases), it was not possible to explore whether disease characteristics of a population could influence the relationship between health literacy and HRQOL. There is a need for future research to provide this evidence.

5.3.4.2 Socio-demographics have indirect relationships with health literacy

Unexpectedly, this study did not find direct paths from socio-demographics to health literacy. Instead, socio-demographics only had indirect impacts on health literacy through self-efficacy, social support and school environment. This finding suggests that self-efficacy, social support and school environment are more important and direct predictors of students' health literacy than socio-demographics. To improve students' health literacy, it would be more feasible and effective to pay attention to these modifiable factors (e.g. self-efficacy) than non-modifiable socio-demographics. However, such an inference should be made with caution because the homogeneity of the sample in this study was higher than that of similar studies (36, 52, 176, 177). This study investigated health literacy in Chinese secondary students with a narrow age range and similar backgrounds (i.e. ethnicity, family structure and socio-economic status), whereas previous studies focused on high school students with different cultural backgrounds (52, 176, 177) or adolescents in a broader age range (36, 37). Therefore, the findings of model testing (i.e. the indirect paths from socio-demographics to health literacy) need to be generalised with representative samples in future research.

5.3.4.3 Self-efficacy predicts students' health literacy

This study extends what is known about the relationship between self-efficacy and health literacy in the adolescent population. Previous studies suggested that there was a significant path from health literacy to self-efficacy and self-efficacy to health outcomes (41, 492, 494, 495). In contrast with previous studies, this study found a significant path from self-efficacy to health literacy and health literacy to health outcomes. There might be two explanations for this inconsistency. First, it is probably due to the overlapping construct of self-efficacy and health literacy. Health literacy refers to an individual's skills and capacities to access, understand, appraise and apply health information to protect and maintain health (13), whereas self-efficacy represents an individual's belief in his/her ability to successfully execute a specific task within a given context (298). In the health context, health literacy and self-efficacy have similar measurement items (e.g. self-report personal ability to protect health) and have similar impacts on health outcomes. Therefore, the relationship between self-efficacy and health literacy is intertwined and ambiguous. Second, it may result from the use of different target populations. Previous studies targeted patients with chronic diseases (41, 492, 494, 495) rather than '*healthy*' adolescents. In the chronic disease context, patients are highly motivated to change their unhealthy behaviours to achieve better health outcomes. Therefore, personal self-efficacy seems to be a more direct predictor of outcome change than health literacy (496). That is, patients with chronic diseases are more likely to have high self-efficacy in changing unhealthy behaviours if they have adequate health literacy to understand prescription labels and follow medical instructions. By contrast, school-aged adolescents are experiencing a healthy time in their lives (20). Without the presence of chronic diseases, adolescents are less motivated to change unhealthy behaviours. In this case, the role of self-efficacy in predicting health outcomes is not as direct as it is in patients with chronic diseases. Therefore, personal self-efficacy is more likely to be a precursor of health outcomes including health literacy: students with high self-efficacy are more likely to find, understand, appraise and use health information and surrounding resources to foster healthy lifestyles and outcomes. Given that this study only used cross-sectional data to explain the pathway between self-efficacy and health literacy, the evidence obtained was limited. Further research is needed, using more rigorous methodology (e.g. longitudinal studies or RCTs), to further confirm the relationship between self-efficacy and health literacy.

5.3.4.4 Health literacy is affected by intrapersonal, interpersonal and environment factors

Using a path analytic approach, this study found that students' health literacy was affected by self-efficacy, social support and school environment. This empirical finding supports the robustness and validity of previous theoretical frameworks (16, 44) which advocate an ecological perspective of adolescent health literacy. This means that health literacy is not an individual issue, but needs to be treated systematically. Self-efficacy and social support were found to be both mediating factors between school environment and health literacy. Specifically, there are two things to be learned from the ecological perspective of health literacy: 1) social support ($r=0.18$, $P<0.001$) plays a more crucial role in predicting health literacy than self-efficacy ($r=0.11$, $P<0.01$). This suggests that adolescent health literacy relies more heavily on social support and available resources than on personal self-efficacy. Compared with adults, adolescents have less well-developed cognitive abilities (166). Therefore, it is conceivable that adolescents are likely to seek more support from peers, parents and other people when they address personal health issues; 2) the school environment ($r=0.27$, $P<0.001$) is the most significant influencing factor for health literacy, compared to personal self-efficacy and perceived social support. There may be two explanations for this. First, school is the primary place where students obtain health knowledge and skills (i.e. health literacy) (101). The quality of the school environment is likely to directly affect the degree of students' access to health knowledge, attitudes towards changing unhealthy behaviours, and mastery of health skills. Second, it is probably due to the measurement tool of the school environment (the SES) that is used in this study. The SES comprises three domains: opportunities for pro-social involvement (5 items), rewards for pro-social involvement (4 items) and academic performance (1 item). In terms of the response rate for each item of the SES, there was a large disparity between the academic performance item (i.e. 43.3% of respondents selected '*strongly disagree*' or '*disagree*' options) and other items (i.e. 12.3% to 29.9% of respondents selected '*strongly disagree*' or '*disagree*' options). Therefore, the total score of the SES was largely dependent on students' academic performance. Given previous literature has shown that educational outcome (including academic performance) is an independent factor for health literacy (144, 177), it is conceivable that a significant impact of school environment on health literacy was found in this study. In summary, in response to low health literacy in adolescents, paying attention to personal self-efficacy is not enough. Improving students' social support and creating supportive school environments would be more effective health literacy interventions, as such improvements seem to be responsible for a corresponding improvement in health literacy.

5.3.4.5 Health literacy is a mediating variable

Compared with previous, similar studies of adults (41, 146, 494, 497), the findings of this study extend our understanding of the relationship between health literacy and health outcomes in school-aged adolescents. Health literacy is shown to be a mediating variable between a set of ecological factors (i.e. self-efficacy, social support, and school environment) and health outcomes (e.g. health behaviour, health status). This suggests that to improve students' health outcomes, not only intrapersonal, interpersonal and environmental factors but also health literacy need to be addressed. Specifically, this finding confirms that it is possible to improve students' health behaviours and health status through enhancing health literacy for those with lower self-efficacy, lower social support and lower perceived feeling of school environment. Currently there have been an increasing number of school-based interventions from an ecological perspective (230, 498-502), however, health researchers and school health-related staff need to be aware that positive outcome change does not always occur. As shown in a systematic review of school-based interventions to prevent bullying, Vreeman and Carroll (503) identified 10 studies evaluating the whole-school approach that was from an ecological perspective but only 7 revealed demonstrating decreased bullying, with younger children having fewer positive effects. Given that health literacy is an interactive outcome between an individual's capacity and the broader environment (94), it is imperative to consider one's health literacy when improving health outcomes. Based on the findings from this study, improving health literacy needs to be combined in order to maximise the effectiveness of school-based interventions from an ecological perspective. Interventions for students with more health-compromising behaviours and poorer health status should not only enhance personal self-efficacy through approaches like 'action planning' or 'providing instruction' intervention techniques (504), increase social support from different dimensions such as instrumental support (i.e. provision of tangible aid) and motivational support (i.e. provision of verbal/nonverbal prompts to engage in behaviour of interest) (505), and promote school physical/social environment involving community relationship building and playground improvements (506), but also improving students' health literacy such as delivering skills-based health curricula (220) and experiential learning (507).

In addition, this study shows that the mediating role of health literacy was only found in some specific health outcomes: the overall health behaviour, physical activity, teeth brushing, patient-provider communication and health status. These findings have implications for future health literacy practice and interventions. For instance, promoting health literacy could be a useful and effective strategy for improving healthy behaviours such as physical activity and teeth brushing. On the other hand, health literacy was not shown to be a driven factor of change in students' health behaviours (e.g. cigarette smoking, alcohol drinking) or in improving their use of health services (e.g. seeing a doctor, using emergency services). However, the above inference should be made with caution for three reasons. First, this study only examined the path from health literacy to students' actual health behaviours and health service use, without considering other important variables such as behavioural intentions (508, 509). As shown in the causal pathway model by Paasche-Orlow and Wolf (85), there are three main mediating factors between health literacy and health outcomes: access and utilisation of healthcare services (e.g. complexity of health systems, patients' perceived barriers), provider-patient interaction (e.g. patients' belief, providers' communication skills), and self-care (e.g. patients' motivation, behavioural intentions, support technologies). Also, some of these mediating factors have been demonstrated in previous empirical studies (41, 492, 510). For example, patient health knowledge, self-care activities and communicative practice of sharing information were found to mediate the effect of health literacy on health status among patients with chronic diseases. Given that this study aimed to examine Manganello's health literacy framework, rather than examining the mediating variables between health literacy and health outcomes, students' health knowledge, behavioural intentions, social networks and other important factors were not included and analysed. Students' health behaviours and health service use were complex outcomes influenced by a range of factors (e.g. behavioural intentions, social networks) (347, 511). For instance, there is substantial evidence showing the influence of peers and friends on students' use of tobacco and alcohol (512, 513), unhealthy eating (514, 515), and physical inactivity (516). However, as to how these factors interact with health literacy and contribute to health behaviours and health service use, it is still unknown. Given that the present study only conducted a cross-sectional path analysis with variables of interest, future research is needed to explore the relationships between health literacy and health outcomes by controlling for confounding factors such as behavioural intentions. Second, measurement error may exist for some indicators of health outcomes. For example, each type of health behaviour and each type of health service use were assessed using a single item (e.g. '*how many times have you raised a question during your doctor appointment in the last 12 months?*'). Therefore, the measurement outcome was probably not sufficiently comprehensive or accurate. Future research needs to use comprehensive measures to examine the relationship between health literacy and health outcomes. Third, our findings may not be generalisable to other cultural settings. As adolescents in China are under the family domination and partially or fully reliant on their parents to make health-related decisions (50), the role of adolescent health literacy in predicting health outcomes may be biased in this study. Further evidence is needed to confirm our findings in other cultural contexts and populations.

In relation to splitting data by gender, both health behaviour path model and health status path model showed a good fit with the data for girls, but not for boys. The mediating role of health literacy did not exist for health behaviour path model in boys. This suggests self-efficacy and health literacy are more likely to play important roles in predicting health behaviours for girls than for boys. Gender differences should be considered when conducting health literacy and health behaviour intervention programs. That is, improving self-efficacy and health literacy would be more effective in changing health behaviours in girls than in boys. In a study by Robinson *et al.* (27), it was shown that improving self-efficacy and health literacy were effective in improving children's asthma-related outcomes (e.g. decreased hospitalisations, decreased emergency department visits). However, gender differences were not explored. Given that little evidence exists, there is a need for future research to confirm that there is a gender difference when improving self-efficacy and health literacy and thus changing health behaviours in adolescents.

5.3.4.6 Implications for improving health literacy in Chinese school settings

The findings from this study have direct implications for adolescent health literacy improvement in Chinese school settings. The importance of health literacy to adolescent health was demonstrated by two aspects: 1) As shown in Chapter 5.2.3, the prevalence of low health literacy ranged from 29.0% to 45.5% among high school students in Beijing. That means almost one third or half of high school students do not have adequate health skills to improve and protect their health; 2) the model testing results showed low health literacy predicted health-compromising behaviours and poor health status in Beijing high school students. Therefore, it is logical to dedue that improving adolescent health literacy could have a postive effect in reducing the problems of health-compromising behaviours and poor health status in this population. Given that adolescents with chronic diseases and conditions are rapidly increasing in mainland China (191, 517, 518), it is imperative to develop strategies, for example, enhancing health literacy, to improve their health status and healthy behaviours.

There could be three ways for enhancing health literacy in Chinese school settings for those who have been found to have low health literacy. First, health literacy screening could be integrated as part of a health assessment battery for secondary students in China. For example, the Chinese Youth Risk Behaviours Survey (CYRBS) is a national survey that examines the prevalence and epidemic trend of health-risk behaviours for secondary and college students in China (519-521). This survey has been used to monitor students' health-risk behavours every two years since its first national use in 2008. As the c-HLAT-8 is a valid, reliable and short instrument to measure Chinese students' health literacy, incorparting the c-HLAT-8 into the CYRBS could help schools and policy-makers identify those who are lacking health literacy skills and provide further remedial improvement programs. Second, enhancing personal skills could be a future focal point of school health education in order to develop and improve students' health literacy. As demonstrated in this study, health literacy is assessed using a skill-based instrument and has been shown to be a product of the interaction between personal health skills and the broad environment. Given that students' perceived health skills are relatively low in this study, improving personal health skills could help students better access and coordinate with heath and social resources aroung them and produce better health outcomes (256). In an empirical study by Hubbard and Rainey (220), secondary school students improved significantly their health literacy levels if they were exposed to text-book health literacy instructions from curricula that focused on both health concepts and skills. However, the current school health education in China mainly focuses on delivering basic health knowledge, rather than skills training (37). Therefore, future school health education programs in China should incorporate skill-based curricula that improve both health knowledge and skills in order to achieve the goal of fostering health literate students. Third, another possible approach is to use previous evidence-based school health programs such as 'Health Promoting Schools (HPS)' to improve students' health literacy. This study reveals that health literacy is influenced by a series of ecological factors including self-efficacy, social support and school environment. Therefore, it is necessary to use a systems approach promoting health literacy in school settings. The HPS moves beyond individual outcome change (e.g. health behavioural change) to consider organisational and policy change (e.g. school psychosocial and physical environment) (195). A large body of evidence has accumulated to show that the HPS framework is effective in improve health outcomes (e.g. health literacy and health behaviours) of secondary students in Hong Kong (231, 232), Taiwan (522) and mainlad China (523, 524). However, in practice, few schools have implemented the HPS due to adequate and sustainable resources (e.g. financial stringency) (525, 526) and students' academic stress (272, 273). To address this challenge, Lee *et al.* (234) recommended treating the HPS framework as a new paradigm of schooling rather than add-on programs. Therefore, it is necessary for the education system to call for a transitional change of existing education practices (e.g. more focus on health outcomes, rather than only focusing on academic performance) to sustain the infrastructure and process of school-based HPS programs. Under the new paradigm of schooling, it is possible that students' health literacy levels could be much promoted and lead more positive health outcomes resulting in a more health-literate population.

5.3.4.7 Strengths and limitations

One strength of this study is the use of a comprehensive health literacy measurement tool for adolescents. Unlike similar studies in mainland China (36-38, 51), the present study uses a skills-based and multi-dimensional instrument to measure students' health literacy, rather than focusing on knowledge-based/behaviour-based assessment or functional health literacy evaluation. Another strength of this study is the use Manganello's health literacy framework as a guide to understand the full relationship between health literacy, its influencing factors and health-related outcomes. This enhanced the rigour, transparency and clarity of this current research.

Limitations should also be noted. First, although findings suggest causal relationships between variables, the cross-sectional data make it difficult to draw a robust causal conclusion. This study only indicates a relationship between health literacy, its influencing factors and health-related outcomes at a single point in time. Longitudinal studies are needed in future to confirm the causal relationships between health literacy and relevant variables.

Second, the convenience sample recruited in the study may not represent the overall population of Chinese adolescents. As this study recruited secondary students living in a metropolitan city, participants' demographics were similar between groups (e.g. age, socio-economic status, educational attainment), health literacy differences were not identified between some groups of demographics such as gender. Therefore, future studies are recommended to recruit adolescents from a wider range of socio-demographic backgrounds.

Third, the data collected were based on students' self-report information, which may have introduced bias from deliberately false information. Given that most instruments used in this study are well-established and the sample size is relatively large, self-report bias may have been reduced to some extent.

Fourth, this study only examined indicators of interest in the hypothesised model. For example, only five typical types of health-promoting and health-compromising behaviours were included within the domain of 'health behaviours'. Although previous empirical studies suggested that adolescent health literacy was positively associated with health-seeking behaviours (176, 185, 527), this was not the focus of this PhD study. Therefore, the path way from adolescent health literacy to other health behaviours (e.g. health-seeking) needs to be explored in future.

Fifth, this study only used path analysis to explain the mediating role of health literacy, rather than using structural equation modelling. The disadvantage of path analysis was that it did not consider measurement errors of variables (381, 528). However, path analysis was considered more appropriate than structural equation modelling in this study for three reasons: 1) due to a high number of outcome variables, conducting structural equation modelling with confirmatory factor analysis would have been much more complex; 2) all variables in the model were measured using well-established instruments or items, thus making path analysis safer; and 3) path analysis is still widely used in behavioural science (388).

5.3.5 Conclusion

This empirical study found that Manganello's health literacy framework was supported by the empirical data related to health behaviours, patient-provider communication and health status. Also, health literacy was confirmed as a mediating variable between a set of ecological factors (self-efficacy, social support and school environment) and health outcomes. There is a need to use a systems approach to address low health literacy in Chinese adolescents.

Box 5.2: Key messages about the model testing study in Chinese secondary students

The model testing study in Research Phase 3 of this PhD project found that:

- Socio-demographics only had indirect impacts on students' health literacy.
- Personal self-efficacy, social support and school environment had direct impacts on students' health literacy.
- Health literacy had a direct impact on students' health behaviours, patient-provider communication and health status.
- Health behaviour path model, patient-provider communication path model and health status path model were supported by the data collected. And path model results were more stable in Chinese girls than that in Chinese boys.
- Health literacy played a mediating role in the relationship between its influencing factors and health outcomes.

5.4 Summary

In summary, this chapter measured health literacy and examined the mediating role of health literacy in Chinese secondary students. The validation study demonstrated that the Chinese version of the Health Literacy Assessment Tool (c-HLAT-8) was reliable and valid to measure adolescent health literacy in Chinese school settings. The model testing study confirmed an ecological perspective of students' health literacy, using a quantitative approach. Also, health literacy was confirmed as a mediating variable between its influencing factors and health outcomes (health behaviours, patient-provider communication and health status).

Chapter 6 Health Literacy Measurement among Australian Adolescents: Pilot testing in an Australian Secondary School

6.1 Introduction

The systematic review in Research Phase 1 showed that the HLAT-8 could be useful in school-based studies, as it was short, valid and comprehensive to measure health literacy from the health promotion perspective (4). The validation study in Research Phase 2 and the model testing study in Research Phase 3 demonstrated that the HLAT-8 was reliable and valid for use in Chinese secondary students. However, its appropriateness for use in other populations and cultures is still an unknown. As recommended by Pleasant *et al.* (28), a robust and comprehensive approach to health literacy measurement should allow comparison across cultures. Given that I am doing my PhD at the University of Melbourne, Victoria, Australia, it was an opportunity to explore the applicability of the HLAT-8 in Australian school settings. After assessing the findings of health literacy in Chinese secondary schools, I decided to pilot the HLAT-8 in Australian secondary schools. Due to a lack of appropriate health literacy instruments and a lack of school-based health literacy research in Australian adolescents, I conducted a pilot study among 120 Australian students in one secondary school. The aims of this pilot study were to explore the feasibility of collecting health literacy data in Australian secondary schools and to pilot three health literacy instruments in Australian secondary students. Further details of the rationale and context of this study are outlined below.

6.2 Background: Health literacy in Australian adolescents

Although health literacy is a widely-used term in research, practice and policy in Australia (59-62, 276, 321), few studies focusing on health literacy in adolescents have been conducted. One possible explanation for this is the paucity of appropriate health literacy instruments for use with this population. Currently, the most commonly-used health literacy instruments in Australia target adults, not adolescents. For example, the HLQ is developed for respondents aged 19 and over (63, 64); the HeLMS is designed for patients in healthcare settings (65); the ALLS is used for respondents aged 15 and over (23); the NVS, the REALM and the TOFHLA are used for respondents over the age of 18 (66). Despite a lack of health literacy instruments for use, low health literacy is a serious problem in Australian adolescents. As shown in the 2006 national health literacy survey in Australia (23), 59.5% of respondents aged 15 to 74 had low health literacy scores. Compared with the general population, the 15 to 19 age group had a higher percentage of low health literacy (67.6%). Therefore, it is essential to give attention to health literacy research in Australian adolescents, and to determine how to appropriately measure and effectively improve their health literacy.

Over the last decade, mental health literacy in adolescents has gained increasing attention in Australia (54, 56, 57). National health-based initiatives have been implemented to teach mental health literacy skills to students in Australian schools. For example, the *KidsMatter* (529) and the *MindMatters* (530) are two national mental health and wellbeing initiatives set in primary and secondary schools. The purpose of these initiatives is to build students' resilience skills in dealing with mental health problems. There are two possible reasons for the increasing attention on mental health literacy in adolescents. One reason is the high prevalence of school-aged children with mental health disorders. The 2007 Australian national survey of mental health and wellbeing showed that 25.4% of young people aged 16 to 24 experienced at least one mental disorder (58). The other reason is that mental health literacy plays a crucial role in preventing and managing mental illness. Improving mental health literacy has been an effective strategy for improving mental health outcomes among adolescents (531). Therefore, promoting mental health literacy is becoming a national health priority for Australian adolescents.

In contrast with mental health literacy, little is known about general health literacy in Australian school settings. General health literacy involves students' skills not only in the area of mental health but also in physical health, oral health, and so forth. In 2008, the Australian Curriculum and Assessment Reporting Authority (ACARA) was established to develop a national school curriculum that included a focus on building students' health literacy skills (532). In 2015, the ACARA updated the previous version 7.5 of the Health and Physical Education curriculum to a new version (version 8.3) (321) which explicitly committed to developing students' health literacy skills at school.

Health literacy was conceptualised as an individual's ability to find, understand and use health information and services to promote and maintain health and wellbeing. Nutbeam's three-hierarchy health literacy model was employed as a curriculum guide to developing students' knowledge, understanding and skills (321). However, there has been little empirical evidence available on students' general health literacy since the implementation of the new curriculum.

The systematic review in Research Phase 1 recommended the HLAT-8 as a useful and appropriate instrument to measure adolescent health literacy in school settings. The construct of health literacy underlying the HLAT-8 was aligned with the definition outlined in the national health and physical education curriculum in Australia. Also, the HLAT-8 captured the three-domain nature of health literacy (functional, interactive and critical), which was in keeping with the rationale of the national curriculum. Given the lack of school-based general health literacy research and the lack of appropriate health literacy instruments for adolescents, a pilot study of health literacy measurement was conducted in an Australian secondary school as part of this PhD research.

6.3 Aim and objectives

This pilot study was conducted to further support the findings of health literacy measurement not only in Chinese secondary schools but also in Australian secondary schools. Specifically, there were three research objectives:

- To explore the feasibility of collecting data on health literacy through one Australian secondary school, and to reflect on that experience;
- To pilot three instruments for measuring students' health literacy in one Australian secondary school;
- To provide evidence regarding students' general health literacy in one Australian secondary school.

6.4 Methods

6.4.1 Study design

A cross-sectional study was designed based on the hypothesised model of this thesis (See **Figure 3.2**). To ensure the methodological quality of this study, I used the STROBE statement (379) and Pleasant's evaluation principles for health literacy measurement (28). The STROBE statement consists of 22 items which are widely used to improve the reporting quality of observational studies in epidemiology (379). Further information on how to use this statement is presented in **Appendix 3.7**: STROBE statement for reporting the pilot study. Pleasant's seven evaluation principles for health literacy measurement were used to guide the study design (28). As I explained earlier in Chapter 3.3: Methodology used in the thesis, health literacy is a broad concept, making its measurement complex. Using Pleasant's evaluation principles is a rigorous way to try to standardise the field of health literacy measurement. Further details of how to consider these seven principles are provided in **Appendix 3.5**: Pleasant's evaluation principles for health literacy measurement.

6.4.2 Ethical considerations

Ethics approval was obtained from the University of Melbourne (Ethics number: 1442884, see **Appendix 5.1**) and the Department of Education and Training (Ethics number: 2015_002665, see **Appendix 6.1**) prior to data collection. A Working with Children approval was also obtained for undertaking the field survey in Melbourne.

6.4.3 Sampling and recruitment

6.4.3.1 Sampling method

Convenience sampling was used to recruit Australian adolescents from one secondary school, which was located in a high socio-economic area of Melbourne, Australia. All students (n=918) in Years 7 to 9 (approximate age range: 11-15 years) were invited to participate in the health literacy survey.

6.4.3.2 Recruitment of participants

Students in Years 7 to 9 were approached using the following recruitment strategies:

- First, the ethics committee of the University of Melbourne and the Department of Education and Training approved the conduct of this pilot study.
- Second, the principal of the pilot school was contacted by email. The school principal supported researchers in conducting the health literacy survey among students. A research protocol (**Appendix 6.2**) outlining further details of the school's involvement in this study was sent to the school representative.
- Third, parental/guardian consent forms (**Appendix 6.3**) and plain language statements (**Appendix 6.4**) were sent to parents via the school online system '*Compass*' by the school information technology team. Parents were invited to complete an online consent form and send it back to the school.
- Fourth, all students in Years 7 to 9 were invited to participate in an online survey via Survey Monkey during health and physical education classes. An online consent form (**Appendix 6.5**) and online plain language statement (**Appendix 6.6**) were sent to each student prior to data collection. Students gave their consent for participating in this research.

6.4.4 Data collection procedures

The online survey was conducted between July and September 2016. With the support of school health and physical education teachers, a web link to the health literacy survey was sent to students in Years 7 to 9 by class email. All students were invited to complete the online survey (**Appendix 6.7**) when participating in the first health and physical education class in the third school term.

6.4.5 Questionnaire

The online health literacy survey used in the Australian pilot secondary school was similar to the paper-and-pencil survey used in Chinese secondary schools. It included information on student's intrapersonal factors, interpersonal factors, environmental factors, health literacy assessment and health-related outcomes. To ensure the online survey was understood by the students, I conducted a pilot test with seven students in Years 7 to 9 prior to data collection. During the pilot test, some minor changes were made in the online survey (**Appendix 6.8**). For example, one item on the Family Affluence Scale (FAS) '*how many computers does your family own?*' was changed to '*How many computers does your family own? (note: 'computers' could be laptops,* *desktops, or tablet (e.g. iPad))*'. Given that this pilot study did not aim to examine the relationships between health literacy, its influencing factors and health-related outcomes, only students' socio-demographics and health literacy assessments are reported here.

6.4.5.1 Socio-demographics

Socio-demographics included age (continuous), gender (male or female), year level (Years 7, 8 or 9), family structure (intact families[3] or other types of families[4]) (436), socio-economic status (low, medium or high) (439) and migrant characteristics (country of birth, years of living in Australia, first language spoken at home) (533, 534).

Socio-economic status

Students' socio-economic status was assessed using the Family Affluence Scale (FAS) developed by Currie *et al.* (439) in 2008. The FAS includes four questions on the number of computers and cars in the household, family holiday frequency, and whether the child had an own bedroom. According to the FAS scoring system, a composite FAS score is classified into three groups: low (0-3), medium (4-5) and high (6-7) family affluence (439). The FAS has been used as a validated measure of socio-economic status for adolescents aged 11 to 17 years in Australia (535-537).

Migrant characteristics

Students' migrant characteristics were measured by three items (533, 534): 1) country of birth of students themselves and of their parents (Australia, China/Hong Kong/Macao/Taiwan or others); 2) years of living in Australia (continuous); and 3) the first language spoken at home (English, Chinese or others).

[3] Intact families were defined as those in which participants indicated residing in a household with both biological parents.
[4] Other types of families were defined as those in which participants indicated residing in a household with either one of their parents, foster parents, step parents, a relative, or who were living in a shared care institution.

6.4.5.2 Health literacy assessment

Using multiple measures of health literacy, as recommended by McCormack (35), allows researchers to compare the results and to learn about how each measure performs. In this pilot study, three instruments were used to assess students' health literacy: The Health Literacy Assessment Tool (HLAT-8), the Newest Vital Sign (NVS) and the Health Literacy Survey-European-Questionnaire (HLS-EU-Q).

The Health Literacy Assessment Tool (HLAT-8)

The HLAT-8 is an 8-item health literacy scale developed by Abel *et al.* (4) in 2014. It measures an individual's ability to access, understand, evaluate and communicate health information in everyday life. Respondents answer each item on a 5-point scale (1=strongly disagree, 4=strongly agree; 0=I do not have such experiences) or a 6-point scale (1=very bad, 5=very good; 0=there have never been any questions). The HLAT-8 total score range is from 0 to 37, with higher scores indicating higher levels of health literacy. The HLAT-8 was chosen for three main reasons: 1) it was developed in the health promotion context, which was aligned with the school setting of this pilot study; 2) it measures health literacy in three domains (functional, interactive and critical), which was in keeping with the health literacy construct of the hypothesised model in this PhD thesis; and 3) it was identified in the systematic review in Research Phase 1 as showing positive evidence of structural validity (CFI=0.99, TLI=0.97, RMSEA=0.03, SRMR=0.03). In the present study, Cronbach's α of the HLAT-8 was 0.81, suggesting satisfactory internal consistency.

The Newest Vital Sign (NVS)

The NVS, developed by Weiss *et al.* (240) in 2005, measures an individual's ability to comprehend health-related materials and calculate numbers (i.e. functional health literacy). It consists of six questions, with each question scoring one point when the respondent answers correctly (240). The total score ranges from 0 to 6. Scores of 4 to 6 suggest '*possibility of high health literacy*', whereas scores 0 to 3 indicate '*possibility of low health literacy*' (169). The NVS was chosen in this pilot study for two reasons: 1) the NVS was shown to be a reliable and valid screening instrument to assess functional health literacy in adolescents (Cronbach's α=0.71; Spearman correlation coefficient=0.71, $p<0.001$) (169, 397); and 2) there were several studies examining health literacy using the NVS in Australian contexts (66, 538, 539). Therefore, the NVS was used to examine students' functional health literacy in this pilot study. In the present study, Cronbach's α of the NVS was 0.69, indicating acceptable internal consistency.

The Health Literacy Survey-European-Questionnaire (HLS-EU-Q)

The HLS-EU-Q is a 47-item health literacy scale developed by Sørensen *et al.* (241) in 2013. This health literacy instrument is a long and comprehensive survey covering three domains (healthcare, disease prevention and health promotion) and four competencies (obtain, understand, evaluate and use) to manage health information (241). Respondents are asked to rate their perceived difficulty for each item using a 5-point Likert scale (1=poor, 4=excellent; 0=do not know). The HLS-EU-Q total score is calculated by the general health literacy index (index=(mean-1) × (50/3)), ranging from 0 to 50. The HLS-EU total score has four categories: '*inadequate health literacy*' (0-25), '*problematic health literacy*' (>25-33), '*sufficient health literacy*' (>33-42) and '*excellent health literacy*' (>42-50) (540). The HLS-EU-Q was selected for use in this pilot study because it was developed from the health promotion perspective. Also, it showed good psychometric properties when measuring health literacy for respondents aged 15 and over, with high internal consistency (Cronbach's alpha=0.98), test-retest reliability (r=0.87, $p<0.001$) and satisfactory construct validity (Spearman's correlation coefficient=0.49) (541). Given that the HLS-EU-Q has not been validated in the adolescent population, this study also included it as a pilot health literacy instrument. In the present study, Cronbach's α of the HLS-EU-Q was 0.96, indicating high internal consistency.

6.4.6 Data management

Data were exported from the Survey Monkey server to a Microsoft Excel file. The Excel file was then imported into SPSS 22.0 (IBM Corp., US, 2013). All electronic files were kept in a password-protected file. Only researchers associated with this PhD research project have access to the database. Variables in the database were recoded or computed as per the scoring system of each scale.

6.4.7 Statistical analysis

6.4.7.1 Dealing with missing values

The individual mean substitution was used prior to data analysis. This step was conducted to avoid excess missing data due to item non-response in a self-report scale (443). A missing total score was assigned if more than half of the total items on a scale were missing. If one-half or fewer items were missing, a person-specific estimate (mean of the non-missing items) was substituted for the missing items (444). The percentage of missing items for the HLAT-8 and the HLS-EU-Q ranged from 0% to 1.7% and 1.7% to 4.2% respectively.

6.4.7.2 Statistical methods

SPSS 22.0 (IBM Corp., US, 2013) was used for data analysis. Descriptive statistics were used to examine participants' socio-demographics and health literacy scores. Spearman correlation analysis was used to examine correlations between scores of different health literacy instruments.

6.5 Results

6.5.1 Learnings and reflections on data collection

This chapter adds to what is known about health literacy measurement by exploring students' general health literacy in one Australian secondary school. In total, 120 students were recruited (See **Figure 6.1**). Learnings and reflections on data collection in this pilot study included: 1) there was a shared perspective on health literacy evaluation between the pilot school and the researchers. To further motivate school involvement and participation, there is a need to advocate for health literacy among both schools and policy-makers; 2) online data collection was found to be feasible and resource-saving in practice; and 3) opt-out consent could be used to increase response rates in future research.

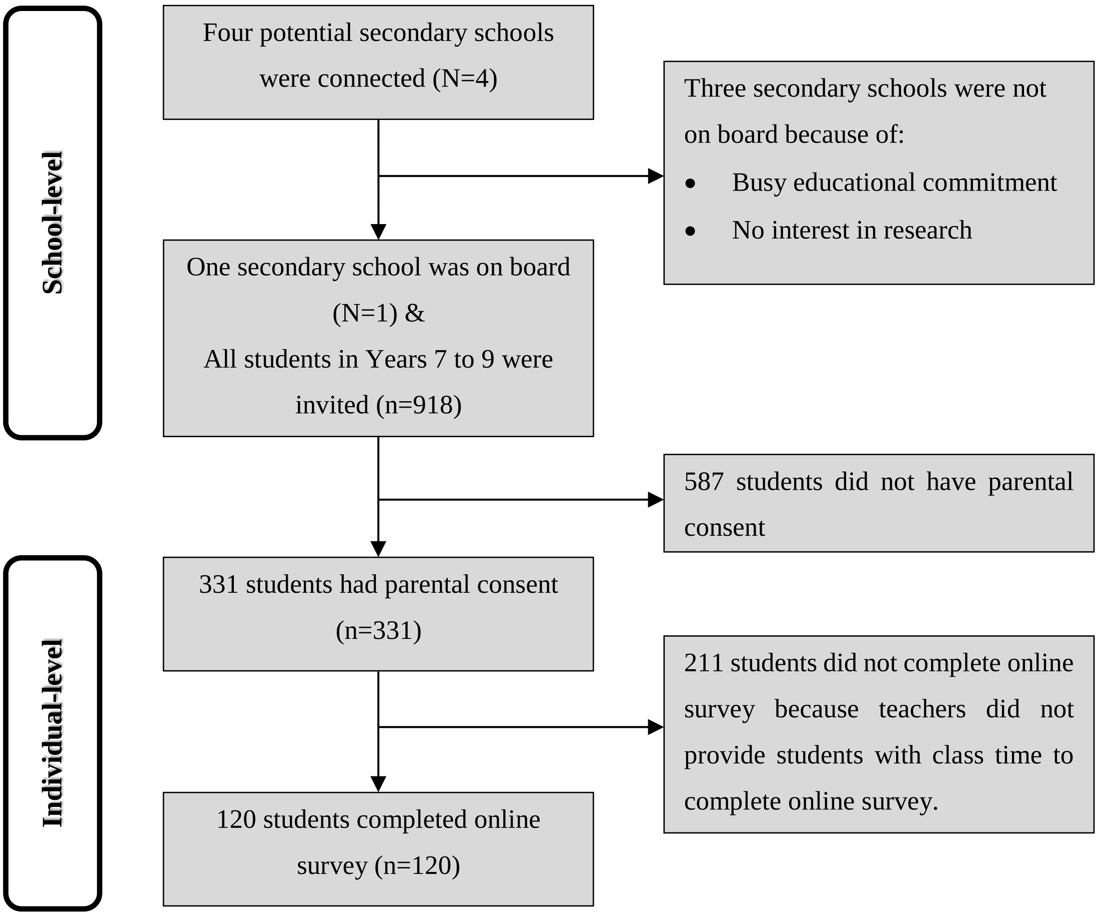

Figure 6.1: Flowchart of recruitment for Australian secondary schools and students

6.5.1.1 A shared perspective of health literacy evaluation

First, there was a shared perspective on health literacy evaluation between the pilot school and the researchers. With the support of my principal supervisor, I contacted four government secondary schools located in Victoria, Australia by email (See **Appendix 6.9**: Four potential schools). However, only one school indicated interest in taking part. That school’s representatives had an interest in this project because they wanted to learn about students’ health literacy levels and to use the findings to help them design school-based health curricula. To learn why the other three school principals did not reply to our emails, we gave each school a follow-up call one week after sending the email. The other three schools declined to participate either due to a busy educational timetable, or because they had no interest in research being conducted at their school.

It should be noted that although health literacy has been explicitly included in the rationale and aims of the Australian Curriculum of Health and Physical Education (321, 542, 543), an offer to evaluate students' health literacy did not draw the attention of the non-respondent schools. It might be speculated from this experience that the term '*health literacy*' and the importance of the construct is yet to be understood by some Australian schools. There may be two underlying reasons for this. One reason is probably the obscure nature of the concept of health literacy. That is, '*health literacy*' is a less well understood topic than other commonly-researched ones (e.g. obesity prevention, mental health promotion) in school settings. Therefore, it is not surprising that there was a poor response from school principals who may never have heard of the concept. The other reason may be a lack of dedicated or funded health literacy program coordinators at local, state and national levels. As shown in previous successful school-based health programs in the USA (544, 545), assistance with recruitment of such people was often provided by state and district health education coordinators. Health literacy program coordinators can assist researchers to design, manage, coordinate and progress research programs effectively and efficiently. In the Chinese secondary school recruitment process for this PhD research project, the directors of the Healthcare Institute of Primary and Secondary School played a crucial role in recruiting Chinese students in Xicheng District and Tongzhou District of Beijing. During the Australian secondary school recruitment process, however, although I tried to contact some potential coordinators from the regional office of the Department of Education and Training in Victoria, I received no response. Without the assistance of the local education department, the possibility of successful recruitment was low. To improve the response rate of participating schools in future research, there are two possible responses to the above challenges: one is to advocate the importance of health literacy and raise school principals' awareness of it; the other is to motivate health education staff in regional education department to assist in and coordinate health literacy research in school-based settings. Given that a mismatch exists between the health literacy statement in the national health and physical education curriculum and health literacy evaluation in Australian schools, there is a pressing need to obtain evidence on how to measure and improve students' health literacy in Australian schools.

6.5.1.2 Obtaining informed consent

Second, obtaining informed consent from parents was challenging, with only 36.1% (331/918) of students providing parental consent. Unlike the passive, opt-out consent of data collection in Chinese secondary students, active, opt-in consent was obtained from Australian parents through a school online system '*Compass*'. In this PhD research project, the pilot study in Australia was not approved as a minimal risk study by the ethics committee at the University of Melbourne. There were several risks associated with this pilot study because it targeted **minors** under 18 years and included questions about '***race or ethnic identity***' and '***substance abuse***' (cigarette smoking and alcohol drinking). Such questions may lead to adverse effects such as discrimination on the basis of cultural identity, or stimulating the onset of smoking or drinking alcohol, so passive, opt-out consent was not able to be used in this part of the PhD research.

Opt-in consent is deemed ethically more defensible (546) because it provides great assurance that a parent has indeed seen, read, understood and signed the consent form (547). However, it has several limitations such as a likelihood of reducing sample size (546, 548) and increasing sample bias (549, 550). In this pilot study, the return rate (36.1%) of online consent forms was much lower than expected. The school representative[5] has mentioned that the return rate in previous school-based research had been about eighty per cent. When reflecting on the data collection process, there might be two reasons for this low response rate. One possible reason was that parents did not want their children to take part in this research because they thought the school-based research (taking 30 to 35 minutes) would steal from their children's learning time. The other reason might be that '*health literacy*' was a new topic for parents. They were not familiar with the concept of health literacy or its importance, and/or they did not read the plain language statement, thus resulting in a low response. To assist researchers to recruit large samples for future school-based health literacy research, there are two possible strategies for increasing the levels of parental consent. The first is to reduce the risks associated with conducting child-related research, thus making it possible to have passive, opt-out consent approved by the ethics committee. Future researchers should carefully consider questions regarding such matters as '*substance abuse*' and

[5] The estimation of eighty percent was obtained from Madam Adele Symon, who is the Head of Physical Education and one of the school representatives in the pilot school in Melbourne.

other sensitive topics to avoid potential adverse impacts. As opt-out consent has been used in the monitoring of early child development in schools through the Australian Early Development Index (551), it is possible to collect data on health literacy in Australian schools using opt-out consent. The second strategy is focusing on increasing response rates via active, opt-in consent. Several techniques can be used to arouse parents' interest in participating in the research: for example, explaining the research project as simply as possible in the plain language statement (e.g. using a shorter survey); sending mails to each family as a reminder after sending online parental consent forms; and offering educational incentives to students and parents. Compared to the second strategy, the first seems to be more feasible and efficient. Any issues resulting from an opt-out consent arrangement should be resolved with the ethics committee before research proceeds.

6.5.1.3 Online data collection

Third, online data collection was considered a feasible technique in this pilot study. Compared with paper-and-pencil surveys, online surveys have several advantages such as speed of dissemination and response, less expensive printing and postage and more time-efficient data entry (552-554). This study used an online survey not only because of the above advantages but also because of its practicality. During a face-to-face meeting with the school representative, we confirmed the feasibility of online data collection - all students in the pilot school used laptops or tablets in class. Using the Survey Monkey tool, I designed the online survey, consent forms and plain language statement for parents and students.

Although 331 students (36.1%, 331/918) received parental consent, only 120 of them completed the online health literacy survey. In other words, the other 211 students did not complete the survey. There might be two reasons. The first reason might be students' negative feelings towards the online survey. In practice, it took 30 to 35 minutes for students to complete the online health literacy survey, making students reluctant to participate. The second reason (the main reason) might be connected to the data collection process. That is, some teachers did not provide the opportunity and class time for students to carry out the online survey. Although the school representative and I agreed to collect data from all students (n=918) in Years 7 to 9 (this agreement was made to meet the school's expectation, not only for research purpose), 505 students finally completed the online health literacy survey (this sample size was used for writing the school report, see **Appendix 6.10**: Report to the pilot school). This meant that almost half of the classes did not participate in the online survey. A possible reason for this was that some teachers forgot to invite students to do the survey in the first class of health and physical education in the third school term of 2016. The first class was the only available time for the survey. In this case, if the 211 students were from the non-participating classes, then they did not have the opportunity to access the online survey. The result was a sample size of only 120 for this pilot study, which included only 13.1% (120/918) of the total school enrolments.

In summary, the final response rate of 13.1% (120/918) was a composite outcome resulting from a set of challenges and possible issues discussed above (e.g. the low response rate of school principals; opt-in consent from parents; long administration time of the online survey; some classes not completing the online survey). Although the school representative and school principal supported this pilot study of students' health literacy, time was still limited to administering the health literacy survey (i.e. only the first class of health and physical education for the term was available). To make health literacy surveys more practicable in school-based settings, researchers need to design shorter questionnaires and to advocate the importance of health literacy for policy-makers, schools and parents. In addition, schools need to pay attention to health literacy evaluation in response to the requirement for developing health literacy in the national health and physical education curriculum.

6.5.2 Findings from the pilot school

6.5.2.1 Students' demographics

In total, 120 students with parental consent participated in the online survey, resulting in a low response rate (13.1%, 120/918). The mean age of students was 13.63 ± 1.03 (age range: 12-15). The distribution of gender, year level, country of birth, country of mother's birth, county of father's birth, years of living in Australia, first language spoken at home, family structure and socio-economic status are shown in **Table 6.1**.

Table 6.1: Students' socio-demographics in the Australian pilot school

Participant characteristic	Mean ± SD or frequency (%)
Age	13.63 ± 1.03
Gender	
Male	73 (60.8)
Female	47 (39.2)
Year level	
Year 7	32 (26.7)
Year 8	35 (29.2)
Year 9	53 (44.2)
Country of birth	
Australia	84 (70.0)
Mainland China/Hong Kong/Macao/Taiwan	13 (10.8)
Other countries	23 (19.2)
Country of mother's birth	
Australia	43 (35.8)
Mainland China/Hong Kong/Macao/Taiwan	29 (24.1)
Other countries	48 (40.0)
Country of father's birth	
Australia	46 (39.0)
Mainland China/Hong Kong/Macao/Taiwan	26 (22.0)
Other countries	46 (39.0)
Years of living in Australia*(n=36)	7.56 ± 3.95
First language spoken at home	
English	85 (70.8)
Chinese	20 (16.7)
Other languages	15 (12.5)
Family structure #	
Intact families	105 (87.5)
Other types of families	15 (12.5)
Socio-economic status	
Low	2 (1.7)
Medium	28 (23.3)
High	90 (75.0)

Note: * average years living in Australia for students born in other countries; # intact families were defined as those in which participants indicated residing in a household with both biological parents, other types of families were defined as those in which participants indicated residing in a household with either one of their parents, foster parents, step parents, a relative or who were living in a shared care institution. SD, Standard Deviation.

To learn about students' representativeness in the pilot school, I compared respondents' characteristics in the pilot school with those of young Australians aged 12 to 24 years in the 2011 national report '*Young Australians: their health and wellbeing*' (555). Results showed that students in the pilot study had an uneven gender distribution, diverse cultural backgrounds and a high socio-economic status (See **Table 6.2**).

Table 6.2: Students' representativeness in the Australian pilot school

Students in the pilot school		Young Australians in the national report	
Participant characteristic	**Proportion (%)**	**Participant characteristic**	**Proportion (%)**
Gender		***Gender***	
Male (12-15ys)	60.8	Male (12-14ys)	51.3
Female (12-15ys)	39.2	Female (12-14ys)	48.7
Country of birth		***Country of birth***	
Australia	70.0	Australia	78.0
Other countries	30.0	Other countries	22.0
Family structure [a]		***Family structure*** [a]	
Intact families	87.5	Intact families	87.0
Other types of families	12.5	Other types of families	13.0
Low socio-economic status [b]	1.7	***Low socio-economic status*** [c]	9.0-11.0
		Parents had not completed secondary school	9.0
		Jobless families	11.0

Note: *a* intact families referred to those in which participants indicated residing in a household with both biological parents, other types of families referred to those in which participants indicated residing in a household with either one of their parents, foster parents, step parents, a relative or who were living in a shared care institution; *b* low socio-economic status was measured by family affluence level scale (scores: 0-3); *c* low socio-economic status was measured by proportion of young people aged 12-24 years whose parents did not complete secondary school (Year 10 or above) and proportion of young people living in jobless families.

6.5.2.2 Descriptive statistics of health literacy

As shown in **Table 6.3**, the mean scores for the HLAT-8, the NVS and the HLS-EU-Q were 28.25 ± 6.00, 4.13 ± 1.73 and 37.72 ± 8.40 respectively. Spearman correlation analysis showed that the HLAT-8 was moderately correlated with the HLS-EU-Q (r=0.58, p<0.01). However, the NVS was neither correlated with the HLAT-8 (r=0.03, p=0.76), nor correlated with the HLS-EU-Q (r=0.08, p=0.39).

Table 6.3: Students' health literacy scores in the Australian pilot school

Statistical variable	**Health literacy instrument**		
	HLAT-8 (n=120)	**NVS (n=118)**	**HLS-EU-Q (n=118)**
Mean ± SD	28.25 ± 6.00	4.13 ± 1.73	37.72 ± 8.40
Median (IQR)	29.36 (26.00, 32.00)	5.00 (3.00, 6.00)	38.48 (33.33, 43.62)

Note: HLAT-8, the 8-item Health Literacy Assessment Tool; HLS-EU-Q, the Health Literacy Survey-European-Questionnaire; IQR, Interquartile Range; NVS, the Newest Vital Sign; SD, Standard Deviation.

As per the scoring system of the NVS (169) and the HLS-EU-Q (540), the proportion of students with low health literacy varied: 32.2% (38/118) for the NVS and 23.7% (28/118) for the HLS-EU-Q. Findings from these two health literacy instruments showed that almost half (53.0%) of students were concordant for high health literacy and 9.4% were concordant for low health literacy (See **Table 6.4**). Nearly a quarter of students (23.1%) had low health literacy on the NVS and high health literacy on the HLS-EU-Q, and 14.5% of students had high health literacy on the NVS and low health literacy on the HLS-EU-Q.

Table 6.4: The prevalence of low health literacy for students in the Australian pilot school

Health literacy instrument	Percentage (%)
NVS (n=118)	
Low health literacy (n=38)	32.2
High health literacy (n=80)	67.8
HLS-EU-Q (n=118)	
Low health literacy [a] (n=28)	23.7
High health literacy [b] (n=90)	76.3
NVS & HLS-EU-Q (n=117)	
Concordant low health literacy (n=11)	9.4
Concordant high health literacy (n=62)	53.0
NVS low/ HLS-EU-Q high (n=27)	23.1
NVS high/ HLS-EU-Q low (n=17)	14.5

Note: *a* the category of '*inadequate health literacy*' and '*problematic health literacy*' were combined into '*low health literacy*'; *b* the category of '*sufficient health literacy*' and '*excellent health literacy*' were combined into '*high health literacy*'. HLS-EU-Q, the Health Literacy Survey-European-Questionnaire; NVS, the Newest Vital Sign.

6.6 Discussion

This chapter outlined a pilot study of health literacy measurement in one Australian secondary school. Each of the three instruments (the HLAT-8, the NVS and the HLS-EU-Q) provided a different lens for students' health literacy. The HLAT-8 was correlated with the HLS-EU-Q, but not with the NVS. About one quarter of students were identified as having low health literacy at the pilot school. However, the prevalence of low health literacy for general students was likely to be higher than that for students at the pilot school.

6.6.1 Health literacy measurement by the NVS

Based on the cut-off value of the NVS (240), 32.2% (38/118) of students in the pilot school had a high likelihood of low health literacy. This prevalence was higher than that of a previous Australia-based study (66) which showed that 26.0% (80/308) of the Australian general population aged 18 and over had low health literacy using the NVS as a measure. This comparative result is expected because adolescents have less well-developed cognitive abilities than adults. Because of this, adolescents would probably get lower scores on the NVS than adults. However, this pilot study was likely to underestimate the true prevalence of low health literacy in Australian students in general, because the sample in this study was recruited from only one secondary school, which was located in a high socio-economic status area. The demographic data showed that most students (75.0%, 90/120) were from high affluence families. Compared with those from low socio-economic areas, students from high socio-economic areas have better access to high-quality education which contributes to better health literacy. Therefore, the general Australian secondary student population probably has a higher percentage of those with low health literacy.

Compared with the NVS results in American adolescents (169, 176), the NVS results in this pilot study showed an intermediate level of health literacy. Driessnack *et al.* (169) used the NVS to measure health literacy among school-aged children aged 7 to 12 and found that the prevalence of low health literacy was 19.1% (9/47). Another study conducted by Ghaddar *et al.* (176) showed 47.9% (125/261) of high school students aged 14-20 years had low health literacy as measured by the NVS. These findings, together with the results of this pilot study, suggest that the prevalence of low health literacy increases with the age of children and adolescents. This contradicts child development theory which supports a positive relationship between health literacy and age (166). Due to small samples, convenience sampling and the varying sensitivity of the NVS to different populations (169, 176, 397), the above inference should be made with caution. More evidence is needed to verify the relationship between health literacy and age groups (primary school students and secondary school students) in future research, with large and representative samples.

6.6.2 Health literacy measurement by the HLAT-8 and the HLS-EU-Q

This is the first study to explore the utility and feasibility of the HLAT-8 and HLS-EU-Q in Australian adolescents. Both of these instruments suggested that Australian students had higher levels of health literacy than their counterparts in other countries. Specifically, the HLAT-8 result showed that health literacy mean scores were 28.20±6.18 in Australian boys and 28.32±5.78 in Australian girls. Compared with a previous study in Swiss youths (4), students in the pilot school had higher levels of health literacy than Swiss samples (25.54±5.38 in males; 27.57±4.87 in females). Given that the HLAT-8 had a continuous scoring system (4), the prevalence of low health literacy was not examined by this instrument. The HLS-EU-Q instrument revealed that 23.7% (28/118) of Australian students had low health literacy, whereas 36.8%-60% of Portuguese students in Grades 9 to 12 had low health literacy (450, 451). This finding also showed a higher proportion of students with high health literacy in the pilot school. There might be two reasons for this. The first reason was convenience sampling. As explained earlier, students in the pilot school were mainly from high socio-economic backgrounds. Due to the positive relationship between socio-economic status and educational outcomes (556, 557), students were more likely to have high health literacy if they had high socio-economic status. The second reason was self-report bias. Unlike the NVS (a performance-based measure), the HLS-EU-Q is a self-report measure of health literacy. As shown in similar studies (4, 168, 303), students may over-restimate their ability to find, understand and apply health information. Also, Australian students in this pilot study were younger than the Portuguese students (450, 451), and their cognitive abilities more likely to be under-developed. Therefore, self-reporting of health literacy was more challenging for them, which may result in a higher level of self-report health literacy. There is a need for future research to examine the prevalence of low health literacy with rigorous measurement methods (e.g. by controlling for self-report bias) and representative samples.

6.6.3 Correlations between the NVS and the HLAT-8 and the HLS-EU-Q

From multiple measurement perspectives, this pilot study used three instruments (the HLAT-8, the NVS and the HLS-EU-Q) to measure students' health literacy in one Australian secondary school. Correlation analysis showed that the NVS was neither related to the HLAT-8, nor related to the HLS-EU-Q. However, the HLAT-8 was correlated with the HLS-EU-Q. This finding was similar to that of Chinese samples in this PhD thesis, suggesting that the health literacy construct underlying the NVS is different from that underlying the HLAT-8 and the HLS-EU-Q. The NVS is a proxy measure of functional health literacy (240), whereas the HLAT-8 and the HLS-EU-Q measure three-domain health literacy, including functional, interactive and critical health literacy (4, 241). This study found that the concordance rate was 62.4% for the NVS and the HLS-EU-Q. The difference in health literacy testing results between these two instruments may have two reasons. The first is the different constructs of health literacy underlying each instrument. The second is the self-report bias of the HLS-EU-Q. Students may over-report their health literacy levels when using self-report instruments. In this pilot study, almost one quarter of students (23.1%) were identified as having high health literacy using the self-report HLS-EU-Q. However, they were identified as having low health literacy using the performance-based NVS. To identify the root cause of this discordance, there is a need for future research to explore whether the difference results from different forms of administration (self-report versus performance-based) and different constructs of health literacy measurement, or whether the difference only results from different constructs of health literacy measurement (functional health literacy versus three-domain health literacy).

6.6.4 Health literacy comparisons between students in the pilot school and national samples

This pilot study identified about one quarter of students (23.7%-32.2%) with low health literacy in the pilot school. Consistent with the findings from Chinese secondary schools in this PhD thesis, Australian secondary students had a higher percentage of low health literacy using the NVS instrument (32.2%) than they did using the HLS-EU-Q (23.7%). As for health literacy research in Australian adolescents, the only available data were from the 2006 Australian health literacy survey which showed that 67.6% of adolescents aged 15 to 19 had low health literacy (23). There might be two reasons for the pilot study showing a lower proportion of students with low health literacy. One reason was the different health literacy instruments used. This pilot study used the 6-item NVS and the 47-item HLS-EU-Q as health literacy instruments, while the 2006 Australian health literacy survey using 191 items would have proved more time-consuming and more challenging for adolescents. The other reason was that the sample in this pilot study was recruited from only one secondary school, whereas the sample in the 2006 Australian health literacy survey was recruited from a broader setting of society. A sample recruited from a school setting was more likely to be health literate than a sample of people recruited from other settings. Therefore, the prevalence of low health literacy was likely to be under-estimated in the pilot school. No matter which health literacy instrument was used, low health literacy was a common issue in the pilot school, an issue that requires attention from both schools and education departments. Due to a lack of school-based health literacy research among Australian adolescents, further evidence is needed to accurately assess the prevalence of low health literacy in Australian students, and to motivate education departments to take action to improve health literacy in schools.

6.6.5 Strengths and limitations

This pilot study has two strengths: 1) compared with previous health literacy studies in Australia (53, 54, 56), this study examined general health literacy for adolescents in school settings, rather than mental health literacy; and 2) this study used three instruments to measure students' health literacy in the pilot school. Using multiple tools to measure health literacy in a single study is a robust way to enhance the rigour of findings (35).

It is also important to note the limitations of the study. First, the sample size did not allow the HLAT-8 to be validated based on an adequate sample of at least 400 respondents. Therefore, this study could only explore internal consistency of the HLAT-8. Given that the HLAT-8 has been demonstrated to be a valid, reliable and time-efficient instrument to measure health literacy in Chinese secondary students, the HLAT-8 is worthy of further validation in larger and more representative samples in

Australian settings. Second, due to convenience sampling, students from the pilot school were not representative. That is, students in the pilot school had a higher socio-economic status and more diverse cultural backgrounds than a nationally representative sample. Therefore, it was likely that the prevalence of low health literacy in the general Australian population of adolescents would be much higher. There is a need for future research to recruit participants from a broader range of socio-demographics to generalise the findings.

6.7 Conclusion

This chapter reported on a pilot study of health literacy measurement in one Australian secondary school. Consistent with the findings of health literacy measurement in Chinese secondary schools, this pilot study found that the percentage of low health literacy was higher using the NVS than that using the HLS-EU-Q. Although it was challenging to recruit students, the pilot study provided useful insights into future large-scale health literacy surveys in Australian secondary schools. Given that the prevalence of low health literacy among Australian adolescents is probably under-estimated based on the results from the pilot school, there is a need for future researchers to examine health literacy with more representative samples and to draw attention to the need for a focus on health literacy in schools.

Box 6.1: Key messages about the pilot study in an Australian secondary school

- This pilot study provided new insights into future school-based health literacy research in Australia, including a shared perspective of health literacy evaluation between the pilot school and the researcher, feasible online data collection techniques, and possible opt-out consent techniques.
- Consistent with the findings from Chinese secondary schools, the NVS (32.2%) showed a higher proportion of students with low health literacy than the HLS-EU-Q (23.7%) did. About one quarter of students were identified as having low health literacy in the pilot school.

Chapter 7 Synthesis and Discussion

7.1 Introduction

This chapter aims to draw together and integrate the key findings from each research phase in this PhD thesis. There are five key findings that require further discussion due to their importance in informing health literacy measurement and model testing for secondary school students. These findings include:

1) Adolescent health literacy is more than a skills-based concept in current research and practice, referring to an interactive outcome influenced by individuals' health skills and social resources that are needed to make informed decisions.
2) Adolescent health literacy measurement varies in its dimensions, forms of administration and considerations of population characteristics. The prevalence of low health literacy in adolescents varies with use of different health literacy instruments.
3) A small number of methodological issues exist when applying the COSMIN checklist, Pleasant's evaluation principles and Manganello's health literacy framework in practice.
4) Adolescent health literacy is related to a set of ecological factors including personal self-efficacy, social support and school environment.
5) Adolescent health literacy is closely related to physical activity, teeth brushing, patient-provider communication and health status.

Research challenges and gaps are summarised throughout the discussion. Following discussion of the above five topics, research contributions are outlined for each research phase of this PhD research. Finally, strengths and limitations of the entire research project are summarised.

7.2 Adolescent health literacy is more than a skills-based concept

Findings from this PhD thesis show that adolescent health literacy is more than a skills-based concept that represents an interactive outcome influenced by an individual's health skills and the broad environment. Understanding what health literacy means to adolescents is important to determine how to measure health literacy in practice and how to reduce the ambiguity of the measurement of a concept (558). The conceptual definitions discussed here are abstract definitions of health literacy which reflect their basic characteristics (559).

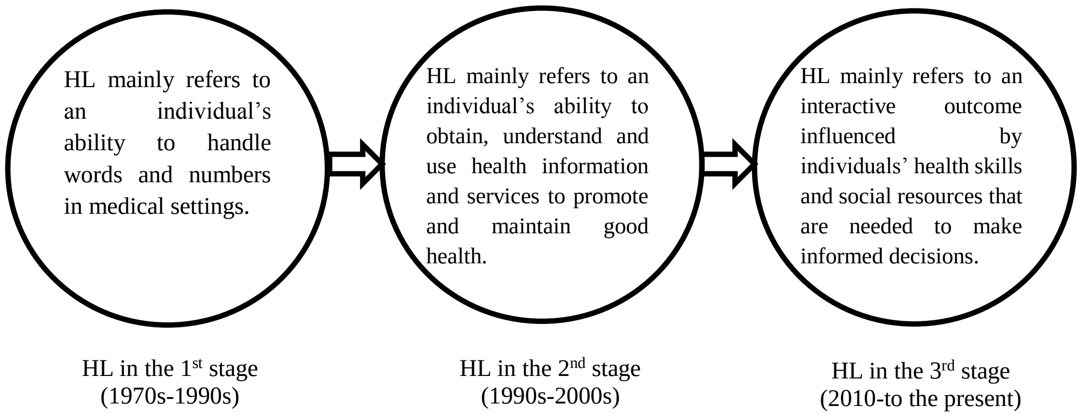

Figure 7.1: The evolving concept of health literacy (HL) in each stage

The systematic review in Research Phase 1 found that adolescent health literacy was mainly defined as a skills-based concept (e.g. finding, understanding, communicating skills) in current measurement studies (14/15). This finding is aligned with the evolving concept of health literacy in the second stage (See **Figure 7.1**). It should be noted that although adolescent health literacy was mainly defined as a skills-based concept in Western countries such as the USA, this was not the case in mainland China. Currently, health literacy research in China is mainly conducted in the domains of health knowledge and behaviours (25, 36, 37, 560, 561). Due to its different conceptual understanding of health literacy, health literacy measurement in China is different from that in other countries. This makes it difficult to learn about the status of health literacy in China on an international platform, that is, difficult to compare health literacy results between Chinese adolescents and their counterparts in other countries. Given that promoting health literacy is a key strategy to reduce health inequities in the global context (9), health literacy evidence from a skills-based perspective is needed in China.

The validation study in Research Phase 2 demonstrated that the c-HLAT-8 captured a skills-based construct of health literacy with four dimensions (finding, understanding, communicating and evaluating skills). The skills-based concept of health literacy highlights the importance of practical skills to health practices. As explained by Paakkari *et al.* (43), practical skills are often linked to daily practices. Therefore, practical skills are more direct factors in the initiation of health behaviours than theoretical knowledge (105). Given that most evidence on health literacy in China obtained so far is not from the skills-based perspective (25, 36, 37, 560, 561), the c-HLAT-8 provides new opportunities for future researchers to re-discover the role of health literacy in Chinese students' health outcomes (e.g. in their health behaviours and health status). Also, the skills-based health literacy instrument makes it possible to compare students' health literacy results between countries, identify health literacy needs, design effective interventions, and eventually motivate Chinese governments to invest more effort in promoting health literacy in adolescents.

Although adolescent health literacy is mainly a skills-based concept in current research and practice, the systematic review in Research Phase 1 identified that one included study defined adolescent health literacy as an interactive outcome influenced by individuals' health skills and the broader health environment (246). This finding indicates that researchers have begun to consider adolescent health literacy from a broader perspective, which aligns with the evolving concept of health literacy in the third stage (See **Figure 7.1**). This broad perspective calls for a systems approach to understanding adolescent health literacy (95, 96). As demonstrated in the model testing of Research Phase 3, student's health literacy was found to be associated with the broader environment and the resources that were around them (e.g. social support, school environment and community environment). This suggests that integrating the broader health environment into the conceptual understanding of adolescent health literacy is necessary. Low health literacy is not just an issue at the individual level; it is an outcome affected by the broader environment. Only based on a systems approach can the problem of low health literacy be addressed (91, 96).

Given that current definitions of adolescent health literacy focus mainly on individuals' health skills (4, 6, 50, 169, 177, 208, 249, 251, 252, 397-401), there is a need for future research to consider both individual health literacy and the health literacy environment for adolescents. One possible way to define and measure the health literacy environment for adolescents is to leverage the knowledge obtained from defining and measuring the health literacy environment for adults. For instance, the health literacy universal precaution toolkits provide a series of tools (e.g. using teach-back method, using health education material effectively) to identify and address health literacy issues within the healthcare setting (562). Compared with adults, school-aged adolescents have different social resources and environments. They spend most of their time in families, at schools, and in communities. Therefore, these environments and their resources (e.g. parents, teachers, peers, the internet) should be examined more closely in order to better understand the health literacy environment for adolescents. For example, the increasing use of the Internet requires researchers to define and measure the online health literacy environment for adolescents (e.g. understanding how adolescents use online resources to address personal questions about health concerns, identifying health literacy needs via personal use of Internet), thus assisting them to optimally use online health information to promote health.

In summary, adolescent health literacy is more than a skills-based concept. Further evidence is needed on the application of the skills-based concept of health literacy in China. Meanwhile, the skills-based concept of adolescent health literacy needs to be expanded in future and be seen as an interactive outcome influenced both by an individual's health skills and by the broader environment (e.g. families, schools and communities).

7.3 Multiple methods exist to measure adolescent health literacy, resulting in different prevalence rates

The second key finding from this thesis is that adolescent health literacy measurement varies according to its dimensions, forms of administration and different adolescents' characteristics. In the context of different measurement tools, the proportion of students with low health literacy varies in both Beijing secondary schools and the pilot school in Melbourne.

The systematic review in Research Phase 1 revealed that health literacy had different dimensions and was subject to different forms of administration among the 15 included studies. This finding is similar to previous findings by Ormshaw *et al.* (33) and other reviewers (29, 32, 245). Among the 15 included studies, some researchers measured health literacy in terms of health knowledge, attitudes, communication and self-efficacy (249), while others measured a set of health skills such as reading and understanding health information (4, 177, 399). Some adopted interviewer-administered and performance-based instruments (169, 251, 397, 401), while others preferred self-administered and self-report tools (4, 208, 246). As discussed earlier in Chapter 4.6.3, disparities in health literacy measurement results have several causes: a lack of agreed-upon conceptual definitions; different considerations of conceptual models; and varying research purposes. Due to the complex and multi-dimensional nature of health literacy (5, 45), it is challenging to identify and use a unified framework for establishing consistent dimensions and forms of administration when measuring health literacy in adolescents. This is the same case for measuring health literacy in adults (31, 32, 245). Although it fails to establish such a unified framework for measuring adolescent health literacy, there is a set of evaluation principles available to guide the field of health literacy measurement (28, 35). As an example, seven evaluation principles recommended by Pleasant *et al.* (28) were used in Research Phase 2. Further details regarding the use of these evaluation principles will be discussed in Chapter 7.4.2: Reflections on using Pleasant's evaluation principles.

The systematic review in Research Phase 1 also showed that researchers focused on different participant characteristics when measuring health literacy in adolescents. For example, some researchers were more interested in students' cognitive development (50, 177, 246, 249, 252), some focused on the resources and environments that were around adolescents (e.g. friends and family contexts, eHealth resources and contexts, media health contexts) (4, 6, 208), while others considered recruiting adolescents from broad socio-demographic backgrounds (e.g. different cultural backgrounds and socio-economic status) (6, 50, 169, 177, 208, 246, 249, 252, 399, 400). One explanation for this disparity was their different research interests and purposes. Another reason (the main reason) was probably the difference between adolescents' characteristics and adults' characteristics. As discussed in Chapter 2.3.1, four unique adolescent characteristics should be considered, according to Forrest's '*4D*' model, when researching health literacy in adolescents (162, 163). These four characteristics include developmental change, dependency, differential epidemiology and demographic patterns. Based on this '*4D*' model, our review suggested most health literacy measurement studies considered adolescents' developmental change, dependency and demographic patterns, but rarely considered differential epidemiology. For example, the timing of chronic disease initiation might have different effects on adolescents' cognitive development and health literacy skills (162). There is a need for future researchers to conduct health literacy measurement studies in adolescents with chronic conditions. Although the '*4D*' model cannot be used to reduce the disparities in health literacy measurement, it does provide an opportunity to identify gaps in current research and assist researchers to consider adolescent characteristics comprehensively in future research. Further details of this implication will be given in Chapter 8.3.1.2: New directions for future research.

The validation study in Research Phase 2 among Beijing secondary students and the pilot study among Melbourne secondary students both confirmed that use of different health literacy instruments resulted in different prevalence rates of low health literacy in their results. The NVS, a performance-based instrument, revealed that 45.5% of Beijing secondary students and 32.2% of Melbourne secondary students had low health literacy, whereas the HLS, a self-report instrument, found that 29.0% of Beijing secondary students and 23.7% of Melbourne secondary students had low health literacy. As discussed earlier in Chapters 5 and 6, one reason for the disparity was the different underlying constructs of health literacy in each instrument. The other reason was probably measurement error inherent in self-report instruments. Students were likely to over-estimate their health literacy levels when using the self-report HLS (168). Given that the purpose of this thesis was not to examine the difference between health literacy instruments, such research could be carried out by future researchers to examine the over-estimation effect of self-report measures by controlling for the same underlying construct of health literacy.

In summary, although it is challenging to establish a unified framework for health literacy measurement, there are already-established evaluation principles and frameworks that can be used to reduce the apparent disparities. There is a need for researchers to apply these evaluation principles in practice to guide health literacy measurement in adolescents in the future.

7.4 Reflections on methodological issues in this PhD research

The third finding from this thesis suggests that a small number of methodological issues need consideration when putting theoretical frameworks and evaluation principles into practice. The COSMIN checklist was shown to be a useful quality control tool to guide the systematic review in Research Phase 1. Also, Research Phase 2 showed that Pleasant's evaluation principles were useful to guide health literacy measurement. Research Phase 3 found that Manganello's health literacy framework was useful to explain the mediating role of health literacy in adolescent health outcomes such as health behaviours. Although theoretical frameworks and evaluation principles were useful in this PhD research, some issues and challenges arose when applying them into practice. In the following paragraphs, I reflect on methodological issues in this PhD research, because explaining the methodological issues is important to assist other researchers to understand why I performed my research in a particular way and what I actually did, just as it can assist other researchers to understand what worked and what did not work.

7.4.1 Reflections on using the COSMIN checklist

There were three considerations when using the COSMIN checklist as a methodological quality assessment framework for the systematic review in Research Phase 1. Reflection on these considerations is essential to ensure clarity, transparency and rigour of use of the COSMIN checklist in future research.

First, the COSMIN checklist was originally developed for evaluating the quality of studies on measurement properties of patient-report instruments in healthcare settings (372), not on measurement properties of self-report/performance-based instruments in public health contexts. Some items were found to be inappropriate when the COSMIN checklist was applied in the public health context. For example, the evaluation box for '*internal consistency*', '*reliability*' and '*hypotheses testing*' defines a sample size of '*<30*' as poor, '*30-49*' as fair, '*50-99*' as good and '*≥100*' as excellent for general design requirements. It is anticipated that population-based studies in non-clinical settings are likely to have larger sample sizes than individual-based studies in clinical practice. Therefore, studies in the public health context are more likely to rate as '*excellent*' quality in the above evaluation boxes.

To better differentiate the quality of studies by sample size in public health studies, I adapted the '*sample size≥100 (excellent); sample size 50-99 (good); sample size 30-49 (fair) and sample size <30 (poor)*' to '*a subject to item ratio greater than 7 and sample size ≥100 (excellent); a subject to item ratio equal to 6-7 and sample size ≥100 (good); a subject to item ratio equal to 5-6 and sample size ≥100 (fair); and a subject to item ratio smaller than or equal to 5 (poor)*' for included studies conducted in public health contexts (n=11) in the systematic review [6]. This adaptation resulted in poor methodological quality of the CHC test study on reliability and hypotheses testing (399), poor quality of the REALM-Teen study on hypotheses testing (400), poor quality of the NVS study on hypotheses testing (169) and poor quality of the HLAT-51 study on hypotheses testing (398). As to whether the above adaptation for the sample size requirement was adequate or not, more evidence is needed in future (e.g. from Delphi consultation with experts in the field of psychometrics). As for evaluating the quality of studies on the measurement properties of performance-based instruments (n=10), no adaptations were made because all items were considered appropriate for use. In brief, my experience of using the COSMIN checklist suggests that future researchers need to adapt items related to sample size when evaluating the quality of studies in the public health context.

Second, two items on the COSMIN checklist were found to be unclear when evaluating the methodological quality of studies. The first item was from the evaluation box of

[6] The rationale for this adaption: As outlined in the COSMIN manual (260), '*each box contains an item asking if the sample size of the study was adequate. This should be judged by the user of the checklist and may differ between methods*'. Given that factor analysis is commonly-used in validation studies, I adopted rules of thumb (i.e. a subject to ratio) for factor analysis to determine if the sample size was adequate. Also, the sample size of 100 was determined by rules of thumb for reliability studies. As summarised by Charter (419), 41% of the sample sizes were more than 100 in previous 6322 reliability test studies.

reliability: '*was the time interval appropriate?*' There were three ratings: '*time interval appropriate*' (excellent), '*doubtful whether time interval was appropriate*' (fair) and '*time interval not appropriate*' (poor). According to the COSMIN manual (262), a time interval of two weeks is often considered appropriate for reliability evaluation. As to whether one week or more than two weeks are considered not '*appropriate*' (poor) or '*doubtfully appropriate*' (fair), it is difficult for researchers to decide. Findings from the systematic review in Research Phase 1 showed that the c-sTOFHLAd and the REALM-Teen had a time interval of one week and the eHEALS had a time interval of several months for test-retest reliability. Given that previous literature (563, 564) suggested an acceptable time interval of two days to ten months for health-related quality of life instruments if respondents were stable in their characteristics, I gave a fair ('*doubtfully appropriate*') rating for the above three time intervals. The second item was from the evaluation box '*content validity*': '*was there an assessment of whether all items refer to relevant aspects of the construct to be measured?*' It is a subjective matter for researchers to rate. In relation to '*assessment of whether all items refer to relevant aspects of the construct*', the COSMIN manual explains only one possible and appropriate method (expert judgement) for determining the relevance and comprehensiveness of the items. The COSMIN manual does not refer to other appropriate methods (e.g. literature reviews or qualitative interviews). When evaluating this item, I considered three methods (expert judgement, literature reviews, qualitative interviews) as appropriate[7]. In summary, based upon my experience of using the COSMIN checklist, the specifications for the above two items need to be updated for future users.

Third, the COSMIN checklist was found to be still useful when there were two instruments (the DNT-39 and the DNT-14) or three instruments (the REALM-Teen, the s-TOFHLA and the NVS) used in a single study. Although it was repetitive to evaluate the quality of the single study twice or three times, it was necessary to consider the study's quality against each instrument because each instrument threw up different information on the measurement properties. As there were no conflicts of interest associated with using the COSMIN checklist twice or three times in a single study,

[7] This decision was made based on reviewing the methods parts of included studies outlining how they developed health literacy instruments.

future researchers are encouraged to follow this principle to ensure a comprehensive quality assessment of studies for each instrument.

7.4.2 Reflections on using Pleasant's evaluation principles

The systematic review in Research Phase 1 suggested a scarcity of rigorous literature reporting information on the methodological quality of adolescent health literacy instruments. In Research Phase 2, the COSMIN checklist was then used to ensure the methodological quality of the validation study in Chinese secondary students. Also, Pleasant's evaluation principles were used to reduce the disparities in health literacy measurement (28). As seen in **Figure 7.2**, there are seven recommendations made regarding health literacy measurement. Although Pleasant's recommendations were useful, some evaluation principles were found to be insufficiently specific. In the following paragraphs, I reflect on Pleasant's recommendations when applying them into practice.

Recommendation 1	***Explicitly built on a conceptual framework of health literacy***
Recommendation 2	***Multi-dimensional in content and methodology***
Recommendation 3	***Measure health literacy on a continual basis***
Recommendation 4	***Treat health literacy as a 'latent construct'***
Recommendation 5	***Honour the principle of compatibility***
Recommendation 6	***Allow comparison across different contexts including population groups and cultures***
Recommendation 7	***Prioritise public health applications versus clinical screening***

Figure 7.2: Pleasant's recommendations on health literacy measurement

First, it was not clear how one should select an appropriate conceptual framework for health literacy (Recommendation 1). In this PhD thesis, Nutbeam's health literacy model and Manganello's health literacy framework were both considered. Nutbeam's three-domain health literacy model was selected because it was aligned with the skills-based definition of health literacy adopted in this thesis, a definition which highlights the importance of personal skills to protecting health. Also, Nutbeam's model was aligned with the target population's learning characteristics. In Anderson and Krathwohl's learning model (216), students' learning competency includes six levels in its hierarchy: remembering, understanding, applying, analysing, evaluating and creating. Therefore, Nutbeam's three-domain model (functional, interactive and critical) is compatible with Anderson and Krathwohl's learning model. As explained by St Leger (565), the term skills-based '*health literacy*' ensured the connection between '*health*' and '*learning competency*', thus supporting the attainment of optimal health and educational outcomes for adolescents at school. As Nutbeam's health literacy model only focuses on the health literacy construct, ignoring the relationships with other constructs, I also employed Manganello's health literacy framework, which explains how the health literacy construct relates to or differentiates from other variables such as self-efficacy and social support. The decision to use these two models was based on the research purpose and target populations of this PhD thesis. Future researchers are encouraged to specifically consider how to choose an appropriate conceptual framework when measuring health literacy in a particular population for a particular purpose.

Second, the evidence obtained from this PhD research was not sufficient to support the multi-dimensional nature of methodology (Recommendation 2). In the validation study for Beijing secondary students and the pilot study for Melbourne secondary students, two strategies were considered regarding Recommendation 2. One strategy was to use multiple measures of health literacy (the HLAT-8, the NVS and the HLS) in a single study, because multiple measures assisted in capturing students' health literacy from different perspectives (35). Given that the underlying construct of health literacy within the NVS was different from that within the HLAT-8 and the HLS, the results from the NVS, the HLAT-8 and the HLS were not comparable, thus contributing to the limited evidence on students' health literacy outcomes. There is a need for future research to use multiple measures of health literacy with the same underlying construct in order to provide more robust evidence. The other strategy for addressing the multi-dimensional nature of methodology was to employ two forms of data collection (i.e. online surveys and paper-and-pencil surveys) in this study. The online survey was only conducted among Melbourne secondary students, while the paper-and-pencil survey was only conducted among Beijing secondary students. Therefore, the measurement equivalence of two forms of data collection in a single population remains unknown. Further details of this implication will be summarised in Chapter 8.3.1.2: New directions for future research.

Third, it was unclear whether domain weights should be considered when obtaining a continuous score of health literacy (Recommendation 3). In this PhD research, the total score of the HLAT-8 was obtained by adding the score of each item for each dimension of health literacy. Functional health literacy (4 items) took 50% of the overall health literacy score of the HLAT-8, whereas interactive health literacy (2 items) and critical health literacy (2 items) accounted for 25% each. This scoring system was determined by giving equal weight to four health skills: finding, understanding, communicating and evaluating health information. The rationale for this scoring system was similar to that in Ishikawa's study (303) and Van Der Heide's study (566). As to whether the weight of each dimension should be equal or not, more evidence is needed. A further implication of this scoring system will be offered in Chapter 8.3.1.2: New directions for future research.

Fourth, the evidence obtained from this thesis is not sufficient to allow comparison of health literacy between different cultures (Recommendation 6). Although the HLAT-8 was used to examine health literacy in both Beijing secondary students (n=650) and Melbourne secondary students (n=120), findings were not comparable due to the lack of equivalence in sample size. In addition, the psychometric testing of the HLAT-8 was not performed in secondary students in the pilot school in Melbourne. The HLAT-8 needs further testing for use in different cultures. If the HLAT-8 was found to be an appropriate instrument to measure adolescent health literacy across different cultural contexts, it would contribute to the development of an international perspective of adolescent health literacy, allow cross-cultural comparisons, and further mobilise governments to respond to low health literacy in adolescents.

7.4.3 Reflections on using Manganello's health literacy framework

This PhD research used a quantitative approach to understanding and examining Manganello's health literacy framework in Chinese secondary students. Although Manganello's health literacy framework was demonstrated to be a useful guide in the model testing study in Research Phase 3, it was not possible to include all ecological variables or to analyse their relationships through a quantitative survey. Also, there were no specific guidelines for selection of appropriate instruments to measure variables in the model. In the following paragraphs, I reflect on Manganello's health literacy framework when applying it in practice.

First, the number of variables used in Manganello's health literacy framework was limited in this thesis. Manganello's framework was informed by the ecological model (16) which provided a comprehensive understanding of influential factors in students' health literacy. These influencing factors included a set of intrapersonal, interpersonal, environmental, cultural and political factors. Although this framework is useful to provide many options for responding to low health literacy, there is a lack of specificity in its hypothesised influences. It is difficult for researchers and health professionals to identify the most influential factors or to understand how the variables interact with each other. Therefore, the framework needs to be adapted before it is used. As summarised in Chapter 3.2.2, Manganello's health literacy framework was adapted in accordance with the research aim of this thesis. Only variables of interest were included and tested in the empirical study for Beijing secondary students. There is a need for future research to examine and confirm the influence of excluded variables (e.g. physical abilities, mass media, health systems) in Manganello's health literacy framework.

Second, there was no guide for the selection of an appropriate instrument to measure a variable in Manganello's health literacy framework. Based on a quantitative approach, this empirical study needs to measure more than ten variables. Given that most of these variables are not observable variables (e.g. self-efficacy, social support, health literacy), they should be treated as '*latent constructs'* which need to be measured by explicit and measurable items. In practice, there is more than one instrument for measuring a '*latent construct*' such as social support and health literacy. It is difficult for researchers to select the most appropriate instruments when examining variables in Manganello's health literacy framework. In this PhD research, two considerations were made when selecting instruments. The first consideration was the quality of the psychometric properties of instruments for children and adolescents (high internal consistency and strong construct validity). The second consideration was the feasibility of instruments (self-administered, time-efficient). Although the above two considerations were essential, they were not sufficient. As to which Outcome Measurement Instruments (OMIs) should be selected, Prinsen *et al.* (567) have recently developed a practical guideline for reaching a consensus on the methods for selecting OMIs. There are four main steps in the selection of OMIs: 1) conceptual considerations, that is, to agree in detail upon the construct to be measured and the target population; 2) finding existing OMIs by conducting a systematic review or a literature search; 3) quality assessment of OMIs by evaluating measurement properties and feasibility aspects of OMIs; and 4) generic recommendations on the selection of OMIs, such as seeking final agreement on the selected OMIs among relevant stakeholders. Prinsen's practical guideline could prove a useful framework in assisting researchers to select a set of appropriate instruments in future, which can further support the quantitative evidence obtained from Manganello's health literacy framework.

Third, the model testing of Manganello's health literacy framework needs further validation in different cultures. This PhD thesis only examined Manganello's framework in Beijing secondary students. Adolescent health literacy was found to be a mediating variable between a set of ecological factors and health outcomes (e.g. health behaviours, health status). Due to a small sample size, the causal paths between variables in the model could not be tested in Melbourne secondary students. While the causal paths between variables may exist in other cultures, more empirical evidence is needed to support the appropriateness of Manganello's health literacy framework within different cultures.

7.5 Adolescent health literacy is related to personal self-efficacy, social support and school environment

The fourth finding from this thesis is that adolescent health literacy is understood from an ecological perspective, using a quantitative approach. A set of factors are shown to influence students' health literacy, including self-efficacy (an intrapersonal factor), social support (an interpersonal factor) and school environment (an environmental factor). This empirical finding extends the ecological evidence from previous qualitative research (44). Understanding what influential factors are and which influential factor is the most important can assist researchers to identify the most effective entry point for health literacy interventions in adolescents.

In Chinese samples, the model testing showed that self-efficacy, social support and school environment were important and direct influential factors for students' health literacy. As discussed earlier in Chapter 5.3.4, increasing students' self-efficacy and social support skills, and providing a supportive school environment would be effective in enhancing health literacy in students. This suggests that a systems approach should be considered in future research about students' health literacy interventions. As explained by Dodson *et al.* (10), a systems approach refers to the methodology used to support the identification of health literacy needs and the development and testing of potential solutions. Further implications of using this approach will be presented in Chapter 8.4.2.1: Health Promoting Schools (HPS) programs. Currently, health literacy interventions for adolescents are mainly conducted to improve health literacy itself (i.e. health concepts and skills) (26, 220, 254, 258), rather than addressing its influencing factors such as self-efficacy and the broader environment. Whether interventions on the influencing factors of students' health literacy are workable or not is unknown. There is a need for further evidence to confirm the effectiveness of this systems approach.

In Australian samples, I did not conduct correlation analysis between health literacy and its determinants such as demographics and self-efficacy. The main reason was that health literacy measures had not been validated in this sample. Given that health literacy and culture interact with each other and contribute to health outcomes (261, 265), students' cultural backgrounds and native languages are probably important factors for their health literacy. In the pilot secondary school in Melbourne (total sample size=120), 30% of students were born in other countries, and 29.2% spoke languages other than English at home. These immigrant adolescents are likely to face more health challenges (including health literacy) than native-born Australian adolescents (176, 177, 568-570). This PhD thesis did not examine the difference in health literacy between Australian students and non-Australian students, nor examine how cultures interacted with health literacy or contributed to health outcomes. Future research is needed to fill this knowledge gap by providing evidence on how to effectively respond to low health literacy among adolescents from migrant backgrounds.

7.6 Adolescent health literacy is closely related to physical activity, teeth brushing, patient-provider communication and health status

The fifth finding from this thesis is that health literacy is a mediating variable between its influencing factors (e.g. self-efficacy) and health outcomes (e.g. health behaviours). As such, promoting health literacy is probably a useful strategy for improving student's health outcomes. However, the mediating effect of health literacy on health outcomes was reflected only by some specific health outcomes (physical activity, teeth brushing, patient-provider communication and health status), but not others (e.g. regular breakfast eating, emergency service use and health-related quality of life).

When comparing the effect of health literacy, social support and school environment on health outcomes, we found that health literacy, social support and school environment had similar effect size for health behaviours and health status. Specifically, school environment ($r=0.22$, $p<0.001$) showed a larger effect size than social support ($r=0.12$, $p<0.01$) and health literacy ($r=0.11$, $p<0.01$) for health behaviours; whereas social support ($r=0.14$, $p<0.01$) had a larger effect size than health literacy ($r=0.12$, $p<0.01$) and school environment ($r=0.10$, $o<0.05$) for health status. The small difference of effect size suggests that future school-based intervention targeting positive outcomes change should consider strategies comprehensively including both health literacy and social support and school environment, rather than only focusing on student's health literacy. As previous empirical studies and systematic reviews have also shown that increasing social support and school environment contribute to both health behaviours and health literacy (195, 505, 506, 571), it would be a promising way to use a systems approach improving both students' health literacy and distal health outcomes.

In addition, the mediating effect of health literacy on different health outcomes varied in this study. Specifically, the effect size of health literacy was 0.11, 0.12, and 0.17 for health behaviours, health status, and patient-provider communication respectively. This finding is consistent with Paasche-Orlow and Wolf's caual pathway model (85), which suggests provider-patient interaction is an intermediate variable between health literacy and distal health outcomes. Given that adolescents with poor patient-provider communication are at risk of adverse health outcomes (314, 315, 572), it is important to improve their communication skills to better access to and utilise healthcare services. This study also showed that health literacy had a similar effect size for health behavours and health status. As previous empirical stuides examined the effect size of health literacy either on health behaviours (41, 146) or on health status (144, 497), this study extends our understanding of the role of adolescent health literacy in predicting both health behaviours and health status. However, this finding is partly consistently with Nutbeam's health promotion outcome model (3), which explains that health behaviours are regarded as intermediate health outcomes whereas health status is one of distal health outcomes. There should be a larger effect size of health literacy for health behaviours than that for health status. Given that the finding from this study is not generalisable due to convenience sampling, the mechanisms between health literacy, health behaviours, and health status need to be further examined in future studies.

As discussed earlier in Chapter 5.3.4.5, health literacy was only a driving factor for some health outcomes, but not others. Here I discuss students' health behaviours because they are well-established and commonly-used indicators for school-aged adolescents (474, 475). Also, health-compromising behaviours are prevalent in school-aged adolescents, such as skipping breakfast and being physically inactive (181). These health-comprising behaviours can lead to detrimental outcomes (e.g. mortality, chronic diseases) for adolescents at present and in future (180). The findings of path analysis in Beijing secondary students showed that health literacy was associated with physical activity and teeth brushing, but not with regular breakfast eating, non-smoking and non-drinking. There were probably two reasons for this. The first reason was the non-specific content of health literacy measurement. The HLAT-8 measured health literacy using general health content, rather than specific lifestyle content such as eating habits or smoking behaviours. As health literacy was a specific-content concept (5, 45), it was likely that the path from '*health literacy*' to '*breakfast eating, non-smoking, non-drinking*' was not identified when health literacy measurement was broad in its content. The second reason was that breakfast eating, cigarette smoking and alcohol drinking were more likely to be group-driven behaviours in adolescents, compared with physical exercise and teeth brushing. As shown in previous literature (511, 514, 515, 573, 574), behavioural peer influence and parental encouragement influenced the frequency of breakfast eating, the odds of smoking initiation and continuation, and the consumption of alcohol. As for these group-driven behaviours, social networks and peer influence may override students' good health literacy decisions, thus interfering with the path from health literacy to these behaviours. Therefore, the role of adolescent health literacy in predicting health behaviours is likely to be more prominent in self-driven behaviours than in group-driven behaviours. This finding could be used for interventions that aim to improve health literacy and health outcomes in adolescents. Future interventions need to consider the different roles of health literacy in predicting self-driven and group-driven behaviours.

As for the non-significant paths from health literacy to other health outcomes (i.e. health service use and health-related quality of life), there might be two reasons for them: 1) as students normally depend on their parents for using health services (168, 347, 348), measurement error may exist when students answered questions about health service use. For example, '*emergency service use, general practitioner service use, hospital service use, other health professionals' service use*' were all measured using a single item (e.g. '*how many times have you used … services in the last 12 months?*'). Although these items were piloted, some items might be still confusing for students in Years 7 to 9. Without a parent with them, students may find it difficult to distinguish '*general practitioner service use'* with '*hospital service use*'; 2) some confounding factors were not adjusted. Previous literature suggested that a population's health status was a moderator between health literacy and health-related quality of life (150-152). Therefore, without controlling for students' health status, the path from health literacy to health-related quality of life was non-significant.

In summary, there are still some gaps in our ability to explain the specific role of health literacy in predicting students' health outcomes (e.g. health behaviours). All of these gaps are summarised and transformed into new research directions in the next chapter (See Chapter 8.3.1.2: New directions for future research).

7.7 Summary of research contributions

This PhD thesis used a three-phase approach to achieve its three overarching research aims: 1) to systematically review health literacy instruments used for adolescents and to identify at least one appropriate instrument; 2) to validate the selected health literacy instrument in Chinese secondary students; and 3) to work within Manganello's health literacy framework to examine pathways from health literacy influencing factors through to health outcomes in Chinese secondary students. Based on its findings, this PhD research has made three main contributions.

7.7.1 Methodology advancement for health literacy measurement

The first contribution of this PhD research is to advance the methodology of health literacy measurement in adolescents. Specifically, the COSMIN checklist was first used in the systematic review to examine the quality of health literacy measurement studies. The systematic review in Research Phase 1 provides an overview of the rapidly emerging research interest in measuring adolescent health literacy from 2006 to 2014 and updates what is known about health literacy instruments used for adolescents. The present review identifies seven more adolescent health literacy instruments (i.e. the NVS, the MMAHL, the DNT-39, the DNT-14, the eHEALS, the HLAT-51 and the HLAT-8) than previous, similar reviews (33, 34). More importantly, this review contributes to the current understanding of health literacy instruments in relation to their measurement properties, based on a methodological quality assessment framework. Although the evidence obtained from the COSMIN checklist is limited due to a lack of information, it provides a clear recommendation for future research. It is essential to use the COSMIN checklist to ensure the quality of health literacy measurement studies in future.

Also, Pleasant's evaluation principles were first used in health literacy measurement studies in Beijing and Melbourne as part of this research. Given that multiple methods exist to measure health literacy, it is important that Pleasant's evaluation principles are shown to be useful and rigorous in standardising the field of health literacy measurement. Although some principles were found to be insufficiently specific, the experience of putting these evaluation principles into practice provides researchers with evidence and implications for future health literacy measurement studies. For example, using a conceptual framework to measure health literacy according to the particular research purpose and target population; and considering the weight of each domain when obtaining a continuous score of health literacy. With consideration given to these evaluation principles, health literacy research in future can be conducted with more rigour and clarity.

7.7.2 Practical advancement for health literacy measurement

The second contribution of this PhD research is to advance the practice of health literacy measurement in China and Australia. The validation study in Research Phase 2 demonstrated the c-HLAT-8 as a skills-based health literacy instrument for field use in Chinese school settings. Given that current health literacy measures in mainland China mainly focus on knowledge/behaviour-based assessment or the functional domain, the c-HLAT-8 has two contributions to make to future research. The first is that it can be used as a skills-based and three-domain measure of health literacy for different purposes: for the purpose of examining health literacy in a single population; for the purpose of monitoring health literacy over time; for the purpose of testing health literacy in an intervention; and for the purpose of comparing health literacy in different cultures. Its second contribution is that it can assist researchers to better understand the relationship between health literacy and health outcomes. As current evidence on the relationship between health literacy and health outcomes is mostly obtained by the measurement of functional health literacy (12, 117), the c-HLAT-8 can provide new evidence and opportunities for future researchers. For example, in exploring the different roles of functional, interactive and critical health literacy in predicting health outcomes; or in examining the relationship between health literacy, health knowledge and health behaviours.

The pilot study in one Melbourne secondary school also provides new evidence in relation to adolescents' general health literacy in school settings. About one quarter of students were found to have low health literacy, an issue requiring the attention of both schools and the education department. The finding from the pilot school extends what is known about general health literacy in Australian adolescents because previous studies focused mainly on mental health literacy. The pilot study also provides new insights into the future conduct of school-based health literacy research. These insights include: 1) the need for a shared perspective of health literacy between the pilot school and the researcher; 2) the feasibility of online data collection; and 3) the possibility of using opt-out consent. Despite the small sample size, health literacy measurement findings from the pilot study were similar to those in Beijing secondary students (i.e. the NVS result showed a higher percentage of low health literacy than the HLS result did). Given that the HLAT-8 has strengths such as three-domain structure and quick administration, it is worthy of further validation in future with larger samples in school-based studies.

7.7.3 An evidence-based framework for adolescent health literacy

The last contribution of this PhD research is to put Manganello's health literacy framework into practice. The model testing in Research Phase 3 provides new empirical evidence on four hypothesised models of health literacy in Beijing secondary students. Although health literacy models have been tested in previous studies (41, 146, 492), little is known about model testing in adolescents. Using a quantitative approach, the empirical study extends the current understanding of health literacy in adolescents in two ways. First, the model testing confirms an ecological perspective of adolescent health literacy. Students' health literacy was found to be associated with personal self-efficacy, social support and the school environment. Low health literacy was found to be an issue not only for individuals, but also for environments and systems. This suggests that a systems approach is needed to understand and respond to low health literacy in adolescents. Second, adolescent health literacy is confirmed as a mediating variable between its influencing factors and health outcomes (See **Figure 7.1**). This information can be useful in suggesting a mechanism for generating a specific health outcome, and explaining how adolescent health literacy and health outcomes can be improved in a systematic way. Promoting health literacy could be an effective and useful strategy to improve students' health behaviours, patient-provider communication and health status.

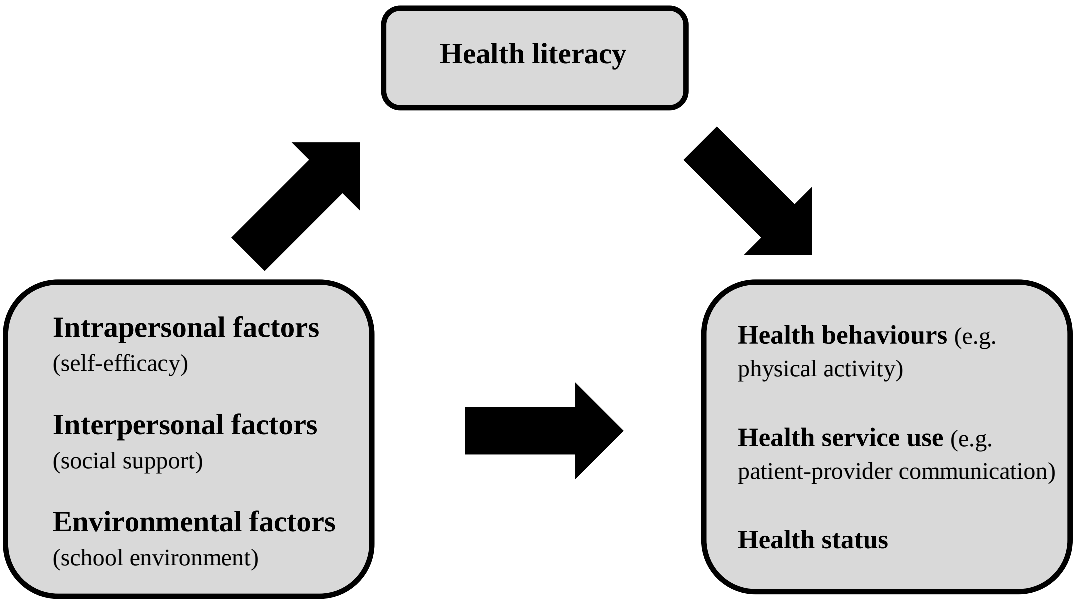

Figure 7.1 Health literacy as a mediator between its influencing factors and health outcomes for secondary students

7.8 Strengths and limitations of this PhD research

7.8.1 Strengths of this PhD research

First, this PhD research took a systematic approach to health literacy measurement, from instrument identification to validation, and validation to application in the model testing. A three-phase research design was used, ensuring that each phase was closely related to the next phase, which could explain the robustness of using the HLAT-8 as a health literacy instrument in secondary students. Compared with a single study of health literacy validation, this research provides more rigorous and convincing evidence to support the field use of the HLAT-8.

Second, the sub-study in each research phase was underpinned by a methodological framework to ensure the clarity, transparency and rigour of the study. Specifically, the Cochrane guidelines, the PRISMA statement and the COSMIN checklist were used to ensure the methodological quality and reporting quality of the systematic review in Research Phase 1. The COSMIN checklist, Pleasant's recommendations and the

STROBE statement were used to guide and report the validation study in Research Phase 2. In the model testing study of Research Phase 3, Manganello's health literacy framework was adapted and used to underpin the empirical study. In addition, the STROBE statement was used as a guide in designing and reporting the cross-sectional study.

Third, this research used three instruments (the HLAT-8, the NVS and the HLS) to measure health literacy in Beijing and Melbourne secondary students. Health literacy measurement using three instruments provides a more comprehensive understanding of health literacy in secondary students. Although the above three instruments may represent different constructs, they can assist researchers to understand students' health literacy from different perspectives.

7.8.2 Limitations of this PhD research

Limitations should be noted. First, due to convenience sampling, students in Beijing secondary schools and in the pilot school in Melbourne were not representative. This may undermine the generalisability of findings to the general population of secondary students. Beijing and Melbourne secondary students' health literacy might be higher than the general population of secondary students, because they live in metropolitan cities, which means that they have better access to education than their counterparts from disadvantaged backgrounds. Therefore, studies with representative samples are needed in future to enable generalisability of findings.

Second, the sample size was not equivalent for Beijing and Melbourne secondary students. Due to different recruitment challenges in Beijing and Melbourne secondary schools, 650 Chinese students and 120 Australian students were recruited. The sample size was too small to validate the HLAT-8 in Australian secondary schools. Therefore, there is a need for future research to validate the HLAT-8 across cultures.

Third, the HLAT-8 used in this PhD research did not include all potential components for measuring students' health literacy. The HLAT-8 measured an individual's ability to find (functional domain), understand (functional domain), communicate (interactive domain) and evaluate health information (critical domain). As proposed in the skills-based pyramid model (42) and the inclusive hierarchy model (43), there are many other components that may measure adolescent health literacy. For example, self-management ability and advocacy ability. Given that this PhD research focused on the three-domain health literacy and aimed to find an existing and appropriate instrument to measure adolescent health literacy, the HLAT-8 was considered the most suitable instrument in current research and practice. As for those overlooked components, they could be explored in future research to contribute to a better understanding of comprehensive health literacy measurement in adolescents.

Fourth, the subjective assessment of the HLAT-8 may have introduced self-report bias in Research Phase 2 and Research Phase 3. That is, students may have over-estimated their health literacy (4). However, because of the dynamic nature of health literacy, self-report health literacy is considered appropriate for directly assessing the mismatch between an individual's health skills and the demands and complexity of the broader environment (212). As this PhD research did not focus on a comparison of self-report measures and performance-based measures, the relationship between self-report and performance-based instruments could be explored in future research.

Fifth, the findings from this PhD research were based on cross-sectional data. Longitudinal studies or intervention studies are needed to further confirm the causal relationship between health literacy, its influencing factors and health outcomes in future.

Chapter 8 Implications for future research, practice and policy

8.1 Introduction

This PhD thesis sought to respond to three research questions about health literacy measurement and model testing in secondary school students. Based on its main findings, I used a knowledge translation framework to consider the implications for future research, practice and school health policies.

8.2 Knowledge translation framework

Knowledge translation is defined by the Canadian Institutes of Health Research as the '*exchange, synthesis and ethically sound application of research findings within a complex set of interactions among researchers and knowledge users*' (575). The knowledge translation strategy is a commonly-used method to increase the use of evidence within policy and practice decision-making contexts (576). Translating best available research evidence into evidence-based practice and policy is a complex process which confronts multiple barriers at individual, organisational and political levels (577-579). In the field of public health, there is a well-known gap between research and practice (580-582), including in the sub-fields of school health (233, 583) and health literacy (238). In this chapter, I adapted Wandersman's Interactive Systems Framework (ISF) to identify how best to apply the findings of this thesis to bridge the gap between health literacy research, practice and relevant policies (584).

The ISF was proposed by Wandersman *et al.* (584) in 2008 to generate ideas when considering dissemination of research and planning its implementation. Briefly, the ISF consists of three systems that have been identified as important when considering implementation (See **Figure 8.1**). As explained by the authors (584), the term '*system*' here is used broadly to describe '*a set of activities that may vary in the degree to which they are systematic or coherently organised*'. The first system is the Prevention Synthesis and Translation System which involves the synthesis of existing research information on innovations (i.e. programs, principles, processes and policies) and translation of the information into user-friendly products for implementation. The second system is the Prevention Support System, which is needed to support the work of those who will put the innovations into practice. This system focuses on capacity building via either general support or innovation-specific support. The term '*capacity*' here refers to the skills and motivation necessary to implement innovations (580). The third system is the Prevention Delivery System, which is where the implementation of innovations in the field occurs (or is considered). This system focuses on either general capacity use or innovation-specific capacity use. In summary, the three systems interact with each other and contribute to the dissemination and implementation of innovations (584). The ISF was chosen in this discussion because it provided a conceptual and practical way to guide thinking on dissemination and implementation issues at individual, organisation and system levels (581). Also, the ISF is aligned with the finding of this PhD research which identifies low health literacy as a composite outcome influenced by both individual and environmental factors. Addressing low health literacy requires a complex approach to implementation. In addition, given that the ISF has been used as a successful guide for prevention strategies in adolescent reproductive health (585, 586), it was used in this chapter.

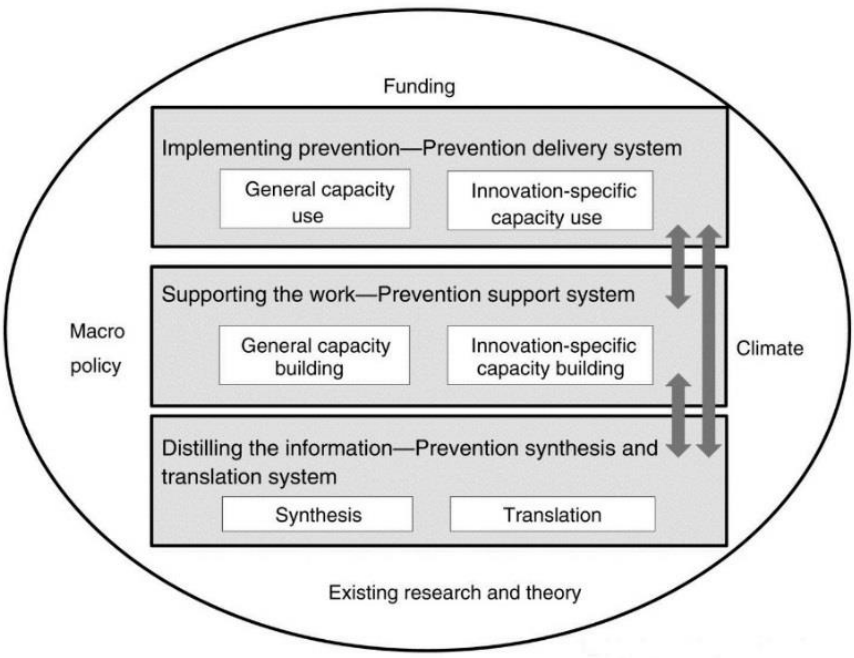

Figure 8.1: The Interactive Systems Framework proposed by Wandersman *et al.* (584)

Although the original ISF includes elements of the broader context such as macro policy and funding, it does not fully address dissemination and implementation activities at the policy level. As seen in **Figure 8.2**, I adapted the ISF by adding the component '*policy*'. This adaptation was made based on the Child and Adolescent Health Logic Framework (587) which highlighted the importance of research information to both school health practice and policies. '*Innovations*', as discussed in this PhD research, refer to school-based health literacy promotion programs and curricula, health literacy evaluation tools, and other practices related to implementing effective programs, that is, programs that contribute to developing students' health literacy.

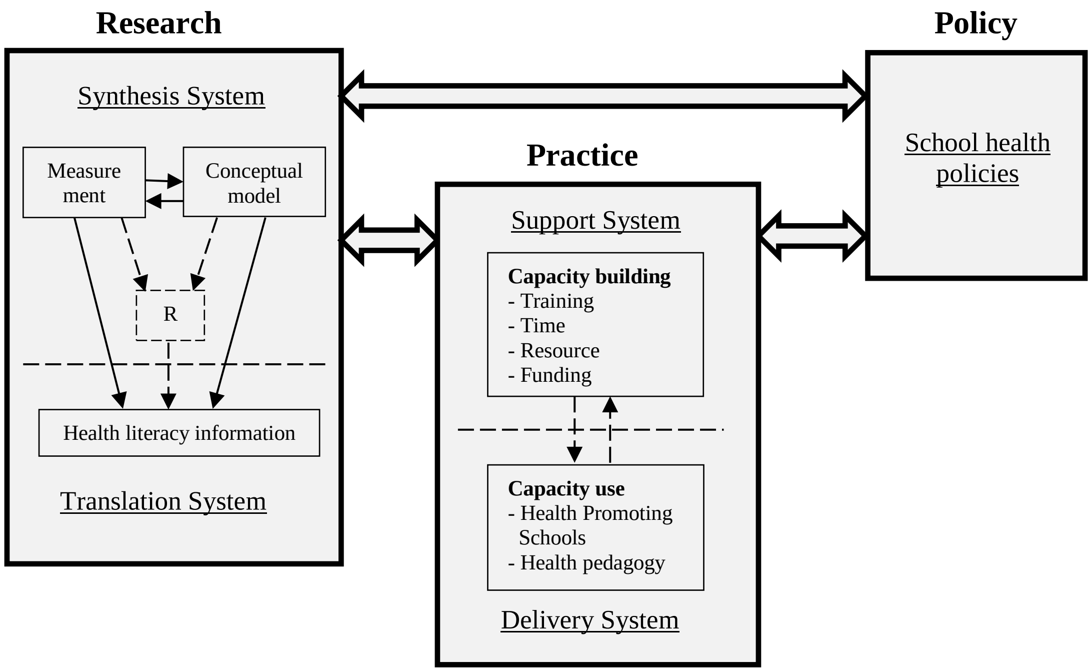

Figure 8.2: Knowledge translation framework for health literacy research, practice and policy
(Note: R=Recommendations and new directions for future research.)

8.3 Implications for research

The first section of the final adapted knowledge translation framework involves the synthesis and translation system which aims to generate implications for health literacy research. There are three sub-sections in this section. First, I will explain the synthesis system, which is the research work that has been done in this PhD thesis. Based on the synthesis results, I will give a summary of recommendations and new directions for future research. Second, I will introduce the translation system, which works to translate research information into user-friendly products for end-users. Third, I will briefly outline the relationships between the synthesis system and the translation system.

8.3.1 The synthesis system

The synthesis system is used to synthesise and distil research information (584). There are two parts to the research work that has been carried out in this PhD research: health literacy measurement and health literacy conceptual model testing.

In relation to health literacy measurement, the HLAT-8 was identified as the most appropriate instrument to measure health literacy in secondary students via conducting a systematic review in Research Phase 1. The findings of the systematic review indicate a large gap in the methodological issues associated with health literacy measurement in adolescents. Recommendations are made to enhance the methodological quality of health literacy measurement studies. With regard to health literacy conceptual model testing, Manganello's health literacy framework was identified as the most suitable model underpinning this PhD research after conducting a literature review. Manganello's health literacy framework was tested and supported by empirical data collected from Beijing secondary students in Research Phase 3. The findings of health literacy model testing also generated new ideas about how to better understand the role of health literacy in adolescent health. These research outputs and new ideas were transformed into the following recommendations and new directions for future research (See **Figure 8.3**).

Recommendations for HLM in adolescents	New directions for HLM in adolescents	New directions for HLMT in adolescents
1. Apply the COSMIN checklist 2. Adopt Pleasant's evaluation principles 3. Adopt Nutbeam's three-domain model	1. Develop specific health literacy instruments 2. Evaluate the impact of different forms of administration 3. Evaluate the weight for each health literacy domain 4. Examine the HLAT-8 in other cultural settings	1. Examine Manganello's health literacy framework in other cultural settings 2. Examine health literacy with specific health content 3. Explore health literacy domains 4. Examine relationships between health literacy and other important variables

Figure 8.3: Recommendations and new directions for future research

(Note: HLM, Health Literacy Measurement; HLMT, Health Literacy Model Testing)

8.3.1.1 Recommendations for future research

The findings from Research Phase 1 and Research Phase 2 have led to **<u>three recommendations for future research on health literacy measurement in adolescents</u>**. As for each recommendation, I will summarise the rationale for each recommendation below.

1. **<u>Recommendation 1: Apply the COSMIN checklist to ensure the quality of health literacy measurement studies for adolescents</u>**

   Rationale: The COSMIN checklist is a generic toolkit for field use in measurement studies. It aims to standardise the selection of the most appropriate instrument and its reporting (362). The systematic review in Research Phase 1 suggests that the quality of health literacy measurement studies needs to be improved, because the methodological quality of the 15 included studies was either unknown or varied from poor to excellent. Using the validation study in

Research Phase 2 as an example, the COSMIN checklist was shown to be a useful guide for ensuring the methodological and reporting quality of health literacy measurement studies.

2. **<u>Recommendation 2: Adopt Pleasant's evaluation principles to advance health literacy measurement for adolescents</u>**

Rationale: Pleasant *et al.* (28) proposed seven evaluation principles for building a comprehensive and robust approach to health literacy measurement. The systematic review in Research Phase 1 suggests that health literacy measurement requires a more consistent set of evaluation principles because, in current research and practice, multiple methods exist to measure adolescent health literacy. As shown in the validation study in Research Phase 2, Pleasant's evaluation principles were useful to guide the study design. Therefore, Pleasant's evaluation principles can be used to reduce the inconsistencies in health literacy measurement in future research.

3. **<u>Recommendation 3: Adopt Nutbeam's three-domain model to measure health literacy for adolescents</u>**

Rationale: Nutbeam's three-domain model is a widely-used framework to measure health literacy from a health promotion perspective (3). Health literacy in adolescents represents more than being able to read and write (functional health literacy); it includes interpersonal skills (interactive health literacy) and critical evaluation skills (critical health literacy). Integrating interactive and critical domains into health literacy measurement is aligned with the rationale for emphasising empowerment in health promotion (19, 167). However, the systematic review in Research Phase 1 suggests that health literacy measurement for adolescents mainly focuses on the functional domain, rather than three domains. Take the HLAT-8 as an example, Beijing secondary students in the validation study and Melbourne secondary students in the pilot study were questioned about their health literacy levels from a three-domain perspective. The HLAT-8 was thus shown to be a useful instrument to capture the three-domain nature of students' health literacy.

8.3.1.2 New directions for future research

New ideas and directions for future research are also generated in this PhD research. First, I will outline **four directions for future research in relation to health literacy measurement in adolescents**. These directions have been generated in accordance with Forrest's '*4D*' model and Pleasant's evaluation principles, as well as being based on the findings from this PhD research. Second, I will summarise another **four directions for future research about health literacy model testing in adolescents** based on Manganello's health literacy framework and research findings in this thesis. The rationale for each research direction is briefly explained as follows.

Four directions for future research about health literacy measurement in adolescents:

1. **Development of specific health literacy instruments for adolescents**

   Rationale: As explained in Chapter 2.3.1, Forrest's '*4D*' model (162, 163) is a useful framework to elaborate the unique characteristics of adolescent health literacy research. The systematic review in Research Phase 1 found that while '*3D*' (developmental change, dependency and demographic patterns) was considered in the 15 included studies, there were few health literacy measurement studies which considered '*differential epidemiology*' in adolescents. As argued by Rothman *et al.* (162), adolescents experience a unique pattern of health, illness and disability that is different from adults. For example, early timing of chronic disease occurrence may have a greater impact on developing health literacy skills than late timing. The timing of disease occurrence and the impact of disease development should be considered when measuring health literacy in adolescents with chronic diseases. In the systematic review of Research Phase 1, only one included study focused on health literacy measurement in adolescents with chronic diseases (type 1 diabetes) (401). Given that chronic conditions are steadily rising in prevalence and are a predominant cause of burden of disease in adolescents (21), more attention needs to be given to adolescents with chronic conditions. As suggested by Pleasant (193), effective chronic disease prevention and self-management both require people with adequate health literacy skills to carry out self-care plans and make informed decisions related to health-promoting behaviour changes.

As an initial step, health literacy assessment can be used to improve health service planning and public health education (238). Given that health literacy is a specific-content-and-context concept (5, 45), health literacy assessment will vary with each chronic disease. There is a need developing specific health literacy instruments for adolescents with different chronic diseases in future.

2. **Evaluation of the impact of different forms of administration**

Rationale: The second evaluation principle proposed by Pleasant *et al.* (28) is to consider multi-dimensionality in methodology for health literacy measurement. McCormack *et al*. (35) also recommended using multiple modalities as a robust method of collecting data (e.g. web-based, paper-based) and for examining whether analysis results are replicated. Although two forms of administration (online and paper-and-pencil surveys) were used to measure students' health literacy in this PhD research, online data were only available in Australian samples and paper-based data only available in Chinese samples. Therefore, this PhD research cannot compare the impact of data collection modes in a single population. To enhance the rigour of methodological quality and enable meaningful comparison of health literacy results, measurement equivalence needs to be established across two forms of administration for health literacy instruments. As shown in the previous literature, some researchers concluded that online and paper-and-pencil methods were mostly equivalent (588-590), whereas others found they were not equivalent in terms of psychometric properties (591), response rates (592) and missing data (593). In the field of health literacy, few studies have evaluated the impact of different administration modes for health literacy instruments. Given that low health literacy may be embarrassing for individuals (125), respondents are more likely to report authentically on their health literacy levels if their privacy and confidentiality are protected. From this perspective, the online administration may well increase the honesty of participant responses when they are responding to sensitive questions (592). To confirm whether measurement equivalence exists, future research needs to evaluate the effects of the two administration modes in terms of their response rates, missing data, completion time, as well as instruments' validity and reliability.

3. **Evaluation of the weight for each health literacy domain**

   Rationale: Pleasant's third evaluation principle refers to measuring health literacy on a continuous basis (28). However, the means of obtaining an accurate score for health literacy is still unclear. This PhD research treated each domain of Nutbeam's three-domain health literacy as having equal weight. This scoring rationale was obtained from earlier, similar studies (303, 566). However, in order to establish a more scientific scoring system, there is a need for future researchers to explore the degree to which each domain contributes to the overall health literacy score. Both quantitative and qualitative methods can be considered. For example, the weight of each domain can be analysed using regression equations by identifying each domain's variance (594) or using confirmatory factor analysis by displaying the variance of each component (595). Also, Delphi consultation with experts might be used to estimate a subjective weight for each domain of adolescent health literacy (360). Establishing such a specific scoring system will assist researchers to better understand the role of each domain and further advance the field of adolescent health literacy.

4. **Examination of the HLAT-8 in other cultural settings**

   Rationale: Pleasant's sixth evaluation principle refers to allowing health literacy comparison across different cultures (28). Given that the HLAT-8 was only validated in Chinese secondary students, there is a need to further assess its validity and reliability in other cultural settings and populations.

Four directions for future research in relation to health literacy model testing in adolescents:

1. **Examination of Manganello's health literacy framework in other cultural settings**

   Rationale: This PhD research conducted health literacy measurement in two cultural settings (i.e. four Beijing secondary schools and one Melbourne secondary school), but the model testing was only conducted among Beijing secondary school students. Due to a small sample size of students in the pilot school in Melbourne, it was not possible to examine Manganello's health literacy framework in Australian secondary school contexts. There is a need to test the generalisability of the findings from Beijing secondary schools in other cultural settings.

2. **Examination of adolescent health literacy with specific health content**

Rationale: The findings from Research Phase 3 showed that health literacy was only associated with some specific health behaviours, such as physical activity, but not with others, such as breakfast eating. One explanation for this finding is probably the specific-content nature of health literacy. Health literacy is a concept that requires a specific content in a health context (5, 45). This PhD research used a general health literacy instrument with generally-worded questions about student's health skills in everyday life, rather than a specific health literacy instrument focusing on a specific health content. Therefore, it was possible to identify positive relationships with some types of health behaviours, but not with others. Although it is necessary to use general health literacy instruments to test general health skills, the sensitivity of these types of instruments may be too low for measuring health skills in a particular health context. As shown in the database of '*Health literacy tool shed*' (https://healthliteracy.bu.edu/), health literacy instruments are needed in both general health contexts and specific health contexts (e.g. smoking or dental health). Developing a health literacy instrument focusing on specific content can improve its sensitivity. Given that mental health literacy has become a separate research field from general health literacy (426, 596), there is room to consider other types of health literacy separately, in particular the specific-content nature of health literacy for adolescents.

3. **Exploration of health literacy domains for adolescents**

Rationale: This PhD research did not explore the determinants and impacts of each domain of health literacy (functional, interactive and critical) in adolescents. As explained by Nutbeam (3, 71), functional health literacy assists people to communicate with diverse information in everyday life. Interactive health literacy allows people to develop personal skills to promote and maintain good health, and critical health literacy empowers individuals and communities to take action to change health determinants for better health outcomes. In practice, however, there is little evidence available on the determinants and impacts of each domain of health literacy in adolescents. For example, which of its antecedents are more important to functional health literacy? Which influencing factor plays a key role in developing interactive health literacy? Does critical health literacy contribute more than functional health literacy to health behaviours in adolescents? Understanding the determinants and impacts of each domain of health literacy is important to assist researchers in designing effective health literacy intervention programs for adolescents. Further research is needed to fill this gap in future.

4. **Examination of relationships between adolescent health literacy and other important variables (peer influence, self-efficacy, HRQOL)**

a) Relationship between adolescent health literacy and peer influence

Rationale: The findings from Research Phase 3 suggest non-statistically significant relationships between health literacy and group-driven health behaviours (cigarette smoking, alcohol drinking and breakfast eating). One probable reason is that peer influence overrides students' health literacy skills, even when they know that smoking, drinking and skipping breakfast are health-compromising. Due to the complexity of measurement within Manganello's health literacy framework (16), this PhD research only included variables of interest based on its research aims and priorities, ignoring confounders such as peer influence. Given that peer influence plays an important role in adolescents' everyday health (511, 514, 515, 573), the relationship between peer influence and health literacy and its impact on students' health behaviours is worthy of exploration in future.

b) Relationship between adolescent health literacy and self-efficacy

Rationale: Given that this PhD research only collected cross-sectional data for path analysis, the path from self-efficacy to health literacy needs to be examined in longitudinal studies. As self-efficacy and health literacy (3, 425) are overlapping constructs, concept analysis (210) may be a useful way to clarify meanings and reduce ambiguity between self-efficacy and health literacy in adolescents.

c) Relationship between adolescent health literacy and health-related quality of life (HRQOL)

Rationale: This PhD research did not find positive evidence of a path from health literacy to HRQOL in adolescents. Given that previous literature suggested that the path existed in populations with chronic diseases (150, 151, 492, 493), a population's disease characteristics is probably a moderator between health literacy and HRQOL. The relationship between health literacy and HRQOL in adolescents with chronic diseases needs to be further explored.

8.3.2 The translation system

The role of the translation system is to make research information on health literacy programs accessible to end users (e.g. school nurses, principals and health education teachers) (584). The translation process is an essential step that can provide '*so what*' and '*how to*' insights for both researchers and school health staff (597), thus making the research findings more useful. The end users in this PhD research include students, school health education teachers, school nurses, school principals, parents, community members, as well as school health policy-makers. As suggested in the Health Promoting Schools (HPS) framework (42), there is a need to develop health literacy via a multi-sectoral collaboration between schools, families, communities and governments (115).

For this PhD research, school representatives were involved during the translation process to ensure the final school report was useful and relevant to school health education teachers. The final health literacy information derived from the research findings included the following:

- Health literacy is important to students' health because it can empower students to make healthy choices in everyday life.
- Health literacy can be developed by increasing individual health skills and providing supportive environments.
- Health literacy can be used as a measurable outcome to school health education. Health literacy results can be used to design the school health curriculum.

Further details of the final health literacy information offered are presented in the translation products. In this PhD research, there were two translation products. One was a school report written in plain language (**Appendix 6.10**: Report to the pilot school). The other was a final research project report prepared for the Department of Education and Training (**Appendix 6.11**: Report to the Department of Education and Training). After sending the school report, I received positive feedback from one school health education teacher who emphasised that '*health literacy will be a big part of (health curriculum) planning focus*'. Therefore, the school report may prove useful to school health education teachers in designing health curricula to promote student health. The findings from the pilot school suggested several ways to improve students' health literacy. For example, enhancing students' interest in discussing health topics; increasing students' interpersonal communication skills; and creating a supportive school environment. However, the final health literacy information was only prepared for school representatives and government policy-makers, not for parents, school nurses and students themselves. Given that this PhD research mainly focused on the research level in the synthesis system, **there is a need for more investment in the translation system to make health literacy information more user-friendly and useful for end-users in practice**.

8.3.3 Relationship between the synthesis system and the translation system

The synthesis system has three components: health literacy measurement; health literacy conceptual model; and recommendations & new directions for future research. The translation system has a single component, which is health literacy information. The relationships between these four components are discussed below.

Health literacy measurement and the conceptual model interact with each other. On the one hand, the synthesis of health literacy measurement research can provide reliable and valid instruments for measuring the health literacy construct in the conceptual model, while, on the other hand, findings from health literacy conceptual model testing can assist researchers to better understand the health literacy construct and how it relates to other variables. Both health literacy measurement research and model testing research can produce evidence-based and user-friendly health literacy information for end-users. Also, health literacy measurement research and model testing research can produce ideas for future research (i.e. recommendations and new directions for future research). Once these recommendations are adopted and new directions explored in future, their findings can again contribute to new, user-friendly health literacy information for end-users. In this way, health literacy measurement research and conceptual model empirical research can contribute to health literacy information directly and indirectly.

Box 8.1: Key messages about implications for future research

Implications for future research include:

- Recommendations are needed to enhance the methodological quality of health literacy measurement studies for adolescents in future (i.e. applying the COSMIN checklist, adopting Pleasant's evaluation principles, and using Nutbeam's three-domain health literacy model).
- New directions for future research are generated in terms of health literacy measurement and model testing for adolescents based on previous frameworks and the main findings from this PhD research.
- There is a need for more investment in the translation system to make health literacy information more user-friendly and useful in practice.

8.4 Implications for practice

The second section of the final adapted knowledge translation framework aims to provide implications for practice. This section has three sub-sections: 1) the support system; 2) the delivery system; and 3) the relationships between the support system and the delivery system. Although this PhD research was not a health literacy intervention study, the findings confirmed the necessity of using the Health Promoting Schools (HPS) framework to implement health literacy programs. As this PhD research targeted adolescents in school settings, I have discussed school practice that is related to improving students' health literacy.

8.4.1 The support system

The support system is needed to assist those who work to improve students' health literacy in school settings. People who work in the field are not only school health education teachers, but also school nurses, school principals, parents, community members and government staff. Here I discuss the role of school health education (SHE) teachers as an example, because they are still the main implementers of HPS programs designed to promote students' health literacy. This does not mean that other agents (e.g. school nurses, parents, principals) are less important implementers. As to capacity building (i.e. skills and motivation to implement health literacy programs) for SHE teachers, **a range of barriers preclude them implementing health literacy programs**. As summarised by St Leger (79) in a journal article '*Schools, health literacy and public health: possibilities and challenges*', barriers include: 1) lack of ongoing and effective professional development for SHE teachers; 2) limited resources for SHE teachers; 3) limited time for school health education; 4) lack of funding for HPS programs; and 5) lack of a skills-based health education approach.

In China, school health education has been delivered through a range of curricula (e.g. physical education, science, history) in primary and secondary schools since the 1990s (274). Although HPS programs were introduced in China in 1995 (524), multiple barriers still exist, thus leading to a lack of support and resources for SHE teachers. Some barriers arise from local culture and education systems. For example, the time available for school health education is limited due to the academic focus in the school culture (598). The knowledge-based and didactic approach to school health education, as opposed to the skills-based approach (599), is still mainstream (600). Other barriers arise from the implementation process of HPS programs. School health policies, school-based health service resources and teachers' professional training are always lacking (523, 525, 601, 602). All these barriers make it difficult for SHE teachers to promote students' health literacy in practice.

In Australia, the HPS framework was recommended by the National Health and Medical Research Council in 1996 (603). Although schools have adopted a student-centred and skills-based health education approach, many barriers still exist (604), thus inhibiting the widespread use of the HPS framework. These barriers include lack of understanding of the HPS concept and its importance (605), lack of professional preparation for SHE teachers (606), lack of reliable and valid testing instruments (607), lack of administrative support (608) and limited funding from governments (198). Therefore, support is needed from both organisational and political levels to assist SHE teachers to implement HPS programs.

Within the support system, here I discuss more on the resources that are needed for SHE teachers, especially the health literacy evaluation toolkit. This is because health literacy is a key measurable outcome to school health education (3, 45, 79). Although improving health literacy is regarded as a goal of school health education in both China and Australia (275, 321), there have been no health literacy evaluation toolkits developed for school use. Without health literacy evaluation, SHE teachers are unaware of whether current school health programs are effective. The lack of such toolkits can hinder SHE teachers' capacity to use health curricula to most effectively improve students' health literacy. As exemplified by the West Virginia Department of Education in the USA (219), the school health education assessment project was a successful demonstration of the importance of health literacy evaluation in designing professional development training for SHE teachers. Given that school health education assessment can provide evidence of students' health literacy, there is a need to establish a similar monitoring system in China and Australia. Establishing such a system involves a trans-disciplinary approach and a multi-sectoral collaboration process. Although it is time-consuming and costly to establish state or national surveillance systems to measure and monitor students' health literacy, the rewards and benefits from such monitoring systems are far-reaching and massive. As demonstrated in the health education assessment project in the USA (215), state education agencies and schools can use health education assessment resources to better foster students' health literacy. Further information about these resources can be obtained from the following website: http://heaphealthliteracy.com/about.html. More importantly, health literacy data collected by such surveillance systems can be combined with information available on national education and health surveys, thus helping policy-makers understand the impact of health literacy on students' educational and health outcomes.

8.4.2 The delivery system

The delivery system is where the implementation of programs to improve students' health literacy occurs in practice. This system also needs a multi-sectoral collaboration between schools, families and communities. All these agents use their capacities to carry out such programs. Based on the main findings from this PhD research, two specific strategies that schools and SHE teachers can employ to promote students' health literacy are discussed below.

8.4.2.1 Health promoting schools (HPS) programs

The findings from this PhD research show low health literacy as a common problem for secondary students in Beijing (29.0%-45.5%) and Melbourne (23.7%-32.2%). However, of note is that the prevalence of low health literacy is likely to have been underestimated due to participants' high socio-economic status. Therefore, it is vital to promote health literacy at school. The findings from this PhD research also show that students' health literacy is related to a range of ecological factors, including self-efficacy, social support and the school environment. Low health literacy is an issue for individuals, schools and systems. This finding further **confirms developing students' health literacy using the Health Promoting Schools (HPS) framework**. Only in a holistic way can interventions be effective to improve students' health literacy and health outcomes. Although HPS programs have been demonstrated to be successful in improving students' health literacy (42, 195, 198, 199), the lack of long-term funding challenges the sustainability of these programs (234). A further constraint is that evidence based on the use of HPS framework is still lacking. For example, little is known about improving students' health literacy beyond health education classes (48), creating supportive school environments (609), encouraging community participation

(522), or building partnerships with school nurses (610). The 2016 Lancet report on adolescent health and wellbeing has shown that current school-based health programs and interventions are limited to the provision of health education (21). As recommended by the WHO (10), a systems approach (the Ophelia approach) involves the collaboration of a wide range of community members, community leaders and workers to develop health literacy interventions that are based on needs identified within a community. In school settings, the HPS framework is in keeping with the Ophelia approach (97) which calls for a multi-sectoral collaboration and a participatory engagement strategy to effectively identify and address health literacy needs of students, parents, teachers and education sectors. In keeping with this approach, legislation might be introduced to ensure that health literacy is an integral element of teacher training and school curricula (115). The family-school partnerships also need to be considered to aid health literacy implementation (611). A '*healthy school award*' system could be introduced to encourage the sustaining of HPS programs, the changing of health policies and shifts in organisational practice (231, 234, 522). Given that evidence-based practice is still lacking based on the HPS and the Ophelia approach to improving students' health literacy, there is a need for further evidence to examine the responsiveness and effectiveness of the systems approach to improving adolescent health literacy in future.

In China, HPS programs have been launched in more than 300 primary and middle schools in different provinces since 1996 (523, 612-617). Based on this framework, a number of positive changes have been achieved, for example, input to the health curriculum, changes to the school's physical and social environment, and engagement with families or communities (229, 618, 619). HPS programs consider a whole-school approach, involving participatory decision-making between schools, families and communities (620), thus enabling students to better improve health literacy from an ecological perspective. The finding from this PhD research suggests more involvement is needed for Chinese adolescents to improve their social support from parents and peers and to create a supportive school environment. More importantly, health literacy should be included as an effective indicator not only at the individual level, but also at the school level. As recommended by McCormack *et al.* (35), health literacy should be measured at four levels (i.e. the individual level, intervention group level, healthcare system level and population level). Population level monitoring students' health literacy would assist government policy-makers to make informed decisions about school health education and promotion.

Despite the substantial achievement of HPS programs in China, several barriers remain challenging to better improve students' health literacy: 1) due to the fierce academic pressure in Chinese schools (618, 621), the implementation of school health education through health curricula (one important component of HPS programs) has different constraints like limited class time and inadequate teaching resources. For example, although school health education in China has been delivered through a range of curricula (e.g. physical education) since the 1990s (274), only 6-7 classes (i.e. 40 minutes) in one semester are required for primary and secondary students (275). In some resource-poor and rural areas, the health curriculum is not even implemented at school due to lack of teaching materials and qualified teachers (621). To address this issue, the legislation regarding school health education needs to be updated to ensure students to have adequate class time and resources, thus improving their health literacy through school-based curricula. 2) the skill-based health curriculum is still lacking in Chinese HPS programs. Traditionally, the Chinese educational system expects students to be passive and not to question their teachers (523). This top-down and cramming pedagogical approach focuses on communition of health knowledge (i.e. functional health literacy), rather than developing health skills and empowering students to consider how to take actions to improve their health. Therefore, participatory teaching and learning strategies and a bottom-up approach need to be used to modify the paradigm of health curricular at school in China. 3) the effective evaluation system of HPS programs in China are not well-established. Given that funding and resources are not balanced across the country, current HPS evaluation system mainly targets for schools in urban areas (614). For example, schools in rural areas are less likely to meet HPS infrastructure criteria than those in urban areas (622). Adaptation to local resources is needed to be considered for the implementation and evaluation of HPS programs. 4) the sustainability of HPS programs mainly depends on the financial support from governments (526). Due to lack of project funding, only short-term effectiveness (e.g. improved health knowledge, health skills) of HPS programs are observed. This is not aligned with the philosophy behind HPS programs which state that long-term benefits will only follow if HPS programs sustain (623). As suggested by Lee *et al.* (234), one possible solution is to treat the HPS model as a new schooling paradigm, rather than an add-on program. The education government should increase funding support to examine the effect of HPS programs on health literacy outcomes. With more evidence from effective HPS programs, funding is more likely to be sustainable and the importance of HPS programs is more likely to be obtained from the public society including governments, schools and parents.

8.4.2.2 Health pedagogy

This PhD research also has **implications for students' learning and health curriculum development**. Health literacy in this study is defined as a skills-based concept which consists of three domains: functional (i.e. finding and understanding health information); interactive (i.e. communicating health information) and critical (i.e. evaluating health information). These health skills are aligned with Anderson and Krathwohl's learning model (See **Figure 8.4**) (216). Students' learning competencies include six components in a hierarchical order: remembering, understanding, applying, analysing, evaluating and creating. These learning competencies are actually the detailed components and signposts of health literacy (565). As exemplified by Paakkari *et al.* (43), students' health literacy can be acquired through particular kinds of learning conditions such as memorising important concepts of health, practising skills to resist smoking, and evaluating the reliability of health-related information. Therefore, health literacy can be seen as a learning outcome that puts Anderson and Krathwohl's learning model into practice, particularly in the school-based health curriculum.

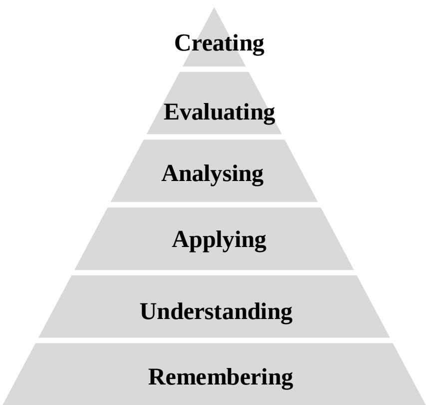

Figure 8.4: Anderson and Krathwohl's learning model

In terms of curriculum development, a three-domain health literacy measurement can provide school teachers with a more specific direction for curriculum design. For example, the findings from the validation study in Research Phase 2 showed that 57.1%-66.4% of Beijing secondary students considered that they understood health information (functional health literacy) well or very well, whereas only 38.8% of students often or always got information and advice from others when they encountered health issues (interactive health literacy), suggesting that curriculum design should focus more on developing interactive health literacy than functional health literacy in students. Using the three-domain health literacy measurement, teachers can identify the strengths and limitations of students' health literacy from different domains, thus contributing to a more effective and balanced health curriculum design at school. Therefore, from a health pedagogy perspective, low health literacy is a problem that can be improved and prevented in future through the use of appropriate health curricula in schools.

From a pedagogical perspective, this study suggests improving health literacy in school-based health curricula in China should not only focus on functional health literacy (i.e. basic skills in reading and writing health information), but also interactive and critical health literacy which need advanced health skills. As explained by Nutbeam (3), each domain of health literacy has a different educational goal: health education mainly involves the communication of health information for improving functional health literacy. As to enhancing interactive health literacy, the development of personal skills should be the main focus. And a personal and community empowerment approach is needed to promote students' critical health literacy. Given that school health education in China has been characterised by top-down methods which only target improving functional health literacy (624), a bottom-up approach is needed to impove both interactive and critical health literacy. Also, as recommended by Hu (600), making well-informed pedagogical choices should be grounded in an understanding of socio-cultural influences in China. In China, curriculum reform including the health curriculum has been conducted since the 1990s (625). However, Chinese curriculum reform for the 21st century may not unfold completely as the government expects mainly due to the socio-culutural influences (599, 626). In many areas in China, students' academic performance remains a major consideration in the educational system (627). Therefore, the education system puts more emphasis on academic examination and academic stress, with only 6-7 classes (i.e. 40 minutes) for school health education in one semester (275). In addition, the Chinese culture of learning is characterised by the transmission of knowledge principally through an imitative and repetitive learning process and teacher-dominated teaching process (600). Therefore, the institutional change is needed for the Chinese educational system. Since March in 2013, the ministry of education in China has called actions to reduce study load and improve quality education in primary and middle schools across China (626, 628). Given that this new effort is still underway, the effect remains unknown about the institutional change.

8.4.3 Relationships between the support system and the delivery system

The support system is closely linked to the delivery system when health literacy programs are conducted in practice. For example, the support system can assist SHE teachers to better use their capacities to implement health literacy programs. Similarly, the delivery system can assist SHE teachers to identify the capacities that need to be built. The interaction between the support system and the delivery system can assist SHE teachers, school principals, school nurses, parents, community members and policy-makers in understanding how technical assistance and resources should be provided by matching the capacity of the support system and the delivery system.

Box 8.2: Key messages about implications for practice

Implications for practice include:

- This PhD research confirms the necessity of using the Health Promoting Schools (HPS) framework to improve students' health literacy.
- To support those who work to improve students' health literacy by using HPS programs, a range of barriers need to be tackled, barriers such as lack of professional training for school health education teachers, limited time and resources, and lack of funding from governments.
- This PhD research also suggests strategies for developing school-based health curricula that aim to improve students' health literacy.

8.5 Implications for school health policies

The last section of the knowledge translation framework is to provide implications for school health policies. As is well known, policy making and change are complex processes (629). Research evidence is only one factor influencing decision-making. Given that health literacy is an important concept that relates to school health education (42, 46, 79), two specific documents from China and Australia concerning school health education are discussed.

8.5.1 The Chinese Primary and Secondary School Health Education Guideline

In China, the earliest government document relating to adolescent health literacy was the Chinese Primary and Secondary School Health Education Guideline (CPSSHEG) (275) that was issued by the department of education in 2008. The CPSSHEG was developed to promote the development of school health education in primary and secondary schools. Improving students' health literacy was clearly specified as a goal of school health education.

Similar to its conceptualisation in the health literacy construct in another government document entitled '*Basic Knowledge and Skills of People's Health Literacy (BKSPHL)*' (49), health literacy in the CPSSHEG is conceptualised as having three domains: conceptual knowledge and attitudes (71 items), behaviour and lifestyles (48 items) and health-related skills (40 items) (275). It should be noted that health-related skills only account for 25% of the total items in the CPSSHEG. Due to the impact of this political document, health literacy research in China mainly focuses on health knowledge and behaviours, rather than health skills. The systematic review of Research Phase 1 suggests that health literacy is a skills-based concept rather than a knowledge-based or behaviour-based concept in adolescents. Policy-makers in China need to **recognise and highlight the importance of health-related skills for students, and to update the CPSSHEG** for future use.

Also, **a specific strategy is needed to better improve adolescent health literacy at school**. Currently, the CPSSHEG only specifies the health content of the curriculum, ignoring other important considerations in health literacy development in schools such as effective teaching methods (e.g. skills-based and student-centric approaches), connections with families and communities, and creating supportive school environments. Broader information is needed in the CPSSHEG to guide and support the implementation of school health programs to more effectively promote students' health literacy. There is still a long way to go in providing government policy-makers with evidence-based and user-friendly information on students' health literacy within Chinese culture prior to any such informed change in policies occurring.

8.5.2 The Australian Curriculum: Health and Physical Education

In Australia, health literacy is explicitly included in the rationale and aims of the Australian Curriculum: Health and Physical Education (ACHPE, version 8.3) (321) which was updated from the previous version 7.5 by the Australian Curriculum, Assessment and Reporting Authority (ACARA) in 2015. Health literacy is conceptualised as having a set of skills to access, understand and use health information and services in everyday life (321). The ACHPE aims to develop students' health literacy in terms of three domains: functional, interactive and critical.

Although health literacy is explained as a skills-based concept in the ACHPE, there is little empirical evidence from school-based studies to support this contention. There may be two underlying reasons. First, there have been few evaluation tools available to examine the status of students' health literacy and the effectiveness of the ACHPE. Second, health literacy is still mainly researched in the healthcare context in accordance with the National Statement on Health Literacy in Australia (13). In summary, current adolescent health literacy research is not keeping up with the need of related policies. **There is a strong need to move health literacy from the policy level to practice, in particular, developing appropriate health literacy instruments used for adolescents**.

This PhD research provides an opportunity to understand students' health literacy in one Melbourne secondary school. Health literacy in this study is defined as a skills-based concept within three domains, which is aligned with the rationale of the ACHPE. My experience of working with the pilot school indicates that relevant organisations and health educators are supportive of health literacy research at school. For example, the ethics committee of the department of education and training supported and gave consent for this research; the principal and school representatives of the pilot school in Melbourne had an interest in learning about students' health literacy; and school health education teachers gave positive feedback. All of this suggests that empirical evidence on health literacy is needed from school-based studies in Australia to assist school teachers and policy-makers in understanding the status of students' health literacy and evaluating the effectiveness of the ACHPE's implementation.

Box 8.3: Key messages about implications for school health policies

Implications for school health policies include:

- This PhD research indicates that a skills-based focus in the Chinese Primary and Secondary School Health Education Guideline (CPSSHEG) is needed to improve students' health literacy and a specific strategy is required in the CPSSHEG to better improve students' health literacy in Chinese school settings, rather than a simple focus on the health content.
- This PhD research also indicates that there is a need to implement policy (the Australian Curriculum Guideline: Health and Physical Education) into practice in Australian school settings.

8.6 Summary

In summary, this chapter used the Interactive Systems Framework (ISF) to outline the implications for future research, practice and school health policies. As health literacy is an interactive outcome influenced by individuals' health skills and surrounding environments, its implementation requires a complex approach. The ISF was shown to be a useful framework for providing insights into '*so what*' and '*how to*' for both researchers and staff who work in the field. To improve adolescent health literacy in school settings, there is a need to bridge research, practice and relevant policies.

Chapter 9 Conclusion

This chapter outlines an overall conclusion for the whole research project. To answer the three research questions regarding health literacy measurement and model testing in adolescents, this PhD research employed a three-phase study design with Beijing secondary school students. These included: 1) a systematic review of health literacy instruments for adolescents to identify the most appropriate instrument; 2) a validation study to examine the reliability and validity of the selected health literacy instrument; and 3) a cross-sectional study of model testing to examine the relationships between health literacy, its influencing factors and health-related outcomes. Additionally, a pilot study was conducted in one secondary school in Melbourne, Victoria in order to provide implications for health literacy measurement in Australian secondary school contexts. The relevance of this PhD study to research, practice and policy is outlined in the following paragraphs.

The systematic review shows more than half of measurement properties are unknown due to either poor methodological quality or a lack of reporting or assessment, suggesting a huge gap in the methodological issues when developing and/or validating health literacy instruments for adolescents. More rigorous and high-quality studies are needed in the future to fill this knowledge gap. This PhD research recommends three strategies for improving the methodological quality of future health literacy research in adolescents: applying the COSMIN checklist to ensure the quality of health literacy measurement studies; adopting Pleasant's evaluation principles to advance health literacy measurement; and using Nutbeam's three-domain model to measure health literacy comprehensively. Although it is challenging to draw a robust conclusion about which instrument is the best, there is positive evidence showing the HLAT-8 is worthy of further validation for adolescents due to its strong validity and quick administration.

The validation study in Beijing secondary schools reveals that the c-HLAT-8 is a reliable and valid instrument for measuring adolescent health literacy in Chinese school settings. Given that current evidence on students' health literacy in China is mostly drawn from the knowledge or behaviour-based assessment or the functional domain, the c-HLAT-8 can provide a new opportunity to measure students' health literacy comprehensively, as well it can offer an opportunity to explore the role of three-domain health literacy in health outcomes in future research in China. The pilot study in one Melbourne secondary school shows a similar result of health literacy measurement with the validation study in Beijing secondary schools: The HLAT-8 is closely correlated with the HLS, but not with the NVS. The HLAT-8 is worthy of further validation in larger and more representative samples in Australian school settings. This pilot study also provides useful insights into future health literacy surveys in Australian secondary schools, including a shared perspective of health literacy evaluation between the pilot school and the researcher, the feasibility of online data collection and the possibility of obtaining passive, opt-out consent.

Model testing reveals that the adapted Manganello's health literacy framework is supported by the data. Adolescent health literacy is confirmed as a mediating variable between influencing factors (self-efficacy, social support and school environment) and health-related outcomes (health behaviours, health status and patient-provider communication). This suggests that a systems approach is required to improve adolescent health literacy in school settings. Although the 'Health Promoting Schools' framework is useful in guiding school-based health literacy programs, there remains a range of barriers that must be addressed at the individual and organisational level.

The research conducted in this PhD has implications for developing health literacy through school health policies. In the Chinese government document entitled 'The Primary and Secondary School Health Education Guideline', the focus of developing health literacy should be transformed from teaching/learning health knowledge and behaviours to facilitating and supporting students in employing health skills. This guideline also needs to be expanded to explain how to improve adolescent health literacy in school settings rather than only explaining health content. In Australia, the Australian Curriculum, Assessment and Reporting Authority issued the 'Australian Curriculum: Health and Physical Education' guideline to develop students' health literacy, however there is little evidence to support this guideline. There is a need to implement policy into practice. Prior to the policy implementation, developing appropriate adolescent health literacy instruments is a prerequisite to obtaining such empirical evidence.

In summary, this PhD research contributes to an evidence-based understanding of health literacy measurement and model testing in adolescents from Beijing and Melbourne secondary school settings. The research focuses on methodological quality and provides evidence for the measurement properties of the HLAT-8 and for the robustness and practicability of Manganello's health literacy framework. In particular, this PhD research makes a contribution to how adolescent health literacy can be improved in school settings using a systems approach. Particularly, increasing personal self-efficacy, social support and creating supportive environments are important for promoting health literacy in secondary school settings in China. Incorporating the evidence from health literacy research (measurement and model testing) into school practice and relevant policies is needed to better implement health literacy programs at school. Practice and policies can in turn stimulate new research directions to better develop and promote adolescent health literacy in school settings.

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Appendices

Appendix A: Poster presentation

Measurement properties of health literacy instruments in children and adolescents: a systematic review

Shuaijun Guo[1], Rebecca Armstrong[1], Elizabeth Waters [1], Thirunavukkarasu Sathish [1], Sheikh M Alif [1], Geoffrey R Browne [1] and Xiaoming Yu[2]

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Background

Child and adolescent health literacy are comparatively under-researched, even though this is the life stage when long-term health habits and lifestyles develop and form. Although previous studies have found evidence on measurement properties of health literacy tools used for children and adolescents, most of the conclusions seemed not to be as persuasive as is proclaimed, principally due to a lack of quality assessment of their methodology.

Aim

This study aimed to examine and compare measurement properties of health literacy instruments in children and adolescents via a methodological assessment framework - the 'COnsensus-based Standards for the selection of health Measurement INstruments' (COSMIN) checklist.

Figure 1: Flowchart of the search and selection process according to PRISMA guideline

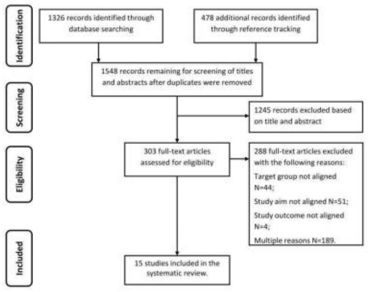

Table 1: Characteristics of included studied ordered by published year (studies no=15)

Author (year)	Health literacy instrument	Country	Target population	Sample size	Setting
Cameron et al. (2006)	eHEALS	Canada	Adolescents aged 13-21 years (mean age=14.95±1.24)	664	Secondary schools
Terry et al. (2006)	REALM-Teen	USA	Adolescents aged 10-19 years (mean age=14.8±1.9)	1533	Middle schools, high schools, pediatric primary care clinic and summer programs
Deena et al. (2007)	TOFHLA	USA	Young people aged 13-17 years (mean age=14.7)	50	Children's hospital
Anke et al. (2009)	CHC Test	Germany	Students in Grade 10-11 and university	322(Sample 1) 107 (Sample 2)	Secondary schools; university
Carsten et al. (2010)	HKACSS	Germany	Children aged 9-13 years (mean age=10.4)	852	Primary school
Amery et al. (2010)	HLAB	Canada	Students in Grade 8-12	275	Secondary schools
Diane et al. (2011)	MHL	Israel	Adolescents in Grade 7, 9, 11 (approximately age 13, 15 and 17)	1316	Public schools
Li-Chun et al. (2012)	c-sTOFHLAd	Taiwan	Students in high school (mean age=16.01±1.02)	300	High schools
Philip et al. (2013)	MMAHL	USA	Adolescents aged 13-17 years (mean age=14.8)	1208	Publicly health insurance network
Shelagh et al. (2013)	DNT-39 and DNT-14	USA	Adolescents aged 12-17 years (Sample 1: mean age=13.92; Sample 2: mean age=15.10)	61(Sample 1) 72 (Sample 2)	Diabetes clinics
Steven et al. (2013)	REALM-Teen; NVS; and s-TOFHLA	USA	Youth aged 14-19 years (mean age=17)	229	Private high school
Martha et al. (2014)	NVS	USA	Children aged 7-12 years	47	The Science Center
Joel et al. (2014)	NVS	USA	Children aged 7-17 years (median age=11)	97	Pediatric clinics
Raquel (2014)	HLAT-YACS	New Zealand	Students aged 18-24 years	144	College
Thomas et al. (2014)	HLAT-YA	Switzerland	Young adults aged 18-25 years (male	7428	Compulsory military service;

Note: eHEALS, the eHealth Literacy Scale; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; TOFHLA, the Test of Functional Health Literacy in Adults; CHC Test, the Critical Health Competence Test; HKACSS, Health Knowledge; Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; MHL, Media Health Literacy; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; MMAHL, a Multidimensional Measure of Adolescent Health Literacy; DNT, the Diabetes Numeracy Test; NVS, the Newest Vital Sign; s-TOFHLA, the Short-form Test of Functional Health Literacy in Adults; HLAT-YACS, Health Literacy Assessment Tool for Young Adult College Students; HLAT-YA, Health Literacy Assessment Tool for Young Adults.

Search strategy

Seven electronic databases were used to search for articles published between January 1974 and May 2014: Medline, PubMed, Embase, PsycINFO, CINAHL, ERIC and The Cochrane Library. Reference lists of included studies and previous systematic reviews regarding health literacy were also checked as a secondary source. No language restriction was made.

Selection criteria

Studies had to fulfill the following criteria to be included: (1) The stated aim of the study was to develop or validate a health literacy instrument; (2) Participants were children or adolescents aged 6-24 years; (3) The term 'health literacy' was explicitly defined, although studies assessing health numeracy were also considered; (4) At least one measurement property (i.e. reliability, validity or responsiveness) was reported in the outcomes.

Data extraction and synthesis

Two authors independently screened the studies and extracted data. Three steps were taken for data synthesis to obtain the overall ratings of each measurement property for each health literacy instrument. Firstly, the methodological quality of a study was assessed according to the COSMIN checklist [1]. Secondly, the quality of an instrument's measurement properties was evaluated using a quality criteria proposed by Terwee et al [2]. Thirdly, the consistency of rating results of measurement properties across studies were considered based on levels of evidence from the Cochrane Back Review Group [3].

Table 2: Overall ratings of the measurement properties per health literacy instrument in children and adolescents

Health literacy instrument	Internal consistency	Reliability	Measurement error	Content validity	Structural validity	Hypotheses testing	Cross-cultural validity	Responsiveness	Scores
NVS	?	na	na	?	na	±	na	na	0.5
c-sTOFHLAd	+	+	na	++	?	+	?	na	5
TOFHLA	na	na	na	?	na	+ (TOFHLA-R) - (TOFHLA-N)	na	na	1 (TOFHLA-R) 0 (TOFHLA-N)
s-TOFHLA	?	na	na	?	na	-	na	na	0
REALM-Teen	?	+	na	++	na	±	na	na	3
HLAB	+	?	na	++	na	-	na	na	3
MMAHL	++	na	na	++	--	na	na	na	4
MHL	?	na	na	++	na	++	na	na	4
DNT-39	+	na	na	?	na	-	na	na	1
DNT-14	+	na	na	?	na	-	na	na	1
eHEALS	+	-	na	++	+	-	na	na	4
CHC Test	na	+	na	++	++	na	na	na	5
HKACSS	+++ (Health communication) --- (Health attitude)	na	na	++	na	++	na	na	7 (Health communication) 4 (Health attitude)
HLAT-YACS	?	na	na	++	?	na	na	na	2
HLAT-YA	---	na	na	?	+++	++	na	na	5

Note: +++ or --- strong evidence and positive/negative result; ++ or -- moderate evidence and positive/negative result; + or - limited evidence and positive/negative result; ± conflicting evidence; ? unknown, due to poor methodological quality; na no information available.

Results

Fifteen studies were identified from a total of 1804 studies, yielding 15 health literacy measurement tools. More than half (69.2%) of measurement properties were unknown, due to either poor methodological quality or a lack of reporting or assessment information. Based on the available information, there were high proportions of positive ratings in terms of internal consistency (87.5%), reliability (75.0%), content validity (100.0%), structural validity (75.0%) and hypothesis testing (41.7%).

Conclusions

Drawing a robust conclusion in reference to the research aim was challenging, because much of the information on measurement properties was not available. Future research regarding measurement properties should be oriented to using the COSMIN checklist to ensure that appropriate measurement properties are explored and appropriately reported.

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Appendix B: Oral presentation

The 23rd National Australian Health Promotion Association Conference

The Role of Health Literacy in the Health of School-aged Adolescents

June 20, 2016

The Jack Brockhoff
Child Health and Wellbeing Program
Research partnerships working for every child

Shuaijun (Jun) GUO
PhD student
School of Population and Global Health, The University of Melbourne

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Background

❑ This study is part of my PhD

- ❖ PhD Research Title: Understand and Measure Health Literacy in School-aged Adolescents from Three Cultural Groups
- ❖ Participants : Chinese students, Australian students, and immigrant Chinese students
- ❖ Research process: Data collection was completed in China

2

Background

❑ What is health literacy?

- ❖ Health literacy is defined as "the cognitive and social skills to gain access to, understand and use information in ways which promote and maintain good health[1]". It is closely related to the sub-theme '<u>Develop Personal Skills</u>' in the Health Promotion Framework.

❑ Why is HL important in health promotion area?

- ❖ A measurable outcome to health education and health promotion[2]
- ❖ Health literacy is found to be associated with a range of health outcomes[3]
- ❖ The epidemic of low health literacy is a common and serious problem across nations[4]

1. Nutbeam, D. (1998). Health promotion glossary¹. Health promotion international, 13(4): 349-364
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3. Berkman, N. D., Sheridan, S. L., Donahue, K. E., Halpern, D. J., & Crotty, K. (2011). Low health literacy and health outcomes: an updated systematic review. Annals of internal medicine. 155(2), 97-107.
4. Hls-Eu Consortium. (2012). Comparative report of health literacy in eight EU member states. The European health literacy survey HLS-EU.

3

Background

- ❑ **Limited evidence about the relationship between health literacy and adolescent health**
  - ❖ Most studies are focusing on the adult population;
  - ❖ Few studies are exploring the causal pathways linking health literacy to health outcomes;
  - ❖ Little evidence is known about the relationship between health, education and health literacy;
  - ❖ Few empirical studies were built on a conceptual model.

4

Research Questions

- ❑ **What factors influence health literacy among adolescents?**
- ❑ **What impacts does health literacy have on health outcomes?**
- ❑ **What is the role of health literacy in health and education?**

5

Research Objectives

- ❑ **To determine the influencing factors of health literacy among adolescents;**
- ❑ **To examine the causal pathways linking health literacy to health status;**
- ❑ **To examine the role of health literacy in health and education.**

6

Conceptual Model

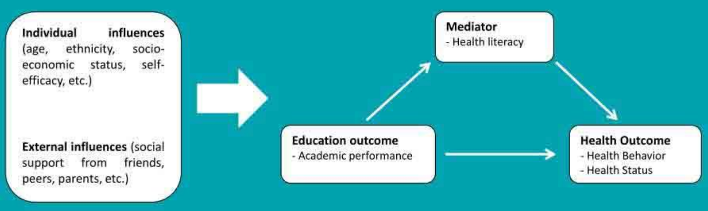

Figure 1 Hypothesis of a health literacy model for school-aged adolescents
(Based on the model of Manganello[1] and van der Heide[2])

1. Manganello, J. A. (2008). Health literacy and adolescents: a framework and agenda for future research. Health education research, 23(5), 840-847.
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7

Methods

- **Study design:** cross-sectional
- **Recruitment settings:** secondary schools in Beijing (n=4)
- **Sampling method:** convenience and cluster sampling
- **Participants:** Year 7-9 students (n=650)
- **Adolescent Health Questionnaire**
  - Socio-demographics, self-efficacy scale, social support scale, health literacy scale, self-reported academic performance, self-reported health behaviors and self-reported health status

Note: the internal consistency coefficient (α) of the health literacy scale, self-efficacy scale and social support scale is 0.79, 0.89, and 0.93 respectively.

8

Results

- Characteristics of participants
  - Sample size=650
  - Male: female= 1:1.2
  - Age range: 11 to 17
  - Mean age=13.42 ± 1.01

Table 1 Characteristics of the sample (n=650)

Characteristics	Category	Frequency	Percent (%)
School geographic area	Urban	283	43.5
	Suburb	367	56.5
Grade level	Grade 7	232	35.7
	Grade 8	215	33.1
	Grade 9	203	31.2
Gender	Male	357	54.9
	Female	293	45.1
Ethnicity	Han	617	94.9
	Ethnic minorities	33	5.1
Family affluence level	Low (FAS score≤3)	179	27.8
	Medium (FAS score=4 or 5)	296	46.0
	High (FAS score≥6)	169	26.2
Academic performance	Poor or very poor	208	32.1
	Average	197	30.4
	Good or very good	243	37.5
Health status	Fair or poor	224	34.5
	Good	227	34.9
	Excellent or very good	199	30.6

Univariate analysis

Table 2 Univariate analysis of self-efficacy, social support, health literacy and health behaviour by characteristics

Participant characteristics	Self-efficacy		Social support		Health literacy		Health behavior	
	Mean ± Std	*P* value	Median (IQ range)	*P* value	Median (IQ range)	*P* value	Median (IQ range)	*P* value
School geographic area								
Urban	27.06±6.70	0.421	65.00 (53.00-74.50)	0.968	27.00 (23.00-30.00)	0.539	26.00 (23.00-28.00)	0.886
Suburb	26.65±6.10		66.00 (54.50-74.00)		27.00 (23.00-31.00)		26.00 (23.00-28.00)	
Gender								
Male	27.47±6.20	0.005	65.00 (54.00-73.00)	0.950	27.00 (24.00-30.00)	0.669	26.00 (23.00-28.00)	0.067
Female	26.05±6.49		66.00 (53.00-74.00)		27.00 (23.00-31.00)		25.00 (23.00-28.00)	
Grade level								
Grade 7	27.93±6.47	0.003	67.00 (56.00-76.00)	0.110	27.00 (23.00-31.00)	0.255	26.00 (23.00-28.00)	0.057
Grade 8	26.55±6.63		65.00 (55.00-73.00)		27.00 (24.00-31.00)		26.00 (23.00-28.00)	
Grade 9	25.90±5.78		63.00 (50.00-73.00)		26.50 (22.00-30.00)		25.00 (22.00-27.00)	
Ethnicity								
Han	26.87±6.28	0.605	66.00 (54.00-74.00)	0.796	27.00 (23.00-30.00)	0.816	26.00 (23.00-28.00)	0.296
Ethnic minorities	26.13±7.91		68.00 (53.00-75.00)		28.00 (24.00-31.00)		25.00 (22.00-27.50)	
Family affluence level								
Low	25.06±6.29	<0.001	60.00 (49.00-69.00)	<0.001	26.00 (22.00-29.00)	0.002	25.00 (22.25-27.00)	<0.001
Medium	26.98±6.17		67.00 (56.00-74.00)		27.00 (24.00-30.00)		25.00 (23.00-28.00)	
High	28.47±6.43		69.50 (59.00-78.75)		27.50 (24.00-31.00)		26.00 (24.00-28.00)	
Academic performance								
Poor or very poor	25.48±6.33	<0.001	60.00 (49.75-72.00)	<0.001	25.00 (22.00-28.00)	<0.001	24.50 (22.00-27.00)	<0.001
Average	26.45±6.32		65.00 (55.00-72.75)		27.00 (23.00-30.00)		26.00 (23.00-28.00)	
Good or very good	28.18±6.16		70.00 (58.00-78.00)		28.00 (25.00-32.00)		26.00 (24.00-28.00)	
Health status								
Fair or poor	24.85±6.09	<0.001	62.00 (48.00-72.00)	<0.001	25.00 (22.00-29.00)	<0.001	25.00 (22.00-27.00)	<0.001
Good	26.54±6.28		64.00 (53.00-72.00)		26.00 (23.00-29.00)		25.00 (23.00-27.00)	
Excellent or very good	29.30±5.95		71.50 (60.00-80.00)		29.00 (26.00-33.00)		27.00 (24.00-29.00)	

Correlation between variables

Table 3 Correlation between family affluence, self-efficacy, social support, academic performance, health literacy, health behavior and health status

Variables	Family affluence	Self-efficacy	Social support	Academic performance	Health literacy	Health behavior	Health status
Family affluence	1.000						
Self-efficacy	0.218**	1.000					
Social support	0.201**	0.449**	1.000				
Academic Performance	0.175**	0.222**	0.231**	1.000			
Health literacy	0.160**	0.392**	0.433**	0.235**	1.000		
Health behavior	0.154**	0.308**	0.288**	0.193**	0.296**	1.000	
Health status	0.146**	0.280**	0.231**	0.059	0.263**	0.187**	1.000

Note: ** means $P<0.01$

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Path analysis

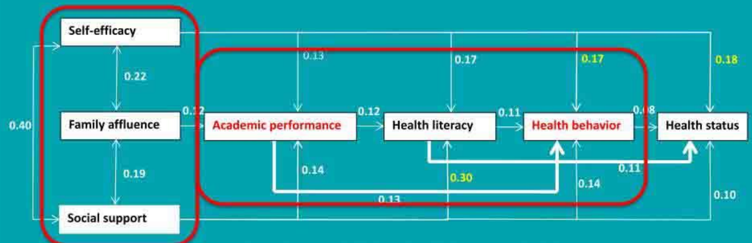

Figure 2 Path analysis model linking health literacy to health status

- The hypothesis model demonstrated excellent data fit (Chi square=8.475, df=4, P=0.076, CFI=0.991, RMSEA=0.042).
- The proportion of variance explained by each variable in this model is: Academic performance: 8%, Health literacy: 20%, Health behavior: 15%, Health status: 11%.

12

Summary and Implications

Influencing factors of health literacy

- Socio-economic status (Family affluence)
- Self-efficacy
- Social support
- Educational outcome (academic performance)

Impacts of health literacy

- Health outcomes (health behaviour, health status)

The role of health literacy

- A mediator between the education outcome and health outcome

13

Thank you!

Further contacts

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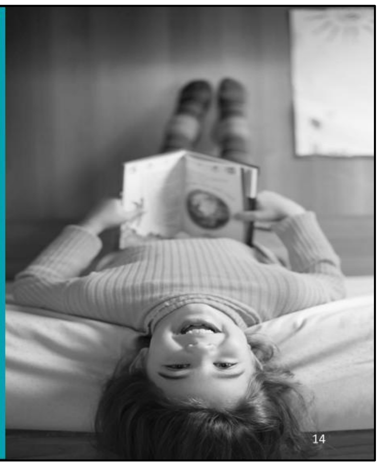

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Appendix C: Accepted abstract

Measuring Functional, Interactive and Critical Health Literacy of Chinese School-aged Adolescents: Realistic, Desirable, or Feasible?

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Background

While health literacy is an increasingly important topic in the global context, China has lagged far behind, especially for health literacy measurement in school-aged adolescents. In China, health literacy measures focus mainly on knowledge/behaviour-based assessment or the functional domain. However, focusing on these domains cannot meet the needs of conducting health literacy research in the health promotion context. This is because health literacy from the health promotion perspective represents more than being able to read and write (functional health literacy). It also includes interpersonal skills (interactive health literacy) and critical evaluation skills (critical health literacy). Integrating interactive and critical domains into health literacy measurement is aligned with the rationale of emphasizing empowerment in health promotion. Up to now, China has yet to adopt the skill-based and three-domain (functional, interactive, and critical) assessments that are used in western countries such as the USA. Also, little is known about the determinants of different domains of health literacy in current research. Therefore, this study aims to adapt a skill-based, multi-dimensional health literacy instrument for use in Chinese culture and to examine the status and determinants of each domain of health literacy in school-aged adolescents.

Methods

Based on a systematic review, the Health Literacy Assessment Tool (HLAT-8) developed by Thomas Abel et al. was selected and translated from English to Chinese (c-HLAT-8). Following the translation process, a cross-sectional study was conducted in four secondary schools in

Beijing, China, using convenience sampling. Students were invited to complete a self-administered questionnaire that assessed socio-demographics, self-efficacy, social support, school and community environment, and health literacy (the c-HLAT-8, the Health Literacy Survey (HLS)-Asia, and the Newest Vital Sign (NVS)).

Results

The study found that the c-HLAT-8 had satisfactory reliability (Cronbach's alpha=0.79; intra-class correlation coefficient=0.72) and strong validity (translation validity index≥0.95; $\chi 2/df=3.388$, $P<0.001$; CFI=0.975, TLI=0.945, NFI=0.965, RMSEA=0.061; scores of the c-HLAT-8 were strongly correlated with the HLS-Asia, but weakly with the NVS). Chinese students had an average score of 26.37 (± 5.89) for the c-HLAT-8. Low health literacy was associated with low socio-economic-status, low self-efficacy, low social support, and low perceptions of school environment. When examining the determinants of each domain of health literacy, self-efficacy and school environment were more related to functional health literacy, whereas social support was more related to interactive and critical health literacy.

Conclusions

The study demonstrated that the c-HLAT-8 was a realistic, feasible, and desirable tool for measuring functional, interactive, and critical health literacy for Chinese students. Increasing self-efficacy and social support and creating supportive environments within school-based settings are important to develop adolescent health literacy.

Implications

The c-HLAT-8 would be useful for future health literacy measurement in Chinese school settings and other cultural settings. The c-HLAT-8 can be used on its own as a measurable outcome of school health education or incorporated into parts of a health assessment battery in school health programs. Using a holistic and system-level approach, such as the health promoting school framework, would be also useful and effective to promote students' health literacy in each domain.

Appendix 3.1: A systematic review protocol

Measuring the Quality of Child and Adolescent Health Literacy Instruments: A Systematic Review

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Background

Health literacy research has been a growing interest by researchers across the globe. The term *'health literacy'* was first used in 1974 in the proceedings of a health education conference discussing health education as a social policy issue affecting the healthcare system, mass communication and the education system (1, 2). However, few references were found regarding health literacy in the literature until 1992 (3). Since 1992, health literacy has been broadly studied both in clinical and public health contexts. In clinical settings, health literacy is typically defined as '*the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions*' by the Institute of Medicine (IOM) in America (4). In such circumstances, health literacy is a derivative concept from literacy and numeracy skills, which is often used as a risk factor that needs to be identified and appropriately managed for patients and health professionals (5). Accordingly, health literacy measurement tools and 'screening aids' for clinicians are developed to assess patient literacy levels, and help health professionals to tailor health information for better communication with their patients (6). From the public health perspective, health literacy is defined and accepted by World Health Organization (WHO) as '*the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health*' (7). This understanding of health literacy identifies it as a broad concept, which is seen as a personal asset to enable individuals to take more control over their health and determinants of health (5). With a different understanding of the concept, health literacy measures vary in a different way. Although health literacy measurement varies and is still being debated (1, 8-10), there is consistent evidence showing health literacy is of potential importance and considered as a public health goal internationally. A recent WHO report pointed out that poor health literacy skills were associated with riskier behaviours, poorer health status, less self-management and longer hospitalization and more health costs (11).

Based on a preliminary search of health literacy, there were more interests in studies focusing on adult health literacy than adolescent health literacy. However, previous research studies suggested that poor health literacy was a prevalent problem in adolescents. In Australia, the 2006 National Health Literacy Survey reported that 67.6% of adolescents aged 15 to 19 years old did not attain the minimum skills required to deal with health information and service in everyday life (12). Compared with adult health literacy, there are several reasons for the potential importance of adolescent health literacy: 1) adolescents are future mainstream and independent healthcare consumers, a health literate person can contribute to less health care costs, better health status compared to that is not health literate (13); 2) adolescents are at a critical stage of development characterised by physical, emotional and cognitive changes, attempting to prepare for independence but lacking the adequate ability of reasoning and decision-making. Therefore, improving their health literacy skills could support sound health decisions in future (14, 15); 3) low health literacy has been demonstrated to associate with high levels of health-risk behaviors (16, 17) and low levels of health-promoting behaviors for adolescents (18); 4) enhancing health literacy through school-based interventions has great potential for improving students' access to and interpretation of health information (19). Adolescents spend most of their daily time in school, which means they can receive health education and learn how to improve healthy lifestyles and related skills through this setting (20, 21).

Health literacy is more challenging to understand for adolescents than that for adults. Researchers may have different understandings and underlying constructs when using the same definition. That is why there are such a large number of measurement tools of health literacy currently (22, 23), along with some newly-developed health literacy instruments (24). According to Mancuso (1), it is recommended to use specific assessment tools for a specific age group in a specific context. Studies measuring childhood and adolescent health literacy have been a research focus, particularly in the past five years (23). Ormshaw *et al.* (23) conducted a systematic review on measuring childhood and adolescent health literacy in 2011. They found 16 studies that were involved with health literacy measures in children and adolescents. The authors also identified 13 health topics and nine underlying components from existing health literacy instruments. However, the authors did not critically appraise health literacy indices explicitly regarding their validity and reliability. More importantly, the authors did not assess the methodological quality of each included study. This may undermine the persuasiveness of its conclusion. To fill this knowledge gap, we aim to conduct a systematic review that examines studies' methodological quality and examine reliability and validity of each health literacy instrument, thus providing researchers with unbiased information about which instruments have good psychometric properties. The '*COnsensus-based Standards for the selection of health status Measurement INstruments*' (COSMIN) group has recently developed as a critical appraisal tool (a checklist) to evaluate the methodological quality of studies on measurement properties of health measurement instruments (25). These measurement properties are divided into three domains: reliability, validity, and responsiveness (26). According to the COSMIN checklist, it is possible and scientific to critically appraise and compare psychometric properties of health literacy instruments for children and adolescents.

In this protocol, our target population is adolescent. According to the definition of the WHO, adolescents are those people aged 10 to 19 years and young people aged 10-24 years (27, 28). Given that the term '*adolescent*', '*child*', '*youth*' and '*young people*' is closely related, and Erikson (29) reckoned that children between the ages of 6 and 12 years could learn, compete and co-operate with others, we define our target group as those aged 6-24 years old.

Objectives of the review

This review aims to identify which health literacy instruments have good psychometric properties for children and adolescents. Specifically, there are three objectives:

1) To examine the methodological quality of included studies that aim to measure health literacy in children and adolescents;
2) To examine the measurement properties (i.e. reliability; validity; responsiveness) of health literacy instruments in children and adolescents;
3) To compare the overall rating of measurement properties between each health literacy instrument used in children and adolescents.

Search strategy

Database and search terms

As the term '*health literacy*' was first coined in 1974, articles published from 1st,January 1974 to 30th May 2014 in all languages will be searched. Search strategies will be first designed and then be consulted with two librarian experts. Articles indexed in the following seven databases: Medline, Pubmed, Embase, PsycINFO, CINAHL, ERIC and Cochrane Library will be searched. The search key terms are '*health literacy*' and '*assessment*' according to previously published studies (1, 23, 30, 31). Age group for '*child, adolescent and young adult*' will be defined in the database settings. The synonyms are listed in **Appendix Table 1**. These synonyms are connected by '*or*' and search strategies are completed by '*and*'.

Appendix Table 1 Searching terms in databases

Key term (1)	Key term (2)
health literacy	health literacy measur*
health AND literacy AND education	health literacy assess*
	health literacy evaluat*
	health literacy instrument*
	health literacy tool*

Other sources of literature

Searching other sources to identify relevant research including:

- Reference lists of identified studies;
- Reference lists of previous systematic reviews on health literacy (1, 23, 30-33).

Eligibility criteria for inclusion and exclusion

According to the guidelines recommended by Cochrane Handbook for systematic reviews (34), inclusion criteria will be addressed regarding population, intervention, comparison, outcome and study design (PICOS):

Inclusion criteria-Participants

The target group should be children and/or adolescents, any age from 6 to 24 years of age.

Inclusion criteria-Interventions and Comparators

As interventional studies are not our interest in this review, it is not applicable to set out guidelines for interventions and comparators

Inclusion criteria-Outcomes

The included studies must be involved with health literacy assessment for children and adolescents, that is, the study should specify the term '*health literacy*', and studies are included if they report on at least one or more attributes of the three measurement properties: 1) reliability; 2) validity; and 3) responsiveness.

Inclusion criteria-Study design

The article should be research-based and peer-reviewed paper including study aim, methods, and results. Also, the study aim should focus on health literacy instrument development or validation.

Exclusion criteria

Studies will be excluded if they are: 1) not focusing on the target group; 2) not focusing on the health literacy instrument development or tool validation; 3) not research-based and peer-reviewed papers including editorials, comments and letters; 4) not reporting findings or results regarding any one of the measurement properties.

Study selection

Search records will be kept including the names of databases searched, keywords, search timeframe, and the search results. All the electronic search results will be initially inputted into the bibliography software of EndNote X7 (Thomson Reuters, New York, NY), and other sources of literature results will be summarised in the print paper. This screening process will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement (35). One reviewer will screen studies by titles and abstracts. Secondly, full copies of articles identified will be obtained for thorough screening according to the inclusion criteria by two reviewers independently. Any disagreements in reviewer selections will be resolved at a meeting.

Quality assessment

The methodological quality of each included study will be assessed by two reviewers independently using the COSMIN checklist (25). The checklist consists of nine boxes with 5-18 items concerning methodological standards for how each measurement property should be assessed. Four response options for each item of the COSMIN checklist are defined, representing '*excellent*', '*good*', '*fair*' and '*poor*' quality. An overall score for the methodological quality of a study will be determined for each measurement property separately, by taking the lowest rating of any items in a box ('*worst score counts*') (36). Discrepancies arise between the reviewers will be resolved through discussion, if necessary with a third independent person.

Data extraction

Data extraction will be performed along with the assessment of methodological quality using the COSMIN checklist (25). In addition, information on the interpretability (e.g. norm scores, floor-ceiling effects, minimal important change of the instruments), generalisability (e.g. characteristics of the study population and sampling procedure), respondent and administrative burden, and forms of administration will be also collected because they are important characteristics of a measurement instrument (26, 37). The data will be entered in an electronic form. Where possible, authors of the original studies will be contacted to obtain essential missing or additional data. Two reviewers will independently extract the data. Consensus should be reached afterward, if necessary with a third independent person.

Data synthesis

The results of the quality of health literacy instruments will be assessed using Terwee's quality criteria (38), to see whether the results of the measurement attributes are '*positive*', '*negative*', or '*indeterminate*'. To summarise the overall ratings of the measurement properties of one health literacy instruments by different authors, the synthesis will be performed by combining the results of the quality of health literacy instruments, the results of methodological quality of health literacy measurement studies and the consistency of their results. The possible overall rating for a measurement property is '*positive*', '*indeterminate*', or '*negative*', accompanied by levels of evidence, similarly as was proposed by the Cochrane Back Review Group (39, 40). One reviewer will perform the data synthesis and a second reviewer will check the synthesised results. Discrepancies of the results will be resolved by discussion.

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Appendix 3.2: PRISMA checklist for reporting systematic review

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	111
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	iii-v
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	60-61,112
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	112
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Appendix 3.1
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	115-116
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	114-115
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 4.1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	116
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	116
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	116-118
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	116-117; Appendix 4.2
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	118-119

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	118-119
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	119; Figure 4.1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	121; Table 4.5
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	130; Table 4.8
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	132; Table 4.9
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	134; Table 4.10
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	134; Table 4.10
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	140-151
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	152
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	152
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	vii

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

Appendix 3.3: COSMIN checklist for examining studies' quality

COSMIN checklist with 4-point scale

COSMIN

Contact
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Instructions

This version of the COSMIN checklist is recommended for use in systematic reviews of measurement properties. With this version it is possible to calculate overall methodological quality scores per study on a measurement property. A methodological quality score per box is obtained by taking the lowest rating of any item in a box ('worse score counts'). For example, if for a reliability study one item in the box 'Reliability' is scored poor, the methodological quality of that reliability study is rated as poor. The Interpretability box and the Generalizability box are mainly used as data extraction forms. We recommend to use the Interpretability box to extract all information on the interpretability issues described in this box (e.g. norm scores, floor-ceiling effects, minimal important change) of the instruments under study from the included articles. Similar, we recommend to use the Generalizability box to extract data on the characteristics of the study population and sampling procedure. Therefore no scoring system was developed for these boxes.

This scoring system is described in this paper:

Terwee CB, Mokkink LB, Knol DL, Ostelo RWJG, Bouter LM, de Vet HCW. Rating the methodological quality in systematic reviews of studies on measurement properties: a scoring system for the COSMIN checklist. Quality of Life Research 2011, July 6 [epub ahead of print].

Step 1. Evaluated measurement properties in the article

	Internal consistency	Box A
	Reliability	Box B
	Measurement error	Box C
	Content validity	Box D
	Structural validity	Box E
	Hypotheses testing	Box F
	Cross-cultural validity	Box G
	Criterion validity	Box H
	Responsiveness	Box I

Step 2. Determining if the statistical method used in the article are based on CTT or IRT

Box General requirements for studies that applied Item Response Theory (IRT) models		excellent	good	fair	poor
1	Was the IRT model used adequately described? e.g. One Parameter Logistic Model (OPLM), Partial Credit Model (PCM), Graded Response Model (GRM)	IRT model adequately described	IRT model not adequately described		
2	Was the computer software package used adequately described? e.g. RUMM2020, WINSTEPS, OPLM, MULTILOG, PARSCALE, BILOG, NLMIXED	Software package adequately described	Software package not adequately described		
3	Was the method of estimation used adequately described? e.g. conditional maximum likelihood (CML), marginal maximum likelihood (MML)	Method of estimation adequately described	Method of estimation not adequately described		
4	Were the assumptions for estimating parameters of the IRT model checked? e.g. unidimensionality, local independence, and item fit (e.g. differential item functioning (DIF))	assumptions of the IRT model checked	assumptions of the IRT model partly checked	assumptions of the IRT model not checked or unknown	

To obtain a total score for the methodological quality of studies that use IRT methods, the 'worse score counts' algorithm should be applied to the IRT box in combination with the box of the measurement property that was evaluated in the IRT study. For example, if IRT methods are used to study internal consistency and item 4 in the IRT box is scored fair, while the items in the internal consistency box (box A) are all scored as good or excellent, the methodological quality score for internal consistency will be fair. However, if any of the items in box A is scored poor, the methodological quality score for internal consistency will be poor.

Step 3. Determining if a study meets the standards for good methodological quality

Box A. Internal consistency

		excellent	good	fair	poor
1	Does the scale consist of effect indicators, i.e. is it based on a reflective model?				
	Design requirements				
2	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
3	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
4	Was the sample size included in the internal consistency analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
5	Was the unidimensionality of the scale checked? i.e. was factor analysis or IRT model applied?	Factor analysis performed in the study population	Authors refer to another study in which factor analysis was performed in a similar study population	Authors refer to another study in which factor analysis was performed, but not in a similar study population	Factor analysis NOT performed and no reference to another study
6	Was the sample size included in the unidimensionality analysis adequate?	7* #items and ≥100	5* #items and ≥100 OR 6-7* #items but <100	5* #items but <100	<5* #items
7	Was an internal consistency statistic calculated for each (unidimensional) (sub)scale separately?	Internal consistency statistic calculated for each subscale separately			Internal consistency statistic NOT calculated for each subscale separately
8	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
	Statistical methods				
9	for Classical Test Theory (CTT), continuous scores: Was Cronbach's alpha calculated?	Cronbach's alpha calculated		Only item-total correlations calculated	No Cronbach's alpha and no item-total correlations calculated
10	for CTT, dichotomous scores: Was Cronbach's alpha or KR-20 calculated?	Cronbach's alpha or KR-20 calculated		Only item-total correlations calculated	No Cronbach's alpha or KR-20 and no item-total correlations calculated
11	for IRT: Was a goodness of fit statistic at a global level calculated? E.g. χ^2, reliability coefficient of estimated latent trait value (index of (subject or item) separation)	Goodness of fit statistic at a global level calculated			Goodness of fit statistic at a global level NOT calculated

NB. Item 1 is used to determine whether internal consistency is relevant for the instrument under study. It is not used to rate the quality of the study.

Box B. Reliability: relative measures (including test-retest reliability, inter-rater reliability and intra-rater reliability)

		excellent	good	fair	poor
	Design requirements				
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
4	Were at least two measurements available?	At least two measurements			Only one measurement
5	Were the administrations independent?	Independent measurements	Assumable that the measurements were independent	Doubtful whether the measurements were independent	measurements NOT independent
6	Was the time interval stated?	Time interval stated		Time interval NOT stated	
7	Were patients stable in the interim period on the construct to be measured?	Patients were stable (evidence provided)	Assumable that patients were stable	Unclear if patients were stable	Patients were NOT stable
8	Was the time interval appropriate?	Time interval appropriate		Doubtful whether time interval was appropriate	Time interval NOT appropriate

		excellent	good	fair	poor
9	Were the test conditions similar for both measurements? e.g. type of administration, environment, instructions	Test conditions were similar (evidence provided)	Assumable that test conditions were similar	Unclear if test conditions were similar	Test conditions were NOT similar
10	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
	Statistical methods				
11	for continuous scores: Was an intraclass correlation coefficient (ICC) calculated?	ICC calculated and model or formula of the ICC is described	ICC calculated but model or formula of the ICC not described or not optimal. Pearson or Spearman correlation coefficient calculated with evidence provided that no systematic change has occurred	Pearson or Spearman correlation coefficient calculated WITHOUT evidence provided that no systematic change has occurred or WITH evidence that systematic change has occurred	No ICC or Pearson or Spearman correlations calculated
12	for dichotomous/nominal/ordinal scores: Was kappa calculated?	Kappa calculated			Only percentage agreement calculated
13	for ordinal scores: Was a weighted kappa calculated?	Weighted Kappa calculated		Unweighted Kappa calculated	Only percentage agreement calculated
14	for ordinal scores: Was the weighting scheme described? e.g. linear, quadratic	Weighting scheme described	Weighting scheme NOT described		

Box C. Measurement error: absolute measures

		excellent	good	fair	poor
	Design requirements				
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
4	Were at least two measurements available?	At least two measurements			Only one measurement
5	Were the administrations independent?	Independent measurements	Assumable that the measurements were independent	Doubtful whether the measurements were independent	measurements NOT independent
6	Was the time interval stated?	Time interval stated		Time interval NOT stated	
7	Were patients stable in the interim period on the construct to be measured?	Patients were stable (evidence provided)	Assumable that patients were stable	Unclear if patients were stable	Patients were NOT stable
8	Was the time interval appropriate?	Time interval appropriate		Doubtful whether time interval was appropriate	Time interval NOT appropriate

		excellent	good	fair	poor
9	Were the test conditions similar for both measurements? e.g. type of administration, environment, instructions	Test conditions were similar (evidence provided)	Assumable that test conditions were similar	Unclear if test conditions were similar	Test conditions were NOT similar
10	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
	Statistical methods				
11	for CTT: Was the Standard Error of Measurement (SEM), Smallest Detectable Change (SDC) or Limits of Agreement (LoA) calculated?	SEM, SDC, or LoA calculated	Possible to calculate LoA from the data presented		SEM calculated based on Cronbach's alpha, or on SD from another population

Box D. Content validity (including face validity)

		excellent	good	fair	poor
	General requirements				
1	Was there an assessment of whether all items refer to relevant aspects of the construct to be measured?	Assessed if all items refer to relevant aspects of the construct to be measured		Aspects of the construct to be measured poorly described AND this was not taken into consideration	NOT assessed if all items refer to relevant aspects of the construct to be measured

2	Was there an assessment of whether all items are relevant for the study population? (e.g. age, gender, disease characteristics, country, setting)	Assessed if all items are relevant for the study population in adequate sample size (≥10)	Assessed if all items are relevant for the study population in moderate sample size (5-9)	Assessed if all items are relevant for the study population in small sample size (<5)	NOT assessed if all items are relevant for the study population OR target population not involved
3	Was there an assessment of whether all items are relevant for the purpose of the measurement instrument? (discriminative, evaluative, and/or predictive)	Assessed if all items are relevant for the purpose of the application	Purpose of the instrument was not described but assumed	NOT assessed if all items are relevant for the purpose of the application	
4	Was there an assessment of whether all items together comprehensively reflect the construct to be measured?	Assessed if all items together comprehensively reflect the construct to be measured		No theoretical foundation of the construct and this was not taken into consideration	NOT assessed if all items together comprehen-sively reflect the construct to be measured
5	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study

Box E. Structural validity

		excellent	good	fair	poor
1	Does the scale consist of effect indicators, i.e. is it based on a reflective model?				
Design requirements					
2	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
3	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
4	Was the sample size included in the analysis adequate?	7* #items and ≥100	5* #items and ≥100 OR 5-7* #items but <100	5* #items but <100	<5* #items
5	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study (e.g. rotation method not described)	Other important methodological flaws in the design or execution of the study (e.g. inappropriate rotation method)

Statistical methods					
6	for CTT: Was exploratory or confirmatory factor analysis performed?	Exploratory or confirmatory factor analysis performed and type of factor analysis appropriate in view of existing information	Exploratory factor analysis performed while confirmatory would have been more appropriate		No exploratory or confirmatory factor analysis performed
7	for IRT: Were IRT tests for determining the (uni-) dimensionality of the items performed?	IRT test for determining (uni)dimension-ality performed			IRT test for determining (uni)dimension-ality NOT performed

Box F. Hypotheses testing

		excellent	good	fair	Poor
Design requirements					
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100 per analysis)	Good sample size (50-99 per analysis)	Moderate sample size (30-49 per analysis)	Small sample size (<30 per analysis)

4 Were hypotheses regarding correlations or mean differences formulated a priori (i.e. before data collection)?	Multiple hypotheses formulated a priori	Minimal number of hypotheses formulate a priori	Hypotheses vague or not formulated but possible to deduce what was expected	Unclear what was expected
5 Was the expected *direction* of correlations or mean differences included in the hypotheses?	Expected direction of the correlations or differences stated	Expected direction of the correlations or differences NOT stated		
6 Was the expected absolute or relative *magnitude* of correlations or mean differences included in the hypotheses?	Expected magnitude of the correlations or differences stated	Expected magnitude of the correlations or differences NOT stated		
7 for convergent validity: Was an adequate description provided of the comparator instrument(s)?	Adequate description of the constructs measured by the comparator instrument(s)	Adequate description of most of the constructs measured by the comparator instrument(s)	Poor description of the constructs measured by the comparator instrument(s)	NO description of the constructs measured by the comparator instrument(s)
8 for convergent validity: Were the measurement properties of the comparator instrument(s) adequately described?	Adequate measurement properties of the comparator instrument(s) in a population similar to the study population	Adequate measurement properties of the comparator instrument(s) but not sure if these apply to the study population	Some information on measurement properties (or a reference to a study on measurement properties) of the comparator instrument(s) in any study population	No information on the measurement properties of the comparator instrument(s)

9 Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study (e.g. only data presented on a comparison with an instrument that measures another construct)	Other important methodological flaws in the design or execution of the study
Statistical methods				
10 Were design and statistical methods adequate for the hypotheses to be tested?	Statistical methods applied appropriate	Assumable that statistical methods were appropriate, e.g. Pearson correlations applied, but distribution of scores or mean (SD) not presented	Statistical methods applied NOT optimal	Statistical methods applied NOT appropriate

Box G. Cross-cultural validity				
	excellent	**good**	**fair**	**poor**
Design requirements				
1 Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2 Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	

3 Was the sample size included in the analysis adequate?	CTT: 7* #items and ≥100 IRT: ≥200 per group	CTT: 5* #items and ≥100 OR 5-7* #items but <100 IRT: ≥200 in 1 group and 100-199 in 1 group	CTT: 5* #items but <100 IRT: 100-199 per group	CTT: <5* #items IRT: (<100 in 1 or both groups
4 Were both the original language in which the HR-PRO instrument was developed, and the language in which the HR-PRO instrument was translated described?	Both source language and target language described			Source language NOT known
5 Was the expertise of the people involved in the translation process adequately described? e.g. expertise in the disease(s) involved, expertise in the construct to be measured, expertise in both languages	Expertise of the translators described with respect to disease, construct, and language	Expertise of the translators with respect to disease or construct poor or not described	Expertise of the translators with respect to language not described	
6 Did the translators work independently from each other?	Translators worked independent	Assumable that the translators worked independent	Unclear whether translators worked independent	Translators worked NOT independent
7 Were items translated forward and backward?	Multiple forward and multiple backward translations	Multiple forward translations but one backward translation	One forward and one backward translation	Only a forward translation
8 Was there an adequate description of how differences between the original and translated versions were resolved?	Adequate description of how differences between translators were resolved	Poorly or NOT described how differences between translators were resolved		

9	Was the translation reviewed by a committee (e.g. original developers)?	Translation reviewed by a committee (involving other people than the translators, e.g. the original developers)	Translation NOT reviewed by (such) a committee		
10	Was the HR-PRO instrument pre-tested (e.g. cognitive interviews) to check interpretation, cultural relevance of the translation, and ease of comprehension?	Translated instrument pre-tested in the target population	Translated instrument pre-tested, but unclear if this was done in the target population	Translated instrument pre-tested, but NOT in the target population	Translated instrument NOT pre-tested
11	Was the sample used in the pre-test adequately described?	Sample used in the pre-test adequately described		Sample used in the pre-test NOT (adequately) described	
12	Were the samples similar for all characteristics except language and/or cultural background?	Shown that samples were similar for all characteristics except language /culture	Stated (but not shown) that samples were similar for all characteristics except language /culture	Unclear whether samples were similar for all characteristics except language /culture	Samples were NOT similar for all characteristics except language /culture
13	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study

Statistical methods					
14	for CTT: Was confirmatory factor analysis performed?	Multiple-group confirmatory factor analysis performed			Multiple-group confirmatory factor analysis NOT performed
15	for IRT: Was differential item function (DIF) between language groups assessed?	DIF between language groups assessed			DIF between language groups NOT assessed

Box H. Criterion validity

		excellent	good	fair	poor
Design requirements					
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
4	Can the criterion used or employed be considered as a reasonable 'gold standard'?	Criterion used can be considered an adequate 'gold standard' (evidence provided)	No evidence provided, but assumable that the criterion used can be considered an adequate 'gold standard'	Unclear whether the criterion used can be considered an adequate 'gold standard'	Criterion used can NOT be considered an adequate 'gold standard'

5	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
Statistical methods					
6	for continuous scores: Were correlations, or the area under the receiver operating curve calculated?	Correlations or AUC calculated			Correlations or AUC NOT calculated
7	for dichotomous scores: Were sensitivity and specificity determined?	Sensitivity and specificity calculated			Sensitivity and specificity NOT calculated

Box I. Responsiveness

		excellent	good	fair	poor
Design requirements					
1	Was the percentage of missing items given?	Percentage of missing items described	Percentage of missing items NOT described		
2	Was there a description of how missing items were handled?	Described how missing items were handled	Not described but it can be deduced how missing items were handled	Not clear how missing items were handled	
3	Was the sample size included in the analysis adequate?	Adequate sample size (≥100)	Good sample size (50-99)	Moderate sample size (30-49)	Small sample size (<30)
4	Was a longitudinal design with at least two measurement used?	Longitudinal design used			No longitudinal design used
5	Was the time interval stated?	Time interval adequately described			Time interval NOT described

6	If anything occurred in the interim period (e.g. intervention, other relevant events), was it adequately described?	Anything that occurred during the interim period (e.g. treatment) adequately described	Assumable what occurred during the interim period	Unclear or NOT described what occurred during the interim period	
7	Was a proportion of the patients changed (i.e. improvement or deterioration)?	Part of the patients were changed (evidence provided)	NO evidence provided, but assumable that part of the patients were changed	Unclear if part of the patients were changed	Patients were NOT changed
	Design requirements for hypotheses testing				
	For constructs for which a gold standard was not available:				
8	Were hypotheses about changes in scores formulated a priori (i.e. before data collection)?	Hypotheses formulated a priori		Hypotheses vague or not formulated but possible to deduce what was expected	Unclear what was expected
9	Was the expected *direction* of correlations or mean differences of the change scores of HR-PRO instruments included in these hypotheses?	Expected direction of the correlations or differences stated	Expected direction of the correlations or differences NOT stated		
10	Were the expected absolute or relative *magnitude* of correlations or mean differences of the change scores of HR-PRO instruments included in these hypotheses?	Expected magnitude of the correlations or differences stated	Expected magnitude of the correlations or differences NOT stated		

11	Was an adequate description provided of the comparator instrument(s)?	Adequate description of the constructs measured by the comparator instrument(s)		Poor description of the constructs measured by the comparator instrument(s)	NO description of the constructs measured by the comparator instrument(s)
12	Were the measurement properties of the comparator instrument(s) adequately described?	Adequate measurement properties of the comparator instrument(s) in a population similar to the study population	Adequate measurement properties of the comparator instrument(s) but not sure if these apply to the study population	Some information on measurement properties (or a reference to a study on measurement properties) of the comparator instrument(s) in any study population	NO information on the measurement properties of the comparator instrument(s)
13	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study (e.g. only data presented on a comparison with an instrument that measures another construct)	Other important methodological flaws in the design or execution of the study
	Statistical methods				
14	Were design and statistical methods adequate for the hypotheses to be tested?	Statistical methods applied appropriate		Statistical methods applied NOT optimal	Statistical methods applied NOT appropriate

	Design requirement for comparison to a gold standard				
	For constructs for which a gold standard was available:				
15	Can the criterion for change be considered as a reasonable gold standard?	Criterion used can be considered an adequate 'gold standard' (evidence provided)	No evidence provided, but assumable that the criterion used can be considered an adequate 'gold standard'	Unclear whether the criterion used can be considered an adequate 'gold standard'	Criterion used can NOT be considered an adequate 'gold standard'
16	Were there any important flaws in the design or methods of the study?	No other important methodological flaws in the design or execution of the study		Other minor methodological flaws in the design or execution of the study	Other important methodological flaws in the design or execution of the study
	Statistical methods				
17	for continuous scores: Were correlations between change scores, or the area under the Receiver Operator Curve (ROC) curve calculated?	Correlations or Area under the ROC Curve (AUC) calculated			Correlations or AUC NOT calculated
18	for dichotomous scales: Were sensitivity and specificity (changed versus not changed) determined?	Sensitivity and specificity calculated			Sensitivity and specificity NOT calculated

Interpretability

We recommend to use the Interpretability box to extract all information on the interpretability issues described in this box of the instruments under study from the included articles.

Box Interpretability	
Percentage of missing items	
Description of how missing items were handled	
Distribution of the (total) scores	
Percentage of the respondents who had the lowest possible (total) score	
Percentage of the respondents who had the highest possible (total) score	
Scores and change scores (i.e. means and SD) for relevant (sub) groups, e.g. for normative groups, subgroups of patients, or the general population	
Minimal Important Change (MIC) or Minimal Important Difference (MID)	

Generalizability

We recommend to use the Generalizability box to extract data on the characteristics of the study populations and sampling procedures of the included studies.

Box Generalisability	
Median or mean age (with standard deviation or range)	
Distribution of sex	
Important disease characteristics (e.g. severity, status, duration) and description of treatment	
Setting(s) in which the study was conducted (e.g. general population, primary care or hospital/rehabilitation care)	
Countries in which the study was conducted	
Language in which the HR-PRO instrument was evaluated	
Method used to select patients (e.g. convenience, consecutive, or random)	
Percentage of missing responses (response rate)	

Appendix 3.4: STROBE statement for reporting validation study

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	154
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	iii-v
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	154-156
Objectives	3	State specific objectives, including any prespecified hypotheses	156
Methods			
Study design	4	Present key elements of study design early in the paper	156-159
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	159-161
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	159-161
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	162
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	162-165
Bias	9	Describe any efforts to address potential sources of bias	162
Study size	10	Explain how the study size was arrived at	159-160
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	162-165
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	165-166
		(*b*) Describe any methods used to examine subgroups and interactions	166
		(*c*) Explain how missing data were addressed	165
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	167
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	167-168
		(b) Indicate number of participants with missing data for each variable of interest	168-169
Outcome data	15*	Report numbers of outcome events or summary measures	168-171
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	168-169
		(*b*) Report category boundaries when continuous variables were categorized	172-173
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	169-172
Discussion			
Key results	18	Summarise key results with reference to study objectives	173
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	177-178
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	173-176
Generalisability	21	Discuss the generalisability (external validity) of the study results	177-178
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	vii

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Appendix 3.5: Pleasant's evaluation principles for health literacy measurement

To build a new and comprehensive approach to measuring health literacy, Pleasant *et al.* (1) proposed a research agenda that recommended seven evaluation principles for health literacy measurement in 2011. These evaluation principles included:

- ✓ **Recommendation 1: Explicitly built on a conceptual framework of health literacy**

  In this PhD research, two conceptual frameworks were used to measure health literacy. The first conceptual framework was Nutbeam's three-domain health literacy model (2) which explained the construct of health literacy. The second conceptual framework was Manganello's health literacy framework (3) which elaborated the relationships between health literacy and other variables such as socio-economic status.

- ✓ **Recommendation 2: Multi-dimensional in content and methodology**

  In this PhD research, health literacy had three dimensions including functional, interactive and critical. As for methodology used in this PhD research, two ways were considered. One way was that multiple measures of health literacy (i.e. the HLAT-8, the NVS and the HLS) were used in a single study. This way could assist researchers to capture the status of students' health literacy from different perspectives (4). The other way for considering the multi-dimensional nature of methodology was that two forms (i.e. online survey, and paper-and-pencil survey) of data collection were used in this PhD research. However, the online survey was only conducted among Australian secondary students, and the paper-and-pencil survey was only conducted among Chinese secondary students.

- ✓ **Recommendation 3: Measure health literacy on a continual basis**

  In this PhD research, the 8-item Health Literacy Assessment Tool (HLAT-8) was used to measure health literacy in both Australian and Chinese secondary students. Health literacy was measured based on a continuous score.

- ✓ **Recommendation 4: Treat health literacy as a 'latent construct'**

  In this PhD research, health literacy was treated as a latent construct in the univariate analysis, correlation analysis and path analysis.

- ✓ **Recommendation 5: Honour the principle of compatibility**

In this PhD research, the content of the HLAT-8 was piloted on both Chinese and Australian secondary students. The wording and content of questions were appropriate to the context of the field use (i.e. secondary schools).

- ✓ **<u>Recommendation 6: Allow comparison across different contexts including population groups and cultures</u>**

  In this PhD research, health literacy measurement was considered for both Chinese and Australian secondary students.

- ✓ **<u>Recommendation 7: Prioritise public health applications versus clinical screening</u>**

  This PhD research targeted secondary schools as research settings. Therefore, health literacy measurement occurred in the public health context rather than in clinical settings. The findings from this PhD research can be used to inform school health education, practice and policies. Further details are outlined in Chapter 8: Implications for future research, practice and policy.

References

1. Pleasant A, McKinney J, Rikard RV. Health Literacy Measurement: A Proposed Research Agenda. J Health Commun. 2011;16(sup3):11-21.
2. Nutbeam D. Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century. Health Promot Int. 2000;15(3):259-67.
3. Manganello J. Health literacy and adolescents: a framework and agenda for future research. Health Educ Res. 2008;23(5):840-7.
4. McCormack L, Haun J, Sørensen K, Valerio M. Recommendations for Advancing Health Literacy Measurement. J Health Commun. 2013;18(sup1):9-14.

Appendix 3.6: STROBE statement for reporting model testing study

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic		Item #	Recommendation	Reported on page #
Title and abstract		1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	180
			(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	iii-v
Introduction				
Background/rationale		2	Explain the scientific background and rationale for the investigation being reported	180-181
Objectives		3	State specific objectives, including any prespecified hypotheses	181
Methods				
Study design		4	Present key elements of study design early in the paper	181-182
Setting		5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	183
Participants		6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	183
Variables		7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	183; Table 5.8
Data sources/ measurement		8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	184-190
Bias		9	Describe any efforts to address potential sources of bias	183
Study size		10	Explain how the study size was arrived at	183
Quantitative variables		11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	184-189
Statistical methods		12	(*a*) Describe all statistical methods, including those used to control for confounding	191-193
			(*b*) Describe any methods used to examine subgroups and interactions	191-192
			(*c*) Explain how missing data were addressed	191
			(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
			(*e*) Describe any sensitivity analyses	192

Results				
Participants		13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	193
			(b) Give reasons for non-participation at each stage	N/A
			(c) Consider use of a flow diagram	N/A
Descriptive data		14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	193
			(b) Indicate number of participants with missing data for each variable of interest	191
Outcome data		15*	Report numbers of outcome events or summary measures	194-195
Main results		16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	195-215
			(*b*) Report category boundaries when continuous variables were categorized	N/A
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses		17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	216
Discussion				
Key results		18	Summarise key results with reference to study objectives	216-217
Limitations		19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	222-223
Interpretation		20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	217-222
Generalisability		21	Discuss the generalisability (external validity) of the study results	222
Other information				
Funding		22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	vii

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Appendix 3.7: STROBE statement for reporting pilot study

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	226
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	iii-v
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	226-228
Objectives	3	State specific objectives, including any prespecified hypotheses	228
Methods			
Study design	4	Present key elements of study design early in the paper	228-229
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	229-230
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	229-230
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	230
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	231-233
Bias	9	Describe any efforts to address potential sources of bias	230
Study size	10	Explain how the study size was arrived at	229
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	231-233
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	234
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	233-234

		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	239-240
		(b) Give reasons for non-participation at each stage	235
		(c) Consider use of a flow diagram	235
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	239-240
		(b) Indicate number of participants with missing data for each variable of interest	234
Outcome data	15*	Report numbers of outcome events or summary measures	234-242
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	241-242
		(*b*) Report category boundaries when continuous variables were categorized	242
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	234; 242
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	246-247
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	235-239; 243-246
Generalisability	21	Discuss the generalisability (external validity) of the study results	247
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	vii

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Appendix 4.1: Search strategy for seven databases

1 MEDLINE (Web of Science) search strategy

MEDLINE database was searched using the Web of Science interface on 16/05/2014 for the period 1974 to 2014.

Basic search:

Set	Results	
# 1	500	**MeSH HEADING:** (health literacy) *OR* ((**TITLE:** (health literacy) *OR* **MeSH HEADING:exp:** (Health Literacy)) *AND* (**TITLE:** (education) *OR* **MeSH HEADING:exp:** (Educational Status) *OR* **MeSH HEADINGS:exp:** (/education) *OR* **MeSH HEADING:exp:** (Teaching) *OR* **MeSH HEADING:exp:** (Educational Status) *OR* **MeSH HEADING:exp:** (Education))) **Refined by: MeSH HEADINGS:** (ADOLESCENT OR YOUNG ADULT OR CHILD) Indexes=MEDLINE Timespan=1974-2014
# 2	3,880	**TOPIC:** ((((health) literacy assess* OR health literacy measur*) OR health literacy evaluat*) OR health literacy instrument*) OR health literacy tool*) Indexes=MEDLINE Timespan=1974-2014
# 3	352	#2 AND #1 Indexes=MEDLINE Timespan=1974-2014

2 PubMed search strategy

PubMed database was searched (Advanced search) on 16/05/2014 for the period 1974 to 16/05/2014.

Set	Results	
# 1	4910	Search **(health literacy[MeSH Terms]) OR (health AND education AND literacy[Title/Abstract])** Sort by: **PublicationDate**
# 2	3248385	Search **(child* OR adolescent* OR student* OR youth OR young people OR teen* OR young adult[Title/Abstract])** Sort by: **PublicationDate** **Because if we select age group including child, adolescent, and young adult, the newest papers such as published in 2014 will not be included, the reason maybe the database doesn't update properly. So we use these terms to identify.**
# 3	1887	Search **(health literacy assess* OR health literacy measur* OR health literacy evaluat* OR health literacy instrument* OR health literacy tool*)** Sort by: **PublicationDate**
# 4	581	Search **((((health literacy[MeSH Terms]) OR (health AND education AND literacy[Title/Abstract]))) AND ((health literacy assess* OR health literacy measur* OR health literacy evaluat* OR health literacy instrument* OR health literacy tool*))) AND ((child* OR adolescent* OR student* OR youth OR young people OR teen* OR young adult[Title/Abstract]))** Filters: **Publication date from 1974/01/01 to 2014/05/16** Sort by: **PublicationDate**

3 EMBASE (Ovid) search strategy

EMBASE database was searched using Ovid interface on 16/05/2014 for the period 1974 to current.

Using **.mp** as searching terms (Advanced Search):

Set	Results	
#1	6060	("health literacy" or (health and literacy and education)).mp.
#2	6043	limit 1 to yr="1974 -Current"
#3	671	limit 2 to (school child <7 to 12 years> or adolescent <13 to 17 years>)
#4	170	(health literacy assess* or health literacy measur* or health literacy evaluat* or health literacy instrument* or health literacy tool*).mp.
#5	170	limit 4 to yr="1974 -Current"
#6	18	3 and 5

4 PsycINFO (EBSCO) search strategy

PsycINFO database was searched using EBSCO interface on 16/05/2014 for the period January 1974 to May 2014.

Advanced Search:

Set	Results		
#1	786	health literacy OR (health AND literacy AND education)	Limiters - Published Date: 19740101-20140531; Age Groups: School Age (6-12 yrs), Adolescence (13-17 yrs), Young Adulthood (18-29 yrs) Search modes - Boolean/Phrase
#2	133	health literacy assess* or health literacy measur* or health literacy evaluat* or health literacy instrument* or health literacy tool*	Limiters - Published Date: 19740101-20140531; Age Groups: School Age (6-12 yrs), Adolescence (13-17 yrs), Young Adulthood (18-29 yrs) Search modes - Boolean/Phrase
#3	133	(health literacy assess* or health literacy measur* or health literacy evaluat* or health literacy instrument* or health literacy tool*) AND (S1 AND S2)	Search modes - Boolean/Phrase

5 CINAHL (EBSCO) search strategy

CINAHL database was searched using EBSCO interface on 16/05/2014 for the period January 1974 to May 2014.

Advanced Search:

Set	Results		
#1	437	health literacy OR (health AND education AND literacy)	Limiters - Published Date: 19740101-20140531; Age Groups: Child: 6-12 years, Adolescent: 13-18 years Search modes - Boolean/Phrase
#2	63	health literacy assess* or health literacy measur* or health literacy evaluat* or health literacy instrument* or health literacy tool*	Limiters - Published Date: 19740101-20140531; Age Groups: Child: 6-12 years, Adolescent: 13-18 years Search modes - Boolean/Phrase
#3	63	(health literacy assess* or health literacy measur* or health literacy evaluat* or health literacy instrument* or health literacy tool*) AND (S1 AND S2)	Search modes - Boolean/Phrase

6 ERIC (EBSCO) search strategy

ERIC database was searched using EBSCO interface on 16/05/2014 for the period January 1974 to May 2014.

Advanced Search:

Set	Results		
#1	59	health literacy assess* or health literacy measur* or health literacy evaluat* or health literacy instrument* or health literacy tool*	Limiters - Date Published: 19740101-20140531 Search modes - Boolean/Phrase
#2	2,250	health literacy OR (health AND education AND literacy)	Limiters - Date Published: 19740101-20140531 Search modes - Boolean/Phrase
#3	59	S1 AND S2	Search modes - Boolean/Phrase

7 The Cochrane Library search strategy

The Cochrane Library database was searched on 30/05/2014 for the period January 1974 to May 2014.

Set	Results	Sub-database
#1	4	Cochrane Reviews: There are 4 results from 8483 records for your search on 'health literacy in Title, Abstract, Keywords and child* OR adolescent* OR student* OR teen* OR youth OR young adult OR young people in Title, Abstract, Keywords and health literacy assess* or health literacy measur* or health literacy evaluat* or health literacy instrument* or health literacy tool* in Title, Abstract, Keywords, Publication Date from 1974 to 2014 in Cochrane Reviews'
#2	114	Trials: There are 114 results from 789657 records for your search on 'health literacy in Title, Abstract, Keywords and child* OR adolescent* OR student* OR teen* OR youth OR young adult OR young people in Title, Abstract, Keywords and health literacy assess* or health literacy measur* or health literacy evaluat* or health literacy instrument* or health literacy tool* in Title, Abstract, Keywords, Publication Date from 1974 to 2014 in Trials'
#3	2	Methods Studies: There are 2 results from 15764 records for your search on 'health literacy in Title, Abstract, Keywords and child* OR adolescent* OR student* OR teen* OR youth OR young adult OR young people in Title, Abstract, Keywords and health literacy assess* or health literacy measur* or health literacy evaluat* or health literacy instrument* or health literacy tool* in Title, Abstract, Keywords, Publication Date from 1974 to 2014 in Methods Studies'
#4	120	

Appendix 4.2: Reliability and validity results for included instruments

Appendix Table 2: The methodological quality of each study based on reliability for each health literacy instrument

Instrument	Internal consistency		Reliability			
	Result	COSMIN score	Result	Design	Time interval	COSMIN score
NVS (Warsh *et al.*, 2014)	na	na	na			na
NVS (Driessnack *et al.*, 2014)	α=0.71 (n=47)	Poor	na			na
NVS (Hoffman *et al.*, 2013)	α=0.67 (n=229)	Poor	na			na
c-sTOFHLAd (Chang *et al.*, 2012)	α=0.85 (n=300) Item-total correlation=0.44-0.86	Fair	Correlation of test and retest was 0.95 (P<0.001)	Test-retest	1 week	Fair
TOFHLA (Chisolm and Buchanan, 2007)	na	na	na			na
s-TOFHLA (Hoffman *et al.*, 2013)	α=0.89 (n=229)	Poor	na			na
REALM-Teen (Davis *et al.*, 2006)	α=0.94 (n=388)	Poor	γ=0.98	Test-retest	1 week	Fair
REALM-Teen (Hoffman *et al.*, 2013)	α=0.92 (n=229)	Poor	na			
HLAB (Wu *et al.*, 2010)	α=0.92 (n=275) Understanding α=0.88 (n=275) Evaluating α=0.82 (n=275)	Fair	Concordance rate=95%	Inter-rater	na	Poor
MMAHL(Massey *et al.*, 2013)	α=0.83 (n=1208) Item-total correlation=0.39-0.74	Good	na			na
MHL (Levin-Zamir *et al.*, 2011)	α=0.74 (n=1316) Coefficient of reproducibility=0.84 Coefficients of scalability=0.54-0.80	Poor	na			na
DNT-39 (Mulvaney *et al.*, 2013)	α=0.93 (n=61)	Fair	na			na
DNT-14 (Mulvaney *et al.*, 2013)	α=0.82 (n=133)	Fair	na			na

Instrument	Internal consistency		Reliability			
	Result	COSMIN score	Result	Design	Time interval	COSMIN score
	α=0.80 (n=61) α=0.83 (n=72)					
eHEALS (Norman and Skinner, 2006)	α=0.88 (n=664) Item-scale correlation coefficient=0.51-0.76	Fair	The correlations between administrations ranged 0.68-0.40.	Test-retest	Immediately after the intervention; 3-month; 6-month	Fair
CHC Test (Steckelberg *et al.*, 2009)	na	na	Cohen's Kappa was excellent for 277 ratings (κ=0.9-1.0), moderate or good for 31 ratings (κ=0.7-0.89) and poor for 5 ratings (κ=<0.7)	Inter-rater	na	Poor
HKACSS (Schmidt *et al.*, 2010)	Health knowledge χ^2=6.45, *P*=0.17 (n=852) Health communication α=0.73 (n=852) Health attitudes α=0.57 (n=852)	Excellent	na			na
HLAT-51 (Harper, 2014)	Goodness of fit statistic was calculated by each domain (CFI=0.33-0.88; TLI=0.66-0.84; RMSEA=0.09-0.17). The internal consistency statistic was not calculated.	Poor	na			na
HLAT-8 (Abel *et al.*, 2014)	α=0.64 (n=7097 for male) α=0.65 (n=331 for female)	Excellent	na			na

Note: na, no information available. CFI, Comparative Fit Index; CHC Test, the Critical Health Competence Test; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; DNT, the Diabetes Numeracy Test; eHEALS, the eHealth Literacy Scale; HKACSS, the Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; HLAT-8, the 8-item Health Literacy Assessment Tool; HLAT-51, the 51-item Health Literacy Assessment Tool; MHL, the Media Health Literacy; MMAHL, the Multidimensional Measure of Adolescent Health Literacy; NVS, the Newest Vital Sign; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; RMSEA, Root Mean Square Error of Approximation; s-TOFHLA, the short-form Test of Functional Health Literacy in Adults; TLI, Tucker-Lewis Index; TOFHLA, the Test of Functional Health Literacy in Adults.

Appendix Table 3: The methodological quality of each study based on validity for each health literacy instrument

Instrument	Content validity		Structural validity		Hypotheses-testing		Cross-cultural validity	
	Results	**COSMIN score**	**Results**	**COSMIN score**	**Results**	**COSMIN score**	**Results**	**COSMIN score**
NVS (Warsh *et al.*, 2014)	A panel of heath literacy experts developed the NVS according to previous experience. The NVS was then refined after feedback from patients, interviewers, and data analysts. No target population is involved in this study.	Poor	na	na	Hypotheses regarding correlation between scores of a comparator instrument of Gray Silent Reading Test (GSRT) and NVS were formulated before data collection. The NVS and GSRT scores were highly correlated (ρ=0.71, p<0.0001). The NVS score increased with child age (ρ=0.53, p<0.0001).	Fair	na	na
NVS (Driessnack *et al.*, 2014)	A panel of heath literacy experts developed the NVS according to previous experience. The NVS was then refined after feedback from patients, interviewers, and data analysts. No target population is involved in this study.	Poor	na	na	A moderate positive correlation was found between children's NVS scores and their age, and between children's NVS scores and their reports of books numbers (γ_s=0.43, p=0.003; γ_s=0.36, p=0.012, respectively), but not found with their parents' report of the number of children's books at home (γ_s=0.06, p=0.671).	Poor	na	na
NVS (Hoffman *et al.*, 2013)	A panel of heath literacy experts developed the NVS according to previous experience. The NVS was then refined after feedback from patients, interviewers, and data analysts. No target population is involved in this study.	Poor	na	na	Convergent validity was measured between NVS and the TerraNova academic achievement test, with a correlation coefficient of 0.49 (p<0.01).	Fair	na	na

Instrument	Content validity		Structural validity		Hypotheses-testing		Cross-cultural validity	
	Results	**COSMIN score**	**Results**	**COSMIN score**	**Results**	**COSMIN score**	**Results**	**COSMIN score**
c-sTOFHLAd (Chang *et al.*, 2012)	The c-sTOFHLAd was translated from the short-version of TOFHLA according to translation procedures and was tested among 30 adolescents to ensure appropriateness.	Good	Confirmatory factor analysis was conducted to determine structural validity. One-factor model indicated an acceptable fit to the data according structural equation modelling analysis.	Fair	Convergent validity was measured between c-sTOFHLAd and the rapid estimate of adult literacy in medicine (REALM), with a correlation coefficient of 0.74 (p<0.001).	Fair	Semantic equivalence was measured by the content validity index (CVI). All items were rated by the experts as having a CVI>0.85. Thirty adolescents were chosen to determine and ensure the cultural congruence of the instrument.	Fair
TOFHLA (Chisolm and Buchanan, 2007)	The TOFHLA was developed from a literacy expert after reviewing commonly used hospital texts and a pilot test. No target population is involved in this study.	Poor	na	na	The reading comprehension component (TOFHLA-R) was significantly collated with the Wide-Ranging Achievement Test (WRAT3) and the rapid estimate of adult literacy in medicine (REALM) (ρ=0.59, p<0.001; ρ=0.60, p<0.001 respectively), however, no correlation were found with the numeracy component (TOFHLA-N) (ρ=0.11, p=0.45; ρ=0.18, p=0.22 respectively).	Fair	na	na
s-TOFHLA (Hoffman *et al.*, 2013)	The s-TOFHLA was developed based on previous data analysis, perceived importance and frequency of the task in the healthcare settings.	Poor	na	na	Convergent validity was measured between NVS and the TerraNova academic achievement test, with a correlation coefficient of 0.28 (p<0.01).	Fair	na	na
REALM-Teen	The REALM-Teen was developed based on a	Good	na	na	Convergent validity was measured between REALM-	Fair	na	na

Instrument	Content validity		Structural validity		Hypotheses-testing		Cross-cultural validity	
	Results	**COSMIN score**	**Results**	**COSMIN score**	**Results**	**COSMIN score**	**Results**	**COSMIN score**
(Davis *et al.*, 2006)	preliminary test and a structured interview among adolescents. And a panel of experts reviewed the word list.				Teen and the WRAT-3 (r=0.83) and SORT-R (r=0.93).			
REALM-Teen (Hoffman *et al.*, 2013)	The REALM-Teen was developed based on a preliminary test and structured interview among adolescents. And a panel of experts reviewed the word list.	Poor	na	na	Convergent validity was measured between NVS and the TerraNova academic achievement test, with a correlation coefficient of 0.40 (*p*<0.01).	Poor	na	na
HLAB (Wu *et al.*, 2010)	Previous experience and literature review were used to develop items; 10 students were pilot-tested for appropriateness of wording, content and format of the final instrument.	Good	na	na	Correlations were assumed between socio-demographic variables and the overall scores. Socio-demographics of gender, age when came to Canada to live, speaking a language other than English were correlated with the scores of HLAB (β=-0.18, *p*=0.004; β=-0.22, *p*=0.014; β=-0.20, *p*=0.008 respectively). No convergent validity is assessed.	Fair	na	na
MMAHL (Massey *et al.*, 2013)	Domains were established from literature review and focus group. Items were developed either using adaptation of existing relevant items or created by the research team.	Good	Explorative principal components factor analysis was conducted and 49.8% of the variance was accounted by 6 factors.	Good	na	na	na	na
MHL (Levin-	The face validity was discussed in the focus	Good	na	na	As hypothesised, MHL was associated with socio-economic	Good	na	na

Instrument	Content validity		Structural validity		Hypotheses-testing		Cross-cultural validity	
	Results	**COSMIN score**	**Results**	**COSMIN score**	**Results**	**COSMIN score**	**Results**	**COSMIN score**
Zamir *et al.*, 2011)	group during pilot test. The content validity was analysed using theory and operational definitions of health literacy and media literacy, and adolescents were invited to write detailed, anonymous responses.				determinants, particularly with gender (β=1.25, $p<0.001$) and mother's education (β=0.16, $p=0.04$). In addition, MHL was also associated with health behaviours (β=0.03, $p=0.05$) and health empowerment (β=0.36, $p<0.001$).			
DNT-39 (Mulvaney *et al.*, 2013)	The DNT-39 was developed from the original 43-item version DNT-43 by eliminating questions specific to type 2 diabetes. An expert team developed the DNT-43 and refined it.	Poor	na	na	The DNT-39 was associated with WRAT-3 and parent education (ρ=0.40, $p=0.001$; ρ=0.29, $p=0.028$ respectively)	Fair	na	na
DNT-14 (Mulvaney *et al.*, 2013)	The DNT-14 was developed from the original 15-item version DNT-15 by eliminating 1 question specific to type 2 diabetes. An expert team developed the DNT-15 by data analysis from DNT-43.	Poor	na	na	The DNT-14 was associated with the Wide-Ranging Achievement Test (WRAT3), parent education, diabetes problem solving and HbA1c (ρ=0.36, $p=0.005$; ρ=0.31, $p=0.019$; ρ=0.27, $p=0.023$; ρ=-0.34, $p=0.004$ respectively)	Fair	na	na
eHEALS (Norman and Skinner, 2006)	The eHEALS was developed by the expert team and pilot-tested and refined by feedback from participants.	Good	Explorative principal components factor analysis was conducted and 56% of the variance was accounted by a single factor. The factor loadings ranged from 0.60-0.84 among the 8	Fair	Correlations were assumed between eHEALS and other measured variables (gender, age, use of information technology overall, self-evaluations of health). However, only gender difference was found at baseline level of eHealth literacy	Fair	na	na

Instrument	Content validity		Structural validity		Hypotheses-testing		Cross-cultural validity	
	Results	COSMIN score	Results	COSMIN score	Results	COSMIN score	Results	COSMIN score
			items.		(t=2.236, *p*=0.026). No convergent validity is assessed.			
CHC Test (Steckelberg *et al.*, 2009)	The CHC Test was developed by the research team and pre-tested by collecting qualitative data and quantitative field test.	Good	IRT test for determining dimensionality was performed.	Poor	na	na	na	na
HKACSS (Schmidt *et al.*, 2010)	The HKACSS items were taken from a previous health survey and selected basing on consideration of item content.	Good	na	na	As hypothesised, health communication, attitudes and self-efficacy were significantly related to each other (ρ=0.15-0.38, P<0.05). And children from higher educational background showed a better knowledge and communicated more about health topics (β=0.16, p<0.05).	Good	na	na
HLAT-51 (Harper, 2014)	The expert team evaluated the initial items using a 5-point Likert scale according to their research experience. And 144 college students were invited to complete a pilot test.	Good	Comprehension (CFI=0.80; TLI=0.78; RMSEA=0.09); health numeracy (CFI=0.57; TLI=0.48; RMSEA=0.09); media literacy (CFI=0.88; TLI=0.84; RMSEA=0.07); digital literacy (CFI=0.33; TLI=0.06; RMSEA=0.16); health information seeking (CFI=0.80; TLI=0.66; RMSEA=0.17)	Poor	na		na	na

Instrument	Content validity		Structural validity		Hypotheses-testing		Cross-cultural validity	
	Results	COSMIN score	Results	COSMIN score	Results	COSMIN score	Results	COSMIN score
HLAT-8 (Abel *et al.*, 2014)	The research team developed the HALT-8 drawing on literature review and their own experience. No target population is involved in this study.	Poor	Explorative principal components factor analysis was conducted and 72.96% of the variance was accounted by four factors among male. In addition, the factor structure was validated using confirmatory factor analysis (CFI=0.99; TLI=0.97; RMSEA=0.03; SRMR=0.03).	Excellent	Hypotheses were formulated a priori regarding correlations between health literacy and gender, socio-cultural characteristics and health values. Results showed that female, higher educational status, and a stronger health valuation were associated with higher HL scores (p<0.05, respectively).	Good	na	na

Note: na, no information available. CFI, Comparative Fit Index; CHC Test, the Critical Health Competence Test; c-sTOFHLAd, the Chinese version of short-form Test of Functional Health Literacy in Adolescents; DNT, the Diabetes Numeracy Test; eHEALS, the eHealth Literacy Scale; HKACSS, the Health Knowledge, Attitudes, Communication and Self-efficacy Scale; HLAB, Health Literacy Assessment Booklet; HLAT-8, the 8-item Health Literacy Assessment Tool; HLAT-51, the 51-item Health Literacy Assessment Tool; MHL, the Media Health Literacy; MMAHL, the Multidimensional Measure of Adolescent Health Literacy; NVS, the Newest Vital Sign; REALM-Teen, the Rapid Estimate of Adolescent Literacy in Medicine; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Square Residual; SORT-R, Slosson Oral Reading Test-Revised; s-TOFHLA, the short-form Test of Functional Health Literacy in Adults; TLI, Tucker-Lewis Index; TOFHLA, the Test of Functional Health Literacy in Adults; WRAT-3, Wide-Range Achievement Test-Revised.

Appendix 5.1: Ethics from University of Melbourne

THE UNIVERSITY OF MELBOURNE

10 September 2015

Prof Elizabeth Waters
Melbourne School of Population and Global Health
The University of Melbourne

Dear Prof Waters

I am pleased to advise that the Health Sciences Human Ethics Sub-Committee approved the following Project:

Project title:	**Understanding and Measuring Adolescent Health Literacy From a Cross-cultural Perspective**
Researchers:	**Ms R L Armstrong, Prof. X Yu, Prof E Waters, S Guo**
Ethics ID:	**1442884**

The Project has been approved for the period: **10-Sep-2015 to 31-Dec-2015**

It is your responsibility to ensure that all people associated with the Project are made aware of what has actually been approved.

Research projects are normally approved to 31 December of the year of approval. Projects may be renewed yearly for up to a total of five years upon receipt of a satisfactory annual report. If a project is to continue beyond five years a new application will normally need to be submitted.

Please note that the following conditions apply to your approval. Failure to abide by these conditions may result in suspension or discontinuation of approval and/or disciplinary action.

(a) **Limit of Approval:** Approval is limited strictly to the research as submitted in your Project application.

(b) **Variation to Project:** Any subsequent variations or modifications you might wish to make to the Project must be notified formally to the Human Ethics Sub-Committee for further consideration and approval. If the Sub-Committee considers that the proposed changes are significant, you may be required to submit a new application for approval of the revised Project.

(c) **Incidents or adverse effects:** Researchers must report immediately to the Sub-Committee anything which might affect the ethical acceptance of the protocol including adverse effects on participants or unforeseen events that might affect continued ethical acceptability of the Project. Failure to do so may result in suspension or cancellation of approval.

(d) **Monitoring:** All projects are subject to monitoring at any time by the Human Research Ethics Committee.

(e) **Annual Report:** Please be aware that the Human Research Ethics Committee requires that researchers submit an annual report on each of their projects at the end of the year, or at the conclusion of a project if it continues for less than this time. Failure to submit an annual report will mean that ethics approval will lapse.

(f) **Auditing:** All projects may be subject to audit by members of the Sub-Committee.

If you have any queries on these matters, or require additional information, please contact me using the details below.

Please quote the ethics registration number and the title of the Project in any future correspondence.

On behalf of the Sub-Committee I wish you well in your research.

Yours sincerely

HYoung

Ms Hilary Young - Secretary
Health Sciences HESC
Phone: 03 8344 8595, Email: hilary.young@unimelb.edu.au

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Appendix 5.2: Ethics from Peking University Health Science Centre

15024 伦理审查批件　　　　PU IRB_OF 15_v2 （2013-8-1）

北京大学生物医学伦理委员会（PU IRB）

伦理审查批件

伦理审查批件号：IRB00001052-15024

受理号	2015020（公卫）-复 1		
项目全称	以社会生态学模型为基础的青少年健康素养研究		
经费来源	北京市教育科学“十二五”规划课题 AHA12107		
项目负责人	余小鸣		
项目负责人所在单位	北京大学医学部儿童青少年卫生研究所		
审查类别	复审	审查方式	非会议审查
审查文件	详见附件“审查文件清单”		

审查意见：

依据世界医学会《赫尔辛基宣言》、国际医学科学组织委员会《涉及人的生物医学研究国际伦理准则》、《药物临床试验质量管理规范》、《涉及人体的生物医学研究伦理审查办法（试行）》、《药物临床试验伦理审查工作指导原则》、等法律、法规、规章、规范性文件和国际准则，以及北京大学受试者保护体系相关政策，经本伦理委员会审查，同意按研究方案开展本项研究。

请遵循伦理委员会批准的方案开展研究，保护受试者的健康与权益。

1. 研究过程中若变更项目负责人，对研究方案、知情同意书、病例报告表、调查问卷、招募材料等的任何修改，请提交修正案审查申请；
2. 请按照相关法律法规规定以及研究方案中对于安全性事件报告计划，及时向北京大学生物医学伦理委员会提交书面不良事件报告；
3. 研究者没有遵从方案开展研究，可能对受试者的权益/健康、以及研究的科学性造成不良影响，请提交违规事件报告；
4. 申请人暂停或提前终止临床研究，请及时提交暂停/中止研究报告；
5. 研究结束时，请提交结题报告。
6. 本批件自批准之日起一年内有效，请至少在失效日期前 1 个月提交持续审查申请。

批准日期	2015-6-5	批件失效日期	2016-6-4
主任委员签字	[illegible]	签署日期	2015.6.8

附件：审查文件清单

北京大学生物医学伦理委员会办公室：北京大学医学部逸夫教学楼 501 室（海淀区学院路 38 号）
电话：010-82805751　　Email: llwyh@bjmu.edu.cn

1/2

文件名称（请注明版本号及版本日期）
1. 复审申请表（签字、签署日期）
2. 研究方案（版本号：3.0；版本日期：2015.05.13）（签字、签署日期）
3. 附件 2-家长告知信（版本号：3.0；版本日期：2015.05.13）
4. 附件 3-调查问卷（版本号：3.0；版本日期：2015.05.13）
5. 附件 4-访谈提纲（版本号：3.0；版本日期：2015.05.13）
6. 附件 5-调查问卷设计结构与依据（版本号：3.0；版本日期：2015.05.13）
7. 附件 6-墨尔本市教育部伦理审查同意证件（版本号：3.0；版本日期：2015.05.13）

北京大学生物医学伦理委员会办公室：北京大学医学部逸夫教学楼 501 室（海淀区学院路 38 号）
电话：010-82805751 Email: llwyh@bjmu.edu.cn

Appendix 5.3: Research protocol in Beijing schools

以社会生态学模型为基础的青少年健康素养研究

北京现场实施方案与细则

2015 年 10 月 13 日

课题名称：以社会生态学模型为基础的青少年健康素养研究

课题类型：墨尔本大学博士生郭帅军研究课题

课题负责人：余小鸣 教授　郭帅军 博士研究生

课题负责人单位：北京大学医学部儿童青少年卫生研究所

墨尔本大学全球公共卫生学院

课题现场时间：2015 年 11 月 12 日-12 月 4 日

一、课题背景

近年来，关注儿童青少年健康素养，已成为当今世界各国促进公共卫生的重点。以往研究显示，促进和发展个人健康素养，可以有效减少疾病负担，促进全民健康。儿童青少年作为国家未来的生力军，其健康状况直接关系国民健康与社会稳定。为进一步促进以学校为基础的儿童青少年健康素养改善项目，本研究借鉴社会生态学理论模型，以北京市初中生为研究对象，探索儿童青少年健康素养状况、影响因素及健康结局之间的相关性。

二、课题目的

（1） 了解北京市初中生健康素养现况，以健康素养的角度评价学校健康教育的水平；

（2） 以理论模型为研究框架，探索初中生健康素养、影响因素及其健康结局的相关性。

三、调查对象

北京市西城区和通州区初中生（共 480 人）

四、调查方法

本研究调查方法为**问卷调查**，具体实施内容如下：

- **调查时间：**2015 年 11 月
- **调查对象：**初一、初二和初三学生
- **调查学校及样本量：** 为保证样本代表性，本研究参照 2010 年北京市学生体质与健康调研的现场抽样方法选择学校，同时，研究者旨在比较不同地区经济发展水平与学生健康素养的相关性，研究者根据北京市统计局发布的城镇居民收支情况，最终确定西城区和通州区。根据学校规模，确定在研究者在西城区和通州区各选取两所学校，样本量分布具体见表 1。共调查 4 所初中，每个初中样本量为 120 人，男女比例均等。每区县各 240 人，共 480 人。

表 1 计划调查学校名单

<table>
<tr><th>城乡</th><th>学校</th><th>年级</th><th>小计（人）</th><th>总计（人）</th></tr>
<tr><td rowspan="6">西城区
（城区）</td><td rowspan="3">徐悲鸿中学</td><td>初一</td><td>40</td><td rowspan="3">120</td></tr>
<tr><td>初二</td><td>40</td></tr>
<tr><td>初三</td><td>40</td></tr>
<tr><td rowspan="3">北京市 43 中学</td><td>初一</td><td>40</td><td rowspan="3">120</td></tr>
<tr><td>初二</td><td>40</td></tr>
<tr><td>初三</td><td>40</td></tr>
<tr><td rowspan="6">通州区
（郊区）</td><td rowspan="3">西集中学</td><td>初一</td><td>40</td><td rowspan="3">120</td></tr>
<tr><td>初二</td><td>40</td></tr>
<tr><td>初三</td><td>40</td></tr>
<tr><td rowspan="3">永乐店中学</td><td>初一</td><td>40</td><td rowspan="3">120</td></tr>
<tr><td>初二</td><td>40</td></tr>
<tr><td>初三</td><td>40</td></tr>
</table>

（注： 根据以往学校调查经验，每个班级大约 40 人。）

- **调查工具：** 青少年健康调查问卷（见**附件 5.5**）
- **调查安排：** 如表 2。

表 2 问卷调查安排与时间

<table>
<tr><th rowspan="2">分类</th><th colspan="2">调查阶段</th></tr>
<tr><th>预调查</th><th>正式现场</th></tr>
<tr><td>目的</td><td>了解问卷的适用性</td><td>收集大规模可靠性数据</td></tr>
<tr><td>预计调查时间</td><td>11 月 13 日（周五）下午</td><td>11 月 16 日-27 日（待确认）</td></tr>
<tr><td>预计调查学校</td><td>西城的某一所初中（待确认）</td><td>徐悲鸿中学、北京市 43 中学、
西集中学、永乐店中学</td></tr>
<tr><td>预计样本量</td><td>10-15 人</td><td>480 人 （两周后重测 30 人）</td></tr>
<tr><td>联系人及方式</td><td colspan="2">西城区保健所所长杨所（13911581326）
通州区保健所所长郁所（13681229620）</td></tr>
</table>

五、课题组织与分工

本课题由北京大学儿童青少年卫生研究所（以下简称“儿少所”）承担，同时，邀请北京市西城区和通州区中小学卫生保健所（以下简称“保健所”）为合作单位，共同完成现场的组织与实施，见表 3。

表 3 课题组织与分工

课题分工	负责单位	负责人
1. 课题前期准备（研究方案制定、调查工具研制等）	儿少所	余小鸣 教授 郭帅军 博士生
2. 调查现场的确定 • 联系保健所所长，寻求意见 • 联系调查学校的负责人 • 确定调查现场时间和班级	西城区保健所 通州区保健所	余小鸣 教授 郭帅军 博士生
3. 调查人员培训与组织	儿少所	余小鸣 教授 保健所所长 郭帅军 博士生
4. 现场调查组织与实施	儿少所 西城区和通州区保健所	余小鸣 教授 郭帅军 博士生
5. 数据录入与分析	儿少所	余小鸣 教授 郭帅军 博士生
6. 报告撰写与反馈	儿少所	余小鸣 教授 郭帅军 博士生

六、质量控制

1、 调查问卷的编制做到有循可依；

2、 调查前对调查人员进行统一培训，统一调查方法；

3、 数据录入前进行核查，采用双录入，数据录入后的逻辑检错等。

七、预期成果

将调查学校的分析结果以报告形式反馈给每个学校，为学校开展健康教育提供建议与对策，并最终形成总报告。

北京大学儿童青少年卫生研究所

2015 年 9 月 15 日

初中生健康问卷调查及填写细则（调查员培训用）

一、调查前准备

1、2015 年 11 月，确定调查学校及校方联系人；

2、11 月中旬，邀请数名在读硕士研究生协助问卷调查，并给予简单的培训；

3、准备好所有的调查工具；

4、根据具体的时间安排确定乘车路线。

二、调查过程中

1、　　调查员在现场进行调查时，应先简单说明调查的用意及自我介绍。同时，对问卷的填写方式和注意事项予以说明。说明采取 1 对多（一个班级）的形式，主要内容具体如下：

a) 简洁明了的开场白：明确调查的意义、目的；

b) 强调问卷匿名、保护隐私，消除调查者的顾忌，并明确要求每个人应该按个人真实情况进行回答；

c) 强调如有学生对问卷的题目不清楚、不明白，可及时向调查员询问。

2、调查问卷填写的方法

a) 提醒同学们仔细阅读问卷首页的卷首语及问卷填写说明。

b) 本调查问卷共包括七部分，每部分的调查题目数量不等。

c) 调查问卷题型包括单选题、多选题和填空题。

- 单选题：要求在所列选项中选择最符合本人情况的一项。在你所选的答案的数字上划“√”。举例如下：

你的性别：	
男生	女生
○√	○

- 多选题（有特别说明“**<u>多选</u>**”）：请学生根据自己的实际情况，可以选一项或多项。在所选的答案的数字上划“**√**”，如问卷第一部分的第五题。

过去六个月里，与你生活在一起的家庭成员包括哪些人（<u>多选</u>）？							
母亲	✓	父亲	✓	姨妈/姑妈	○	姐姐/妹妹	
继母	○	继父	○	姨父/姑父	○	哥哥/弟弟	
养母	○	养父	○	同父异母/同母异父的兄弟姐妹	○	其他的同龄人	
祖母/外祖母	○	祖父/外祖父	○	其他的成年人	○	我就一个人住	
其他 （请具体填写）：__________							

- ○ 填空题：请学生按照自己的实际情况填写。举例如下：

目前，你的身高是：
__160___ 厘米(cm)

3、在调查中可能出现问题及解决方法：

a) 被试对调查产生厌烦心理：在班主任及校医人员的帮助下，应对他们耐心解释，强调问题的重要性，并以积极的态度争取被调查者的支持和配合。

b) 被试对题目不理解：调查员在教室内巡视，在适当时间给予学生适当解释，但必须注意避免诱导性解释或对被试答题产生影响的解释。

c) 问卷填写必须使用签字笔，不能使用铅笔；

三、调查结束后

1、调查员在每次调查结束时要认真核查问卷，不能有缺项，漏项。

2、调查员要将调查问卷按地区、学校区别整理清楚后进行封装，并填写好问卷封装说明表，如下：

问卷封装说明表

北京市____________区
学校名称：
调查班级：
发出问卷数：
回收问卷数：
问卷编码：□□□□□□——□□□□□□
调查时间：2015 年____月____日
调查员：

问卷编码原则

编码位数	编码依据	具体编码
第一位代码	区县	西城 1；通州 2
第二位代码	学校名称	徐悲鸿中学 1；北京市 43 中学 2；西集中学 3；永乐店中学 4
第三位代码	年级	初一 1；初二 2；初三 3

问卷编码共 6 位：第一位为各区县代码，第二位是学校名称代码；第三位是年级代码。

第四、五、六位编码为被调查者编码：各学校各年级被调查者分别从 001 开始进行编码。

举例：如西城区徐悲鸿中学初一年级第 21 位被调查者的编码即为 111021。

3、问卷调查过程及之后遇到任何问题，请随时与课题协调人联系。

联系人：郭帅军，15201292840，邮箱：gshj-1986@163.com 。

北京大学儿童青少年卫生研究所

2015 年 9 月 15 日

Appendix 5.4: Plain language statement for Beijing students

《健康素养》小百科

什么是“健康素养”？

健康素养是健康素质的重要组成部分，是指个人获取和理解基本健康信息和服务，并运用这些信息和服务做出正确判断，以维护和促进自身健康的能力。

为什么“健康素养”很重要？

健康素养不仅是决定个人健康结局（如知识、行为、状况）的重要因素之一，而且是衡量整体国民健康素质的重要指标。研究显示，具备高水平健康素养的人更容易养成良好的健康促进行为，保持健康状况，减少急诊服务利用和医疗开支。

一个有健康素养的人可以在各种生活场景中做出有利于健康的决定

家长告知信

尊敬的家长：

您好!

我们在此诚挚邀请您的孩子参与一项“**以社会生态学模型为基础的青少年健康素养研究**”，您孩子的具体情况符合该项研究的入组条件，以下将向您介绍该研究的目的、步骤、获益、风险、不便或不适等，请您仔细阅读后慎重做出您的孩子是否参加研究的决定。

本项研究的项目负责人是**北京大学儿童青少年卫生研究所 余小鸣 教授**。

1. 为什么进行这项研究？

中小学校是促进儿童青少年获得教育和健康素养的最佳平台，教育部在2008年公布了《中小学健康教育指导纲要》，明确提出了中小学校健康教育的目标和内容。本研究旨在从学校健康教育的角度，借鉴社会生态学理论模型，探索初中生健康素养与其影响因素、健康结局的相关性，从而为进一步改善儿童青少年健康状况，推进学校健康教育，增进学生体质健康提供证据支持和帮助。

2. 哪些人将被邀请参加这项研究？

本研究邀请目前就读于北京市初中学校的10-15岁青少年学生作为研究对象。不包括有严重认知功能障碍、无法进行交流者。

3. 多少人将参与这项研究？

本研究计划招募400名初中生。

4. 本研究包括哪些内容？

本研究为横断面研究，拟以北京市初中生为研究对象，通过问卷调查的方式收集信息，主要内容包括调查对象的一般人口学特征、健康素养状况、健康行为养成情况、个体影响因素以及环境影响因素。问卷调查后，将会对少数学生进行个人访谈，以便深入了解个体的影响因素与环境影响因素。本研究不涉及任何生物标本的采集，不涉及随访。

5. 这项研究会持续多久？

本次研究为横断面研究，一次性收集信息，问卷调查部分不超过20分钟，无随访。

6. 参加本项研究的风险是什么？

问卷调查匿名进行，不会泄露您孩子的个人身份，也不会通过特殊的标识方式记录您孩子的资料，所得信息不会用于除本次研究外的任何用途，您孩子的信息也不会被单独取出分析。调查问卷内容围绕一般人口学特征、健康素养、健康行为及其影响因素四方面展开，不会引起心理不适，如若问卷中的个别问题让您的孩子感到不舒服，您的孩子可以拒绝回答。

7. 参加本项研究的获益是什么？

您的孩子可以通过参与此项研究提高自身健康的意识，激发自身主动寻求或改善健康相关技能，同时您的孩子还可以咨询如何增进自身健康技能、维护和改善自身及家人健康的机会。另外您与您孩子的参与有助于学校健康教育的促进以及学校健康教育政策的制定。

8. 是否一定要参加并完成本项研究？

您的孩子是否参加这个研究完全是自愿的。如果您的孩子不愿意，可以拒绝参加，这对您的孩子目前或未来的教育和医疗不会有任何负面影响。即使您的孩子同意参加以后，您的孩子也可以在任何时间改变主意，您的孩子的退出不会影响她/他获得正常的教育及医疗服务。

原则上，在您的孩子退出之后，研究者将严密保存您的孩子的相关信息直至最终销毁，期间不会继续使用或透露这些信息。但在以下极少数情况下，研究者将继续使用或透露您的孩子的相关信息，即使您的孩子已经退出研究或研究已经结束。这些情况包括：① 除去您孩子的信息将影响研究结果的科学性或对数据安全的评价；② 为研究、教学或其他活动提供一些有限的信息（这些信息不会包括您孩子的姓名、身份证号码、或者其他能识别您孩子身份的个人信息）；③ 一旦出现任何可能会影响您孩子决定是否继续参加该项研究的信息，我们会及时告知您与您的孩子。

9. 关于研究费用和补偿

参加本次研究不需要您的孩子支付任何费用，也不会产生交通费、误工费等。

10. 参加该项研究受试者是否获得报酬？

参加本次研究您的孩子不会获得酬劳。

11. 发生研究相关伤害的处理？

参加本次研究不会对您的孩子造成伤害。

12. 我的信息会保密吗？

本次研究将匿名进行，不涉及可以识别您的孩子的身份资料。如果您决定您的孩子参加本项研究，您的孩子参加研究及在研究中提供的信息均属保密。您的孩子提供的信息将保存在有锁的档案柜中，仅供研究人员查阅。这项研究结果发表时，将不会披露您的孩子的任何资料。

13. 如果我有问题或困难，该与谁联系？

如果您有与本研究相关的任何问题，请联系：余小鸣；联系电话：010-82802631。

如果您有与受试者自身权益相关的问题，可与北京大学生物医学伦理委员会联系，联系电话：010-82805751；电子邮件：llwyh@bjmu.edu.cn。

非常感谢您与您的孩子对本项课题的参与和支持！

北京大学儿童青少年卫生研究所

2015年11月

Appendix 5.5: Questionnaire for Beijing students

青少年健康调查问卷 北京大学儿童青少年卫生研究所

问卷编码：__________
（研究人员填写）

青少年健康调查问卷

AHQ

青少年健康调查问卷 北京大学儿童青少年卫生研究所

亲爱的同学们，你们好！

这是一项关于“青少年健康及其影响因素”的调查研究，为了更好地提高学生健康技能，开展学校健康教育，我们设计了本次调查。你们所提供的信息将为制定学校健康教育政策提供有效的建议与帮助，非常感谢你们的积极参与！

填写说明

1. 不必在问卷上写自己的名字。你的回答是保密的，老师和家长不会知道你的答案。
2. 请根据个人感受选出你认为最合适的答案。
3. 对于选择题，请根据选项在相应的圆圈中打勾“√”，对于填空题，请在相应的空白处写出相关信息。
4. 如果在填写过程中，对某个问题或选项不理解或看不懂，请举手示意，研究人员将会对你进行解释。
5. 问卷的答案没有正确、错误之分，不必费时斟酌，你的最初反应是最真实的。
6. 此次问卷的填写时间大约 25-35 分钟。

青少年健康调查问卷 北京大学儿童青少年卫生研究所

第一部分 – 基本情况

1.1	**你的性别：**							
	男生				女生			
	O				O			
1.2	**你的民族：**							
	汉族				少数民族（请具体填写：______族）			
	O				O			
1.3	**你所在的年级：**							
	O	初一	O	初二	O	初三		
1.4	**你的年龄（周岁）：**							
	O	10 岁及以下	O	11 岁	O	12 岁		
	O	13 岁	O	14 岁	O	15 岁		
	O	16 岁	O	17 岁	O	18 岁		
	O	19 岁及以上						
1.5	**你在家时，长期与你生活在一起的家庭成员包括哪些人？（请注意：*此题为多选题！*）**							
	O	母亲	O	父亲	O	姨妈/姑妈	O	姐姐/妹妹
	O	继母	O	继父	O	姨父/姑父	O	哥哥/弟弟
	O	养母	O	养父	O	同父异母/同母异父的兄弟姐妹	O	其他的同龄人
	O	祖母/外祖母	O	祖父/外祖父	O	其他的成年人	O	我就一个人住
	O	其他（请具体填写）：__________						

1.6	a.	**你有自己的房间吗？**			
		没有		有	
		O		O	
	b.	**你的家中有几台电脑（包括台式电脑、笔记本电脑、平板电脑）？**			
		没有	一台	两台	多于两台
		O	O	O	O
	c.	**你的家里有轿车、货车或是卡车吗？**			
		没有	有，一辆	有，两辆或是更多辆	
		O	O	O	
	d.	**过去的一年里，你跟家人在放假时出去旅行几次？**			
		没有	一次	两次	多于两次
		O	O	O	O

1

青少年健康调查问卷 北京大学儿童青少年卫生研究所

1.7	**你认为，信仰在你生活中的重要性是：**				
	非常不重要	不是很重要	不确定	些许重要	非常重要
	O	O	O	O	O
1.8	**过去 12 个月里，与同班同学相比，你认为自己的学习成绩如何？**				
	差	中等偏下	中等	中等偏上	优秀
	O	O	O	O	O
1.9	**目前，你的身高是：**				
	__________厘米(cm)（请保留一位小数）				
1.10	**目前，你的体重是：**				
	__________公斤 (kg)（请保留一位小数）				

2

青少年健康调查问卷　　北京大学儿童青少年卫生研究所

Part 2 –第二部分 – 健康状况

2.1	一般来说，你会怎样形容自己的健康状况?				
	差	一般	好	非常好	极好
	○	○	○	○	○

2.2	a.	你觉得自己有多大兴趣了解并学习与健康有关的话题?				
		非常没兴趣	没多大兴趣	不确定	些许兴趣	非常有兴趣
		○	○	○	○	○
	b.	你觉得健康重要吗?				
		非常不重要	不是很重要	不确定	些许重要	非常重要
		○	○	○	○	○

2.3 回想**过去一星期**……

a.	你感到健康和状态良好吗?	从不 ○	少许 ○	一般 ○	非常 ○	极度 ○
b.	你感到精力充沛吗?	从不 ○	很少 ○	有时 ○	经常 ○	总是 ○
c.	你感到伤心吗?	从不 ○	很少 ○	有时 ○	经常 ○	总是 ○
d.	你感到孤单吗?	从不 ○	很少 ○	有时 ○	经常 ○	总是 ○
e.	你有足够的私人时间吗?	从不 ○	很少 ○	有时 ○	经常 ○	总是 ○
f.	你在有空时能够做想做的事情吗?	从不 ○	很少 ○	有时 ○	经常 ○	总是 ○
g.	父母对你公平吗?	从不 ○	很少 ○	有时 ○	经常 ○	总是 ○
h.	你跟朋友玩得开心吗?	从不 ○	很少 ○	有时 ○	经常 ○	总是 ○
i.	你在学校快乐吗?	从不 ○	少许 ○	一般 ○	非常 ○	极度 ○
j.	你能专心上课吗?	从不 ○	很少 ○	有时 ○	经常 ○	总是 ○

3

青少年健康调查问卷　　北京大学儿童青少年卫生研究所

2.4 针对以下每一个问题，请选出你认为最合适的一项。

a.	你对药品说明书上的信息理解程度如何？（例如药瓶或药盒上所附的说明）					
	非常差	差	一般	好	非常好	我不看这类信息
	○	○	○	○	○	○
b.	你对健康宣传册上的信息理解程度如何？（例如营养知识宣传册、毒品预防宣传册）					
	非常差	差	一般	好	非常好	我不看这类信息
	○	○	○	○	○	○
c.	当你的家人或朋友有健康方面的疑问时（如压力过大、运动损伤、营养不良），你会经常帮助他们吗?					
	从未	很少	有时	经常	总是	从来没有遇到过这类问题
	○	○	○	○	○	○
d.	当你有健康方面的疑问时，你会经常向他人（如家人、朋友、老师）咨询相关信息和建议吗?					
	从未	很少	有时	经常	总是	从来没有遇到过这类问题
	○	○	○	○	○	○
e.	在日常生活中，我们会遇到很多健康相关的建议。在选择最适合自己的建议时，你觉得自己做得怎么样?					
	非常差	差	一般	好	非常好	我对这类信息不感兴趣
	○	○	○	○	○	○

2.5 针对以下每一个陈述，你是否同意：

a.	当我有疾病或健康方面的疑问时（如头痛、背痛、运动损伤），我知道在哪里可以找到相关的信息。				
	非常不同意	不同意	同意	非常同意	我没有这方面的经历
	○	○	○	○	○
b.	当我没有生病，但希望做些事情进一步提高自己的健康状况时（如加强营养、定期身体锻炼），我知道在哪里可以获取相关的信息。				
	非常不同意	不同意	同意	非常同意	我对这类信息不感兴趣
	○	○	○	○	○
c.	当我在网络上寻找与健康相关信息的时候，我可以判断信息质量的高低。				
	非常不同意	不同意	同意	非常同意	我没有这方面的经历
	○	○	○	○	○

4

青少年健康调查问卷　　北京大学儿童青少年卫生研究所

第三部分 – 健康行为

3.1	在过去的一周里，有多少天你吃早过餐?
	○ 从来不吃早餐
	○ 1 天
	○ 2 天
	○ 3 天
	○ 4 天
	○ 5 天
	○ 6 天
	○ 7 天
3.2	在过去 30 天里，你通常每天刷几次牙?
	○ 每天多于一次
	○ 每天一次
	○ 每周至少一次，但不是每天都坚持
	○ 每周不到一次
	○ 从来没有刷过牙
3.3	在过去 30 天里，你吸过多少次香烟?
	○ 0 次
	○ 1-2 次
	○ 3-5 次
	○ 6-9 次
	○ 10-19 次
	○ 20-39 次
	○ 40 次及以上
3.4	在过去 30 天里，你喝了多少次酒（指半瓶或一听啤酒，一小盅白酒，一玻璃杯葡萄酒或黄酒）?
	○ 0 次
	○ 1-2 次
	○ 3-5 次
	○ 6-9 次
	○ 10-19 次
	○ 20-39 次
	○ 40 次及以上

5

青少年健康调查问卷　　北京大学儿童青少年卫生研究所

3.5	在过去 7 天里，有几天你每天至少运动 60 分钟？（运动可以是体育运动、和朋友一起玩或者走路去学校，例如跑步、快走、骑自行车、跳舞、踢足球、打球、跳绳、踢毽子等。）
	○ 0 天
	○ 1 天
	○ 2 天
	○ 3 天
	○ 4 天
	○ 5 天
	○ 6 天
	○ 7 天

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第四部分 - 健康信息识别

以下信息是从一盒冰淇淋的背面标签中提取的，请根据标签中相关信息回答 4.1-4.6 的问题。

食品描述： 冰淇淋
每盒： 4 份
每份： 100 克 (g)

营养成分表	
	每 100 克(g)
能量	1050 千焦(kJ) 250 千卡(kcal)
蛋白质	4 克(g)
碳水化合物总含量	30 克(g)
-糖	23 克(g)
脂肪总含量	13 克(g)
-饱和脂肪酸	9 克(g)
-单一不饱和脂肪酸	0 克(g)
-多不饱和脂肪酸	3 克(g)
-反式脂肪酸	1 克(g)
纤维素	0 克(g)
钠	0.05 克(g)

配料：奶油、脱脂牛奶、白砂糖、蛋清、蛋黄、半乳甘露聚糖（瓜尔胶）、花生油、香草精（0.05%）

4.1	假如你把整盒冰淇淋都吃了，你会摄入多少能量（千卡）？	答：________
4.2	假如你只被允许食用 60 克 的碳水化合物当作点心，那么你最多可以吃几份冰淇淋？	答：________（份）
4.3	有医生建议你降低饮食中饱和脂肪酸的摄入，过去你每天通常吃 42 g 的饱和脂肪酸，其中包含 1 份冰淇淋。如果你开始停止吃冰淇淋，那么你每天所食用的饱和脂肪酸会变成多少克？	答：________
4.4	假如你通常每日摄入 2500 千卡的能量，那么吃一份冰淇淋将占你每日摄入总热量的百分比是多少？	答：________
假如你对以下几种物质过敏：青霉素、花生、橡胶手套和蜂蜇。		
4.5	那么你吃这种冰淇淋安全吗？	答：________
如果你回答“不安全”，请回答 4.6 题。		
4.6	请回答上题的理由。	答：________________________________

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第五部分 - 社会支持

5.1	以下是一些描述你**现在**和你的朋友、家人及其他人的句子，请你表示你对这些句子的同意程度。	非常不同意	很不同意	些许不同意	不确定	些许同意	很同意	非常同意
a.	在我遇到问题时有些人（老师、同学、亲戚）会出现在我的身旁。	○	○	○	○	○	○	○
b.	我能够与有些人（老师、同学、亲戚）共享快乐与忧伤。	○	○	○	○	○	○	○
c.	我的家庭能够切实具体地给我帮助。	○	○	○	○	○	○	○
d.	在需要时我能够从家庭获得情感上的帮助和支持。	○	○	○	○	○	○	○
e.	当我有困难时有些人（老师、同学、亲戚）是安慰我的真正源泉。	○	○	○	○	○	○	○
f.	我的朋友们能真正的帮助我。	○	○	○	○	○	○	○
g.	在发生困难时我可以依赖我的朋友们。	○	○	○	○	○	○	○
h.	我能与自己的家庭谈论我的难题。	○	○	○	○	○	○	○
i.	我的朋友们能与我分享快乐和忧伤。	○	○	○	○	○	○	○
j.	在我的生活中有些人（老师、同学、亲戚）关心着我的感情。	○	○	○	○	○	○	○
k.	我的家庭能心甘情愿协助我做出各种决定。	○	○	○	○	○	○	○
l.	我能与朋友们讨论自己的难题。	○	○	○	○	○	○	○

5.2	**请选出与你实际情况最符合的一项。**	完全不正确	尚算正确	多数正确	完全正确
a.	如果我尽力去做的话，我总是能够解决难题的。	○	○	○	○
b.	即使别人反对我，我仍有办法取得我所要的。	○	○	○	○
c.	对我来说，坚持理想和达成目标是轻而易举的。	○	○	○	○
d.	我自信能有效的应付任何突如其来的事情。	○	○	○	○
e.	以我的才智，我定能应付意料之外的事情。	○	○	○	○
f.	如果我付出必要的努力，我一定能解决大多数的难题。	○	○	○	○
g.	我能冷静地面对困难，因为我信赖自己处理问题的能力。	○	○	○	○
h.	面对一个难题时，我通常能找到几个解决方法。	○	○	○	○
i.	有麻烦的时候，我通常能想到一些应付的方法。	○	○	○	○
j.	无论什么事在我身上发生，我都能够应付自如。	○	○	○	○

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第六部分 - 学校与社区

6.1	**以下陈述是关于“你的学校”，请选出你认为最合适的一项。**	非常不同意	不同意	同意	非常同意
a.	在我的学校，学生有很多机会参与决定怎样进行课堂活动或参与制定课堂规则等这一类的事情。	○	○	○	○
b.	老师会让我参与一些特别的课堂活动或任务。	○	○	○	○
c.	当我表现好的时候，我的老师会注意到并表扬我。	○	○	○	○
d.	在我的学校，学生有很多机会参与运动、社团以及其他课外活动。	○	○	○	○
e.	在我的学校，学生有很多机会与老师进行一对一的交流。	○	○	○	○
f.	我感觉在学校很安全。	○	○	○	○
g.	当我表现好的时候，学校会让我的父母知道。	○	○	○	○
h.	当我在学校努力学习时，我的老师会表扬我。	○	○	○	○
i.	我的学习成绩比班上大多数同学的成绩好。	○	○	○	○
j.	我有很多机会参与课堂讨论或课堂活动。	○	○	○	○

9

AHQ

6.2 你是否同意以下关于“你所住的小区”的描述？
如果你住在农村/边远地区，“你所住的小区”是指你家附近的区域；
如果你住在城市地区，“你所住的小区”是指距离你家 1-2 千米、走路约 20-30 分钟范围的地方。

		非常不同意	不同意	同意	非常同意	不知道
a.	这是一个安全的小区。	○	○	○	○	○
b.	这是一个干净的小区。	○	○	○	○	○
c.	这个小区有很好的公园、运动场和活动空间。	○	○	○	○	○
d.	这个小区有很好的路灯照明。	○	○	○	○	○
e.	这个小区的人行道和马路状况很好。	○	○	○	○	○
f.	这个小区周边有方便、便宜、而且班次固定的公共交通。	○	○	○	○	○
g.	这个小区周边购物比较方便。	○	○	○	○	○
h.	这个小区周边有银行、医疗诊所等基本的服务。	○	○	○	○	○
i.	这个小区的道路交通很繁忙。	○	○	○	○	○

6.3	**你是否发生过以下这些经历：**	0	1－2 次	3－5 次	6 次及以上	不知道
a.	在过去 12 个月里，曾使用过急诊服务（如救护车、去医院急诊室等）？	○	○	○	○	○
b.	在过去 12 个月里，曾看过医生（指在社区卫生服务中心、社区诊所、私人诊所等机构工作的医生）？	○	○	○	○	○
c.	在过去 12 个月里，曾使用过医院服务（如体检、看专科门诊、看急诊等）？	○	○	○	○	○
d.	在过去 12 个月里，曾使用过其他健康专业人士提供的服务，如牙医、理疗师、心理医生、营养师、验光师。	○	○	○	○	○
e.	在过去 12 个月里，你在看病过程中，曾问过医生问题。	○	○	○	○	○

10

第七部分 - 健康技能

请根据你**目前的状况**，在以下表格的圆圈中勾选出最适合自己的一项，如：○☑○○○。

☺ **开始填写的时间：**___时___分___秒

	请选出与你实际情况最符合的一项。	**非常困难**	**有点困难**	**还算容易**	**相当容易**	**不知道/我没有此类经历**
7.1	当你想要了解某些疾病的症状时，你能否找到相关资料？	○	○	○	○	○
7.2	当你想要了解某些疾病的治疗方法时，你能否找到相关资料？	○	○	○	○	○
7.3	发生紧急医疗状况时，你可以即时找到处理的资讯？	○	○	○	○	○
7.4	当你生病时，你知道要去哪里寻求专业的帮助吗？（如：医生、药剂师或心理咨询师）	○	○	○	○	○
7.5	针对你过去的医疗经验而言，你了解医生跟你说的话吗？	○	○	○	○	○
7.6	你了解药瓶上或药盒上所附的说明吗？	○	○	○	○	○
7.7	当紧急医疗状况发生时，你知道要如何处理吗？	○	○	○	○	○
7.8	当医生或药剂师对你讲解处方用药说明时，你能了解吗？	○	○	○	○	○
7.9	一般而言，你能判断医生给你的建议（包括诊疗或行为）对你适不适用吗？（如：医生觉得你不能再喝酒，你觉得合适及合理吗？）	○	○	○	○	○
7.10	你能否判断不同治疗方法的好处与坏处？	○	○	○	○	○
7.11	你能否判断在某些时候可能需要听听另一位医生的医疗意见？	○	○	○	○	○
7.12	你能否判断媒体（电视、网站、报纸或其他媒体）上疾病的资讯是否可信？	○	○	○	○	○
7.13	你能运用医生的建议（包括诊疗或行为）做病情有关的决定吗？（如：医生觉得喝酒会恶化你的病情，你就不再喝酒。）	○	○	○	○	○
7.14	你能依照药瓶上或药盒上所附的说明，依指示按剂量服用药物吗？	○	○	○	○	○
7.15	当紧急状况发生时，你能判断并知道如何呼叫救护车吗？	○	○	○	○	○
7.16	一般而言，你能遵从医生或药剂师对你的健康提出的建议吗？（如：少吃油炸食物、多运动等）	○	○	○	○	○

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	请选出与你实际情况最符合的一项。	**非常困难**	**有点困难**	**还算容易**	**相当容易**	**不知道/我没有此类经历**
7.17	你能找到如何自我管理不健康行为的资讯吗？（如：吸烟、身体活动量低或饮酒过量等）	○	○	○	○	○
7.18	你能找到处理心理健康方面问题的资讯吗？（如：压力或忧虑症状）	○	○	○	○	○
7.19	你能找到要接受的疫苗以及健康体检（如：血压测量、血糖检测等）的相关资讯吗？	○	○	○	○	○
7.20	你能找出如何预防或控制像体重过重、血压高或高胆固醇等情况的资讯吗？	○	○	○	○	○
7.21	你了解有关不健康行为（吸烟、身体活动量低或饮酒过量等）的警讯所要传达的讯息吗？（如：吸烟导致癌症等）	○	○	○	○	○
7.22	你了解为什么需要接种疫苗（口服、注射）吗？	○	○	○	○	○
7.23	你了解为什么需要健康体检吗？（如：血糖检测、血压测量等）	○	○	○	○	○
7.24	你能判断有关不健康行为（吸烟、身体活动量低或饮酒过量等）的警告讯息是否可信？（如：吸烟导致癌症等）	○	○	○	○	○
7.25	你可以衡量或安排什么时候需要去做健康检查吗？	○	○	○	○	○
7.26	你能判断你需要接受的是哪种疫苗？（如：去非洲旅游时）	○	○	○	○	○
7.27	你能判断你需要接受的是哪种健康体检吗？（如：血糖检测、血压测量等）	○	○	○	○	○
7.28	你能判断媒体（电视、网站或其他媒体）所提供的一些会危害健康的资讯是否可信？（如：某种激烈的减肥行为会危害健康）	○	○	○	○	○
7.29	你能决定是否应该接种流感疫苗吗？	○	○	○	○	○
7.30	基于家人和朋友的建议，你会相信并采纳他们的建议来保护自己免于生病吗？	○	○	○	○	○
7.31	你会相信并采纳媒体的讯息（报纸、网站或其他媒体）来保护自己免于生病吗？	○	○	○	○	○
7.32	你能找到像运动、健康饮食及营养等健康活动的资讯吗？	○	○	○	○	○
7.33	你能找到有助增进你心理上幸福感的活动吗？（如：冥想、运动、散步、瑜伽等）	○	○	○	○	○
7.34	你能找出哪些可以让你的社区环境更健康的资讯吗？（如：增加绿地、公园、休闲设施等方面的资讯）	○	○	○	○	○

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	请选出与你实际情况最符合的一项。	**非常困难**	**有点困难**	**还算容易**	**相当容易**	**不知道/我没有此类经历**
7.35	你能找出哪些政策上的改变（如：新的健康筛检计划、医疗服务改革等）会影响人们的健康吗？	○	○	○	○	○
7.36	你在学习时知道如何帮助自己促进自身的健康吗？（如：当你学习压力大或长时间静坐学习时）	○	○	○	○	○
7.37	你了解家人或朋友在促进健康上给你的建议吗？（如：饮食习惯、运动的建议）	○	○	○	○	○
7.38	你了解食品包装上所提供的资讯吗？	○	○	○	○	○
7.39	你了解媒体（电视、网站或其他媒体）在促进健康议题上提供的资讯吗？	○	○	○	○	○
7.40	你了解如何使你保持心理健康的资讯吗？	○	○	○	○	○
7.41	你能判断你的生活环境（包括你所住的社区和邻近地区）是否会影响你的健康与幸福感？	○	○	○	○	○
7.42	你能判断你居住的房屋环境如何影响你的健康吗？	○	○	○	○	○
7.43	你能判断哪些日常生活行为与你的健康有关吗？（如：饮食习惯、运动等行为）	○	○	○	○	○
7.44	你能否为自己的健康做决定并改变行为？	○	○	○	○	○
7.45	你要参加运动团体或运动课程容易吗？	○	○	○	○	○
7.46	你要调整生活及居住状态容易吗？（如：饮食习惯、运动等状态）	○	○	○	○	○
7.47	你要参加你社区中增进健康与幸福感的活动容易吗？	○	○	○	○	○

☺ **结束填写的时间：**___时___分___秒

填写日期：____年____月____日

非常感谢你的合作！

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Appendix 5.6: HLS-Asia-Q item change after pilot test

HLS-Asia-Q item change after pilot test

The Health Literacy Study-Asia-Questionnaire (HLS-Asia-Q) was piloted on ten secondary students in Years 7 and 8. Several items and their response options were changed to ensure their readability and clarity for secondary school students. Further details of these item changes are presented in the following table.

Item number	Original item	Adapted item
4	当你生病时，你知道要去哪里寻求专业的协助吗？（如：医师、药师或心理师）	当你生病时，你知道要去哪里寻求专业的帮助吗？（如：医生、药剂师或心理咨询师）
5	过去医疗经验而言，你了解医生跟你说的话吗？	针对你过去的医疗经验而言，你了解医生跟你说的话吗？
6	你了解药袋上或药品所附的说明吗？	你了解药瓶上或药盒上所附的说明吗？
8	当医师或药师对你讲解处方用药说明时，你能了解吗？	当医生或药剂师对你讲解处方用药说明时，你能了解吗？
14	你能依照药袋上或药品所附的说明，依指示按剂量服用药物吗？	你能依照药瓶上或药盒上所附的说明，依指示按剂量服用药物吗？
19	你能找到要接受的疫苗以及疾病筛检（乳房检查、血糖检测、血压测量等）的相关资讯吗？	你能找到要接受的疫苗以及健康体检（如：血压测量、血糖检测等）的相关资讯吗？
23	你了解为什么需要健康筛检吗？（如：乳房检查、血糖检测、血压测量等）	你了解为什么需要健康体检吗？（如：血糖检测、血压测量等）
27	你能判断你需要接受的是哪种健康筛检吗？（如：乳房检查、血糖检测、血压测量）	你能判断你需要接受的是哪种健康体检吗？（如：血糖检测、血压测量等）
35	你能找出哪些政策上的改变（立法、新健康筛检计划、政党轮替、健康服务改革等）会影响健康吗？	你能找出哪些政策上的改变（如：新的健康筛检计划、医疗服务改革等）会影响人们的健康吗？
36	你在工作中知道如何帮助自己促进自身的健康吗？（如：当你工作压力大或长时间工作时）	你在学习时知道如何帮助自己促进自身的健康吗？（如：当你学习压力大或长时间静坐学习时）

Original response option	Adapted response option
① 非常困难	⑤ 非常困难
② 有点困难	⑥ 有点困难
③ 还算容易	⑦ 还算容易
④ 相当容易	⑧ 相当容易
	⑨ 不知道/ 我没有此类经历

Appendix 5.7: Translation details of the c-HLAT-8

Step 1: Forward translation

Translator requirements:

- At least two translators are needed;
- Mother tongue is Chinese;
- One is from the medical background, and the others are from other backgrounds of expertise.

Procedures:

The first step was to translate the original version of the HLAT-8 from English to Chinese. According to the cross-cultural translation and adaption recommendation (1), at least two translators whose mother tongue is Chinese are needed. In addition, it is preferable that one of them is from medical background and the other is not. In the present study, three Chinese-native speakers who speak fluently in Chinese and English were involved. They are from different backgrounds of expertise (i.e. medicine, education, and engineering). They translated the original version of the HLAT-8 independently.

Step 2: Synthesis of forward translation

After forward translation, the above three translators had a group meeting to compare the three translations and to identify discrepancies between items. The discussed items included:

- The term '*how well do you*' in Item 1 and Item 2: one translator translated '*how well can you*', however, we concurred with the original connotation of the items '*how well do you*' after discussion.

- The term '*written information*' in Item 1: one translator did not translate '*written information*', however, we reached consensus to add '*written information*' in the Chinese version of the HLAT-8 after discussion.
- The response option '*I have not used such information*' in Item 1 and Item 2: the response option was adapted to '*I have not seen such information*'. This was changed to ensure that these two items tested students' ability to understand information rather than using information.
- The term '*how often can you*' in Item 3 and Item 4: one translator translated '*how often do you*', however, we reached consensus to maintain the original meaning of '*how often can you*' after discussion.
- The term '*the advice and suggestions that suit you the most*' in Item 5: one translator translated '*the most helpful advice and suggestions for you*'. This was a very different meaning with the original version. After discussion, we accepted the other two translators' translation results.
- The term '*improve my health*' in Item 7: According to the Chinese culture, we reached consensus to adapt the phrase into '*improve my health status*'.
- The term '*which sources are of high and which are of poor quality*' in Item 8: Two translators translated '*which sources are reliable or not*'. After discussion, we reached consensus on '*which sources are of good and which are of poor quality*'.

Step 3: Backward translation

Translator requirements:

- At least two translators are needed;
- Mother tongue is English;
- Both are naïve to the outcome measurement.

Procedures:

- Two English-native master students in the University of Melbourne translated the 1st Chinese version into the English version. They are Australian-born Chinese. Both of them speak fluent Mandarin and Chinese. Also, they are naïve to the outcome measurement.

Step 4: Translation committee review

- The above five translators compared four versions of the HLAT-8 (English version, the 1st Chinese version, backward translation A, and backward translation B). Problematic items were identified, especially those with vague meanings or translations. Ambiguities and discrepancies were discussed to reach a consensus. Based on this discussion, the 2nd Chinese version was formed.

Resolving cultural discrepancies:

- Item 1 and Item 2: the response option '*I have not used such information*' was culturally-adapted to '*I have not read such information*' in Chinese version. This change was to ensure that these two items tested students' ability to understand information, rather than using information.
- Item 2: the question '*how well do you understand information brochures on health issues (e.g. nutrition, addictive drugs)*' was culturally adapted to '*how well do you understand information presented in health pamphlets (e.g. good nutrition, prevention of addictive drugs abuse)*' in the Chinese version. This was because, in Chinese culture, the phrases '*nutrition*' and '*addictive drugs*' are typically used in a normative way in educational settings.

- Item 5: the phrase '*much advice and many suggestions*' in the English version was adapted to '*much advice*' in the Chinese version, because '*much advice*' and '*many suggestions*' had the same meanings in Chinese culture.
- Other discrepancies were considered only due to differences of expression in English. For example, '*medical instruction*' in the backward translation version and '*written information that comes with medication*' in the English version; '*pamphlets*' in the backward translation version and '*brochures*' in the English version; '*health problems*' in the backward translation version and '*health issues*' in the English version; '*illness*' in the backward translation version and '*diseases*' in the English version; '*not feeling sick*' in the backward translation version and '*not ill*' in the English version; '*searching on the internet for health information*' in the backward translation version and '*looking for health information on the Internet*' in the English version.

Step 5: Expert panel evaluation of the translation validity index (TVI)

A small expert panel was established to compare the TVI between the 2nd Chinese version and the English version. The expert panel consisted of five Chinese-native bilingual members from different expertise backgrounds (i.e. public health, nutrition, linguistics, adolescent health, and epidemiology). Experts were asked to judge the equivalence of corresponding items on both versions using a four-point scale ('1'='totally different'; '2'='needs major item modification to be equivalent'; '3'='equivalent but needs minor modification'; '4'='equivalent'). The criteria for a good TVI is that it achieves at 80% of item comparisons rated as 4 ('equivalent') and 100% of item comparisons rated as 3 or 4 ('equivalent but needs minor modification' or 'equivalent') (2). After two rounds of expert evaluation, the TVI examination results showed that 95% of items were rated as score 4 ('equivalent'), and 100% of all items rated as score 3 or 4 ('equivalent but needs minor modification' and 'equivalent'). The pre-final Chinese version was formed.

Step 6: Pilot test

A pilot test was conducted to test the clarity of instructions, item and response formats of the pre-final Chinese version. Ten participants (Years 7 and Year 8) were recruited using convenience sampling from participating schools in Beijing. They were asked to complete a paper-and-pencil questionnaire. After the questionnaire completion, students were also asked about what they thought of each item and response option. The pilot test showed the eight-item c-HLAT-8 was understood by all participants.

References

1. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine. 2000;25(24):3186-91.
2. Tang ST, Dixon J. Instrument translation and evaluation of equivalence and psychometric properties: the Chinese Sense of Coherence Scale. J Nurs Meas. 2002;10(1):59-76.

Appendix 5.8: Summary of questionnaire structure and indicators

Survey domain	Content area	Question item	Source questionnaire (Author/organisation)	Ref.	Original or Adapted	Used for adolescents
Demographics	Gender	Are you male or female?	Census at School 2014 (ABS, q1)	(1)	Original	Yes (Years 4 to12)
	Ethnicity (Only in Chinese samples)	What is your ethnic background?	CRHLS 2008 (CPGPRC, q3)	(2)	Adapted (Combine response options ‘Hui’, ‘Man’, ‘Weiwuer’, ‘Menggu’ and ‘Others ’to one option ‘Ethnic minorities’)	Yes (15-19 years old)
	Year level	What Year level are you in at school?	Census at School 2014 (ABS, q6)	(1)	Original	Yes (Years 4 to12)
	Age	How old are you?	CTC 2013 (CSAP, page 2, q1)	(3)	Original	Yes (10-19 years old)
	Country of birth (Only in Australian samples)	In which country were you born?	CTC 2010 (CTCL, page 8, q4)	(4)	Adapted (Add response option ‘China’ and ‘Hong Kong/Macao/Taiwan’)	Yes (11-16 years old)
		In which country was your mother born?	CTC 2010 (CTCL, page 8, q5)	(4)	Adapted (Add response option ‘China’ and ‘Hong Kong/Macao/Taiwan’)	Yes (11-16 years old)
		In which country was your father born?	CTC 2010 (CTCL, page 8, q6)	(4)	Adapted (Add response option ‘China’ and ‘Hong Kong/Macao/Taiwan’)	Yes (11-16 years old)
	Family structure	Think of where you live most of the time. Who usually lives there with you?	CTC 2010 (CTCL, page 29, 104)	(4)	Adapted after pilot test (Add ‘usually’ in the question)	Yes (11-16 years old)
	Year of arrival in Australia (Only in Australian samples)	How many years have you lived in Australia?	ALLS 2006 (NCES, page 4, A2)	(5)	Adapted (Change ‘Open-ended’ question to ‘Multiple choice question’)	Yes (15-24 years old)
	Socio-economic status	Does your family own a car, van or truck? Do you have your own bedroom for yourself?	FAS II 2008 (HBSC, page 3)	(6)	Adapted after pilot test (Add notes to explain ‘holiday’ and ‘computer’)	Yes (11-17 years old)

Survey domain	Content area	Question item	Source questionnaire (Author/organisation)	Ref.	Original or Adapted	Used for adolescents
		During the past 12 months, how many times did you travel away on holiday with your family? How many computers does your family own?				
	Language spoken at home (Only in Australian samples)	What is the language you use most often at home?	CTC 2013 (CSAP, page 2, q5)	(3)	Adapted (Change response option 'Spanish' to 'Chinese/ Mandarin/ Cantonese/ Taiwanese')	Yes (10-19 years old)
	General academic achievement	Putting them all together, what were your marks like last year?	CTC 2010 (CTCL, page 10, 15)	(4)	Original	Yes (11-16 years old)
	Personal religion	How important is religion or spirituality in your life?	CTC 2010 (CTCL, page 29, 104)	(4)	Original	Yes (11-16 years old)
	Body mass index (BMI)	How tall are you without your shoes on?	Census at School 2014 (ABS, q9)	(1)	Original	Yes (Years 4 to12)
		How much do you weigh without your shoes on?	GSHS Core Modules 2013 (CDC, page 5, q2)	(7)	Adapted (Change 'Table response option' into 'Open-ended' response option)	Yes (11-18 years old)
Self-efficacy	The general self-efficacy scale	Proportion of adolescents who can always manage to solve difficult problems if they try hard enough Proportion of adolescents who report that if someone opposes them, they can find the means and ways to get what they want Proportion of adolescents who report that it is easy for them to stick to their aims and accomplish their goals Proportion of adolescents who report that they are confident that	GSE 1995 (Schwarzer & Jerusalem, 10-item scale)	(8)	Adapted after pilot test (Add notes to explain 'unforeseen' and 'confronted')	Yes (14-20 years old)

Survey domain	Content area	Question item	Source questionnaire (Author/organisation)	Ref.	Original or Adapted	Used for adolescents
		they could deal efficiently with unexpected events Proportion of adolescents who report that thanks to their resourcefulness, they know how to handle unforeseen situations Proportion of adolescents who report that they can solve most problems if they invest the necessary effort Proportion of adolescents who report that they can remain calm when facing difficulties because they can rely on their coping abilities Proportion of adolescents who report that when they are confronted with a problem, they can usually find several solutions Proportion of adolescents who report that if they are in trouble, they can usually think of a solution Proportion of adolescents who report that they can usually handle whatever comes their way				
Social support	Perceived social support	Proportion of adolescents who report that there is a special person who is around when they are in need Proportion of adolescents who report that there is a special person with whom they can share their joys and sorrows	MSPSS 1988 (Zimet *et al.*, 12-item scale)	(9)	Adapted after pilot test (Add notes to explain 'special people' and 'sorrow')	Yes (11-23 years old)

Survey domain	Content area	Question item	Source questionnaire (Author/organisation)	Ref.	Original or Adapted	Used for adolescents
		Proportion of adolescents who report that their family really tries to help them Proportion of adolescents who report that they get the emotional help and support they need from their family Proportion of adolescents who report that they have a special person who is a real source of comfort to them Proportion of adolescents who report that their friends really try to help them Proportion of adolescents who report that they can count on their friends when things go wrong Proportion of adolescents who report that they can talk about their problems with their family Proportion of adolescents who report that they have friends with whom they can share their joys and sorrows Proportion of adolescents who report that there is a special person in their life who cares about their feelings Proportion of adolescents who report that their family is willing to help them make decisions				

Survey domain	Content area	Question item	Source questionnaire (Author/organisation)	Ref.	Original or Adapted	Used for adolescents
		Proportion of adolescents who report that they can talk about their problems with their friends				
Environmental factors	Community environment	Proportion of adolescents from a household where the respondent reports living in a safe neighborhood Proportion of adolescents from a household where the respondent reports living in a clean neighborhood Proportion of adolescents from a household where the respondent reports living in an area with good parks, playgrounds and play spaces Proportion of adolescents from a household where the respondent reports good street lighting in the neighborhood Proportion of adolescents from a household where the respondent reports footpaths and roads are in good condition in their neighborhood Proportion of adolescents from a household where the respondent reports good, affordable, easily accessible public transport Proportion of adolescents from a household where the respondent reports basic shopping facilities in their neighborhood	Growing up in Australia, LSAC 2014 (ABS, 9-item scale, page 45, K1CL11-19)	(10)	Adapted (Change ‘Parent version’ questionnaire to ‘adolescent version’)	No, but used in parents of a child aged under 13 years old

Survey domain	Content area	Question item	Source questionnaire (Author/organisation)	Ref.	Original or Adapted	Used for adolescents
		Proportion of adolescents from a household where the respondent reports basic facilities such as medical clinics, banks, etc. in their neighborhood Proportion of adolescents from a household where the respondent reports heavy traffic in the street or road				
	School environment	Proportion of adolescents who report that in their school, students have lots of chances to help decide things like class activities and rules Proportion of adolescents who report that teachers ask them to work on special classroom projects Proportion of adolescents who report that their teacher(s) notices when they are doing a good job and lets them know about it Proportion of adolescents who report that there are lots of chances for students in their school to get involved in sports, clubs, and other school activities outside of class Proportion of adolescents who report that there are lots of chances for students in their school to talk with a teacher one-on-one Proportion of adolescents who report that they feel safe at their school	CTC 2010 (CTCL, 10-item scale, page 11, 17-26)	(4)	Adapted after pilot test (Add notes to explain ‘praise’; change one ‘question sentence’ into ‘declarative sentence’)	Yes (11-16 years old)

Survey domain	Content area	Question item	Source questionnaire (Author/organisation)	Ref.	Original or Adapted	Used for adolescents
		Proportion of adolescents who report that the school lets their parents know when they have done something well Proportion of adolescents who report that their teachers praise them when they work hard in school Proportion of adolescents who report that their school grades are better than the grades of most students in their class Proportion of adolescents who report that they have lots of chances to be part of class discussions or activities				
Health literacy	HLS-EU-Asia-comparison tool	Proportion of adolescents who report that they have adequate ability to find information on health Proportion of adolescents who report that they have adequate ability to understand information on health Proportion of adolescents who report that they have adequate ability to appraise/judge information on health Proportion of adolescents who report that they have adequate ability to apply information on health	HLS-EU-Asia 2013 (HLS-Asia Consortium, 47-item scale)	(11)	Adapted after pilot test (Change 'leaflets' into 'written information' or 'brochures'; change 'health screenings' into 'health checks'; delete examples of 'high cholesterol'; change 'Pilates' into 'Yoga'; add notes to explain 'efforts to promote your health at school'; add notes to explain 'living conditions')	Yes (12-18 years old)

Survey domain	Content area	Question item	Source questionnaire (Author/organisation)	Ref.	Original or Adapted	Used for adolescents
	HLAT-validation tool	Proportion of adolescents who report that they have adequate ability to understand health information Proportion of adolescents who report that they have adequate ability to find health information Proportion of adolescents who report that they have adequate ability to communicate health information Proportion of adolescents who report that they have adequate ability to make decision about health information	HLAT 2014 (Abel *et al.*, 8-item scale)	(12)	Adapted after pilot test (Change 'seldom' into 'sometimes' or 'hardly ever'; change 'instruction leaflets' into 'written information'; change 'when I want to do something for my health without sick' into 'when I am not ill, but want to do something to further improve my health')	Young adults (18-25 years old)
	NVS-comparison tool	Proportion of adolescents who calculate the right number using numeracy skills Proportion of adolescents who understand the health information and answer correctly	HLS-EU-Asia 2013 (HLS-Asia Consortium, 6-item scale)	(11)	Adapted after pilot test (Change picture label 'servings per container' into 'servings per package'; change picture label 'serving size: 100ml' into 'serving size: 100g'; change 'container' into 'package')	Yes (7-17 years old)
Health belief	General attitude towards health	Self-rating of interest on health	Youth Health Information Study 2008 (Paek *et al.*, page 10, q90; q91; q92-96)	(13)	Original	Yes (Year 7)
		Self-rating of importance of health			Adapted (Change 'Multiple health topics' questions into 'General health topic')	Yes (Year 7)
Health behaviour	Regular breakfast eating	Frequency of adolescents who usually have breakfast	VSHAWS 2014 (DET)	(14)	Original	Yes (Years 5, 8 and 11)
	Oral health	Frequency of adolescents who usually brush teeth	VSHAWS 2014 (DET)	(14)	Original	Yes (Years 5, 8 and 11)

Survey domain	Content area	Question item	Source questionnaire (Author/organisation)	Ref.	Original or Adapted	Used for adolescents
	Cigarette smoking	Frequency of adolescents who have smoked cigarettes in the last 30 days	VSHAWS 2014 (DET)	(14)	Original	Yes (Years 5, 8 and 11)
	Alcohol consumption	Frequency of adolescents who have drunk alcohol in the last 30 days	VSHAWS 2014 (DET)	(14)	Original	Yes (Years 5, 8 and 11)
	Physical activity	Frequency of adolescents who are physically active for a total of at least 60 minutes per day during the past 7 days	VSHAWS 2014 (DET)	(14)	Original	Yes (Years 5, 8 and 11)
Health service use	Emergent health service use	Frequency of adolescents who have used the emergency in the last 12 months	HLS-EU-Asia 2013 (HLS-Asia Consortium, page 10, Q3.5A)	(11)	Adapted after pilot test (change 'contact the emergency service' into 'use the emergency service')	Yes (15-24 years old)
	General health service use	Frequency of adolescents who have been to see a doctor in the last 12 months Frequency of adolescents who have used a hospital service in the last 12 months Frequency of adolescents who have used service from other health professionals	HLS-EU-Asia 2013 (HLS-Asia Consortium, page 10, Q3.5)	(11)	Adapted after pilot test (Add notes to explain 'see a doctor'; add notes to explain 'hospital service'; change 'optician' into 'optometrist)	Yes (15-24 years old)
	Patient-provider communication	Frequency of adolescents who have raised a question during the doctor appointment	HLS-EU-Asia 2013 (HLS-Asia Consortium, page 10, Q3.5)	(11)	Adapted after pilot test (Add timeframe to ask question of patient-provider communication)	Yes (15-24 years old)
Health status	General health status	Self-rating of adolescent's general health status	CHQ 2001 (Elizabeth Waters *et al.*, q1.1)	(15)	Original	Yes (10-18 years old)
	Health-related quality of life	Self-rating of adolescent's health-related quality of life	Kidscreen-10 2004 (Ravens-Sieberer, *et al.*, 10-item scale)	(16)	Adapted after pilot test (Change 'seldom' into 'sometimes')	Yes (8-18 years old)

Note: ABS, Australian Bureau of Statistics; ACMA, Australian Communications and Media Authority; AHL, Adolescent Health Literacy; ALLS, Adult Literacy and Life Skills Survey; CDC, Centers for Disease Control and Prevention; CHQ, Child Health Questionnaire; CPGPRC, Central People's Government of the People's Republic of China; CRHLS, Chinese Resident Health Literacy Scale; CSAP, Center for Substance Abuse Prevention; CTC, The Communities That Care Youth Survey; CTCL, Communities That Care Ltd; DET, Department of Education & Training; FAS, Family Affluence Scale; HBSC, Health Behavior in School-Aged Children; HLAT, Health Literacy Assessment Tool; HLS-Asia-Q, Health Literacy Study-Asia-Questionnaire; GSE, General Self-Efficacy Scale; GSHS, Global School-based Student Health Survey; LSAC, Longitudinal Study of Australian Children; MCAF, Media and Communications in Australian Families; MSPSS, Multidimensional Scale of Perceived Social Support; NCES, National Center for Education Statistics; VSHAWS, Victorian Student Health and Wellbeing Survey.

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Appendix 6.1 Ethics from Department of Education and Training

Department of
Education & Training
Strategy & Review Group

2 Treasury Place
East Melbourne, Victoria 3002
Telephone: +61 3 9637 2000
DX 210083
GPO Box 4367
Melbourne, Victoria 3001

2015_002665

Mr Shuaijun Go
The Jack Brockhoff Child Health and Wellbeing Program
School of Population and Global Health
The University of Melbourne
Room 540
Level 5, 207 Bouverie Street
CARLTON 3010

Dear Mr Guo

Thank you for your application of 27 March 2015 in which you request permission to conduct research in Victorian government schools and/or early childhood settings *Understanding and measuring adolescent health literacy from a cross-cultural perspective.*

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. The research is conducted in accordance with the final documentation you provided to the Department of Education and Training.
2. Separate approval for the research needs to be sought from school principals and/or centre directors. This is to be supported by the Department of Education and Training approved documentation and, if applicable, the letter of approval from a relevant and formally constituted Human Research Ethics Committee.
3. The project is commenced within 12 months of this approval letter and any extensions or variations to your study, including those requested by an ethics committee must be submitted to the Department of Education and Training for its consideration before you proceed.
4. As a matter of courtesy, you advise the relevant Regional Director of the schools or governing body of the early childhood settings that you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director or governing body.
5. You acknowledge the support of the Department of Education Training in any publications arising from the research.

State Government Victoria

6. The Research Agreement conditions, which include the reporting requirements at the conclusion of your study, are upheld. A reminder will be sent for reports not submitted by the study's indicative completion date.

7. If the Department of Education Training has commissioned you to undertake this research, the responsible Branch/Division will need to approve any material you provide for publication on the Department's Research and Evaluation Register.

I wish you well with your research study. Should you have further enquiries on this matter, please contact Youla Michaels, Project Support Officer, Insights and Evidence Branch, by telephone on (03) 9637 2707 or by email at michaels.youla.y@edumail.vic.gov.au.

Yours sincerely

Susan Thomas
Director
Performance Reporting & Analytics

06/05/2015

Appendix 6.2: Research protocol in the pilot school

A Research Project in Balwyn High School

-Understanding and Measuring Adolescent Health Literacy from a Cross-cultural Perspective

18 April, 2016

THE UNIVERSITY OF MELBOURNE

The Jack Brockhoff Child Health and Wellbeing Program

Research partnerships working for every child

Contents

1

Jack Brockhoff Child Health & Wellbeing Program
Centre for Health Equity | Melbourne School of Population & Global Health
Room 540, Level 5, 207 Bouverie Street, The University of Melbourne Victoria 3010

THE UNIVERSITY OF MELBOURNE

Letter of Invitation to School Principal

Dear Ms Harman,

We are writing to invite you and your school to participate in a research study that aims to examine the relationship between students' health skills and health & learning outcomes.

The project is titled "**Understanding and measuring adolescent health literacy from a cross-cultural perspective**", and is being led by a PhD candidate Shuaijun (Jun) Guo and his supervisors Dr Elise Davis and Dr Rebecca Armstrong from The University of Melbourne. Jun comes from The Peking University of China. He has experience and expertise in child and adolescent health and school-based health education.

This study involves students in Year 7-9. The study will be set in Australia and China in collaboration with The Peking University. Data will be collected using a self-administered online survey. Questions about students' health skills, health and learning outcomes, and environmental factors will be asked. The questions are not sensitive or expected to cause distress.

The findings will allow schools to understand students' general health and wellbeing, health skills, health behaviours, academic outcomes, and some environmental factors that may influence students' health. A final report will be provided to each school when the study is completed. In addition, a 100-dollar voucher for books or sporting equipment will be provided to each school.

The University of Melbourne and The Department of Education and Training have given approval to approach schools for this research. A copy of their approval is attached. If you are interested in participating in this research, we would like to make an appointment with you or a representative to discuss the research in more details.

If you require further information, please contact:

Shuaijun Guo (Jun)

Mobile: 0452110331

E-mail: shuaijung@student.unimelb.edu.au

Sincerely,

Dr Elise Davis, Associate Director, Jack Brockhoff Child Health and Wellbeing Program, the University of Melbourne Ph 83440921

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Jack Brockhoff Child Health & Wellbeing Program
Centre for Health Equity | Melbourne School of Population & Global Health
Room 540, Level 5, 207 Bouverie Street, The University of Melbourne Victoria 3010

THE UNIVERSITY OF MELBOURNE

Project Information Statement

Title of the Research

Understanding and measuring adolescent health literacy from a cross-cultural perspective

Aims of the Research

The research aims to:

- Understand levels of adolescent health literacy (i.e. students' skills to find, understand and apply health information in their daily life) in school settings;
- Examine influences of social support and environmental factors on students' health and learning outcomes.

Significance of the Research Project

The research is significant in three ways:

1. It will provide information about students' general health and how they engage with their health;
2. It will provide information about how social support, school environment and neighborhood environment influence students' health and learning outcomes;
3. It will provide schools with a greater understanding about the role of schools to facilitate students' health literacy.

Benefits of the Research to Schools

1. The research team will provide the school a health report about their students' health and welling, and environmental factors (e.g. social support, school and neighborhood environment) that may have an impact on students' health. The results will help schools to identify the strengths and weaknesses of current approaches to improve adolescent health literacy in school settings.
2. A 100-dollar voucher for books or sporting equipment will be also provided to participating school.
3. The results will be also disseminated to schools, parents, the Department of Education and Training, and the broader public (e.g. published journal articles, conference presentations), helping to strengthen the importance of health education and health promotion in school settings.

3

Research Plan and Method

We will ask students in Year 7-9 to take part in this study. Data will be collected using an online self-administered questionnaire (https://www.surveymonkey.com/r/462765364). The questionnaire will ask students to assess their general health and wellbeing, health skills in daily life, health-related behaviors and some potential environmental factors that may influence their health. No sensitive questions are involved. Permission will be sought from students and their parents prior to their participation. Only those who consent and whose parents consent will participate. Shuaijun (Jun) Guo will administer the questionnaire survey, and the administration time is about 25-35 minutes. All information collected will be treated in strictest confidence. Neither the school nor students will be identifiable in any reports that are written.

School Involvement

Once we have received your consent to approach students to participate in the study, we will invite school to

- arrange for informed consent and plain language statements to parents and students;
- arrange a time for the online survey among students in Year 7-9;

Thank you for taking the time to read this information.

Shuaijun (Jun) Guo
PhD candidate
University of Melbourne

Dr Elise Davis & Dr Rebecca Armstrong
Supervisors
University of Melbourne

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Jack Brockhoff Child Health & Wellbeing Program
Centre for Health Equity | Melbourne School of Population & Global Health
Room 540, Level 5, 207 Bouverie Street, The University of Melbourne Victoria 3010

THE UNIVERSITY OF MELBOURNE

School Principal Consent Form

I give consent for you to approach students in Year 7, 8 & 9 to participate in the project entitled '**Understanding and measuring adolescent health literacy from a cross-cultural perspective**'.

I have read the Project Information Statement explaining the purpose of the research project and understand that:

- The role of the school is voluntary.
- I may decide to withdraw the school's participation at any time.
- Students in Year 7, 8 & 9 will be invited to participate and that permission will be sought from them and also from their parents.
- Only students who consent and whose parents consent will participate in the project.
- All information obtained will be treated in strictest confidence.
- The students' names will not be used and individual students will not be identifiable in any written reports about the study.
- The school will not be identifiable in any written reports about the study.
- Participants may withdraw from the study at any time.
- A report of the findings will be made available to the school.
- I may seek further information on the project from Shuaijun (Jun) Guo on 0452110331.

Ms Deborah Harman
Principal

Signature

Date

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Appendix 1: Ethics Approval Letter from the DET

Department of Education & Training
Strategy & Review Group

2 Treasury Place
East Melbourne, Victoria 3002
Telephone: +61 3 9637 2000
DX 210083
GPO Box 4367
Melbourne, Victoria 3001

2015_002665

Mr Shuaijun Go
The Jack Brockhoff Child Health and Wellbeing Program
School of Population and Global Health
The University of Melbourne
Room 540
Level 5, 207 Bouverie Street
CARLTON 3010

Dear Mr Guo

Thank you for your application of 27 March 2015 in which you request permission to conduct research in Victorian government schools and/or early childhood settings *Understanding and measuring adolescent health literacy from a cross-cultural perspective.*

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. The research is conducted in accordance with the final documentation you provided to the Department of Education and Training.
2. Separate approval for the research needs to be sought from school principals and/or centre directors. This is to be supported by the Department of Education and Training approved documentation and, if applicable, the letter of approval from a relevant and formally constituted Human Research Ethics Committee.
3. The project is commenced within 12 months of this approval letter and any extensions or variations to your study, including those requested by an ethics committee must be submitted to the Department of Education and Training for its consideration before you proceed.
4. As a matter of courtesy, you advise the relevant Regional Director of the schools or governing body of the early childhood settings that you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director or governing body.
5. You acknowledge the support of the Department of Education Training in any publications arising from the research.

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Victoria

6. The Research Agreement conditions, which include the reporting requirements at the conclusion of your study, are upheld. A reminder will be sent for reports not submitted by the study's indicative completion date.
7. If the Department of Education Training has commissioned you to undertake this research, the responsible Branch/Division will need to approve any material you provide for publication on the Department's Research and Evaluation Register.

I wish you well with your research study. Should you have further enquiries on this matter, please contact Youla Michaels, Project Support Officer, Insights and Evidence Branch, by telephone on (03) 9637 2707 or by email at michaels.youla.y@edumail.vic.gov.au.

Yours sincerely

Susan Thomas
Director
Performance Reporting & Analytics

06/05/2015

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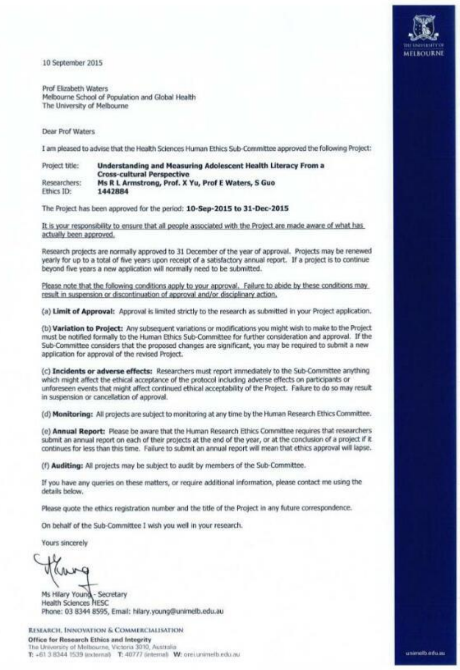
Appendix 2: Ethics Approval Letter from the University



THE UNIVERSITY OF MELBOURNE

10 September 2015

Prof Elizabeth Waters
Melbourne School of Population and Global Health
The University of Melbourne

Dear Prof Waters

I am pleased to advise that the Health Sciences Human Ethics Sub-Committee approved the following Project:

Project title:	**Understanding and Measuring Adolescent Health Literacy From a Cross-cultural Perspective**
Researchers:	**Ms R L Armstrong, Prof. X Yu, Prof E Waters, S Guo**
Ethics ID:	**1442884**

The Project has been approved for the period: **10-Sep-2015 to 31-Dec-2015**

It is your responsibility to ensure that all people associated with the Project are made aware of what has actually been approved.

Research projects are normally approved to 31 December of the year of approval. Projects may be renewed yearly for up to a total of five years upon receipt of a satisfactory annual report. If a project is to continue beyond five years a new application will normally need to be submitted.

Please note that the following conditions apply to your approval. Failure to abide by these conditions may result in suspension or discontinuation of approval and/or disciplinary action.

(a) **Limit of Approval:** Approval is limited strictly to the research as submitted in your Project application.

(b) **Variation to Project:** Any subsequent variations or modifications you might wish to make to the Project must be notified formally to the Human Ethics Sub-Committee for further consideration and approval. If the Sub-Committee considers that the proposed changes are significant, you may be required to submit a new application for approval of the revised Project.

(c) **Incidents or adverse effects:** Researchers must report immediately to the Sub-Committee anything which might affect the ethical acceptance of the protocol including adverse effects on participants or unforeseen events that might affect continued ethical acceptability of the Project. Failure to do so may result in suspension or cancellation of approval.

(d) **Monitoring:** All projects are subject to monitoring at any time by the Human Research Ethics Committee.

(e) **Annual Report:** Please be aware that the Human Research Ethics Committee requires that researchers submit an annual report on each of their projects at the end of the year, or at the conclusion of a project if it continues for less than this time. Failure to submit an annual report will mean that ethics approval will lapse.

(f) **Auditing:** All projects may be subject to audit by members of the Sub-Committee.

If you have any queries on these matters, or require additional information, please contact me using the details below.

Please quote the ethics registration number and the title of the Project in any future correspondence.

On behalf of the Sub-Committee I wish you well in your research.

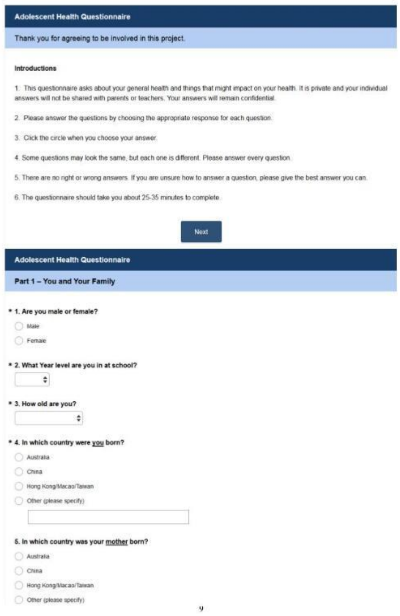
Yours sincerely

Ms Hilary Young - Secretary
Health Sciences HESC
Phone: 03 8344 8595, Email: hilary.young@unimelb.edu.au

RESEARCH, INNOVATION & COMMERCIALISATION
Office for Research Ethics and Integrity
The University of Melbourne, Victoria 3010, Australia
T: +61 3 8344 1539 (external) T: 40777 (internal) W: orei.unimelb.edu.au

unimelb.edu.au

Appendix 3: Sample of Online Survey



Adolescent Health Questionnaire

Thank you for agreeing to be involved in this project.

Introductions

1. This questionnaire asks about your general health and things that might impact on your health. It is private and your individual answers will not be shared with parents or teachers. Your answers will remain confidential.

2. Please answer the questions by choosing the appropriate response for each question.

3. Click the circle when you choose your answer.

4. Some questions may look the same, but each one is different. Please answer every question.

5. There are no right or wrong answers. If you are unsure how to answer a question, please give the best answer you can.

6. The questionnaire should take you about 25-35 minutes to complete.

Next

Adolescent Health Questionnaire

Part 1 – You and Your Family

*** 1. Are you male or female?**
- Male
- Female

*** 2. What Year level are you in at school?**

*** 3. How old are you?**

*** 4. In which country were you born?**
- Australia
- China
- Hong Kong/Macao/Taiwan
- Other (please specify)

5. In which country was your mother born?
- Australia
- China
- Hong Kong/Macao/Taiwan
- Other (please specify)

Appendix 4: Plain Language Statement to Parents

Appendix 5: Plain Language Statement to Students

Ethics ID 1442884.1 Plain Language Statement to Adolescents

Plain Language Statement to Adolescents

THE UNIVERSITY OF MELBOURNE

"Understanding and measuring adolescent health literacy from a cross-cultural perspective"

Hello! My name is Shuaijun Guo. I am a student at The University of Melbourne. I am doing a project to learn about your ability to find, understand and use health information in their daily life, and the relationship between your health skills and your health & learning outcomes. When I finish my project, it will be part of my degree, called a "PhD". Elise Davis and Rebecca Armstrong are helping me with my project. They are called my "supervisors". We work in The School of Population and Global Health.

My project tries to learn about your health literacy (i.e. your knowledge about your health and where to go for health information), and find environmental factors that might impact on your health. Improving health literacy is an important goal for school health curriculums. However, it is difficult to achieve this goal for school-aged children from diverse backgrounds, because culture influences health and learning a lot. In my project, in order to help schools to develop a better health-centered setting for children from different cultural backgrounds, I will use an online survey to get the relevant information.

Your school principal and your teacher have given me permission to send you this letter to tell you a bit about my project. Once you have read the letter you can decide if you would like to take part. You should talk to your parents about the project too.

If you want to be part of the project, I will ask you to answer some questions about your health. You and all the other people from your class who are taking part will spend 25-35 minutes answering the online survey. I will be there to explain the questions if you have questions. You can stop doing the questions at any time. If you don't know an answer, or you don't want to answer a question, that's fine too.

Your answers to these questions are confidential. Your responses will not be shared with parents or teachers. The project will have nothing to do with your grades. You don't even have to write your name on the questionnaire, so no one will be able to tell which answers are yours.

After the project is over, all electronic files will be password protected safely in the School of Population and Global Health for 5 years. I have to do this because it is a University rule. After that my supervisors and I will destroy them.

Remember, you don't have to take part unless you want to. If you have any questions you can talk to your parent or your teacher. If they don't know the answer to your question, they can contact me, my supervisors, or the Research Ethics Office at the University for you.

If you want to be part of my project, and your parents agree, please get your parent or guardian to sign on the **Parental Consent Form**, and sign your name on the **Adolescent Consent Form**.

Jack Brockhoff Child Health & Wellbeing Program
Centre for Health Equity | Melbourne School of Population & Global Health
Room 540, Level 5, 207 Bouverie Street, The University of Melbourne Victoria 3010
Shuaijun Guo; Mobile Phone: 0452110331; Email: shuaijung@student.unimelb.edu.au

Appendix 6: Parental/Guardian Consent Form

Ethics ID 1442884.1 — Parental/Guardian Consent Form

ID number: ______________ (Office Use Only)

THE UNIVERSITY OF MELBOURNE

Parental/Guardian Consent Form

I (your full name, please print)..

am the mother/father/guardian (please circle) of ....(child's full name)

and consent to my child taking part in the research project called '**Understanding and measuring adolescent health literacy from a cross-cultural perspective**' which has been explained to me by the plain language statement.

The project is being led by a PhD candidate Shuaijun Guo and his supervisors Dr Elise Davis and Dr Rebecca Armstrong from The University of Melbourne.

I consent to a questionnaire survey being completed by my child ☐ **yes** ☐ **no** (please tick)

I wish to receive a copy of the summary project report on the research findings ☐ **yes** ☐ **no** (please tick)

(If yes, please provide your email address: ________________________________)

What country was your child born? ☐ **Australia** ☐ **China** ☐ **Other:** ______ (please tick)

What is the first language of your child at home? ☐ **English** ☐ **Chinese** ☐ **Other:** ______ (please tick)

I have received a letter explaining the study and I fully understand the purpose, extent and possible effects of my involvement.

I understand that my child will be sent a questionnaire to complete and that the questionnaire will take approximately 25-35 minutes.

I understand that participation is voluntary. All of the information that my child provides will be treated confidentially. My child's results will not be identifiable in any reports. All data that is collected will be coded so that it cannot be identified. All paper-based data will be kept in a locked cabinet at The University of Melbourne and all electronic files will be password protected. Only the research team will have access to this data.

I understand that I am free to withdraw my child from the study at any time without explanation and that non-participation in this study will not affect me or my child in any way.

SIGNED .... **Date**....../...../........

Jack Brockhoff Child Health & Wellbeing Program
Centre for Health Equity | Melbourne School of Population & Global Health
Level 5, 207 Bouverie Street, The University of Melbourne Victoria 3010
Shuaijun Guo; Mobile Phone: 0452110331; Email: shuaijung@student.unimelb.edu.au

Appendix 7: Adolescent Consent Form

Ethics ID 1442884.1 — Adolescent Consent Form

ID number: ______________ (Office Use Only)

THE UNIVERSITY OF MELBOURNE

Adolescent Consent Form

I (your full name, please print)..

consent to taking part in the research project called '**Understanding and measuring adolescent health literacy from a cross-cultural perspective**' which has been explained to me by the plain language statement.

The project is being led by a PhD student Shuaijun Guo and his supervisors Elise Davis and Rebecca Armstrong from The University of Melbourne.

I consent to completing an online questionnaire survey. ☐ **yes** ☐ **no** (please tick)

I have received a letter explaining the study and I fully understand the purpose, extent and possible effects of my involvement.

I understand that I will be sent a questionnaire survey to complete and that the questionnaire will take approximately 25-35 minutes.

I understand that participation is voluntary. All of the information that I provide will be treated confidentially. My results will not be identifiable in any reports. All data that is collected will be coded so that it cannot be identified. All paper-based data will be kept in a locked cabinet at The University of Melbourne and all electronic files will be password protected. Only the research team will have access to this data.

I understand that I am free to withdraw from the study at any time without explanation and that non-participation in this study will not affect me in any way.

SIGNED .... **Date**....../...../........

Jack Brockhoff Child Health & Wellbeing Program
Centre for Health Equity | Melbourne School of Population & Global Health
Level 5, 207 Bouverie Street, The University of Melbourne Victoria 3010
Shuaijun Guo; Mobile Phone: 0452110331; Email: shuaijung@student.unimelb.edu.au

Appendix 8: Template Report to Balwyn High School

Contents

Appendix 6.3: Parental consent form in the pilot school

ID number: ____________
(Office Use Only)

Parental/Guardian Consent Form

THE UNIVERSITY OF MELBOURNE

I (your full name, please print)..

am the mother/father/guardian (please circle) of ....(child's full name)

and consent to my child taking part in the research project called '**Understanding and measuring adolescent health literacy from a cross-cultural perspective**' which has been explained to me by the plain language statement.

The project is being led by a PhD candidate Shuaijun Guo and his supervisors Dr Elise Davis and Dr Rebecca Armstrong from The University of Melbourne.

I consent to a questionnaire survey being completed by my child ☐ **yes** ☐ **no** (please tick)

I wish to receive a copy of the summary project report on the research findings ☐ **yes** ☐ **no** (please tick)

(If yes, please provide your email address: ________________________________)

What country was your child born? ☐ **Australia** ☐ **China** ☐ **Other:** ______ (please tick)

What is the first language of your child at home? ☐ **English** ☐ **Chinese** ☐ **Other:** ______ (please tick)

I have received a letter explaining the study and I fully understand the purpose, extent and possible effects of my involvement.

I understand that my child will be sent a questionnaire to complete and that the questionnaire will take approximately 25-35 minutes.

I understand that participation is voluntary. All of the information that my child provides will be treated confidentially. My child's results will not be identifiable in any reports. All data that is collected will be coded so that it cannot be identified. All paper-based data will be kept in a locked cabinet at The University of Melbourne and all electronic files will be password protected. Only the research team will have access to this data.

I understand that I am free to withdraw my child from the study at any time without explanation and that non-participation in this study will not affect me or my child in any way.

SIGNED .... **Date**......../....../...........

Jack Brockhoff Child Health & Wellbeing Program
Centre for Health Equity | Melbourne School of Population & Global Health
Level 5, 207 Bouverie Street, The University of Melbourne Victoria 3010
Shuaijun Guo; Mobile Phone: 0452110331; Email: shuaijung@student.unimelb.edu.au

Appendix 6.4: Plain language statement to parents in the pilot school

A New Way to Understand Your Child's Health

-Health Literacy, a new and important concept

What is 'health literacy'?

Health literacy means one's ability to find, understand, and use health information to make good health decisions in daily life.

Why 'health literacy' is important ?

People who are more health literate will have better health and wellbeing, and will be less likely to engage in poor health behaviors. Health literacy applies into different settings.

A health literate person can make health decisions in these settings!

A Cover Letter to Parents

Dear Parents,

We are undertaking a study looking at students' ability to find, understand, and use health information in their daily life. The project is titled "**Understanding and measuring adolescent health literacy from a cross-cultural perspective**", and is being led by a PhD candidate Shuaijun Guo (Jun) and his supervisors Dr Elise Davis and Dr Rebecca Armstrong from The University of Melbourne.

The study will be set in Australia and China in collaboration with The Peking University. We will ask students from a small number of government secondary schools to take part in this study. Data will be collected using an online survey in a health education class. Questions about students' general health and wellbeing, health skills, health behaviors, academic outcomes, and environmental factors that may influence their health will be asked. The questions are not sensitive or expected to cause distress.

Following this letter you will find the plain language statement which describes in detail the aims of this study and what you or your child would need to do if you want to be involved. If you are interested in taking part in this study, please sign the attached consent form. The findings from this study will help to identify opportunities to develop better health education programs and improve adolescent health in school settings. If you would like further information, please contact:

Shuaijun Guo (Jun)
Mobile: 0452110331
E-mail: shuaijung@student.unimelb.edu.au

Sincerely,
The Jack Brockhoff Child Health and Wellbeing Program

Population & Global Health

The Jack Brockhoff Child Health and Wellbeing Program
Research partnerships working for every child

Plain Language Statement to Parents

Dear Participant,

Your child is invited to take part in a research project called:

"Understanding and measuring adolescent health literacy from a cross-cultural perspective"

-A new way to learn adolescents' health knowledge and skills

The project is being led by a PhD student Shuaijun Guo and his supervisors Dr Elise Davis and Dr Rebecca Armstrong from The University of Melbourne. This study aims to assess adolescent health literacy (i.e. health knowledge and skills) and to examine the relationship between adolescent health literacy and their health & learning outcomes in school settings.

The study will be set in Australia and China in collaboration with The Peking University. We are asking students from a small number of government secondary schools to participate. To take part we will invite students to complete a questionnaire. The questionnaire will ask your child to assess their general health and wellbeing, health skills in daily life, health behaviors and some environmental factors that may influence their health. Examples of questions we will ask your child are "How easy would you say it is to find information about symptoms of illness that concern you?" and "In the last week, have you felt fit and well?" The questionnaire is expected to take about 25-35 minutes to complete.

The questionnaire is not expected to be upsetting, however the survey does ask a few questions about students' mental health and wellbeing (e.g. In the last week…have you felt full of energy? Have you felt lonely? Have you had fun with your friends?). A teacher will be present during the completion of the survey and available for discussion with students if required.

The findings will allow schools to understand students' general health and how they engage with their health, and how school and neighborhood environment influence their health. The findings will help identify opportunities to develop better health education programs that improve students' health knowledge and skills.

Your participation is voluntary and your child is free to withdraw from the study at any time without explanation. Non-participation in this study will not affect you or your child in any way. All of the information that your child gives to us will be treated confidentially and individual results will not be identifiable in any reports or in the stored databases. Paper-based data will be kept in a locked cabinet at The University of Melbourne and all electronic files will be password protected. Only those in the research team will have access to this information. All data will be stored at The University of Melbourne for five years after public release of the work, as required by University regulations and then destroyed. If your child withdraws, any unprocessed information your child has provided at that time will be destroyed and not included in any results. The results of the research will be made available to you or your child when the project is finished in the form of a summary report and research paper.

There are no direct benefits to you or your child. There are no potential risks to you or your child. There is no reimbursement for your child's participation, although a $ 100 voucher for books or sporting equipment will be provided to each school to thank them for their time.

Please keep this information sheet for your information.

If you would like to get involved, or require further information, please contact the following project manager:

Shuaijun Guo (Jun)
Mobile: 0452110331
E-mail: shuaijung@student.unimelb.edu.au

If you have any concerns about the conduct of this research project, you can contact the Executive Officer, Human Research Ethics, The University of Melbourne, ph: 8344 2073; fax 9347 6739. Project ID: 1442884.1.

Sincerely,
The Jack Brockhoff Child Health and Wellbeing Program

Appendix 6.5: Adolescent consent form in the pilot school

ID number: ___________
(Office Use Only)

Adolescent Consent Form

THE UNIVERSITY OF MELBOURNE

I (your full name, please print)..

consent to taking part in the research project called '**Understanding and measuring adolescent health literacy from a cross-cultural perspective**' which has been explained to me by the plain language statement.

The project is being led by a PhD student Shuaijun Guo and his supervisors Elise Davis and Rebecca Armstrong from The University of Melbourne.

I consent to completing an online questionnaire survey. ☐ **yes** ☐ **no**
(please tick)

I have received a letter explaining the study and I fully understand the purpose, extent and possible effects of my involvement.

I understand that I will be sent a questionnaire survey to complete and that the questionnaire will take approximately 25-35 minutes.

I understand that participation is voluntary. All of the information that I provide will be treated confidentially. My results will not be identifiable in any reports. All data that is collected will be coded so that it cannot be identified. All paper-based data will be kept in a locked cabinet at The University of Melbourne and all electronic files will be password protected. Only the research team will have access to this data.

I understand that I am free to withdraw from the study at any time without explanation and that non-participation in this study will not affect me in any way.

SIGNED .... **Date**......... /...... /...........

Jack Brockhoff Child Health & Wellbeing Program
Centre for Health Equity | Melbourne School of Population & Global Health
Level 5, 207 Bouverie Street, The University of Melbourne Victoria 3010
Shuaijun Guo; Mobile Phone: 0452110331; Email: shuaijung@student.unimelb.edu.au

Appendix 6.6: Plain language statement to adolescents in the pilot school

Plain Language Statement to Adolescents

THE UNIVERSITY OF MELBOURNE

"Understanding and measuring adolescent health literacy from a cross-cultural perspective"

Hello! My name is Shuaijun Guo. I am a student at The University of Melbourne. I am doing a project to learn about your ability to find, understand and use health information in their daily life, and the relationship between your health skills and your health & learning outcomes. When I finish my project, it will be part of my degree, called a "PhD". Elise Davis and Rebecca Armstrong are helping me with my project. They are called my "supervisors". We work in The School of Population and Global Health.

My project tries to learn about your health literacy (i.e. your knowledge about your health and where to go for health information), and find environmental factors that might impact on your health. Improving health literacy is an important goal for school health curriculums. However, it is difficult to achieve this goal for school-aged children from diverse backgrounds, because culture influences health and learning a lot. In my project, in order to help schools to develop a better health-centered setting for children from different cultural backgrounds, I will use an online survey to get the relevant information.

Your school principal and your teacher have given me permission to send you this letter to tell you a bit about my project. Once you have read the letter you can decide if you would like to take part. You should talk to your parents about the project too.

If you want to be part of the project, I will ask you to answer some questions about your health. You and all the other people from your class who are taking part will spend 25-35 minutes answering the online survey. I will be there to explain the questions if you have questions. You can stop doing the questions at any time. If you don't know an answer, or you don't want to answer a question, that's fine too.

Your answers to these questions are confidential. Your responses will not be shared with parents or teachers. The project will have nothing to do with your grades. You don't even have to write your name on the questionnaire, so no one will be able to tell which answers are yours.

After the project is over, all electronic files will be password protected safely in the School of Population and Global Health for 5 years. I have to do this because it is a University rule. After that my supervisors and I will destroy them.

Remember, you don't have to take part unless you want to. If you have any questions you can talk to your parent or your teacher. If they don't know the answer to your question, they can contact me, my supervisors, or the Research Ethics Office at the University for you.

If you want to be part of my project, and your parent/s agree, please get your parent or guardian to sign on the **Parental Consent Form**, and sign your name on the **Adolescent Consent Form**.

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Appendix 6.7: Online survey in the pilot school

Adolescent Health Questionnaire

Thank you for agreeing to be involved in this project.

Introductions

1. This questionnaire asks about your general health and things that might impact on your health. It is private and your individual answers will not be shared with parents or teachers. Your answers will remain confidential.

2. Please answer the questions by choosing the appropriate response for each question.

3. Put a tick in the circle when you choose your answer.

4. Some questions may look the same, but each one is different. Please answer every question.

5. There are no right or wrong answers. If you are unsure how to answer a question, please give the best answer you can.

6. The questionnaire should take you about 25-35 minutes to complete.

1

Adolescent Health Questionnaire

Part 1 – You and Your Family

* 1. Are you male or female?

- Male
- Female

* 2. What Year level are you in at school?

* 3. How old are you?

* 4. In which country were **you** born?

- Australia
- China
- Hong Kong/Macao/Taiwan
- Other (please specify)

5. In which country was your **mother** born?

- Australia
- China
- Hong Kong/Macao/Taiwan
- Other (please specify)

2

6. In which country was your **father** born?

- Australia
- China
- Hong Kong/Macao/Taiwan
- Other (please specify)

7. How many years have you lived in Australia?

- I was born in Australia.
- I have lived in Australia since I was ______ years old (Please specify using numbers in the box below).

8. Think of where you live most of the time. Who usually lives there with you? ***Please choose All that apply***)

- Mother
- Father
- Sister (s)
- Brother (s)
- Aunt
- Uncle
- Stepmother
- Stepfather
- Foster Mother
- Foster Father
- Stepbrother (s) or stepsister (s)
- Grandmother
- Grandfather
- Other Adults
- Other Children
- I don't live with anyone at the moment
- Other (please specify)

3

* 9. Do you have your own bedroom for yourself?

- No
- Yes

* 10. How many computers does your family own?
(Note: "computers" include laptops, desktops and tablets, not including game consoles and smartphones.)

- None
- One
- Two
- More than two

* 11. Does your family own a car/van/truck?

- No
- Yes, one
- Yes, two or more

* 12. During the past 12 months, how many times did you travel away on holiday with your family?
(Note: "holiday" could be short or long.)

- Not at all
- Once
- Twice
- More than twice

* 13. What is the language you use most often at home?

- English
- Chinese/Mandarin/Cantonese/Taiwanese
- Another language (please specify)

4

14. Think of your marks at school, if putting them all together, what were your marks like last year?

- Very poor
- Poor
- Average
- Good
- Very good

15. How important is religion or spirituality in your life?

- Not at all important
- Not very important
- Somewhat important
- Very important
- Extremely important

16. How tall are you without your shoes on? _____ cm (Please answer to the nearest centimeter using numbers in the box below)

17. How much do you weigh without your shoes on? _____ kg (Please answer to the nearest kilogram using numbers in the box below)

5

Adolescent Health Questionnaire

Part 2–Your Personal Health

* 18. In general, would you say your health is?

- Poor
- Fair
- Good
- Very good
- Excellent

* 19. How interested are you in learning about health?

- Not at all interested
- Not very interested
- Unsure
- Somewhat interested
- Very interested

* 20. How important is health to you?

- Not at all important
- Not very important
- Neither important nor unimportant
- Somewhat important
- Very important

* 21. Thinking about the last week ...

	not at all	slightly	moderately	very	extremely
Have you felt fit and well?					

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* 22. Thinking about the last week ...

	never	sometimes	quite often	very often	always
a. Have you felt full of energy?					
b. Have you felt sad?					
c. Have you felt lonely?					
d. Have you had enough time for yourself?					
e. Have you been able to do the things that you want to do in your free time?					
f. Have your parent(s) treated you fairly?					
g. Have you had fun with your friends?					

* 23. Thinking about the last week ...

	not at all	slightly	moderately	very	extremely
Have you got on well at school?					

* 24. Thinking about the last week ...

	never	sometimes	quite often	very often	always
Have you been able to pay attention?					

Please indicate how you feel about each of the following questions:

7

* 25. How well do you understand the written information that comes with medication (e.g. the information on the pill bottle or pill box)?

- Very bad
- Bad
- Moderate
- Good
- Very good
- I have not used such information

* 26. How well do you understand information brochures on health issues (e.g. nutrition, illegal drugs)?

- Very bad
- Bad
- Moderate
- Good
- Very good
- I have not used such information

* 27. How often can you help your family members or a friend if they had questions concerning health issues (e.g. stress, sport injury, nutrition)?

- Never
- Hardly ever
- Sometimes
- Often
- Always
- There have never been any questions

8

* 28. When you come up with questions concerning health issues, how often can you get information and advice from others (e.g. family, friends, teachers)?

- Never
- Hardly ever
- Sometimes
- Often
- Always
- There have never been any questions

* 29. There is much advice and many suggestions for health in daily life. How well can you choose the advice and suggestions that suit you the most?

- Very bad
- Bad
- Moderate
- Good
- Very good
- I have not been interested in these issues

* 30. When I have questions on diseases or health problems (e.g. headache, back pain, sport injury), I know where I can find information on these issues.

- Strongly disagree
- Disagree
- Agree
- Strongly agree
- I do not have such experiences

* 31. When I am not ill, but want to do something to further improve my health (e.g. good nutrition, regular physical activity), I know where I can find information on these issues.

- Strongly disagree
- Disagree
- Agree
- Strongly agree
- I have not been interested in these issues

9

* 32. When looking for health information on the Internet, I can determine which sources are of high and which are of poor quality.

- Strongly disagree
- Disagree
- Agree
- Strongly agree
- I do not have experiences with these issues

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Adolescent Health Questionnaire

Part 3–Your Health Behaviors

33. During the past 7 days, how often did you have breakfast (more than a glass of milk or fruit juice)?

- 0 days
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

34. How often do you brush your teeth?

- Never
- Less than once a week
- At least once a week but not daily
- Once a day
- More than once a day

35. On how many occasions (if any) have you smoked cigarettes in the last 30 days?

- Never
- 1-2 times
- 3-5 times
- 6-9 times
- 10-19 times
- 20-39 times
- 40 or more

11

36. On how many occasions have you drunk alcohol in the last 30 days?

- Never
- 1-2 times
- 3-5 times
- 6-9 times
- 10-19 times
- 20-39 times
- 40 or more

37. During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Some examples of physical activity are running, fast walking, biking, dancing, etc.)

- 0 days
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

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Adolescent Health Questionnaire

Part 4–Your Literacy Skills

The following information gives you the kind of information that you might find on the back of a container of ice cream. Please read the information carefully before you move on to the questions 38-43.

38. How many calories (Cal) will you consume if you ate the whole package of ice-cream?*(Please use __numbers__ to answer this question)*

39. If you are advised to eat no more than 60 grams of carbohydrate for dessert, what is the maximum amount of ice cream you could have? *(Please use __numbers__ to answer this question)*

40. Imagine that your doctor advises you to reduce the amount of saturated fat in your diet. You usually have 42 g of saturated fat each day, some of which comes from one serving of ice cream. If you stop eating ice cream, how many grams of saturated fat would you be eating each day? *(Please use __numbers__ to answer this question)*

41. If you usually eat 2500 calories (Cal) each day, what percentage of your daily calorie (Cal) intake will you get if you eat one serving of ice cream? *(Please use __numbers__ to answer this question)*

42. Imagine that you are allergic to the following substances: penicillin, peanuts, latex gloves, and bee stings. Is it safe for you to eat this ice cream?

43. Why? (Please answer this question if you answered 'No' to question 42. If you answered 'Yes' to question 42, please click 'next' button below.)

13

Adolescent Health Questionnaire

Part 5–People in Your Life

* 44. These questions ask about special people in your life. Special people may include your mother or father or someone else. Please indicate how you feel about each of the following statements:

	Very Strongly Disagree	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree	Very Strongly Agree
a. There is a special person who is around when I am in need.	○	○	○	○	○	○	○
b. There is a special person with whom I can share my joys and sorrows (i.e. sadness).	○	○	○	○	○	○	○
c. My family really tries to help me.	○	○	○	○	○	○	○
d. I get the emotional help and support I need from my family.	○	○	○	○	○	○	○
e. I have a special person who is a real source of comfort to me.	○	○	○	○	○	○	○
f. My friends really try to help me.	○	○	○	○	○	○	○
g. I can count on my friends when things go wrong.	○	○	○	○	○	○	○
h. I can talk about my problems with my family.	○	○	○	○	○	○	○
i. I have friends with whom I can share my joys and sorrows.	○	○	○	○	○	○	○
j. There is a special person in my life who cares about my feelings.	○	○	○	○	○	○	○
k. My family is willing to help me make decisions.	○	○	○	○	○	○	○
l. I can talk about my problems with my friends.	○	○	○	○	○	○	○

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* 45. How true is each of the following statements for you?

	Not at all true	Hardly true	Moderately true	Exactly true
a. I can always manage to solve difficult problems if I try hard enough.	○	○	○	○
b. If someone opposes me, I can find the means and ways to get what I want.	○	○	○	○
c. It is easy for me to stick to my aims and accomplish my goals.	○	○	○	○
d. I am confident that I could deal efficiently with unexpected events.	○	○	○	○
e. Thanks to my resourcefulness, I know how to handle unforeseen (i.e. unexpected) situations.	○	○	○	○
f. I can solve most problems if I invest the necessary effort.	○	○	○	○
g. I can remain calm when facing difficulties because I can rely on my coping abilities.	○	○	○	○
h. When I am confronted (i.e. faced) with a problem, I can usually find several solutions.	○	○	○	○
i. If I am in trouble, I can usually think of a solution.	○	○	○	○
j. I can usually handle whatever comes my way.	○	○	○	○

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Adolescent Health Questionnaire

Part 6–Your School and Community

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* 46. Please indicate how you feel about each of the following statements<u>about your school</u>:

	Strongly Disagree	Disagree	Agree	Strongly Agree
a. In my school, students have lots of chances to help decide things like class activities and rules.				
b. Teachers ask me to work on special classroom projects.				
c. My teacher(s) notices when I am doing a good job and lets me know about it.				
d. There are lots of chances for students in my school to get involved in sports, clubs, and other school activities outside of class.				
e. There are lots of chances for students in my school to talk with a teacher one-on-one.				
f. I feel safe at my school.				
g. The school lets my parents know when I have done something well.				
h. My teachers praise (i.e. express approval) me when I work hard in school.				
i. My school grades are better than the grades of most students in my class.				
j. I have lots of chances to be part of class discussions or activities.				

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* 47. To what extent do you agree or disagree with each of the following statements <u>about your neighborhood</u>?

<u>If you are living in rural/remote area</u> neighborhood means "Your local area";
<u>If you are living in city/urban area</u> Neighborhood means "Your suburb within 1 or 2 km from your home, about 20-30 minutes walking".

	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't know
a. This is a safe neighborhood.					
b. This is a clean neighborhood.					
c. There are good parks, playgrounds and play spaces in this neighborhood.					
d. There is good street lighting in this neighborhood.					
e. The state of the footpaths and roads is good in this neighborhood.					
f. There is access to close, affordable, regular public transport in this neighborhood.					
g. There is access to basic shopping facilities in this neighborhood.					
h. There is access to basic services such as banks, medical clinics, etc. in this neighborhood.					
i. There is heavy traffic on my street or road .					

The next questions are asking about your experience of health services use in the last year.

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48. How many times have you ...?

	0 times	1–2 times	3–5 times	6 times or more	Don't know
(1) ...used the emergency service (e.g. ambulance, emergency department of a hospital) in the last 12 months?					
(2) ... been to see a doctor (i.e. general practitioner-GP) in the last 12 months?					
(3) ...used a hospital service (e.g. health checks, seeing a specialist, emergency service) in the last 12 months?					
(4) ...used service from other health professionals, such as dentist, physiotherapist, psychologist, dietician, or optometrist in the last 12 months?					
(5) ...raised a question during your doctor appointment in the last 12 months?					

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Adolescent Health Questionnaire

Part 7–Your Health Skills

Please indicate how difficult or easy the following tasks are for you **<u>now</u>**.

* 49. On a scale from very easy to very difficult, how easy would you say it is to:

	Very difficult	Fairly difficult	Fairly easy	Very easy	Don't know
(1) Find information about symptoms of illnesses that concern you?					
(2) Find information on treatments of illnesses that concern you?					
(3) Find out what to do in case of a medical emergency (e.g. calling emergency service)?					
(4) Find out where to get professional help (e.g. doctor, pharmacist, psychologist) when you are ill?					
(5) Understand what your doctor says to you?					
(6) Understand the written information that comes with your medicine?					
(7) Understand what to do in a medical emergency (e.g. calling emergency service)?					
(8) Understand your doctor's or pharmacist's instruction on how to take medicine?					

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* 50. On a scale from very easy to very difficult, how easy would you say it is to:

	Very difficult	Fairly difficult	Fairly easy	Very easy	Don't know
(9) Judge how information from your doctor applies to you?					
(10) Judge the advantages and disadvantages of different treatment options?					
(11) Judge when you may need to get a second opinion from another doctor?					
(12) Judge if the information about illness in the media (e.g. TV, Internet, or other media) is reliable?					
(13) Use information the doctor gives you to make decisions about your illness?					
(14) Follow the instructions on medication?					
(15) Call an ambulance in an emergency?					
(16) Follow instructions from your doctor or pharmacist?					

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* 51. On a scale from very easy to very difficult, how easy would you say it is to:

	Very difficult	Fairly difficult	Fairly easy	Very easy	Don't know
(17) Find information about how to manage unhealthy behavior such as smoking, low physical activity and drinking too much?					
(18) Find information on how to manage mental health problems like stress or depression?					
(19) Find information about vaccinations and health checks (e.g. blood pressure, blood sugar test) that you should have?					
(20) Find information on how to prevent or manage conditions like being overweight, high blood pressure?					
(21) Understand health warnings about behavior such as smoking, low physical activity and drinking too much?					
(22) Understand why you need vaccinations?					
(23) Understand why you need health checks (e.g. blood sugar test, blood pressure)?					

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* 52. On a scale from very easy to very difficult, how easy would you say it is to:

	Very difficult	Fairly difficult	Fairly easy	Very easy	Don't know
(24) Judge how reliable health warnings are, such as smoking, low physical activity and drinking too much?					
(25) Judge when you need to go to a doctor for a health check?					
(26) Judge which vaccinations you may need?					
(27) Judge which health checks (e.g. blood sugar test, blood pressure) you should have?					
(28) Judge if the information on health risks in the media (e.g. TV, Internet, or other media) is reliable?					
(29) Decide if you should have a flu vaccination?					
(30) Decide how you can protect yourself from illness based on advice from family and friends?					
(31) Decide how you can protect yourself from illness based on information in the media (e.g. Newspaper, brochures, Internet or other media)?					

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* 53. On a scale from very easy to very difficult, how easy would you say it is to:

	Very difficult	Fairly difficult	Fairly easy	Very easy	Don't know
(32) Find information on healthy activities such as exercise, healthy food and nutrition?					
(33) Find out about activities (e.g. mediation, exercise, walking, Yoga, etc.) that are good for your mental well-being?					
(34) Find information (e.g. reducing noise and pollution, creating green spaces, leisure facilities) on how your neighborhood could be more healthy and friendly?					
(35) Find out about political changes (e.g. smoke-free law, new health checks programs, etc.) that may affect health?					
(36) Find out about efforts (e.g. school health programs, fun sports activities) to promote your health at school?					
(37) Understand advice on health from family members or friends?					
(38) Understand information on food packaging?					
(39) Understand information in the media (e.g. Internet, newspaper, magazines) on how to get healthier?					
(40) Understand information on how to keep your mind healthy?					

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* 54. On a scale from very easy to very difficult, how easy would you say it is to:

	Very difficult	Fairly difficult	Fairly easy	Very easy	Don't know
(41) Judge how where you live (e.g. your community, neighborhood) affects your health and well-being?	○	○	○	○	○
(42) Judge how your housing conditions help you to stay healthy?	○	○	○	○	○
(43) Judge which everyday behavior (e.g. drinking and eating habits, exercise etc.) is related to your health?	○	○	○	○	○
(44) Make decisions to improve your health?	○	○	○	○	○
(45) Join a sports club or exercise class if you want to?	○	○	○	○	○
(46) Influence your living conditions (i.e. home environment) that affect your health and well-being?	○	○	○	○	○
(47) Take part in activities that improve health and well-being in your community?	○	○	○	○	○

55. What is the date today?

Date DD / MM / YYYY

Thank you for taking time to fill in this questionnaire.

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Appendix 6.8: Online survey item change after pilot test

Online survey item change after pilot test

The health literacy online survey was piloted on seven secondary students aged 11-14 years (5 males and 2 females, 6 in Year 7 and 1 in Year 9). Several items and their response options were changed to ensure their readability and clarity for secondary school students. Further details of these item changes are presented in the following table.

Part of survey	Average time to complete	Original item/response option	Adapted item/response option
Part 1	2 min 29 s	1.6: Think of where you live most of the time. Who lives there with you? ***(Please choose All that apply)***	1.6: Think of where you live most of the time. Who usually lives there with you? ***(Please choose All that apply)***
		1.7 c: During the past 12 months, how many times did you travel away on holiday with your family?	1.7 c: During the past 12 months, how many times did you travel away on **holiday** with your family? *Note: "holiday" could be short or long.*
		1.7 d: How many computers does your family own?	1.7 d: How many **computers** does your family own? *Note: "computers" include laptops, desktops and tablets, not including game consoles and smartphones.*
Part 2	3 min 16 s	2.3 Response options: Never, seldom, quite often, very often, always	2.3 Response options: Never, sometimes, quite often, very often, always
		2.4 Response options: Never, seldom, sometimes, often, always	2.4 Response options: Never, hardly ever, sometimes, often, always
		2.4 a: How well do you understand the instruction leaflets for medication?	2.4 a: How well do you understand the written information that comes with medication (e.g. the information on the pill bottle or pill box)?
		2.5 b: When I want to do something for my health without sick, I know where I can find information on these issues.	2.5 b: When I am not ill, but want to do something to further improve my health (e.g. good nutrition, regular physical activity), I know where I can find information on these issues.
Part 3	52 s		No need to change
Part 4	4 min 1 s	Picture label: Servings per container: 4 Serving Size: 100ml	Picture label: Servings per package: 4 Serving Size: 100 g
		4.1: How many calories (Cal) will you consume if you ate the whole container of ice-cream?	4.1: How many calories (Cal) will you consume if you ate the whole package of ice-cream?
Part 5	2 min 26 s	5.1 a: There is a special person who is around when I am in need.	5.1 a: There is a special person who is around when I am in need. *Note: special people may include your mother or father or someone else.*

Part of survey	Average time to complete	Original item/response option	Adapted item/response option
		5.1 b: There is a special person with whom I can share my joys and sorrows.	5.1 b: There is a special person with whom I can share my joys and sorrows (i.e. sadness).
		5.2 e: Thanks to my resourcefulness, I know how to handle unforeseen situations.	5.2 e: Thanks to my resourcefulness, I know how to handle unforeseen (i.e. unexpected) situations.
		5.2 h: When I am confronted with a problem, I can usually find several solutions.	5.2 h: When I am confronted (i.e. faced) with a problem, I can usually find several solutions.
Part 6	4 min 3 s	6.1 h: My teachers praise me when I work hard in school.	6.1 h: My teachers praise (i.e. express approval) me when I work hard in school.
		6.1 i: Are your school grades better than the grades of most students in your class?	6.1 i: My school grades are better than the grades of most students in my class.
		6.3 a: How many times have you had to contact the emergency service in the last 2 years? (e.g. ambulance, out of hours clinic, emergency department)	6.3 a: How many times have you used the emergency service (e.g. ambulance, emergency department of a hospital) in the last 12 months?
		6.3 b: How many times have you been to the doctor (Western medicine) in the last 12 months?	6.3 b: How many times have you been to see a doctor (i.e. general practitioner- GP) in the last 12 months?
		6.3 c: How many times have you used a hospital service in the last 12 months?	6.3 c: How many times have you used a hospital service (e.g. health checks, seeing a specialist, emergency service) in the last 12 months?
		6.3 d: How many times have you used service from other health professionals, such as dentist, physiotherapist, psychologist, dietician, or optician in the last 12 months?	6.3 d: How many times have you used service from other health professionals, such as dentist, physiotherapist, psychologist, dietician, or optometrist in the last 12 months?
		6.3 e: How many times have you raised a question during your doctor appointment?	6.3 e: How many times have you raised a question during your doctor appointment in the last 12 months?
Part 7	7 min 5 s	7.6: How easy would you say it is to understand the leaflets that come with your medicine?	7.6: How easy would you say it is to understand the written information that comes with your medicine?
		7.8: How easy would you say it is to understand your doctor's or pharmacist's instruction on how to take a prescribed medicine?	7.8: How easy would you say it is to understand your doctor's or pharmacist's instruction on how to take medicine?
		7.19: How easy would you say it is to find information about vaccinations and health screenings (such as breast exam, blood pressure, blood sugar test) that you should have?	7.19: How easy would you say it is to find information about vaccinations and health checks (e.g. blood pressure, blood sugar test) that you should have?
		7.20: How easy would you say it is to find information on how to prevent or manage conditions such as being overweight, high blood pressure or high cholesterol?	7.20: How easy would you say it is to find information on how to prevent or manage conditions such as being overweight or high blood pressure?
		7.23: How easy would you say it is to understand why you need health	7.23: How easy would you say it is to understand why you need health checks (e.g. blood sugar test, blood pressure)?

Part of survey	Average time to complete	Original item/response option	Adapted item/response option
		screenings (such as breast exam, blood sugar test, blood pressure)?	
		7.27: How easy would you say it is to judge which health screenings (such as breast exam, blood sugar test, blood pressure) you should have?	7.27: How easy would you say it is to judge which health checks (e.g. blood sugar test, blood pressure) you should have?
		7.31: How easy would you say it is to decide how you can protect yourself from illness based on information in the media (such as Newspaper, leaflets, Internet or other media)?	7.31: How easy would you say it is to decide how you can protect yourself from illness based on information in the media (e.g. Newspaper, brochures, Internet or other media)?
		7.33: How easy would you say it is to find out about activities (such as meditation, exercise, walking, Pilates etc.) that are good for your mental well-being?	7.33: How easy would you say it is to find out about activities (e.g. mediation, exercise, walking, Yoga, etc.) that are good for your mental well-being?
		7.35: How easy would you say it is to find out about political changes (such as legislation, new health screening programs, change of government, restructuring of health services etc.) that may affect health?	7.35: How easy would you say it is to find out about political changes (e.g. smoke-free law, new health check programs, etc.) that may affect health?
		7.36: How easy would you say it is to find out about efforts to promote your health at work?	7.36: How easy would you say it is to find out about efforts (e.g. school health programs, fun sports activities) to promote your health at school?
		7.46: How easy would you say it is to influence your living conditions that affect your health and wellbeing?	7.46: How easy would you say it is to influence your living conditions (i.e. home environment) that affect your health and wellbeing?
Survey total time: 24 min 12 s			

Appendix 6.9: Four potential schools

A cluster convenience sampling method was used to recruit secondary students in Melbourne, Australia. Participants were selected in Years 7 to 9 (approximate age range: 11-15 years) from four potential government secondary schools located in Victoria.

- First, five areas in Victoria where many Chinese-born migrants live were identified from the 2014 Social Health Atlas of Australia[8]: Inner Melbourne, Whitehorse, Monash, Boroondara and Manningham.
- Second, four government secondary schools located in these areas were identified based on the location's socio-economic level (low or high)[9], students' language backgrounds (≥ 50% of students speaking English as a second language)[10], and school enrolment size (≥ 100 students). These schools were Box Hill High School, South Oakleigh Secondary College, Balwyn High School and Auburn High School (See **Appendix Table 4**). However, only one school principal (i.e. Balwyn High School) gave consent to access to the school.
- Third, all students in Years 7 to 9 in Balwyn High School were invited to participate in the health literacy online survey.

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[8] Social Health Atlas of Australia. Victoria, Statistical Local Areas (2011 ASGC), Published 2014. Adelaide, South Australia: Social Health Atlas of Australia; 2014 [cited 2015 Feb10]; Available from: https://www.adelaide.edu.au/phidu/current/maps/sha-aust/sla-single-map/vic/atlas.html.

[9] Australian Bureau of Statistics. 2033.0.55.001-Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia, 2011. Canberra: Australian Bureau of Statistics; 2013 Mar 28 [cited 2015 Feb 10]; Available from: http://www.abs.gov.au/ausstats/abs@.nsf/DetailsPage/2033.0.55.0012011?OpenDocument.

[10] Australian Curriculum, Assessment and Reporting Authority (ACARA). My School. Sydney, NSW: ACARA; [cited 2015 Apr 15]; Available from: http://www.myschool.edu.au/.

Appendix Table 4: A summary list of potential schools in Melbourne

Statistical local area with highest percentage of persons born in China [a]	Government School	Total enrolment [b]	Socio-economic level (Rank, Decile, Percentile [c])	Language background other than English [b] (%)	On board
Inner Melbourne	1. Kensington Community High School	176	1231; 9; 82	18	
	2. The University High School	1242	1353; 9; 90	62	
	3. Victorian College of the Arts	345	1468; 10; 97	23	
Whitehorse	1. Blackburn High School	845	1396; 10; 93	39	
	2. Box Hill High School	**1146**	**875; 6; 58 (Low)**	**50**	√
	3. Forest Hill College	556	1097; 8; 73	38	
	4. Koonung Secondary College	1084	1413; 10; 94	37	
	5. Mullauna Secondary College	517	1199; 8; 80	29	
	6. Vermont Secondary College	1316	1250; 9; 83	32	
Monash	1. Ashwood Secondary College	358	1007; 7; 67	43	
	2. Brentwood Secondary College	1439	1297; 9; 86	47	
	3. Glen Waverley Secondary College	2011	1297; 9; 86	84	
	4. Highvale Secondary College	971	1297; 9; 86	37	
	5. Mt Waverley Secondary College	1804	1326; 9; 88	56	
	6. South Oakleigh Secondary College	**418**	**853; 6; 57 (Low)**	**65**	×
	7. Wellington Secondary College	1505	1082; 8; 72	82	
	8. Wheelers Hill Secondary College	552	1412; 10; 94	29	
Boroondara	1. Ashwood School	216	1007; 7; 67	19	
	2. Balwyn High School	**2059**	**1457; 10; 97 (High)**	**66**	×
	3. Belmore School	45	1427; 10; 95	16	
	4. Camberwell High School	1264	1510; 10; 100	26	
	5. Canterbury Girls' Secondary College	1002	1510; 10; 100	28	
	6. Auburn High School	**296**	**1473; 10; 98 (High)**	**64**	×
	7. Kew High School	1041	1459; 10; 97	39	
	8. Swinburne Senior Secondary College	403	1445; 10; 96	11	
Manningham	1.Doncaster Secondary College	1294	1217; 9; 81	36	
	2. East Doncaster Secondary College	1532	1266; 9; 84	62	
	3. Templestowe College	527	1337; 9; 89	25	
	4. Warrandyte High School	512	1496; 10; 99	5	
	5. Bulleen Heights School	289	1170; 8; 78	22	

Note: *a* Data were from Social Health Atlas of Australia, 2014; *b* Data were from My School website: http://www.myschool.edu.au/; *c* Data were from Census of Population and Housing: Socio-Economic Indexes for Areas, SEIFA, Australia, 2011

Appendix 6.10: Report to the pilot school

Understanding Health Literacy in Secondary Students

Final Report to Balwyn High School

Shuaijun Guo
Ph.D. Candidate
Melbourne School of Population and Global Health
University of Melbourne

14 December 2016

THE UNIVERSITY OF MELBOURNE

The Jack Brockhoff Child Health and Wellbeing Program
Research partnerships working for every child

Understanding Health Literacy in Secondary Students

Final Report to:
Balwyn High School

December 2016

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Executive Summary

In 2016 your school kindly agreed to participate in a research project entitled *"Understanding and measuring adolescent health literacy from a cross-cultural perspective."* This section reports the health literacy, general health and wellbeing, and health behaviours of Year 7-9 Balwyn High School students. These findings can be used to understand the health status of students and may help to inform areas for future health initiatives.

Health literacy

Health literacy refers to one's ability to obtain, understand, and use health information and services to promote and maintain good health (The US Institute of Medicine, 2004, p5).

- Two instruments were used to assess students' health literacy at your school.
  - A performance-based instrument (i.e. the Newest Vital Sign, NVS) was used to objectively measure students' ability to comprehend health-related materials and calculate numbers. The results of the NVS test showed that 84.7% (216/255) of participating adolescents had high health literacy.
  - A self-report instrument (i.e. the Health Literacy Survey, HLS) was used to subjectively measure students' ability to ability to find, understand, evaluate, and use health information. The results of the HLS test showed that 74.4% (253/340) of participating adolescents had high health literacy.
- Students were more likely to have high health literacy if they spoke English as the first language at home, had a good academic performance, had an interest in learning about health, and had high self-efficacy.

- Students were more likely to have high health literacy if they obtained more social support from families, friends and others.
- Students had higher health literacy if they had a better feeling about the school environment and neighbourhood environment.
- Students with higher health literacy had better health status, more health-promoting behaviours, and better quality of life.

General health and wellbeing

- 20.5% of adolescents at your school rated their health as 'very good' or 'excellent', 65.8% rated as 'good', and 13.7% rated as 'fair' or 'poor'.
- 87.4% of adolescents at your school reported they had a healthy weight, whereas 12.6% reported they were 'overweight' or 'obese'.
    - 10.6% of boys reported they were 'overweight' and 4.0% reported 'obese'.
    - 5.9% of girls reported they were 'overweight' and 3.7% reported 'obese'.

Health behaviour

- 64.2% of participating adolescents ate breakfast every day in the 7 days prior to the survey date.
- 44.9% of adolescents reported that they were physically active for a total of at least 60 minutes per day in the past 7 days, meeting national recommendations for physical activity (i.e. at least 60 minutes of physical activity every day are needed for the 12-18 age group).
- 96.6% of adolescents reported that they did not smoke cigarettes in the past 30 days.
- 88.7% of adolescents reported that they did not drink alcohol in the past 30 days.

- 71.2% of participating adolescents brushed their teeth 'twice a day', 24.3% reported they brushed teeth 'once a day', and 4.4% reported 'less than once a day'.

Recommendations for improving health literacy

Overall, this report shows that students in Year 7-9 in your school (84.7% had high health literacy) were more health literate than their counterparts in previous similar studies (52.0% or 81.0%). However, there were still 15.3% of students who had low health literacy. Based on the analysing results, we proposed some recommendations for your consideration to further improve students' health literacy in your school.

- When designing and implementing health-related curricula, teachers should pay particular attention to students from non-English speaking backgrounds (NESB), as those students from NESB were more likely to have low health literacy. It is important to consider materials' readability for those students. Only in an understandable way can students develop health literacy more effectively.
- Motivating students to participate in health education programs may be an effective strategy to improve their health literacy.
- Developing and implementing health-related curricula that pay attention to increasing students' interpersonal communication skills with parents, peers and others could facilitate the development of health literacy.
- Creating a supportive school and neighbourhood environment could contribute to students' health literacy.
- Promoting health literacy could be an effective strategy to reduce health-compromising behaviours, and increase the quality of students' life and health status.

Background

Project introduction

In 2016 your school agreed to participate in a research project entitled "*Understanding and measuring adolescent health literacy from a cross-cultural perspective*". This project was led by a PhD candidate Shuaijun (Jun) Guo and his supervisors Dr Elise Davis, Dr Lucio Naccarella, and Dr Rebecca Armstrong from The University of Melbourne. The aim of this project was to examine the relationships between health literacy, potential influencing factors and health-related outcomes among secondary students.

The specific research objectives were to:

- Understand students' health literacy, general health, and health behaviours;
- Examine what factors influence students' health literacy;
- Examine what impacts of health literacy on students' health-related outcomes (i.e. general health status, health behaviours, health services use, and health-related quality of life)

Working definitions of relevant terms

The working definitions of relevant terms used in this project are outlined as follows:

- **Health literacy** refers to one's ability to obtain, understand, and use health information and services to promote and maintain good health[1].
- **Intrapersonal factors** are defined as personal demographics, biological factors, psychological factors, and family situation that may underlie one's health literacy, for example, age, gender, birth of county, *etc*.

[1] Nielsen-Bohlman, L., Panzer, A. M., Hamlin, B., & Kindig, D. A. (2004). Health literacy: a prescription to end confusion. Institute of Medicine of the National Academies, Washington, D.C., America.

- **Interpersonal factors** refer to social support and influences from families, friends, and significant others.
- **Environmental factors** represent the school and neighbourhood environment in which social relationships occur for adolescents.
- **General health status** is defined as a subjective description of the health of an individual or population at a particular point in time.
- **Health behaviour** refers to any activity undertaken by an individual, regardless of actual or perceived health status, for the purpose of promoting, protecting, or maintaining health, whether or not such behaviour is objectively effective towards that end.
- **Health services use** refers to the utilisation of all services that deal with the diagnosis and treatment of disease, or the promotion, maintenance, and restoration of health.
- **Health-related quality of life** refers to an individual's perception and subjective evaluation of their health and well-being within their unique cultural environment.

Methods

This study is a sub-study of the PhD candidate's research project. Students in Year 7-9 in your school were invited to take part. Data were collected using an online survey (https://www.surveymonkey.com/r/462765364) during class time. A teacher was present during the completion of the survey and available to answer students' questions. The administration time was about 25-40 minutes. The field work was conducted in the third school term (11 Jul to 16 Sep 2016).

The following measures were collected:

- **Health literacy** which captured students' ability to find, understand, evaluate, and apply health information in everyday life. Two instruments were used: a performance-based instrument (the NVS) [2] and a self-report instrument (the HLS)[3].

- **Intrapersonal factors** which captured students' age, gender, Year level, living arrangements, family affluence level[4], country of birth, first language spoken at home, academic performance, self-reported importance of personal religion, self-reported interest in learning about health, self-reported importance of health, and personal self-efficacy.
- **Interpersonal factors** which captured students' social support from families, friends, and others.
- **Environmental factors** which captured students' subjective feelings about their school environment and neighbourhood environment.
- **Health-related outcomes** which captured students' general health status (poor or fair, good, very good or excellent), health behaviours (regular breakfast eating, physical activity, cigarette smoking, alcohol drinking, and teeth brushing), health services use (emergency service use, general practitioner service use, hospital service use, other health professionals' service use, and patient-provider communication), and health-related quality of life.

Ethics approval was granted by the University of Melbourne (Ethics ID: 1442884) and The Department of Education and Training (Ethics ID: 2015_002665) for this research project, and consent was given by parents, students, teachers, and schools prior to data collection.

[2] The European Health Literacy Survey: http://www.biomedcentral.com/content/supplementary/1471-2458-13-948-s1.pdF
[3] The Newest Vital Sign: http://www.pfizer.com/files/health/nvs_flipbook_english_final.pdf
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What we have learnt

Participants from your school

In 2016, 505 adolescents from your school participated in our online survey. The mean age of students was 13.70±1.02 (age range: 11-19). The general profile of these participants is outlined in **Table 1**.

Table 1 The general profile of participants in your school

Participant characteristics	Number	Percentage (%)
Total	505	100.0
Gender		
Male	298	59.2
Female	207	40.8
Year level		
Year 7	127	25.0
Year 8	145	28.6
Year 9	233	46.0
Living arrangements		
Living with two parents	421	83.4
Other family arrangements	84	16.6
Family affluence level		
Low	10	2.0
Medium	139	27.5
High	356	70.5
Country of birth		
Australia	319	63.2
China/Hong Kong/Macao/Taiwan	70	13.9
Other countries	116	23.0
First language spoken at home		
English	327	64.8
Mandarin/Cantonese/Taiwanese	112	22.2
Other languages	66	13.1

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Health literacy levels of students

We measured health literacy using two instruments: a performance-based instrument (i.e. the NVS) that objectively measured students' ability to comprehend health-related materials and calculate numbers; and a self-report instrument (i.e. the HLS) that subjectively measured students' ability to ability to find, understand, evaluate, and use health information (See **Fig. 1**).

The NVS test showed that **84.7% (216/255)** of students had high health literacy, which was higher than previous similar studies (32.4% had high health literacy among 15-19 age group in the 2006 Australian National Health Literacy Survey[5]; 52.0% had high health literacy among high school students in the USA[6]; 81.0% had high health literacy among school-aged children in the USA[7]).

The HLS test showed that **74.4% (253/340)** of students had high health literacy, which was also higher than previous similar studies (63.2% and 74.0% of Portugal secondary students had high health literacy[8,9]). As self-reported measures capture a more comprehensive nature of health literacy than performance-based measures[10], we examined the relationship between the self-report health literacy (i.e. the HLS), potential influencing factors and health-related outcomes in the following sections.

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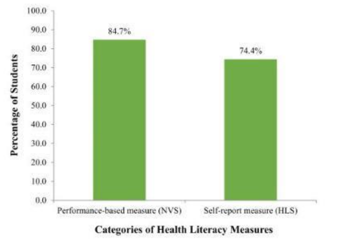
Fig. 1 The percentage of students with high health literacy



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Intrapersonal factors of Health literacy

We examined 11 potential intrapersonal factors of health literacy: gender, year level, living arrangements, family affluence level, country of birth, first language spoken at home, academic performance, self-reported importance of personal religion, self-reported interest in learning about health, self-reported importance of health, and self-efficacy.

Results showed that there were statistical differences in health literacy in terms of first language spoken at home, academic performance, self-reported interest in learning about health, and self-efficacy, but there were no statistical differences in health literacy by gender, year level, living arrangements, family affluence level, country of birth, self-reported importance of personal religion, and self-reported importance of health (See **Table 2**).

Table 2 Examination of intrapersonal factors of students' health literacy

Intrapersonal factors	Number of students with high health literacy (%)	Number of students with low health literacy (%)	Statistical difference
Gender			
Male	145 (74.0)	51 (26.0)	No
Female	108 (76.1)	34 (23.9)	
Year level			
Year 7	63 (69.2)	28 (30.8)	
Year 8	80 (80.0)	20 (20.0)	No
Year 9	110 (74.8)	37 (25.2)	
Living arrangements			
Living with two parents	215 (75.4)	70 (24.6)	
Other family arrangements	38 (71.7)	15 (28.3)	No
Family affluence level			
Low	4 (66.7)	2 (33.3)	No
Medium	62 (67.4)	30 (32.6)	
High	187 (77.9)	53 (22.1)	
Country of birth			
Australia	165 (73.7)	59 (26.3)	
China/Hong Kong/ Macao/Taiwan	30 (71.4)	12 (28.6)	No
Other countries	58 (80.6)	14 (19.4)	
First language spoken at home			
English	181 (79.4)	47 (20.6)	
Mandarin/Cantonese/ Taiwanese	42 (60.9)	27 (39.1)	Yes
Other languages	30 (73.2)	11 (26.8)	
Academic performance			
Less than average	2 (40.0)	3 (60.0)	
Average	41 (64.1)	23 (35.9)	Yes
More than average	210 (78.1)	59 (21.9)	
Self-reported importance of personal religion			
Not important	127 (76.0)	40 (24.0)	
Not sure	56 (71.8)	22 (28.2)	No
Important	69 (75.0)	23 (25.0)	
Self-reported interest in learning about health			
Not interested	48 (64.9)	26 (35.1)	
Not sure	47 (70.1)	20 (29.9)	Yes
Interested	158 (80.2)	39 (19.8)	
Self-reported importance of health			
Not important	7 (63.6)	4 (36.4)	
Not sure	22 (73.3)	8 (26.7)	No
Important	222 (75.3)	73 (24.7)	
Self-efficacy	31.56±4.86*	28.37±5.43*	Yes

Note: Blue shading highlights statistical difference that exists between groups; * scores of self-efficacy in high health literacy group and low health literacy group (mean±standard deviation).

Interpersonal factors of Health literacy

We examined students' overall social support from their families, friends, and others as potential interpersonal factors of health literacy. Results showed that there was a statistical difference in health literacy for overall social support. We also found that statistical differences occurred across each source of social support (See **Table 3**).

Table 3 Examination of interpersonal factors of students' health literacy

Interpersonal factors	High health literacy group (Mean±SD)	Low health literacy group (Mean±SD)	Statistical difference
Overall social support	31.56±4.86	28.37±5.43	Yes
Support from families	12.15±2.55	11.28±2.77	Yes
Support from friends	10.37±2.98	9.23±3.10	Yes
Support from others	11.29±2.87	10.28±2.97	Yes

Note: Blue shading highlights statistical difference that exists between groups; SD=standard deviation.

Environmental factors of Health literacy

We examined environmental factors of health literacy from two aspects: school environment and neighbourhood environment. Results showed that there were statistical differences in health literacy based on different feelings about the school and neighbourhood environment (See **Table 4**).

Table 4 Examination of environmental factors of students' health literacy

Environmental factors	High health literacy group (Mean±SD)	Low health literacy group (Mean±SD)	Statistical difference
School environment	30.41±4.83	27.68±5.36	Yes
Neighbourhood environment	29.51±5.92	27.11±7.83	Yes

Note: Blue shading highlights statistical difference that exists between groups; SD=standardized deviation.

Relationships between Health literacy and Health-related outcomes

We also examined the relationships between health literacy and four types of health-related outcomes (i.e. general health status, health behaviours, health services use, and health-related quality of life). Results showed that there were statistical differences in health literacy in terms of general health status, health behaviours, and health-related quality of life, but there was not a statistical difference in health literacy by health services use (See **Table 5**).

Table 5 Examination of relationships between students' health literacy and health-related outcomes

Health-related outcomes	Number of students with high health literacy (%)	Number of students with low health literacy (%)	Statistical difference
General health status			
Poor or fair	25 (56.8)	19 (43.2)	
Good	177 (77.0)	53 (23.0)	Yes
Very good or excellent	51 (79.7)	13 (20.3)	
Health behaviours			
Regular breakfast eating			
Yes	176 (80.0)	44 (20.0)	Yes
No	76 (65.0)	41 (35.0)	
Physical activity			
Physically active	118 (80.3)	29 (19.7)	Yes
Not physically active	133 (70.4)	56 (29.6)	
Cigarette smoking			
Ever smoking	4 (40.0)	6 (60.0)	Yes
No smoking	249 (75.9)	79 (24.1)	
Alcohol drinking			
Ever drinking alcohol	18 (56.3)	14 (43.8)	Yes
No drinking alcohol	235 (77.3)	69 (22.7)	
Teeth brushing			
Less than once a day	57 (59.4)	39 (40.6)	Yes
More than once a day	195 (80.9)	46 (19.1)	

Health-related outcomes	Number of students with high health literacy (%)	Number of students with low health literacy (%)	Statistical difference
Health services use			
Emergency service use			
Yes	48 (78.7)	13 (21.3)	No
No	202 (75.9)	64 (24.1)	
General practitioner service use			
Yes	201 (75.6)	65 (24.4)	No
No	48 (77.4)	14 (22.6)	
Hospital service use			
Yes	101 (75.4)	33 (24.6)	No
No	146 (76.0)	46 (24.0)	
Other health professionals' service use			
Yes	207 (76.4)	64 (23.6)	No
No	45 (75.0)	15 (25.0)	
Patient-provider communication			
Yes	154 (79.4)	40 (20.6)	No
No	92 (71.9)	36 (28.1)	
Health-related quality of life	38.84±5.80*	35.23±6.54*	Yes

Note: Blue shading highlights statistical difference that exists between groups; * scores of health-related quality of life in high health literacy group and low health literacy group (mean±standard deviation).

Key findings for health literacy

Intrapersonal factors of health literacy:

- Students who spoke English as the first language at home had higher health literacy than those with non-English speaking backgrounds.
- Students were more likely to have high health literacy if they had a good academic performance.
- Self-reported interest in learning about health played a vital role in developing students' health literacy.
- Personal self-efficacy also contributed to students' health literacy.

Interpersonal factors of health literacy:

- Social support from families, friends and others were critical to students' health literacy.

Environmental factors of health literacy

- Both school and neighbourhood environment contributed to students' health literacy.

Relationships between health literacy and health-related outcomes:

- Students with higher health literacy had better general health status.
- Students with higher health literacy reported more health-promoting behaviours, for example, eating breakfast regularly, be physically active, no cigarette smoking, no alcohol drinking, and brushing teeth twice a day.
- Students with higher health literacy had a better health-related quality of life.

Recommendations

Overall, this report shows that students in Year 7-9 in your school were more health literate than their counterparts in previous similar studies. However, there were still 15.3% of students who had low health literacy. Based on the analysing results, we proposed some recommendations for your consideration to further improve students' health literacy in your school.

- Our findings suggest that students from non-English speaking backgrounds (NESB) are more likely to have low health literacy. When designing and implementing health-related curricula, ***teachers should pay particular attention to students from NESB***. Only in an understandable way can students from NESB develop health literacy more efficiently and effectively.
- Self-reported interest in learning about health plays a vital role in developing students' health literacy. Therefore, ***motivating students to participate in health education programs may be an effective strategy to improve health literacy***.
- Social support from families, friends and others are vital to students' health literacy. Therefore, developing and implementing health-related curricula that pay attention to ***increasing students' interpersonal communication with parents, peers and others could facilitate the development of health literacy***.
- **Creating a supportive school and neighbourhood environment** could contribute to students' health literacy.
- Due to the close relationships between health literacy and health-related outcomes, **promoting health literacy** could be an effective strategy to reduce health-compromising behaviours, and increase the quality of students' life and health status.

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Appendix 6.11: Report to Department of Education and Training

Project ID number:	2015_002665
Research title:	Understanding and measuring adolescent health literacy from a cross-cultural perspective
Author/s: (optional)	Shuaijun Guo, Elise Davis, Lucio Naccarella

Please keep this report no longer than 2-3 pages in length.

If you have agreed to make this report visible to the public it will appear on the Department's online Research Register with the project title, aim and research questions. No personal details are provided. If you are keen to share more detail of the findings or from publications arising from this project please include your contact details **in this report.**

Contact details **to be published**: *(Provide only the information you want included.* ***Delete if not required****)*	
Name:	Shuaijun Guo
Connection with project:	Project manager
Phone/Email:	Gshj1986@gmail.com

Research abstract *(no more than 100 words)*
Health literacy is defined as an individual's ability to find, understand and use health information to promote health. The literature has suggested that health literacy is closely associated with health outcomes such as health behaviours and health status. However, this finding is mostly based on the adult population; little is known about adolescents. To fill the knowledge gap in current research, this study aimed to explore the general profile of adolescent health literacy in Australian secondary school settings.

Summary/Discussion of findings *(no more than 100 words)*
Using cluster convenience sampling method, a cross-sectional study was conducted in one government secondary school located in Melbourne. An online survey was completed measuring students' demographics, health literacy and other variables related to health outcomes. A total of 120 students in Years 7 to 9 participated in the study. Results showed that 84.8% (95/112) of students had high health literacy using the Newest Vital Sign (NVS) test and 76.3% (90/118) using the European Health Literacy Survey (HLS-EU) test. Students' first language spoken at home, country of father's birth, personal self-efficacy, social support, school environment and community environment were influencing factors to adolescent health literacy. Also, students' health literacy was positively related to regular breakfast eating, non-smoking, regular physical activity, health status and health-related quality of life.

Generalisability and significance for the settings in your study or for the Victoria Government Department of Education and Early Childhood
As health literacy is closely related to students' health, it is necessary to develop and improve health literacy at an early age in school settings. Based on the above findings, we proposed some recommendations to further improve students' health literacy at school. • When designing and implementing health-related curricula, teachers should pay particular attention to students from non-English speaking backgrounds (NESB), as those students from NESB are more likely to have low health literacy. It is important to consider materials' readability for those students. Only in an understandable way can students develop health literacy more effectively. • Developing and implementing health-related curricula that pay attention to increasing students' interpersonal communication skills with parents, peers and others could facilitate the development of health literacy. • Creating a supportive school and neighbourhood environment could contribute to students' health literacy. • Promoting health literacy could be an effective strategy to reduce health-compromising behaviours, and increase the quality of students' life and health status.