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**IDENTIFYING THE ROLE OF THE SCHOOL IN
PREVENTING ADOLESCENT OBESITY**

Kakale Buru

Bachelor of Education-Home Economics

Submitted in fulfilment of the requirement for the degree of

Master of Philosophy

At the College of Medicine and Dentistry

Division of Tropical Health and Medicine

James Cook University

MAY 2022

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Declaration

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text, and a list of references is provided.

I declare that the research included in this thesis was ethically conducted, with approval received for each component of the research from the James Cook University Human Research Ethics Committee. The ethics approval code that relates to the research conducted in this thesis is H7966.

2nd May 2022

.....

Author's signature

Date

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Statement of the Contribution of Others

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Thesis Abstract

Introduction: Adolescent obesity has increasingly become a problem of public health concern and researchers have highlighted its antecedent association with adulthood obesity. Given that most adolescents attend high school, schools are an ideal and influential environment to foster preventive measures of adolescent obesity and promote healthy living. Nevertheless, research shows that schools tend to give more priority to educational outcomes at the expense of health-oriented outcomes. Additionally, studies revealed that there were no publicly available policies or regulating guidelines identified in Queensland government schools. Furthermore, it has been suggested that there is a ‘responsibility conflict’ in schools with unclear boundaries about whose responsibility it is to ensure healthy-eating and access to adequate physical activity, which is a concern prompting research focus on prevailing issues in Queensland schools. Due to the many health implications that come with adolescent obesity, it is better to focus on preventive measures than cure. Therefore, this study aimed to (1) assess the scope and efficacy of adolescent obesity intervention strategies in Australian schools, (2) investigate Queensland Australian school stakeholders’ beliefs and perceptions of the barriers and enablers currently experienced by schools and their recommendations for preventing adolescent obesity and (3) develop a reliable adolescent obesity prevention model based on the study findings.

Methods: This thesis involved two phases of research: (1) systematic review and (2) mixed methods research design. The project commenced with a systematic review of the scope and efficacy of adolescent obesity intervention strategies in Australian schools. Findings from the systematic review highlighted the need for the second phase of the project which utilised a sequential explanatory mixed methods approach comprising quantitative online surveys and qualitative telephone interviews to investigate Queensland Australian school stakeholders’ beliefs

and perceptions of the barriers and enablers and their recommendations for preventing adolescent obesity. Quantitative data were analyzed using descriptive statistics. Qualitative data were analyzed using inductive thematic analysis.

Results: The systematic review identified 13 school-based intervention studies which were conducted in Australian high schools. Most of the studies emanated from the State of New South Wales, Queensland had only one study and there was no nationwide study reported. Of the 13 reviewed studies, five studies demonstrated successful implementation of the intervention across all measured outcomes, four met at least one measured outcome and the remaining four were unsuccessful. There was a weak link between teacher involvement and modification of the food environment. Despite the weak evidence of intervention efficacy for most of the reviewed studies, school-based interventions with multi-component combinations of physical activity, nutrition and alignment to one or more theoretical frameworks yielded promising results.

The findings of the review guided the primary research (Phase two) focus on Queensland school stakeholders. In total, 60 school stakeholders (52 subject teachers, 3 senior teachers and 5 heads of department) from both independent and public high schools in Queensland, Australia responded to the survey, while 14 respondents participated in the interviews. The main perceived causes of obesity were poor eating habits and sedentary lifestyle. Highlighted barriers were busy timetables, shortage of trained staff and funding, lack of robustness in the introduction and implementation of school interventions and insufficient motivation of learners to participate in obesity prevention programs. Enabling factors included parental support, easy access to fitness equipment during recess, supportive government policies, provision of healthier school tuck shop menu options and elimination of sugary drinks from vending machines. A model for the prevention of adolescent obesity was developed based on participants' perceptions.

Conclusion: Despite adolescent obesity being a prevailing public health concern, it seems to be overlooked as compared to other health problems such as mental health. The barriers encountered at different stakeholder levels; the students, the parents, the school, and the government need to be specifically addressed. Tripartite collaboration between the school, government and parents is key to effectively addressing adolescent obesity. Strategies targeting nutrition, physical activity, and overall health, including parental education on health, formal health talks in schools by health professionals and online advertisement encouraging healthy lifestyle choices are main recommendations for improving health outcomes.

List of Publications

Publication-Based Thesis Chapters

1. Buru, K.; Emeto, T.I.; Malau-Aduli, A.E.O.; Malau-Aduli, B.S. The Efficacy of School-Based Interventions in Preventing Adolescent Obesity in Australia. *Healthcare* **2020**, *8*, 514. DOI: [10.3390/healthcare8040514](https://doi.org/10.3390/healthcare8040514) Journal Impact Factor is 2.645. This article has five citations.
2. Buru, K.; Emeto, T.I.; Malau-Aduli, A.E.O.; Malau-Aduli, B.S. Australian School Stakeholders' Perceived Strategies for Preventing Adolescent Obesity. *International Journal of Environmental Research and Public Health* **2021**, *18*, 9387. DOI: [10.3390/ijerph18179387](https://doi.org/10.3390/ijerph18179387) Journal Impact Factor is 3.390. This article has 1 citation.

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LIST OF ABBREVIATIONS

ACT:	Australian Capital Territory
AMA:	Aduli Malau-Aduli
AIHW:	Australian Institute of Health Welfare
BSMA:	Bunmi Sherifat Malau-Aduli
BMI:	Body Mass Index
BMIz:	Age and Sex Standardized Body Mass Index
COVID-19	Coronavirus disease of 2019
DEXA:	Dual Energy X-ray absorptiometry
HREC:	Human Research Ethics Committee
KB:	Kakale Buru
NI:	Not indicated
NSW:	New South Wales
PRISMA:	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
QLD:	Queensland
RCTs:	Randomised Control Trials
SES:	Socio-economic Status
TIE:	Theophilus Ikenna Emeto
VIC:	Victoria

Researcher's Personal Story and Study Context

In Botswana being plump is generally perceived as a sign of 'good living' and beauty for a woman. Children as well are supposed to be nourished well as soon as they are born through to all school years until they settle independently. I grew up in this environment and one typical nature of our cuisine is that it is high in starch and meats with a seasonal or constant supply of vegetables if one has a garden. As a result, I grew up chubby and that seemed to be the norm as I also had chubby friends. I transitioned from primary school to junior high school where my weight was significantly reduced by the daily trekking to school which lasted for half an hour each day. I later moved to a boarding school where I spent most of my time at the hostel and I gained the weight back. Connected to this was also the generous meals at our communal school cafeteria where meals were predominantly starch, red meat, and deep-fried chicken. I remember that we only had salads on Sundays for lunch. I started to experience chest pains which would come and go during my final year at high school.

I successfully completed high school and got offered a place at the University of Botswana to pursue my undergraduate degree in Home Economics. Interestingly, I have always loved the subject but never chose it as an elective in high school as I was not sure how I would handle a four-burner stove. During the introductory course to Home Economics, I started feeling very uncomfortable with my body weight. I wanted to see an improvement in my way of life as an individual, which is the focus of Home Economics - to improve the way of life of individuals, families, and the community at large through the skills and knowledge gained in the subject area. I had a very supportive friend who was also chubby, and we started trying out dieting by reducing starchy foods, cutting down on meats, and high sugar treats. The results were tremendous as we lost a significant amount of the waistline. I was able to achieve that success through the exposure

I had to health education, supportive peers, and good role models among my educators. Towards the end of the second semester, the University students went on strike over personal allowance upgrade, so we all had to be evicted from the campus. That would mean that my parents would see my weight transformation for the first time. As I swept the yard in the morning, my dad got off his bike and exclaimed ‘daughter you are finished!’ expressing his disapproval of my new look. To add salt to injury, my dad’s herdsman said he suspected I lost weight because of HIV/AIDS.

After I relocated to Australia in 2013, I worked as an assistant nurse while processing my teacher registration. While working in the health sector, I realized that old people who led an active lifestyle and carefully selected what they ate lived longer and had fewer health complications compared to their counterparts who were not active and heavier. I developed an interest in pursuing research and decided to choose adolescent obesity due to my personal experiences as an adolescent. This interest was intensified when I commenced my teaching career in Australia as a casual teacher. There was a consistent pattern of predominantly sedentary activities among students during recess across schools. Students who looked heavier also tended to avoid taking part in organized or general physical activities during recess. These observations were very concerning, and I realized that I had to do something more formal to pass the message across by enrolling in a Masters by research degree with a focus on adolescent obesity. Working in the high school environment has given me the opportunity to infuse health education into the curriculum and do my best to model healthy behaviors. I have completed this research for my children, as well as the adolescents who are tomorrow’s future, and for my own health and wellbeing because “I have to practice what I preach”.

Chapter 1: General Introduction

1.1 Chapter Overview

This introductory chapter positions my research and gives context for the research questions presented in this thesis. The chapter begins with a brief definition of obesity. It further discusses the current status and prevalence of adolescent obesity both globally and in Australia. The causes and health implications of adolescent obesity are highlighted. Furthermore, the methodological framework and analytical techniques utilised in this research are also presented. Finally, an outline of the thesis chapters and how they address the research questions is presented.

1.2 Overweight and Obesity

Obesity is defined as an abnormal accumulation of excess body fat or adiposity that brings about the risk of chronic illnesses (Hubbard, 2000; WHO, 2014). Body Mass Index (BMI) is the mostly used measure to estimate body fat and define obesity in children and adolescents. BMI is age and sex specific; it is measured by dividing the body weight in kilograms to height in meters squared (kg/m^2). Diagnostically, a BMI above the 85th percentile is taken as a screening index for overweight, and a BMI above the 95th percentile as an index of excess adiposity in adolescents (Himes & Dietz, 1994). An imbalance between energy intake and energy consumption is the main catalyst to weight gain due to excess energy being stored as body fat (Romieu et al., 2017; Anderson et al., 2015). Unhealthy diet and sedentary behavior like habitually watching the television have been reported as some of the factors that may contribute to energy imbalance (Romieu et al., 2017; Liao et al., 2014). Over the past four decades, overweight and obesity prevalence in adolescents has increased in most regions and countries (Abarca-Gómez et al, 2017).

Jaworska and MacQueen (2015) defined adolescence as a period marking the transition from childhood to adulthood ranging from 12 to 18 years.

Adolescent obesity is a multifaceted chronic condition with several contributing factors, including medical illnesses, biological risk factors, genetic disorders, eating disorders (Fernández et al., 2004; Daniels, 2009; Ruiz et al., 2019), health literacy, cultural background, socioeconomic status (SES) and numerous environmental influences (McLauren, 2007; Fock & Khoo, 2013; Andie et al., 2021). For example, adolescents often engage in unhealthy eating of energy dense foods and drinks (Ronto et al., 2017) and sedentary lifestyle, whereby they spend a lot of time on the screen at home and at school (Xiang et al., 2020). Majority of them also get dropped off at school by parents due to safety concerns by parents (Mikaelson et al., 2020; Carver et al., 2010) and this leads to reduced physical activity (Guthold et al., 2020; Schranz et al., 2018).

Adolescent obesity increases the risk of chronic disease development into and throughout adulthood (Raj, 2012). Obesity in adolescents impacts all major organ systems and often contributes to morbidity (Skinner et al., 2015; Liu et al., 2016). Researchers have highlighted the need to focus on adolescent obesity due to its antecedent association with adulthood obesity (Fotu et al., 2011). Studies have also shown that obesity in adolescents is increasing (Abarca-Gómez et al., 2017; Baur & Fitzgerald, 2010; Farhat et al., 2010; Hardy et al., 2017), making this stage an important area of research focus.

1.3 Prevalence of Adolescent Obesity

1.3.1 Global trends

Worldwide trends have shown increasing prevalence of obesity among children and adolescents. Global age-standardized prevalence of obesity increased from 0.7% (0.4–1.2) in 1975 to 5.6% (4.8–6.5) in 2016 in girls, and from 0.9% (0.5–1.3) in 1975 to 7.8% (6.7–9.1) in 2016 in boys;

this is an alarming tenfold increase in the prevalence of obesity within a period of four decades (Abarca-Gómez et al., 2017). Additionally, a recent study indicated that with the current prevailing pandemic worldwide, the prevalence of obesity among school-aged children is likely to be higher due to the halt in normal day to day activities to a more sedentary lifestyle (Xiang et al., 2020). The prevalence of obesity has been forecasted to be even higher in 2022 (Abarca-Gómez et al., 2017).

1.3.2 National trends

As indicated by the Australian Institute of Health and Welfare (AIHW), one in every four Australian children lives with obesity (AIHW, 2020). Hardy et al. (2017) reported that in Australia, between 2010 and 2015, obesity increased from 5.1% to 5.7% in adolescent boys and from 4.2% to 5.4% in adolescent girls respectively. The authors also reported that abdominal obesity (a marker for cardiometabolic risks) significantly increased from 7.2% to 15.8% in boys and from 3.6% to 8% in girls during the same period respectively. In 2016, Australia was recorded among the high-income English-speaking regions with the largest increase in the number of obese children and adolescents after Polynesia and Micronesia regions (WHO, 2021). Australia has also been identified as one of the top ten countries with the highest prevalence of obesity among children and adolescents (AIHW, 2020). A recent AIHW report (AIHW 2020) compared children, adolescents and young people in 2017–18 with those of the same ages 10 years earlier in 2007–08 and 22 years earlier in 1995. As shown in Table 1.1, children born most recently (in 2003–2012) were reported to be more likely to be overweight or obese (24% vs 20%) or obese (7.7% vs 5.1%) at age 5–14 compared to those born in 1981–1990, at the same age.

Table 1.1: Proportion of overweight and obese children and adolescents, by birth cohort, age group and sex*

Survey year	Age at survey	Birth cohort	Overweight or obese		Obese	
			%	95% CI	%	95% CI
<i>Persons</i>						
1995	5–14	1981–1990	20.2	18.0–22.4	5.1	3.9–6.2
1995	15–24	1971–1980	28.3	25.4–31.2	8.4	6.6–10.3
2007–08	5–14	1993–2002	23.1	20.2–25.9	6.4	4.6–8.1
2007–08	15–24	1983–1992	35.5	32.7–38.3	12.6	10.3–14.9
2017–18	5–14	2003–2012	24.5	22.6–26.3	7.7	6.2–9.3
2017–18	15–24	1993–2002	40.6	37.3–43.9	13.9	12.2–15.6
<i>Males</i>						
1995	5–14	1981–1990	18.5	15.7–21.3	4.2	2.9–5.5
1995	15–24	1971–1980	32.5	27.5–37.5	9.5	6.6–12.4
2007–08	5–14	1993–2002	23.8	20.0–27.6	7.6	4.9–10.2
2007–08	15–24	1983–1992	37.5	33.2–41.8	12.7	9.3–16.1
2017–18	5–14	2003–2012	25.1	22.5–27.7	7.9	6.0–9.9
2017–18	15–24	1993–2002	45.8	41.7–49.9	15.6	12.8–18.3
<i>Females</i>						
1995	5–14	1981–1990	21.9	18.6–25.2	6.0	4.1–7.8
1995	15–24	1971–1980	23.9	20.3–27.4	7.3	4.9–9.6
2007–08	5–14	1993–2002	22.3	18.2–26.5	5.1	3.0–7.3
2007–08	15–24	1983–1992	33.5	29.6–37.3	12.4	9.7–15.2
2017–18	5–14	2003–2012	23.8	20.9–26.6	7.5	5.3–9.8
2017–18	15–24	1993–2002	35.2	30.9–39.5	12.2	9.1–15.2

*The cut-off points used to classify children and adolescents aged under 18 as overweight or obese are age and sex specific, as defined by Cole et al. 2000. The cut-off points used to classify adults aged 18 and over as overweight or obese are as defined by WHO 2000.

Sources: 1. ABS (Australian Bureau of Statistics) 2009. Microdata: National Health Survey, Basic and Expanded CURF, 2007-08. ABS cat. no. 4324.0.55.001. Findings based on Expanded Confidentialised Unit Record File analysis. Canberra:

2. ABS 2013. Microdata: National Nutrition Survey, 1995. ABS cat. no. 4807.0.30.001. Findings based on Basic Confidentialised Unit Record File analysis. Canberra: ABS.

1.4 Factors Associated with Adolescent Obesity

There are several factors associated with adolescent obesity and these include genetic, socioeconomic, environmental, psychosocial and behavioral factors. It is important to note that individuals may be affected by these factors to varying degrees and the contribution of each to obesity outcomes is not known, however, taking steps to mitigate the effects of these factors is important for the health outcomes of adolescents.

1.4.1 Genetic factors

For over a century, there has been proposals suggesting that some causes of obesity are a function of heredity or innate biologic mechanisms. Since then, more studies have continued to investigate the genetic causes of obesity suggesting that some people may be predisposed to obesity than others (Stunkard et al., 1986, Stunkard et al., 1990; Chin, 2014). Classic twin studies have found that a large proportion (40–80%) of variation in body fatness is attributable to genetic differences between individuals. For example, Stunkard and colleagues (1990) studied body fatness of 540 adopted Danish twins and found that even though these twins were raised by their adoptive parents, their weight later in adulthood was closely related to that of their biological parents (Stunkard et al., 1986). Tucker (2017) pointed out in his findings that genetic factors may make some people more susceptible to being obese due to chronic glucocorticoid release by the body which has been seen to be mostly related to biological sex, age and also genotype.

1.4.2 Environmental factors

There are some environmental factors that may affect both physical activity and dietary habits like increasing consumption (Dunton et al., 2009). In relation to adolescents, most schools run tuck-shops, and this has the potential to influence what students purchase. For example, the tuck-shop menu in schools can encourage unhealthy eating if whatever is served on the menu is not healthy

(Utter et al., 2007). Schools located close to fast food outlets also have an impact on the choices of food as a result impacting on the weight of adolescents (Grier & Davis, 2013). Sometimes the location and topography of the school limits students on how much access they can have to open spaces for physical activities or ovals. New schools built close to the city center for instance may have less space for fitness infrastructure as compared to those built in the outskirts also affecting the levels of active commuting to schools (Brace et al., 2017; Lee et al 2009; Chiu et al., 2014)

1.4.3. Socioeconomic factors

The socioeconomic status of the communities and families where children come from can also affect their weight. This has been investigated in literature and high socioeconomic status has often been associated with healthier lifestyle choices while on the other hand low socioeconomic status has been associated with poor access to healthy choices and poor nutrition offering high fat and high sugar options (Ruiz et al., 2019; McLaren, 2007; Tomiyana et al., 2018). However, fast-food outlets affect the weight of adolescents negatively in both urban areas and low socioeconomic backgrounds in the same way (Grier and Davis, 2013).

1.4.4. Psychosocial factors

There are several psychosocial factors that have the potential to cause stress. For example, some children are unfortunately exposed to those experiences such as neglect, emotional, physical and even sexual abuse (Bernstein et al., 1994). The eating behavior of close to 40% of children and adolescents has been reported to increase during stress particularly for unhealthy food (Yau & Potenza, 2013). Some discrepancies due to race, weight status, anxiety or disability in some students may make them more vulnerable to bullying, causing low self -esteem and isolation triggering stress, unhealthy eating, and sedentary lifestyle (Fontaine & Barofsky, 2001; Yau & Potenza, 2013). Andie et al (2021), in their study reported that maternal employment, the marital

status of the parents, anxiety, depression, low self-esteem, romantic and sexual relationships, sports, school performance, and school absenteeism showed a significant association to obesity and overweight suggesting the importance of taking these factors into consideration in promoting health towards combating adolescent obesity.

1.4.5. Behavioral factors

Implementing strategies to improve behavioral factors is very important in combating adolescent obesity because these factors can impact the eating and activity patterns of individuals. The drive to eat palatable high fat, high sugar and salty food options can be affected by lack of sleep and this is an important factor in these contemporary times where most students have access to devices and are sleep deprived because of screen time (Knutson, 2012; Stine et al., 2021). Access to unhealthy food options can also encourage unhealthy food choices among students (Ronto et al., 2017). Peer pressure can also contribute to unhealthy eating behavior particularly fast foods among adolescents (Al-Tuwairqi & Matbouli, 2021). Unhealthy food choices and sedentary lifestyle often serve as major causal factors and therefore play a key role in the development of obesity in the long run. Combating the obesity epidemic demands prevention intervention efforts that are particularly targeted at behavioral changes.

1.5 School-Based Adolescent Obesity Prevention Interventions

Public health interventions are instrumental to the prevention of adolescent obesity. Interventions offered in schools can be used to promote health and wellness among adolescents thereby contributing to the mitigation of adolescent obesity. The World Health Organization (WHO) has developed standards and recommendations which schools are encouraged to adhere to; these include promoting physical activity and healthy foods within the school environment (Brown et al., 2019). The expectation is that these standards can be regulated and achieved through the

implementation of guiding policies by schools to limit students' access to unhealthy energy dense foods and drinks (Woods et al., 2014; Ada & Chu, 2017); while fostering increased access to physical activities and other healthy habits (Cradock et al., 2017).

1.5.1 Value of school-based prevention interventions

Given that most adolescents attend high school, schools are an ideal and influential environment that can shape their dietary and physical activity behaviors (Carter, 2002). Clarke et al. (2013) posits that schools have the capacity to reach majority of young people frequently and for longer periods. School stakeholders include school senior management, teachers, health personnel or anyone who is invested in the welfare and success of a school and its students (Clarke, Fletcher, Lancashire, Pallan, & Adab, 2013). Most school stakeholders are the ones who directly implement programs aimed at preventing obesity either as part of their duty or through the curriculum (Clarke et al., 2013). They are well positioned and have the potential to become involved in school-based prevention or treatment of obesity (Carter, 2002). Schools and school stakeholders need to use this opportunity to combat adolescence obesity. Stakeholders such as teachers of Home Economics, Science, Health and Physical Education, Dance and pastoral care advisors, health personnel and senior management have formal and informal access to many young people within the school environment, hence they can facilitate discussions on health topics such as body image, nutrition, and weight control (Landolfi, 2014).

1.5.2. Factors that mitigate the efficacy of school-based interventions

Teachers and other school stakeholders can facilitate mentoring programs, alongside their academic roles and contribute to the reversal of the global epidemic of obesity. In a study that surveyed the perceptions of physical educators, most participants suggested that health curricula should include nutrition and weight control content (Greenleaf and Weiller 2005). The participants

were also of the opinion that low calorie lunches and weight control programs should be available in schools. Nevertheless, research shows that schools tend to give more priority to educational outcomes at the expense of health-oriented experiences and outcomes (Stylianou & Walker, 2018). Common barriers to implementation of physical activity and healthy eating policies include withholding physical activity for detention or correction of bad behaviour (Clarke et al., 2013), lack of time due to engagement with teaching and administrative duties by stakeholders (Stylianou & Walker, 2018), lack of parental concern and support (Greenleaf & Weiller, 2005), shortage of Physical Education teachers, lack of funding and resources, poor school role models, lack of funding and using unhealthy food for rewards and fundraisers (Clarke et al., 2013). School stakeholders have indicated that some of these barriers are beyond their control especially the time allocated for physical activities which has significantly reduced over time (Stylianou & Walker, 2018).

1.5.3 The Australian situation

Children and adolescents have been reported to be failing to meet the Australian physical activity and dietary guidelines especially for vegetable, saturated fat and sugar intake (NHMRC, 2013). The Active Healthy Kids Australia (AHKA), an Australian research collaboration unit that advocates for actions to increase physical activity among Australian children has formulated a physical activity report card which is a core monitoring metric, recommending at least 150 minutes of physical activity per week. Physical activity is considered to be an effective way of shedding excess weight and maintaining a healthy weight (Graf et al., 2014). Furthermore, the Australian Guide to Healthy Eating (NHMRC, 2014) provides national evidence-based guidelines aimed at promoting health and wellbeing, and reduction of diet-related chronic health problems, including

obesity. However, these guidelines and recommendations are not fully adhered to by Australian schools (Bhaskaran et al., 2014; Stylianou & Walker, 2018).

A recent study conducted by Stylianou and Walker (2018), assessed existing physical activity and nutrition policies for Australian schools. The authors reported that physical activity policies were identified at the national level for six of the eight states and territories. The study also revealed that in Queensland and South Australia, there were no publicly available policies or regulatory guidelines in government schools (Stylianou & Walker, 2018). Furthermore, there were no policies identified on the websites of non-government school organisations (Stylianou & Walker, 2018). This absence of specific regulatory policies impairs the ability to establish whether children are achieving the national physical activity guideline for children and adolescents of 60 minutes per day (Schranz et al., 2016). The 2019 enrolments in Australian schools increased to about 3.9 million with about 65% enrolled in government schools, 20% in Catholic schools and about 15% in independent schools (Statistics, 2019). It is therefore important to increase school-based adolescent obesity prevention interventions to foster positive health behaviours among adolescents.

Generally, it is the school principal's responsibility to ensure the implementation of nutrition and physical activity policies in the school, but this is not the case in Queensland (Stylianou & Walker, 2018). In Queensland, it is not stated who holds the responsibility of nutrition and physical activity implementation (Stylianou & Walker, 2018). It has been suggested that there is a 'responsibility conflict' in schools with unclear boundaries about whose responsibility it is to ensure healthy-eating and access to adequate physical activity (Clarke et-al.,2013; Stylianou & Walker, 2018), which is a concern prompting research focus on prevailing issues in Queensland schools. It is therefore important to reassess the role of the school in the prevention of adolescent obesity. More

importantly, due to the many health implications associated with obesity, it is expedient to target preventive measures rather than the cure of likely resultant health disorders.

1.5.4 The significance of government support

Though schools have been found to be an ideal setting for the implementations of these strategies, concerted effort from the government towards the prevention of obesity will support the efforts made by schools (McIsaac et al., 2019). Governments around the world have come up with policies towards the prevention of adolescent obesity. Some of these policies focus on changing the food environment, however, it has been reported that the tools to rate the levels of implementation of these policies by governments are lacking (Vendevijvere et al., 2015). Government support is essential to support schools by controlling marketing of unhealthy food near and outside schools, setting restrictions on advertisement of unhealthy food especially to young people, monitoring sale of sugar sweetened beverages and types of foods sold in schools (Dick et al., 2012, Pettigrew et al., 2012).

1.6 Research Aims and Questions

1.6.1. Research Aims

This thesis aimed to: (1) assess the scope and efficacy of adolescent obesity intervention strategies in Australian schools, (2) investigate Queensland school stakeholders' beliefs and perceptions of the barriers and enablers currently experienced by schools and their recommendations for preventing adolescent obesity and (3) develop a reliable adolescent obesity prevention model based on the study findings.

1.6.2 Research Questions

The following four research questions (RQ) were utilised to address the aims of the thesis.

RQ1: What are the scope and efficacy of adolescent obesity intervention strategies in Australian schools?

RQ2: What factors enable and/ or hinder school stakeholders from implementing school-based obesity interventions programs?

RQ3: How do school stakeholders view their role in preventing adolescent obesity?

RQ4: Can school stakeholders' opinions and recommendations be used for the development of a reliable adolescent obesity prevention model?

1.7 Significance of this Research

Given the health and social burden associated with adolescent obesity and the strategic relevance of the school as a convenient and appropriate environment to foster preventive measures of adolescent obesity and promote healthy living, the significance of this research cannot be overstated. The research will allow for scoping and synthesis of existing research evidence on school-based interventions and help identify gaps in the literature research. The study will also explore existing challenges encountered by Queensland school stakeholders and proffer recommendations for effective intervention programs. Exploration of school stakeholders' opinions about current priorities, barriers and enabling factors would be beneficial in the global effort to prevent adolescent obesity. Additionally, recommendations from school stakeholders are key to future planning and implementation of effective policies and intervention programs. The research findings will be fundamental for the provision of a roadmap to necessary adjustments and developments to effectively combat adolescent obesity. The outcomes from this study will be beneficial to schools, government policy makers, health professionals and inform future research.

1.8 Underpinning Theoretical Frameworks

To adequately test the stated research aims and questions, it is important to hinge the research on an appropriate health behavioral theory. It is recommended that the efficacy of interventions can be increased if they take a multi-component approach and align to one or more theoretical frameworks (Chen et al., 2014, Morgan et al., 2014). It is therefore important to explore the views and perceptions of school stakeholders on school-based approaches towards the prevention of adolescent obesity and explore the components of interventions in light of frameworks that focus on influential factors. Therefore, the Health Belief Model underpinned the development of the questionnaires used in this research and the Social Ecological theory (Green et al., 1996) underpinned the development of a reliable model for the prevention of adolescent obesity. These theories posit that behaviour is influenced by a set of factors, such as knowledge, finances, stress, culture, and peer pressure, which can be modified to positively affect health outcomes in a single person or an entire population (Glanz & Bishop, 2010).

1.8.1 Health Belief Model

The Health Belief Model is one of the most widely used conceptual frameworks for understanding and modifying health-related behaviors. This model was developed in the 1950s in an effort to understand why people do not engage in certain health behaviors despite their knowledge of the consequences following an unsuccessful free tuberculosis screening public health intervention (Reisi et al., 2014). The argument of this model is that our belief in the threat of an illness or disease (which in this case is obesity) is paired with our belief in the effectiveness associated with the proposed behaviors (for example portion control or a more active lifestyle) determines whether we will engage in that behavior (Reisi et al., 2014). However, this model has several theoretical constructs such as perceived susceptibility, perceived severity of the disease or condition,

perceived benefits that may be associated with suggested activities and perceived barriers (Reisi et al., 2014; Skinner,1938). There are modifying variables such as demographics and psychological variables that may either spur someone to action in combating a health problem, for example, obesity if they are for example in an environment that can affect their health motivation, or they realize that they are more susceptible to a health condition (Reisi et al., 2014; Janz & Becker, 1984). The application of this theory in this study is to portray the seriousness of adolescent obesity in light of the specific severe consequences of not taking any preventive actions. The prevalence of obesity over the years should be one of the cues to spur the right behavior into action.

1.8.2. Social Ecological Theory

The Social Ecological theory encapsulates multiple levels of influence beginning with individual factors or intrapersonal level widening to the interpersonal, community level or social environment, physical and macro-level environment (Green et al., 1996). The intrapersonal level in this case includes the knowledge and attitudes adolescents have toward healthy eating, their attitudes and motivation. Under the interpersonal level, the parents may influence their adolescent children even if they are not aware of their influence on the eating habits of their children. Under the community level, the local infrastructure like the safe bikeways may for example encourage or discourage active transport (Jacobs et al., 2021). The school environment falls within the institutional level of this model and at this level the school can influence dietary and sedentary behaviors either negatively or positively through school programs and policies (Green et al., 1996). The highest level of this model is the Policy or government level where the government is expected to develop clearly defined and understandable policy standards for the regulation of selling food and drinks like sugar sweetened beverages and sedentary lifestyle in schools. (Green et al., 1996).

1.9 Overview of Research Methods

The research in this thesis was conducted in two parts: Part 1 – Systematic Review and Part 2 – Mixed Methods Research. The Systematic Review was used to answer RQ1 (Chapter 2) while Mixed Methods Research based on sequential explanatory mixed methods approach was used to answer RQ2, RQ3 and RQ4 (Chapter 3).

1.9.1 Systematic Review - Addressing Research Question One

RQ1: What are the scope and efficacy of adolescent obesity intervention strategies in Australian schools?

Research Method: The method utilised in addressing RQ1 was a systematic review of peer-reviewed quantitative studies conducted in Australia over the past ten years, targeted at adolescents (12- to 18-year-old) attending an Australian high school or college, and involved obesity prevention interventions that were implemented for adolescents by school stakeholders within a school setting. The systematic review was conducted using a search of standard electronic databases. The Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) was utilised as the evidence-based guide for accurate and transparent documentation of the search strategy. The quality of the reviewed articles was assessed using the Quality Assessment Tool for Studies with Diverse Designs (QATSDD), a 16-item tool which allows for comparison of studies with different research method designs. Details of this study are presented in Chapter 2.

1.9.2 Mixed Methods Research - Addressing Research Questions 2-4

RQ2: What factors enable and/ or hinder school stakeholders from implementing school-based obesity interventions programs?

RQ3: How do school stakeholders view their role in preventing adolescent obesity?

RQ4: Can school stakeholders' opinions and recommendations be used for the development of a reliable adolescent obesity prevention model?

Research Method: Considering that this part of the research focused on evaluating school stakeholders' point of view, it was decided that a mixed methods research design approach was most appropriate to investigate these research questions. Mixed methods design is a pragmatic research approach that gives a voice to study participants and ensures that study findings are grounded in participants' experiences. The study participants included school stakeholders (heads of department, senior administrators, senior teachers and subject teachers) from both independent and public Queensland high schools who are certified employees of Queensland Education. The study participants were recruited via online social media platforms. This study followed a sequential explanatory mixed-methods design with two study phases, where the quantitative phase preceded the qualitative phase. Solely using quantitative data can yield significant results however, the deeper underlying meanings from the responses can be easily missed out due to inability to clarify and provide in-depth understanding of the research findings; furthermore, they are unable to assess respondent honesty and interpretation of the questions asked (O'Leary, 2014). Qualitative studies such as interviews and focus groups are able to overcome these limitations of quantitative research, particularly in exploring participants' perceptions about the enablers and barriers to existing intervention programs and their recommendations for improvement (Wisdom et al, 2012). Weaknesses due to bias in qualitative or quantitative approach was controlled by triangulating

between the two research methods to uncover the best possible explanations for the observed phenomenon (Creswell & Clarke, 2017).

In this thesis, the quantitative phase involved the utilization of an online survey to answer RQ2. The survey questions were adapted from two previous studies (Price et al, 1990; Kennedy et al, 2017) and were categorized into six (6) sections that examined participants' background information, their beliefs, attitudes and perceptions about available anti-obesity policies as well as the barriers and enablers of school-based prevention programs. The findings from the quantitative phase were used to guide the development of the semi-structured open-ended interview questions utilised in the qualitative phase to answer RQ3 and RQ4.

Analytical techniques used: Descriptive statistics in the form of frequencies and percentages were used to determine the demographic characteristics of the participant groups and to identify most occurring perceptions, beliefs and attitudes, barriers and enablers, types of policies and prevention programs used in schools. Inductive thematic analysis was utilised for the qualitative data from the interviews, and this involved the identification and coding of key themes raised by participants. Triangulation of the quantitative and qualitative findings within this mixed methods research was then performed to provide meaningful interpretation of the research results as a whole and identify convergent and divergent findings (Creswell & Clarke, 2017). This also aided the development of a reliable conceptual model for the prevention of adolescent obesity. Details of the methodology used and study findings for this part of the research are presented in Chapter 3.

1.9.3 Researcher' 'Self Reflexivity

As a teacher by profession, undertaking this study as an insider researcher gave me a vantage position to engage with teachers which has the potential to bring about biases; amicable mitigation of any bias was an important consideration and some of the strategies recommended by Lincoln

and Guba (1985) and Guba (1981), were employed .In order to reduce bias , minimize ethical implications and increase trustworthiness of the data collected, a sequential mixed method approach was used which allows for triangulation of data. I also established regular formal meetings with other members of the research team (Lincoln & Guba, 1985). These team meetings provided opportunity for debriefing, checking and validating research tools and progress with data collection. Given that the other members of the research team are not schoolteachers, their involvement in the data collection and results validation processes enhanced the credibility of the research findings (Guba, 1981).

1.10 Thesis Structure and Organisation

Table 1.2 below provides a brief outline of the thesis showing an overview of what each chapter in this thesis covers. This thesis comprises five chapters, two of which have been published.

Table 1.2: A summary of the Thesis Outline, Chapter Details, Author Contributions and Publication Status of the thesis chapters.

Chapter Details and Publication Status	Author Contributions
<p>Chapter 1 - General Introduction: The chapter outlined the justification and focus of the current study. Thesis aims, research questions, research design and methodology justification as well as population /study setting, and researcher reflexivity were also discussed.</p> <p><i>Not Published</i></p>	<p>KB wrote the introductory chapter, while BMA, TIE and AMA reviewed each draft and approved the final version.</p>
<p>Chapter 2 - The efficacy of school-based interventions in preventing adolescent obesity in Australia: This chapter answered RQ1 and utilised a systematic review of existing literature to (1) identify the scope of Australian school-based intervention strategies aimed at preventing adolescent obesity and (2) assess the efficacy of the interventions. Intervention characteristics were extracted, and quality, efficacy and outcome measures assessed. The study findings pointed to the need for more research to assess the perceptions of school stakeholders in order to identify the barriers and enablers of school-based interventions needed in combating the adolescent obesity epidemic for achieving sustainable long-term impacts. The findings from this chapter informed the study design and methodological approach used for chapter 3.</p> <p><i>Published in Healthcare 2020, 8(4), 514; https://doi.org/10.3390/healthcare8040514</i></p>	<p>KB conducted the systematic search and quality appraisal and wrote the manuscript drafts. BMA conducted quality appraisal checks and validation of the search strategy and study findings. BMA, TIE and AMA reviewed and edited each draft of the manuscript and approved the final version.</p>
<p>Chapter 3 - Australian School Stakeholders’ Perceived Strategies for Preventing Adolescent Obesity: This chapter answered RQ2-RQ4 and utilised a sequential explanatory mixed methods research design to investigate school stakeholders’ beliefs and perceptions of the barriers and enablers currently experienced by schools, as well as their recommendations towards preventing adolescent obesity. A conceptual model for the prevention of adolescent obesity was developed</p>	<p>KB developed the survey and interview questions and ethics application, conducted the interviews and wrote the manuscript drafts. BMA reviewed the initial interview recordings and confirmed the coding structure. BMA, TIE</p>

<p>based on participants' perceptions. Strategies targeting nutrition, physical activity and overall health were identified as essential for improved adolescent health outcomes.</p> <p><i>Published in Int. J. Environ. Res. Public Health 2021, 18(17), 9387; https://doi.org/10.3390/ijerph18179387</i></p>	<p>and AMA provided guidance with the study design and preparation of the ethics application. KB, TIE, JCB and BMA analysed the data. BMA, TIE and AMA reviewed each draft of the manuscript and approved the final version.</p>
<p>Chapter 4 – General Discussion. This chapter provided a general discussion of the overall results obtained from the preceding chapters and the practical implications of the findings for all stakeholders.</p> <p><i>Not Published</i></p>	<p>KB wrote this chapter. BMA, TIE and AMA reviewed each draft and approved the final version</p>
<p>Chapter 5 - Conclusion and Recommendations: This chapter details the overall conclusion for the thesis, recommendations, and strategies to adopt in the prevention of adolescent obesity as well as direction for future research.</p> <p><i>Not Published</i></p>	<p>KB wrote this chapter. BMA, TIE and AMA reviewed each draft and approved the final version</p>

*Chapters 2 and 3 are publication-based chapters in this thesis

Chapter 2: The efficacy of school-based interventions in preventing adolescent obesity in Australia

2.1 Chapter Overview

Abstract: Current trends suggest that adolescent obesity is an on-going public health issue that is still on the rise in Australia and the social burden associated with it can cause low self-esteem and lack of confidence in personal body image in adulthood. Nonetheless, evidence-based prevention programs are not widely implemented in schools, even though the school is considered an ideal setting for easy access to adolescents. The primary objective of this systematic review was to assess the scope and efficacy of adolescent obesity intervention strategies in Australian schools, to guide future research. Seven electronic databases were searched for peer-reviewed school-based intervention articles written in the English language and targeting 12–18-year-old adolescents. Intervention characteristics were extracted, and quality, efficacy and outcome measures were assessed from thirteen studies that met the inclusion criteria for this review. Most of the Australian adolescent obesity research emanated from the State of New South Wales and none were nationwide. Five studies showed significant results in all measured outcomes, four met at least one measured outcome and the remaining four were unsuccessful. Despite the weak evidence of intervention efficacy for most of the reviewed studies, school-based interventions with multi-component combinations of physical activity, nutrition and alignment to a theory yielded promising results. The study findings point to the need for future research to assess the perceptions of school stakeholders in relation to the barriers and enablers to establishing school-based prevention and intervention programs for adolescents.

2.2 Introduction

Obesity (the abnormal or excessive accumulation of fat in the body) in adolescents continues to be a subject of increasing global public health importance, highlighting the need for evidence-based public health action towards its prevention and control (Guthold et al., 2020; Withrow & Alter, 2011). Adolescence represents a period marking the transition from childhood to adulthood and classically covers the ages ranging from 12 to 18 years (Jaworska & MacQueen, 2015). Obesity increases the health risks of individuals and is a major contributor to chronic disorders such as diabetes, cancer and cardiovascular diseases (Kardassis et al. 2012, Bhaskaran et al., 2014; Daniels, 2009; Hoare et al., 2016; Jackson et al., 2014; Raj, 2012). While excessive food intake and sedentary lifestyles are the main causes of obesity (Stott et al., 2014), other factors such as medical illness, use of certain medications, consumption of energy-dense foods or beverages and eating disorders, especially, binge eating, have also been associated with the risk of the disorder (Fock & J. Khoo, 2013; Stott et al., 2014). Furthermore, the social burden associated with obesity in adolescence can cause low self-esteem and lack of confidence in personal body image in adulthood (Abarca-Gómez et al., 2017).

Over the past three decades, the prevalence of overweight and obesity in adolescents has continued to increase in several regions and countries around the world (Abarca-Gómez et al., 2017). According to the WHO, 340 million children and adolescents (Abarca-Gómez et al., 2017). were overweight or obese in 2016 (WHO, 2020). This problem is of particular importance in Australia because even though the prevalence of childhood obesity has plummeted in the last two decades (Olds et al., 2010), this is not the case among adolescents (Ogden et al., 2014). Australia currently ranks as one of the top ten nations with the highest proportion of overweight or obese adolescents (AIHW, 2019). For example, Abarca-Gómez and colleagues (Abarca-Gómez et al., 2017) reported

that in Australia, between 2010 and 2015, obesity in adolescent boys increased from 5.1% to 5.7% while in girls it increased from 4.2% to 5.4%. The authors suggested that abdominal obesity, which is a marker for cardiometabolic risks significantly increased from 7.2% to 15.8% and 3.6% to 8% in high school adolescent boys and girls, respectively, during the same period.

In the absence of effective preventive interventions, the prevalence of obesity in adolescents is projected to increase exponentially to 91 million worldwide by the year 2025 (Lobstein & Jackson-Leach, 2016). In 2016, the Australian Bureau of Statistics (ABS) reported that over a third of adolescents aged between 12 and 17 were overweight and obese (Department of Social Services et al., 2020). This premise underscores the importance of a prompt public health response to the growing global burden of obesity among adolescents. Available evidence indicates that the prevailing Covid-19 pandemic exacerbates some of the main causes of obesity such as physical inactivity and increased screen time (Xiang et al., 2020). The pandemic is also causing rapid weight gain in most regions of the world; this relationship between Covid-19 and obesity has been recently named “Covibesity” (Khan & Smith, 2020). For instance, in a recent China-based study, physical activity time was estimated to have decreased from 540 min per week before the Covid-19 pandemic to 105 min per week during the pandemic—a reduction of over 430 min of physical activity time per week (Xiang et al., 2020). The study further revealed that the prevalence of physical inactivity has risen from 21.3% to 65%, while screen time has increased to 30 h per week. Similar findings were reported in a recent survey conducted in 298 schools (making up to 1.6 million adolescents aged 11 to 17 years) in 146 countries worldwide (Guthold et al., 2020). This evidence further highlights the need for urgent actions against the obesity epidemic.

In Australia, guidelines aimed at improving the health and wellbeing of children and adolescents through regular participation in physical activities and dietary recommendations (vegetables,

fruits, etc.) are in place (NHMRC, 2013). However, a substantial proportion of adolescents in the country often do not adhere to these guidelines (Daniels, 2009; Schranz et al., 2018). For example, the 2018 report card for “The Active Healthy Kids Australia” (AHKA) indicated that Australian adolescents fell below the set targets for active transport, sedentary behavior and physical activity (Schranz et al., 2018). Guthold et al. (2020) also indicated that Australia had the highest prevalence of physical inactivity among adolescents—precisely 89%—followed by New Zealand in the category of high-income Western Countries. Given the fact that regular physical activity and the practice of healthy diets are critical to shedding excess weight or maintaining a healthy weight, with a range of other health benefits (Alves et al., 2016), it is important to investigate better means of addressing the obesity epidemic among Australian adolescents.

Given that the majority of adolescents are in high school (Clarke et al., 2013), schools represent one of the most ideal environments for implementing dietary and physical activity intervention programs aimed at addressing the obesity epidemic in the country (Al-Mutairi et al., 2015). Clarke and colleagues (Clarke et al., 2013) posit that schools have the capacity to reach the majority of young people frequently and for longer periods. In addition, many school stakeholders are known to have been directly involved in implementing programs aimed at preventing obesity either as part of their duty or through the curriculum (Clarke et al., 2013). Stakeholders such as teachers of Home Economics, Science, Health and Physical Education, Dance and pastoral care advisors, health personnel and senior management have formal and informal access to many young people within the school environment, hence they can facilitate discussions on health topics such as body image, nutrition and weight control (Landolfi, 2014). Nonetheless, evidence-based prevention programs are not widely implemented in Australian schools, even though they are commonplace for easy access to adolescents (Schranz et al., 2018). The prevalence of adolescent obesity in

Australia warrants a review of the efficacy of the intervention programs to identify what the challenges are.

Consequently, the objectives of this systematic review were to (1) identify the scope of Australian school-based intervention strategies aimed at preventing adolescent obesity and (2) assess the efficacy of the interventions. The findings will be fundamental in informing a roadmap to necessary adjustments and developments to be effected in alignment to programs and interventions that have demonstrated significant results in reducing the prevalence of obesity in the past, an area where more evidence is needed. Furthermore, the first objective of the review will allow for scoping and synthesis of existing research evidence on school-based interventions, help identify gaps in the literature and give directions for future research.

2.3 Materials and Methods

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Moher et al., 2009).

2.3.1 Inclusion and exclusion criteria

In this review, the criteria for selection were: (1) peer reviewed quantitative studies conducted in Australia from 2009 to 2019, (2) studies targeting adolescents, (12-18 years old) attending an Australian high school or college, (3) studies where interventions were implemented in a school setting, (4) studies published in English language, (5) Community interventions for adolescents implemented by school stakeholders in a school setting.

The criteria for exclusion were (1) studies targeting children below the age of 12 and young/ mature adults above the age of 18 and (2) intervention studies targeting adolescents but were implemented out of school setting and studies not published in the English language.

2.3.2 Search strategy

For this review, peer reviewed articles published in the last 10 years in English and indexed in the following databases were searched: Eric, Pubmed, InFormit, Scopus, CINAHL, Med-OVID and Psych Info. Google Scholar and included studies were also screened and hand searched for relevant additional inclusions. The 10-year date restriction was to enhance the currency of evidence obtained from the systematic review.

2.3.3 Search terms

The following search terms were used during electronic database searches: Obesity OR obes* OR overweight OR chubby OR plump OR plus size OR body fat OR excess adiposity OR body mass index, AND School personnel OR high school OR school role OR school organization OR school schedule OR school involvement OR school health services OR school policy OR school effectiveness OR high school, AND Program OR intervention OR initiative OR prevent OR solution OR scheme OR strateg* OR project OR program development, OR strategic planning OR early intervention OR program evaluation OR intervention OR program effectiveness OR program success OR program results, AND High school students OR student OR youth OR adolescent* or teenage*.

2.3.4 Data extraction

KB and BSMA identified and independently screened the titles and abstracts of the retrieved articles. The articles which did not meet the inclusion criteria were removed. Full-text articles categorized as potentially eligible for inclusion were subsequently screened by KB and BSMA in a consensus meeting and disagreements were resolved in real time until consensus was reached. Study specific information from the included studies were extracted and these included: the publication year, study design, study location and duration, study participants, type of intervention,

and reported outcomes. TIE and AEOMA validated the data by cross-checking the extracted information.

2.3.5 Risk of bias assessment

The Quality Assessment Tool for Studies with Diverse Designs (QATSDD), a 16-item tool which allows for comparison of studies with different research method designs was used to assess the quality of included studies (Sirriyeh et al., 2012). The tool was modified to exclude 2 items: “Fit between research question and format and content of data collection method (Qualitative only)” and “Assessment of reliability of analytical process (Qualitative only)” as they were not applicable to the study. The criteria included were (1) theoretical framework; (2) aims/objectives; (3) description of research setting; (4) sample size; (5) representative sample of target group, (6) procedure for data collection; (7) rationale for choice of data collection tool(s); (8) detailed recruitment data; (9) fit between research question and method of data collection (Quantitative only) (10) fit between research question and method of analysis; (11) good justification for analytical method selected; (12) strengths and limitations; (13) Evidence of user involvement in design and (14) Statistical assessment of reliability and validity of measurement tools.

A scale of 0-3 (not at all=0, very slightly=1, moderately=2 and complete=3) was used to assess the quality of each criterion item of assessment. All scores for each criterion were added together and converted into percentages for easier interpretation. Scores less than 50% were classified as low quality, 50-80% and over 80% were classified as medium and high quality, respectively.

2.4 Results

2.4.1 Study selection

An initial search identified 413 papers, including seven (7) hand searched ones. After removing duplicates, screening titles and abstracts, 39 papers remained for full text review with thirteen (13) included in the systematic review. The PRISMA flow chart for the review is shown in Figure 2.1.

2.4.2 Characteristics of included studies

Table 2.1 displays the characteristics of the included studies. The studies were conducted in three Australian states and the Capital Territory: New South Wales (NSW) had nine studies (n=9), Victoria had 2 studies (n=2), Queensland (QLD) had one study (n=1) while one study was conducted in the Australian Capital Territory (ACT). Of the 13 included studies, ten (10) were Randomized Controlled Trials, while three (3) were quasi-experimental longitudinal studies. The sample sizes ranged from thirty-three (n=33) to two thousand and fifty-four (n=2054). The number of participating high schools per study ranged from one (n=1) to fourteen (n=14). Eight studies (n=8) had boys only as participants, one study (n=1) had girls only as participants and the remaining five (n=5) studies had both boys and girls as participants. The age range of the participants was 12-17 years. The studies with the longest duration lasted for three (3) years while the shortest duration was approximately four (4) months.

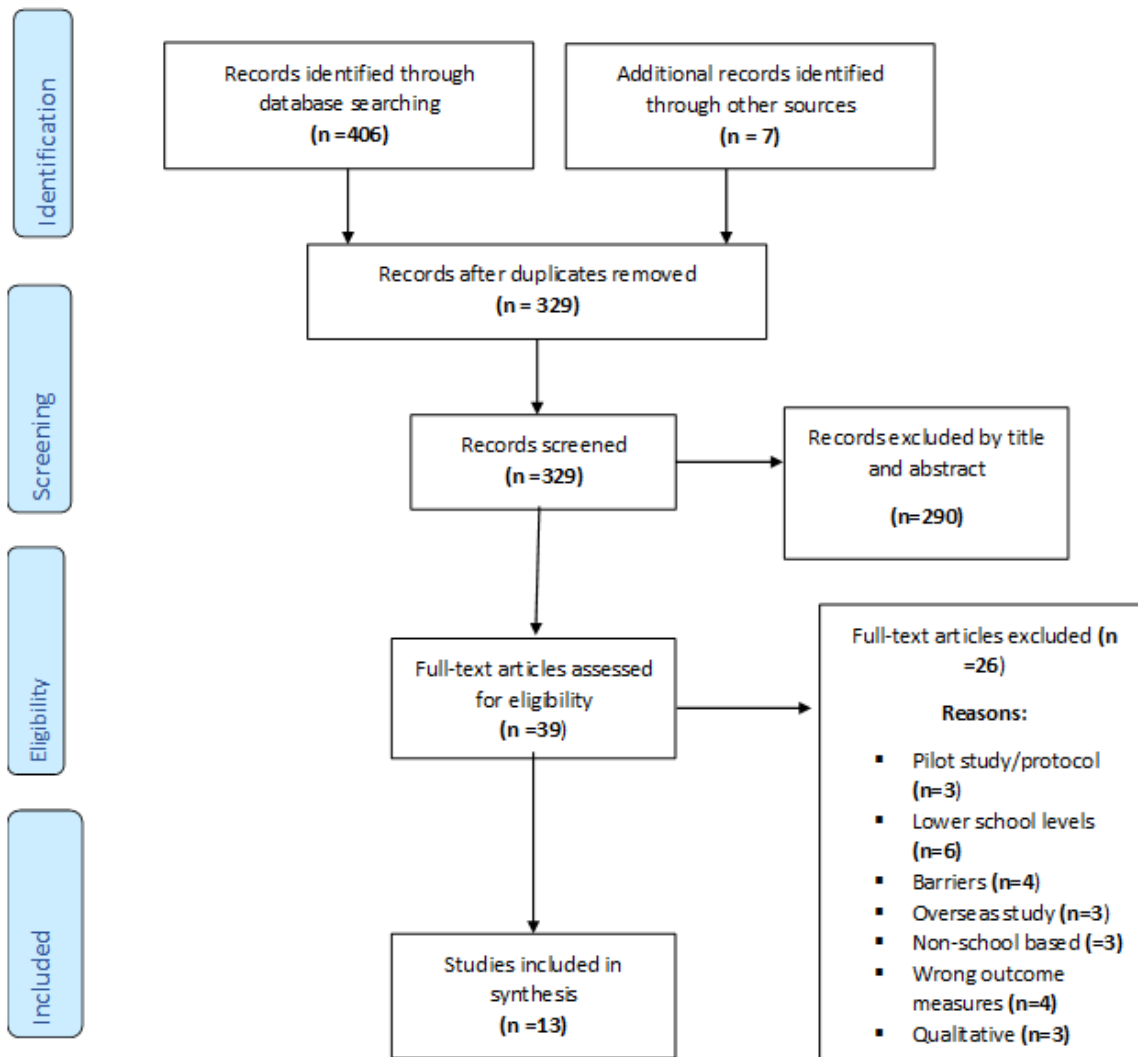


Figure 2.1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Chart.

Table 2.1: Characteristics of included studies

Authors and Year	Study Design and duration	Region and Socio-economic status - Low, Medium, High, Not indicated (NI)	Sample size and Ages of Participant groups
1. Contardo Ayala et al., 2018	Quasi-experimental intervention trial 4-17 weeks (approximately 4 months)	VIC-Melbourne NI	(n=88); 14.4-15.3yrs; boys and girls Intervention and control from 1 school
2. Dewar et al., 2013	Cluster Randomized Controlled Trial (RCT) 24 months	NSW Low SES	(n= 357); adolescent girls from 12 secondary schools (aged 13.2±0.5 years)
3. Hollis et al., 2016	Cluster RCT 12-24 months	NSW Low SES	(n=1233); Grade 7 boys and girls from 10 schools
4. Lubans et al., 2016	Cluster RCT 18 months	NSW Low SES	(n=361); 12.65 - 12.75 years; boys from 14 schools
5. Lubans et al., 2011	Cluster RCT 6 months	NSW NI	(n=100); [mean (Smith et al.) age=14.3(0.6) year boys from 4 schools
6. Malakellis et al., 2017	Quasi-experimental using a longitudinal cohort follow-up after 3 years	ACT High SES	(n=656); 12-16-yrs; boys and girls, 6 schools: 3 controls, 3 interventions
7. Millar et al., 2011	Quasi-experimental using a longitudinal cohort follow-up 3 years	Barwon, Southwestern VIC Low SES	(n=2054); 13-16-yrs; boys and girls 5 interventions, 7 control schools
8. Morgan et al., 2012	Cluster RCT 6 months	NSW Low SES	(n = 100, age = 14.3, boys; intervention (n = 50), control group (n = 50)
9. Parrish et al., 2018	Two-arm parallel group RCT 5 months	NSW NI	(n=172); Grade 7, 12-13-yrs; boys
10. Peralta et al., 2009	RCT 6 months	NSW-Sydney NI	(n=33); 12.5 years, boys Intervention and control
11. Smith et al., 2014	Cluster RCT 20 weeks-around 4.5 months	NSW Low SES	(n=361); 12.65 - 12.75 years; boys 14 high schools
12. Sutherland et al., 2016	RCT 24 months	NSW Low SES	(n=1150); Grade 7, 12 years boys and girls; 10 secondary schools
13. Weeks and Beck., 2012	Cluster RCT 8 months	QLD-Gold Coast	(n=99) adolescents (n=46) boys, (n= 53) girls; 13.8 ± 0.4 years, year 9 in one local high school

ACT-Australian Capital Territory; NSW-New South Wales; QLD-Queensland SES-Socio-economic status; VIC-Victoria; NI-Not Indicated

2.4.3 What types of interventions were identified?

Table 2.2 shows the interventions reported in the included studies. There were three (3) intervention types identified: physical activity, sedentary behavior and nutritional behavior. Of these three types of interventions, physical activity was used in eleven (11) of the thirteen (13) reviewed studies, followed by sedentary behavior which was used in nine (9) studies. Six (6) studies combined all the three types of interventions (Dewar et al., 2013; Lubans et al., 2011; Malakellis et al., 2017; Millar et al., 2011; Morgan et al., 2012 ;Smith et al., 2016). None of the studies utilised only nutritional behavior.

2.4.4 Health outcomes reported

The reviewed articles reported on adiposity, physical activity, behavioral and nutrition outcomes. Adiposity and weight related outcomes were waist circumference, weight, lean tissue mass and percent body fat (Table 2.2). Physical activity included organized sport, standing instead of sitting, jumps and active transport. Behavioral outcomes included screen-time while nutrition outcomes included fresh fruit and vegetable intake and sugar sweetened beverage intake. Twelve (12) studies (Contardo Ayala et al., 2018; Dewar et al., 2013; Hollis et al., 2016; Lubans et al., 2011; Lubans et al., 2016; Malakellis et al., 2017; Millar et al., 2011; Morgan et al., 2012; Parrish et al., 2018; Peralta, 2009; Smith et al., 2014; Weeks & Beck, 2012) had BMI outcomes while five (5) studies had BMIz-score outcome. Six (6) studies (Lubans et al., 2011; Lubans et al., 2016; Malakellis et al., 2017; Millar et al., 2011; Peralta, 2009; Smith et al., 2014) measured multiple outcomes across adiposity, physical activity, sedentary behavior and nutrition outcomes.

2.4.5 Intervention Efficacy on Measured Outcomes

2.4.5.1 *Changes in BMI and BMIZ*

Overall, out of the twelve (n=12) studies (Hollis et al., 2016; Lubans et al., 2011; Malakellis et al., 2017; Morgan et al., 2012; Contardo Ayala et al., 2018; Dewar et al., 2013; Lubans et al., 2016; Millar et al., 2011; Parrish et al., 2018; Smith et al., 2014; Weeks & Beck, 2012; Lubans et al., 2011) that reported on BMI, only four studies recorded a significant reduction in BMI in the intervention group compared to the control group (Hollis et al., 2016; Lubans et al., 2011; Malakellis et al., 2017; Morgan et al., 2012), whereas seven studies (Contardo Ayala et al., 2018; Dewar et al., 2013; Lubans et al., 2016; Millar et al., 2011; Parrish et al., 2018; Smith et al., 2014; Weeks & Beck, 2012) recorded no significant changes in BMI between the intervention and the comparison groups at baseline, during the intervention and the end of the intervention. Of the five studies that reported on BMIZ, three studies (Hollis et al., 2016; Lubans et al., 2011; Millar et al., 2011) recorded significant reduction in BMIZ in favor of the intervention group (Table 2.2).

2.4.5.2 *Changes in other adiposity and weight-related outcomes*

Of the nine studies (Dewar et al., 2013; Lubans et al., 2011; Morgan et al., 2012; Weeks & Beck, 2012; Malakellis et al., 2017; Millar et al., 2011; Parrish et al., 2018; Peralta, 2009; Smith et al., 2014) which measured the effect of the intervention on body fat, three studies (Dewar et al., 2013; Morgan et al., 2012; Weeks & Beck, 2012) reported a significant reduction in body fat for the intervention group in comparison to the control group where no significant changes were reported, while five studies (Malakellis et al., 2017; Millar et al., 2011; Parrish et al., 2018; Peralta, 2009; Smith et al., 2014) reported no significant differences in body fat for both the intervention and control groups. Four studies measured waist circumference (Lubans et al., 2011; Lubans et al.,

2016; Peralta, 2009; Smith et al., 2014), but reported no statistically significant differences between the intervention and the control groups.

As shown in Table 2.2, participants' body weight was measured in five studies (Millar et al., 2011; Hollis et al., 2016; Malakellis et al., 2017; Lubans et al., 2011; Weeks & Beck, 2012). One study (Millar et al., 2011) reported a significant reduction in body weight for the intervention group as compared to the control group. A moderate reduction in body weight was recorded in two studies (Hollis et al., 2016; Malakellis et al., 2017) both at baseline and at the end of the intervention in favor of the intervention group, while the remaining two studies (Lubans et al., 2011; Weeks & Beck, 2012) reported no significant reduction in body weight. Only one study (Weeks & Beck, 2012) measured lean tissue and participants in the intervention group indicated a significant gain in lean tissue compared to the control group. Only one study (Contardo Ayala et al., 2018) measured and recorded a significantly higher energy expenditure among participants in the intervention group compared to the control group.

2.4.5.3 Changes in Physical activity

A total of nine studies (Millar et al., 2011; Morgan et al., 2012; Malakellis et al., 2017; Peralta, 2009; Sutherland et al., 2016; Lubans et al., 2011; Dewar et al., 2013; Lubans et al., 2016; Weeks & Beck, 2012) reported on active transport and physical activity related outcomes. Two studies (Millar et al., 2011; Morgan et al., 2012) recorded a significant increase in active transport in the intervention groups in comparison to the control groups where no changes were seen (Table 2.2). One study recorded an increase in physical activity during recess only but no impact in active transport for both the intervention and control groups (Malakellis et al., 2017) whereas in another study (Peralta, 2009), only 50% of the participants attended physical activity sessions during recess. One study (Morgan et al., 2012) reported significant changes in multiple physical activity

related psychological outcomes such as a significant increase in physical self-worth, perceived physical condition, resistance training self-efficacy and physical activity behavioral strategies, in favor of the intervention group compared to the control group. The remaining five studies (Dewar et al., 2013; Lubans et al., 2011; Lubans et al., 2016; Peralta, 2009; R. Sutherland et al., 2016) did not record any significant increase in physical activity for both intervention and control groups. However, one study (Sutherland et al., 2016) reported that though there was no comparative effect between the intervention and the control groups, boys performed better than girls within the intervention group in moderate-to-vigorous physical activity at 12-month follow-up and the intervention group spent significantly more time in vigorous activities each day.

2.4.5.4 Changes in sedentary behaviors; screen time

Screen time was commonly measured by six studies (Lubans et al., 2011; Lubans et al., 2016; Smith et al., 2014; Malakellis et al., 2017; Millar et al., 2011; Dewar et al., 2013) but yielded diverse results. Three studies (Lubans et al., 2011; Lubans et al., 2016; Smith et al., 2014) reported significant reduction in screen time and compliance with daily recommended restrictions for the intervention group whereas screen time increased for the control group. On the contrary, two studies (Malakellis et al., 2017; Millar et al., 2011) reported a significant drop in screen time in favor of the control group, while screen time increased significantly for the intervention group, exceeding the daily recommendation of not more than two hours. The last study (Dewar et al., 2013) recorded no changes in screen time for both the intervention and control groups.

2.4.5.5 Changes in nutritional behaviors

Six studies (Lubans et al., 2011; Smith et al., 2014; Malakellis et al., 2017; Millar et al., 2011; Peralta, 2009; Lubans et al., 2016) reported on nutritional behaviors particularly, sugar sweetened beverages, fresh fruit and vegetables; where two studies (Lubans et al., 2011; Smith et al., 2014)

reported a significant reduction in the intake of sugar sweetened beverages fresh fruit and vegetables for the intervention group while there was no change with the control group. In one study (Malakellis et al., 2017), even though there were no significant changes in the school tuck-shop menu and role modeling from teachers, the intervention group showed significant increase in the awareness of healthy eating habits compared to the control group where there were no changes observed. None of the studies reported significant increase in the intake of fresh fruit and vegetables for any of the groups. Two studies (Millar et al., 2011; Peralta, 2009) reported no significant changes for the intake of sugar sweetened beverages, fresh vegetables for both intervention and control groups. One study (Lubans et al., 2016) reported no significant changes in the intake of sugar sweetened beverages for both groups.

2.4.5.6 Theoretical model

Table 2.2 depicts that Social cognitive theory was predominantly used as a guide in developing intervention components; 9 out of the 13 reviewed studies (Dewar et al., 2013; Hollis et al., 2016; Lubans et al., 2011; Lubans et al., 2016; Malakellis et al., 2017; Morgan et al., 2012; Peralta, 2009; Smith et al., 2014; R. Sutherland et al., 2016) utilized this theory. Social ecological model was used in two studies (Smith et al., 2014; R. L. Sutherland et al., 2016), one study (Hollis et al., 2016) used a combination of three models; Self-determination theory, Socio-ecological theory and Health Promoting Schools framework. Four studies (Hollis et al., 2016; Lubans et al., 2016; Smith et al., 2014; R. Sutherland et al., 2016) combined more than one theoretical model. One study (Millar et al., 2011) used Community Based Capacity Building Approach. Three (3) out of the 13 selected studies (Contardo Ayala et al., 2018; Parrish et al., 2018; Weeks & Beck, 2012) did not indicate any link to a guiding framework or theory.

2.4.6 Quality Appraisal

The QATSDD assessment shown in Appendix D indicated that the scores ranged from 55 to 83%. Eleven studies (Contardo Ayala et al., 2018; Weeks & Beck, 2012; Millar et al., 2011; Hollis et al., 2016; Lubans et al., 2011; Lubans et al., 2016; Malakellis et al., 2017; Morgan et al., 2012; Peralta, 2009; Smith et al., 2014; R. Sutherland et al., 2016) were of medium quality. Two studies (Hollis et al., 2016; Dewar et al., 2013) were of high quality. One study (Parrish et al., 2018) had the lowest percentage (55%) within the medium quality rated studies because it lacked a theoretical framework, did not provide a rationale for choice of data collection and had a poor description of strengths and limitations of the study. Given that all reviewed studies were RCTs and quasi-experimental research designs, they were judged to be appropriate because they provide a high level of reliable evidence.

Table 2.2: Intervention characteristics and outcome measures*

Authors and Study Design	Intervention type and study objective	Intervention details/components	Main findings (Intervention vs control)	Theory
1. Contardo Ayala., et al 2018 Quasi-experimental intervention trial	Sedentary Behavior - Use of height adjustable desks to reduce classroom sitting time AIM: To investigate the impact of an intervention to reduce classroom sitting time on adolescents' energy expenditure	A secondary school classroom was equipped with height-adjustable desks, posters promoting the health benefits of and strategies for breaking-up sitting time, and desk stickers reminding students to periodically stand up. Classroom teachers participated in a professional development session. The intervention used the classroom equipped for the intervention 2-5 times per week while the comparison used a traditional classroom. Sense Wear Armband was worn by the participants to measure EE	BMI was not significant at baseline, at 4 weeks and at 17 weeks, (p>0.05) At 4-weeks and 17-weeks, waist circumference was significantly lower (-3.5cm-and 2.6cm, respectively) and energy expenditure was significantly higher in the intervention (p<0.05) compared to the control group BF, BW, PA, SC.NT LM were not measured	Not sighted
2. Dewar et., al., 2013 RCT	Physical activity and sedentary behavior Aim: To evaluate the 24-month impact of a school-based obesity prevention program among adolescent girls living in low-income communities	NEAT Girls used: lifestyle promoting strategies (e.g., walking to school) lifetime physical activity (resistance training), improvement of dietary intake reduction of sedentary behaviors. Intervention components: enhanced school sport sessions, lunchtime physical activity sessions, nutrition workshops, interactive educational seminars, pedometers for self-monitoring, student handbooks, newsletters, and text messages to reinforce and encourage targeted behaviors.	After 24 months, there was no significant effects on BMI (p=0.353) and BMIz (p=0.178) while percentage body fat was significantly reduced (-1.96%, p=0.006) in favor of the intervention group No significant changes were observed for physical activity and screen time (p=0.257 and p=0.159) respectively) WC, BW, BF, PA not measured	Social Cognitive Theory
3. Hollis et-al., 2016 RCT	Physical activity - using an accelerometer during waking hours	The 'Physical Activity 4 Everyone' intervention operated under seven PA strategies categorized into Formal Curriculum (i.e. active lessons, Personal PA plans, Enriched sports),	A significant impact of the intervention was recorded for BMI (p=0.0116) and BMIz	Social Cognitive Theory, Socio-ecological theory, Health Promoting

	<p>AIM: To report whether the intervention impacted on adiposity outcomes (weight, BMI, BMIZ), and whether any effect was moderated by sex, baseline BMI and baseline physical activity level, at 12 and 24 months</p>	<p>School Ethos and Environment (recess and/or lunchtime activities, supportive school PA policy). Implementation strategies included an in-school physical activity consultant 1 day per week, establishing leadership and support, teacher training, resources, teacher prompts and intervention implementation feedback to schools.</p>	<p>($p=0.006$). Moderate impact on weight ($p=0.0396$) and BMI at 12 months, and weight, BMI and BMI z-score at 24 months in favor of the intervention group; p-value range ($p<0.01$ to $p<0.02$). The trial had desirable long-term outcomes with 70% incorporated physical activity plans.</p> <p>WC, BF, LM, EE, PA, SC, NT not measured</p>	<p>schools Framework</p>
<p>4. Lubans et., al., 2016 RCT</p>	<p>Physical activity, nutrition and Sedentary behavior - Avoiding Screen-time</p> <p>AIM: To evaluate the sustained impact of the 'Active Teen Leaders Avoiding Screen-time (ATLAS) obesity prevention program.</p>	<p>ATLAS intervention included teacher professional learning for readiness to deliver enhanced sport sessions(2 x 5hr workshops), provision of fitness equipment to schools(1 x pack/school valued at around \$1500), researcher-led seminars for students(3 x 20 min), face-face physical activity sessions delivered by teachers during the school sport period (20 x approximately 90 min in addition to regular PE lessons), lunchtime physical activity leadership sessions run by students(6x 20 min), pedometers for physical activity monitoring(17 weeks) strategies for reducing recreational screen-time(4 x newsletters), and a purpose –built smartphone application(15 weeks)</p>	<p>No significant change for all measures except for screen- time which reduced($p=0.003$); not successful</p> <p>NS for BMI ($p=0.656$), BMIZ ($p=0.485$), Waist circumference ($p=0.549$), PA ($p<0.05$) and SSB ($p=0.561$)</p> <p>BW, BF, LM and EE not measured</p>	<p>Self-Determination Theory and Social Cognitive Theory</p>
<p>5. Lubans et al., 2011 RCT</p>	<p>Physical activity, sedentary and nutritional behaviors.</p> <p>AIM: To prevent obesity among adolescents.</p>	<p>Components included school sports sessions, interactive seminars, lunch-time activities, physical activity and nutrition handbooks, leadership sessions and pedometer for self-monitoring. Focused on the promotion of lifestyle activities and lifetime activities and delivered over two school terms at no cost to the school or students. Participants completed self and teacher</p>	<p>There was a significant reduction in BMI for the intervention group ($p<0.001$) and BMIZ ($p<0.001$), no changes for the control group.</p> <p>The intervention group also significantly reduced consumption of sugary beverages ($P<0.02$), Significant reduction also observed in screen time ($p<0.05$).</p>	<p>Social Cognitive Theory</p>

		<p>directed sessions. Teachers supervised student-led activities.</p> <p>Participants who completed the set activities were recognized and given certificates at school assembly of which about 50% of participants were awarded certificates.</p>	<p>NS changes for waist circumference and physical activity</p> <p>Significant reduction in the number of participants classified as overweight or obese (p=0.03)</p> <p>LM, EE and SC not measured</p>	
6. Malakellis et al., 2017 Quasi-Experimental Intervention Trial	<p>Nutritional and sedentary behaviors and physical activity – multiple initiatives</p> <p>OBJ: To reduce unhealthy weight gain by promoting healthy eating patterns, regular physical activity, healthy body weight and body size perception amongst youth; and improve the capacity of families, schools, and community organizations to sustain the promotion of healthy eating and physical activity in the region.</p>	<p>The Fitness Improvement Lifestyle Awareness program (FILA) components included physical activity at school, active transport to and from school within 30 minutes walking distance. Key personnel-Principals, PE Teachers, students, representatives from ACT Health Directorate, ACT Education and Training Directorate and Nutrition Australia participated in a two-day workshop to develop the multi-component intervention. Participating intervention schools were given funds towards redeveloping the school environment to support nutrition and physical activity, fitness, and sport equipment and for costs associated with presentations to intervention schools</p>	<p>There was no statistically significant change in percentage body fat. Significant changes recorded for BMI (p<0.05) and healthy eating awareness for the intervention group but no significant impact on the food environment.</p> <p>Significant increase in screen time (P<0.02) for the intervention group and significant decrease for the comparison group. Significant fresh fruit and vegetables intake (p<0.05) and physical activity (P<0.05 during recess)</p> <p>Active transport-NS (P<0.143)</p> <p>Two of the intervention schools showed a significant decrease in the prevalence of overweight and obesity (p<0.05)</p> <p>Body fat NS WC, LM and EE were not measured</p>	Social Cognitive Theory
7. Millar et al., 2011 Quasi-experimental intervention trial	<p>Nutritional Behavior, sedentary behavior and Physical activity – multiple initiatives</p>	<p>The intervention focused on 10 objectives, each comprising of a variety of strategies delivered in schools through school project officers and student ambassadors. There was capacity building among officers and increased awareness</p>	<p>Statistically insignificant changes in BMI (p=0.06), significant changes in BMIz (p<0.03), body weight (p<0.04), significantly less weight gained 740g las compared</p>	Community based capacity building approach

	<p>AIM: To report the outcome results of anthropometric indices and relevant obesity-related behaviors.</p>	<p>of project messages among students, promoting water and reducing soft drinks consumption, removal of soft drinks from vending machines, promoting healthy breakfast and consumption of fruit and vegetables, increasing healthiness of school food, promoting active transport and acceptance of body size and shape and finally increasing participation in organize sport. New equipment was installed, vegetable gardens constructed, vending machines removed, school food and water policies were introduced.</p>	<p>to the control group than the control and active transport significantly decreased ($p<0.01$) in both the intervention and control group. Screen time increased for the intervention ($p<0.05$) group as compared to the significant decrease in the control ($p=0.01$.) NS changes for sugar sweetened beverages, s snack food intake from take away shop and fruit drinks/cordial ($p>0.05$), PA recorded NS ($p<0.05$)</p> <p>Body fat recorded NS results for both groups ($p=0.58$) as well as BMI ($p<0.06$)</p> <p>WC, LM and EE not measured</p>	
<p>8. Morgan et al., 2012 RCT</p>	<p>Physical activity</p> <p>AIM: To evaluate the effect of a school-based obesity prevention program and physical self-perception and key physical activity-related cognitions in adolescent boys from disadvantaged secondary schools</p>	<p>Components included enhanced school sport sessions with a focus on resistance training, physical activity and nutrition handbooks with homebased challenges, interactive seminars addressing key physical activity and nutrition behaviors, leadership principles and self-directed lunch-time exercise sessions. The boys participating were encouraged to become physical activity leaders in their school and accreditation was provided to students who complied with the program.</p>	<p>Two of the three intervention schools showed a significant decrease in the prevalence of overweight and obesity and increased physical self-worth, perceived physical condition, resistance training self-efficacy and physical activity behavioral strategies($p=0.02$), Body fat ($p=0.04$) Significant results for all PE related psychological outcomes (-ranging from $p<0.01$ to $p=0.04$) and BMI ($p<0.001$).</p> <p>WC, BW, LM, EE, SC and NT not measured</p>	<p>Social Cognitive Theory</p>

<p>9. Parrish et al., 2018 RCT</p>	<p>Sedentary Behavior – Reduced sitting time</p> <p>AIM: To evaluate the feasibility, acceptability, and potential efficacy of a school-based intervention to reduce adolescent sitting time during the school day.</p>	<p>The intervention involved classroom and outdoor environment measures to break up and reduce the proportion of adolescent school time spent sitting measured by activPal monitors. The intervention was implemented by classroom teachers. Intervention schools were given ‘stand-biased desks, free standing whiteboards and standing outdoor tables to be used for 30 minutes daily during the intervention.</p>	<p>No significant effect on body fat (p=0.36) and BMI (p=0.12)</p> <p>WC, BW, LM, EE, PA, SC and NT were not measured</p>	<p>Not sighted</p>
<p>10. Peralta et., al 2009 RCT</p>	<p>Physical activity promotion through Fitness, self-efficacy, self-esteem improvement, sedentary behavior through screen time reduction and nutrition behaviors</p> <p>AIM: To evaluate the feasibility, acceptability, and potential efficacy of a school-based obesity prevention program among adolescent boys with sub-optimal cardiorespiratory fitness.</p>	<p>The intervention focused on promoting physical activity through increasing physical self-esteem and self-efficacy, reducing time spent in small screen recreation on weekends, decreasing sweetened beverage consumption, and increasing fruit consumption and the acquisition and practice of self-regulatory behaviors such as goal setting, time management, and identifying and overcoming barriers. Behavior modification techniques and use of incentives such as small footballs were used throughout the program</p>	<p>No significant effects on all health outcomes measured for both the intervention and the control. Only 50 % of intervention group attended lunchtime PA sessions. Weekday and weekend moderate and vigorous PA had insignificant results (p<0.05)</p> <p>Fresh fruit(p=0.18), BMI-(p=0.50), Body fat (P=0.30), Sugar-sweetened beverage intake (p=0.65), Waist circumference (p=0.27)</p> <p>BW, LM, EE and SC not measured</p>	<p>Social cognitive theory</p>
<p>11. Smith et al., 2014 RCT</p>	<p>Sedentary behavior through avoiding Screen-time, nutrition and physical activity</p> <p>AIM: To evaluate the impact of the Active Teen Leaders Avoiding Screen-time (ATLAS) intervention for adolescent boys, an obesity prevention using smartphone technology.</p>	<p>The Active Teen Leaders Avoiding Screen-time (ATLAS) intervention components involved Teacher professional development, one fitness instructor, Parents’ newsletter distribution, Researcher-led seminars for students, enhanced 90 minutes school sports sessions, lunchtime physical activity mentoring sessions, smartphone app and web site and also use of pedometers</p>	<p>Significant effects recorded for screen-time (p=0.03) and intake of sugar sweetened beverages (p=0.01) but no significant effects on BMI (p=0.84), waist circumference (p=0.16) and body fat (p=0.99).</p> <p>BW, PA, EE and LM not measured</p>	<p>Self-determination theory and social cognitive theory</p>

12. Sutherland et., al 2016 RCT	Physical activity AIM: To report the 12-month mid-point effect of a two-year multi-component physical activity intervention implemented in disadvantaged secondary schools.	The intervention operated under seven PA strategies categorized into Formal Curriculum (i.e., active lessons, Personal PA plans, Enriched sports), School Ethos and Environment (recess and/or lunchtime activities, supportive school PA policy) and Community Links (i.e., linking with parents, linking with the community). Implementation strategies included an in-school physical activity consultant 1 day per week. Trained research assistants blinded to group allocation	Overall, no significant effects on physical activity ($p>0.05$) for both the intervention and control but there were significant differences noted within the intervention group; boys performed better ($p=0.02$) in PA as compared to girls ($p=0.35$) BMI, WC, BW, BF, LM, EE, SC and NT not measured	Social cognitive and Social-ecological theory, Health Promoting Schools Framework
13. Weeks and Beck 2012 RCT	Physical activity-jumping regime AIM: To determine the effect of a twice-weekly, school-based, 10 min jumping regime on muscle and fat tissue in healthy adolescent boys and girls	An instructor coordinated and demonstrated all jumping activities like jumps, hops, tuck-jumps, jump squats, stride jumps, star jumps, lunges and skipping. Participating students had to complete two sessions of 10 minutes jumps (approximately 300 jumps each session) each week. The control group undertook regular PE warm-ups and stretching directed by usual PE teacher, did brisk walking and light jogging for normal PE lessons	No differences recorded for measurements at baseline and at 8 weeks between the intervention and control group. Significant fat loss ($p=0.10$) and significant gain in lean tissue ($p=0.016$) recorded for boys than girls in the intervention group. No significant effects were recorded for BMI ($p=0.810$) and body weight ($p=0.398$) for both of the intervention and control groups. Girls in the control group increased their external physical activity level($p=0.003$), while the intervention group and boys in both groups did not WC, EE, SC and NT not measured	Not sighted

(WC-Waist circumference; BF-Body fat; BW-Body weight; LM-Lean Mass; EE-Energy expenditure; PA-Physical activity; SC screen-time; NT-Nutritional behavior; NS-not significant; S-significant; M-moderate)

*Intervention characteristics included (e.g., location of study, age, sex, duration of study, type of study, intervention components, main objective, obesity-related outcomes (i.e., Body Mass Index (BMI), age and sex standardized Body Mass Index (BMI_z), waist circumference, body weight, body fat, lean mass and energy expenditure), physical activity and nutrition outcomes and behavioral outcomes).

Table 2.3: Quality Appraisal of included studies*

Author & Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total score	% Maximum possible score/ Quality
1. Contardo Ayala et al., 2018	0	3	3	2	2	3	3	2	3	n/a	1	1	n/a	3	3	3	32/42	76% M
2. Dewar et al., 2013	3	3	3	1	1	3	1	2	3	n/a	2	2	n/a	2	3	3	34/42	81% M
3. Hollis et-al., 2016	3	2	2	2	3	3	1	3	3	n/a	1	2	n/a	3	3	3	35/42	83% H
4. Lubans et al., 2016	2	2	2	3	2	3	0	2	1	n/a	1	0	n/a	3	3	3	27/42	70% M
5. Lubans et al., 2011	3	3	3	2	2	2	1	2	2	n/a	2	2	n/a	2	3	3	32/42	76% M
6. Malakellis et al., 2017	2	3	2	2	2	2	0	1	2	n/a	1	2	n/a	3	2	2	24/42	61% M
7. Millar et al., 2011	3	2	3	1	1	3	0	2	2	n/a	1	1	n/a	2	3	3	27/42	64% M
8. Morgan et al., 2012	3	3	2	2	1	2	0	2	2	n/a	2	2	n/a	1	3	3	26/42	62% M
9. Parrish et al., 2018	0	3	2	3	2	2	0	2	1	n/a	1	1	n/a	3	3	3	23/42	55% M
10. Peralta et al., 2009	3	3	2	2	2	2	3	2	1	n/a	1	2	n/a	3	3	3	32/42	76% M
11. Smith et al., 2014	3	2	3	2	2	2	2	3	2	n/a	1	2	n/a	3	3	3	33/42	79% M
12. Sutherland et al., 2016	3	2	3	3	3	0	2	2	0	n/a	1	2	n/a	3	3	3	30/42	71% M
13. Weeks and Beck 2012	0	3	3	3	3	2	0	2	2	n/a	1	1	n/a	1	3	3	27/42	70% M

*QATSDD-QUALITY ASSESSMENT TOOL FOR STUDIES WITH DIVERSE DESIGNS (KEY: 0=NOT AT ALL, 1=VERY SLIGHTLY, 2=MODERATELY, 3=COMPLETE, N/A=NOT APPLICABLE)

2.5 DISCUSSION

This review identified 13 school-based intervention studies which were conducted in Australian high schools. By focusing only on studies investigating school-based interventions and excluding those that combined school-based interventions with home and community-based interventions, we are able to ascertain that the efficacy of interventions was as a result of school-based interventions (Dobbins et al., 2013). Future research studies should consider investigating reasons for minimal to non-participation in other states in school-based intervention toward adolescent obesity.

Overall, of the 13 reviewed studies, five studies (Hollis et al., 2016; Lubans et al., 2011; Malakellis et al., 2017; Millar et al., 2011; Morgan et al., 2012) showed success across all the measured outcomes, four studies (Contardo Ayala et al., 2018; Dewar et al., 2013; Smith et al., 2014) reported significant results on at least one of the measured outcomes while the remaining four studies (Lubans et al., 2016; Parrish et al., 2018; Peralta, 2009; Sutherland et al., 2016) had no significant results across all measured outcomes. The studies that reported successful outcomes combined physical activity and nutrition behaviours and used one or more theoretical frameworks. The findings from this review corroborate some results from previous systematic reviews that analysed the efficacy of obesity interventions. For instance, Chen and Wilkosz (2014) reported that all the successful interventions in their review incorporated both dietary and physical activity strategies as components of the intervention and had alignment with a theory. Another noteworthy finding is that one of the successful studies (Morgan et al., 2012) also incorporated physical activity related psychological outcomes. The findings suggest that incorporating physical activity, dietary components and psychological outcomes such as improvement of personal self-worth and mental health in future interventions could possibly reduce adolescent obesity (Chen & Wilkosz,

2014; Sobol-Goldberg et al., 2013). The success of these interventions could potentially be because intervention schools were given financial support to develop the school environment for the promotion of good nutrition and physical activities (Malakellis et al., 2017). Participation in the interventions was also made free of charge for the participating schools and students (Lubans et al., 2011; Malakellis et al., 2017). Success rates for these interventions can be attributable to initiatives such as due recognition of participants through certificate awards (Lubans et al., 2011; Morgan et al., 2012), new fitness equipment purchased for the schools, vending machines removal and school food and water policy introduction (Millar et al., 2011). These findings highlight the importance of a multi-pronged approach that involves opportunities for students and a supportive ecosystem in combating adolescent obesity problems. All studies underscore the need to identify barriers to the efficacy of school-based obesity prevention interventions and develop targeted strategies to achieve sustainable outcomes.

The non-significant outcomes from the studies (Lubans et al., 2016; Parrish et al., 2018; Peralta, 2009; Sutherland et al., 2016) that did not yield any noteworthy outcomes have been linked to intervention activities being offered during lunch breaks when there are other competing interests for students. One study indicated that only half of the students attended these sessions (Peralta, 2009). However, it is unclear whether the duration of the intervention had any impact on the efficacy of the intervention as the reviewed studies had different outcomes. For example, two studies (Peralta, 2009, Lubans et al., 2011), each with 6 months intervention duration yielded no significant results. Similarly, another two studies (Lubans et al., 2016; Sutherland et al., 2016) lasted for 18 and 24 respectively, with fairly longer durations but still yielded no significant results. However, other interventions in this review had similar durations but yielded significant results (Morgan et al., 2012). The consensus from the studies is that better ways of mobilising students to

take part in physical activities during recess should be employed to reduce physical inactivity. One way to increase physical activity could be through furnishing school ovals and sports halls with fitness equipment for students to use during recess. However, this strategy should be considered in relation to other competing interests.

There was weak evidence for the efficacy of reviewed intervention studies in reducing the prevalence of adolescent obesity based on BMI changes as only a third; 4 out of 12 studies resulted in significant reduction in BMI. These results are consistent with findings from other systematic reviews (Bagherniya et al., 2017; Silveira et al., 2013) where there were no statistically significant changes in BMI for both the intervention and control groups for most of the reviewed studies. Using BMI only as a measure of adiposity may not be accurate because BMI is not a reliable measure of excess body fat but a measure of excess body weight (Jahanlou & Kouzekanani, 2016). Other ways of measuring adiposity should be utilized in further studies for instance measuring fat mass index. A recent study (Green et al., 2018) that used both BMI and fat mass index established that there was no relationship between leaner adolescents' BMI with their fat mass index while a positive association between BMI and fat mass index was established for heavier participants. However, interventions focusing only on overweight or obese adolescents may appear discriminatory and obtain limited success as Chen and Wilkosz (2014) concluded that a non-discriminatory approach in interventions is more likely to yield success as participants would not feel discriminated against in an inclusive environment. Measuring adiposity using dual energy absorptiometry (DEXA) is costly, other measures like using BMI and weight to height ratio has been found in one study (Martin-Calvo et al., 2016) to be strongly correlated to body fat measured by DEXA. Future interventions should therefore use a combination of BMI and weight to height ratio since these measures are easy to use and affordable.

With regards to physical activity, one study (Hollis et al., 2016) in this review provided strong evidence that incorporation of physical activity alone as an intervention has the potential to significantly reduce obesity (Shaya et al., 2008). The study also utilised three theoretical frameworks (Social Cognitive theory, Socio-ecological theory, and the Health Promoting Schools framework) in the development of the intervention - a possible reason why the intervention yielded positive results. The review findings confirm that the current status of physical activity among Australian adolescents is below national standards (Schranz et al., 2018; Schranz et al., 2016). The high prevalence of physical inactivity needs to be addressed in every state and territory through development and evaluation of physical activity policies, especially in Queensland and South Australia where a recent study (Stylianou & Walker, 2018) could not publicly identify these policies. It is generally agreed that physical activity plays a significant role in reducing obesity and maintenance of a healthy weight (Bagherniya et al., 2017; Lavelle et al., 2012). The findings of this review are crucial for policy makers, school leaders and the government to strive to reduce the prevalence of physical inactivity among Australian adolescents which has recently been escalated by the Covid-19 pandemic (Xiang et al., 2020).

A quarter of the studies (Lubans et al., 2011; Smith et al., 2014) that measured the level of consumption of sugar-sweetened beverages, fresh fruit and vegetables yielded significant results providing weak evidence for this type of intervention. These findings are partially consistent with a study (Meiklejohn et al., 2016) that systematically assessed the impact of multi-strategy nutrition education programs on health and nutrition of adolescents. For instance, Meiklejohn et al. (2016) found significant dietary changes in the consumption of fresh fruit, vegetables, and fat but not in sugar-sweetened beverage consumption. A possible explanation for the high consumption of unhealthy food by adolescents could be the choice of unhealthy fatty and sugary food available at

the school tuckshop and lack of role models (Woods et al., 2014). More intervention studies on nutrition behaviours are needed while schools and state governments need to promote healthy eating within the school environment.

Some of the reviewed studies involved teacher facilitation of nutrition programs, staff presence and changes in the food environment ensured but minimal changes were seen. This weak link between teacher involvement and modification of the food environment during the intervention is consistent with findings from past studies. For instance, a systematic review (Godin et al., 2015) also found that the seven programs reviewed demonstrated limited success in improving students eating behaviours. Another similarity between this study's findings and Godin et al. (2015) is that the knowledge about healthy eating significantly increased albeit with minimal impact on the actual eating behaviours of participants. The findings of this review also suggest that there is a decline in healthy food choices by adolescents despite the knowledge gained on healthy eating. Possible reasons for minimal success of the intervention in yielding desirable results could be because of the disconnect between student dietary choices at school and dietary habits after school hours. This pattern warrants a more in-depth understanding of the dynamics of promoting healthy eating to ensure consistency in eating habits both at school and at home at this critical stage of development. A further exploration of teacher perspectives on the enablers and barriers to implementing intervention programs in school is recommended for future studies. More importantly, due to the many health implications associated with obesity, it is expedient to target preventive measures rather than focusing on reducing overweight and obesity rates.

2.5.1 Study strengths and limitations

To the best of the researcher's knowledge, this is the first review paper that focuses on the efficacy of Australian school-based interventions targeted at adolescent obesity. The findings of this study provide a roadmap to possible adjustments that may facilitate effective adolescent obesity interventions and directions for future research. Additionally, the reviewed studies were RCTs and quasi-experimental research designs and they were judged to be appropriate because they provide a high level of reliable evidence. Nonetheless, the findings of this study are limited by the inclusion and exclusion criteria. Some obesity intervention programs targeting adolescents were excluded because they were not implemented in a school setting. The study was also limited to an Australian context. However, the majority of studies were from NSW, and so it is conspicuous that there is a paucity of data from other states and territories—for example, only one study from QLD. It is uncertain whether study findings can be generalizable across Australia especially in low socio-economic geographical settings. In addition, the variability in the interventions implemented and outcomes measured, as stated earlier, prevented a meta-analysis of the findings. Finally, by limiting included articles to those published in peer-reviewed journals, we may have missed other high-quality studies that are published in non-peer-reviewed journals.

2.6 Conclusion

Interventions combining physical activity and dietary outcomes or physical activity with incorporated theoretical framework in the intervention design are much more promising. It is not clear if intervention duration has any impact on the efficacy of interventions. Additionally, research on intervention studies, perceptions of school stakeholders on adolescent obesity interventions and, hindrances and enablers to implementation of intervention across other states and territories other than NSW is needed to combat the adolescent obesity epidemic and achieve

sustainable long-term impacts. A stronger voice from political leaders and the mass media is crucial in lowering the prevalence of adolescent obesity post Covid-19 restrictions.

The findings of the systematic review indicated the need to further explore the state of adolescent obesity strategies in schools. In the following chapter 3 the remaining 4 questions of this study are going to be addressed by looking at the perceived strategies for the prevention of adolescent obesity.

Chapter 3: Australian School Stakeholders' Perceived Strategies for Preventing Adolescent obesity in Schools

3.1 Chapter Overview

Abstract: Adolescent obesity is a complex multifactorial disease with a combination of environmental, behavioral, psychosocial, biological, cultural and genetic determinants. It remains a global public health issue that presents a major challenge to chronic disease prevention and health into adulthood. Schools have a rich opportunity to improve youth health and tackle obesity, yet they face barriers in fulfilling this function. This study investigated school stakeholders' beliefs and perceptions of the barriers and enablers currently experienced by schools, as well as their recommendations towards preventing adolescent obesity. A sequential explanatory mixed-methods study design was utilised with surveys administered for the quantitative phase and individual interviews for the qualitative phase. Descriptive statistics and inductive thematic analyses were utilised for the survey and interview data, respectively. Triangulation of findings from the quantitative and qualitative phases aided in the better understanding and integration of the overall results. In total, 60 school stakeholders (52 subject teachers, 3 senior teachers and 5 heads of department) from both independent and public high schools in Queensland, Australia responded to the survey, while 14 respondents participated in the interviews. The main perceived causes of obesity were poor eating habits and sedentary lifestyle. Highlighted barriers were busy timetables, shortage of trained staff and funding, lack of robustness in the introduction and implementation of school interventions and insufficient motivation of learners to participate in obesity prevention programs. Enabling factors included parental support, easy access to fitness equipment during recess, supportive government policies, provision of healthier school tuck shop

menu options and elimination of sugary drinks from vending machines. A model for the prevention of adolescent obesity was developed based on participants' perceptions. Tripartite collaboration between the school, government and parents was perceived as fundamental to preventing adolescent obesity. Strategies targeting nutrition, physical activity and overall health, including parental education on health, formal health talks in schools by health professionals and better-targeted advertisement encouraging healthy lifestyle choices, were identified as essential for improved adolescent health outcomes.

3.2 Introduction

Obesity is one of the leading risk factors for global mortality and the exponential increase in the prevalence of obesity among children and adolescents has been projected to reach 91 million by 2025 (Lobstein & Jackson-Leach, 2016). Published literature indicates that adolescents with obesity have higher chances of progressing to persistent obesity in adulthood. Wadman et al (2020) reported that in the USA, 77% of patients hospitalized due to COVID-19 complications had conditions attributable to overweight and obesity. This implies that obesity is both a major risk factor that may be linked to other physical health conditions (such as diabetes and heart diseases) and a potential effect of lockdown (Katsoulis et al., 2021). In Australia, one in every four adolescents is overweight (Health & Welfare, 2019), making Australia one of the top 10 countries with the highest proportion of adolescents with obesity (Abarca-Gómez et al., 2017). The prevalence of obesity may even be higher in recent times due to inactivity among adolescents worldwide, resulting from COVID-19 restrictions (Xiang et al., 2020), a condition now referred to as 'Covibesity' (Khan et al., 2020). It is therefore paramount to focus on actions that could possibly prevent and reduce the prevalence of obesity in adolescents (Bhaskaran, et al., 2014; Hoare et al., 2016; Daniels, 2009).

Obesity is associated with increased energy intake and decreased energy expenditure (Daniels, 2009). It is a multifaceted chronic condition with several contributing factors, including medical illnesses, biological risk factors, genetic disorders, eating disorders (Daniels, 2009; Ruiz et al., 2019), health literacy, cultural background, socioeconomic status (SES) and numerous environmental influences (Fock & Khoo, 2013; McLaren et al., 2007). Adolescent obesity increases the risk of chronic disease development into and throughout adulthood (Raj, 2012). Obesity in adolescents impacts all major organ systems and often contributes to morbidity (Skinner et al., 2015; Liu et al., 2016). Obesity prevalence in adolescents is also exacerbated by differences in ethnic and genetic backgrounds, which affect body composition and fat distribution (Fernández et al., 2004) and cultural body image standards (Kronenfeld et al., 2010).

The current social climate, particularly within high-income countries, with emphasis placed on health messaging and weight loss within society, creates a stressful state for adolescents with obesity due to weight stigma (Tomiyama et al., 2018; Tomiyama et al., 2019). Adolescents who experience stress related to social ostracization are more likely to rely on food-related coping mechanisms (Marco et al., 2018). For example, adolescents with obesity may experience teasing and bullying, which can lead to isolation and inability to make friends (Gray et al., 2009). Isolation can negatively affect the mental well-being of adolescents due to deprivation of social interaction needed at this stage of development (Orben et al., 2020). The interplay between obesity and psychosocial health may lead to increased levels of stress, depressive symptoms and reduced resilience (Ruiz et al., 2019; Orben et al., 2020). This is further confounded with SES, which is one of the most potent indicators of overall health (McLaren et al., 2007; Braveman et al., 2010). Youths from low socio-economic backgrounds tend to have higher rates of obesity compared to other groups (McLaren et al., 2007).

The school is perceived to be at a vantage point in the prevention of adolescent obesity because it provides an opportunity for longer contact hours during school days for successful implementation of interventions (Al-Mutairi et al., 2015; Clarke et al., 2013; Story, 1999). It is therefore important to consider maximizing the use of school environments in preventing adolescent obesity. The school environment can promote physical activity and healthy eating (Daniels, 2009) and has been described as the perfect nexus for teachers, parents and other stakeholders to modify and implement lifestyle, behavioural and nutritional interventions to impede the increase of childhood and adolescent obesity (Ruiz et al., 2019; Lambrinou et al. 2020). Lambrinou et al. (2020) provided a detailed review of effective strategies for obesity prevention via school-based, family-involved interventions and the advantages of the school environment. Nonetheless, research findings indicate that despite the advantages associated with the school environment, the benefits of school-based interventions are questionable and generalized recommendations are difficult to extract and extrapolate (Story et al., 2009; Ogden et al., 2010; Kohl et al., 2013). Studies have mostly focused on stakeholder views on the primary school role in preventing obesity (Clarke et al., 2013; Howard-Drake & Halliday, 2016). Within the Australian context, school-based prevention programs are not widely implemented in high schools (Schranz et al., 2018). A recent review reported weak evidence for the efficacy of the interventions and programs identified in Australian high schools, particularly because of the weak link between teacher involvement and modification of the food environment during the interventions (Buru et al., 2020). Additionally, most of the Australian adolescent obesity research emanated from the State of New South Wales and no studies were nationwide (Buru et al., 2020). It is therefore important to reassess the role of the school in the prevention of adolescent obesity. More importantly, due to the many health implications associated with obesity, it is expedient to target preventive measures rather than a

cure. Exploration of school stakeholders' opinions about current priorities, barriers and enabling factors would be beneficial in the global effort to prevent adolescent obesity. Additionally, recommendations from school stakeholders are key to future planning and implementation of effective policies and intervention programs (Story et al., 2009). This study therefore sought to investigate Queensland, Australia school stakeholders' beliefs and perceptions of the barriers and enablers currently experienced by schools and their recommendations for preventing adolescent obesity. The study also aimed to develop a reliable adolescent obesity prevention model based on the findings.

3.3 Materials and Methods

Ethics approval (Approval number: H7966) for this study was obtained from the James Cook University's Human Research Ethics Committee (HREC).

3.3.1 Study design

A sequential explanatory mixed methods study design was utilised. This design employs a methodical integration of quantitative and qualitative research approaches within a single study to offer detailed explanation of results (O'Leary, 2014). Findings from the quantitative phase comprising online surveys aided the development of the interview questions for the qualitative phase (Tashakkori & Newman, 2010). The inherent weaknesses due to bias in both quantitative and qualitative approaches were addressed by triangulating findings from both phases to uncover the best possible explanations for the observed phenomenon (O'Leary, 2014).

3.3.2 Quantitative Phase

For the quantitative phase, data were obtained from responses to online survey questions on the perceptions and beliefs of school stakeholders from Queensland Education towards the prevention of adolescent obesity.

3.3.2.1 Participants

Study participants included school stakeholders (teachers and senior administrators) from both independent and public certified employees of Queensland Education. Primary school stakeholders were excluded from participation. Information about the study was communicated through paid adverts to different school stakeholder online networks/groups via social media platforms including Facebook, WhatsApp and LinkedIn. Prospective participants were provided with a link to the survey. Snowballing (Noy, 2008) and follow-up phone calls were made to those who indicated interest in the study to maximize participation. The survey was administered electronically to participants via Qualtrics XM, Utah, United States. An information sheet that stated the purpose and confidentiality protocols for the study was provided to prospective participants on the first page of the online survey and informed consent was obtained prior to completion of the survey.

3.3.2.2 Data Collection Instrument

A questionnaire comprising closed and open-ended questions was used (Appendix B). The survey questions were categorized into six (6) sections that examined participants' background information, their beliefs, attitudes and perceptions about available anti-obesity policies as well as the barriers and enablers of school-based prevention programs. The survey questions were adapted from two previous studies (Kenney et al., 2017; Price et al., 1990). The questions on beliefs,

attitudes and perceptions about obesity were adapted from the study by Price et al. (1990), and the questions on anti-obesity policies and school-based prevention programs were adapted from the study by Kennedy et al. (2017). The survey instrument was pilot tested and there was no need to revise any of the questions after the pilot testing. The last question in the survey was used to identify those who had interest in participating in the follow-up individual interviews. However, the quantitative findings and the participants' demographic details were utilised in purposively selecting the interview participants to ensure involvement of all participant groups until data saturation was reached (Creswell & Clark, 2017).

3.3.2.3 Data Analysis

Quantitative data were analysed using SPSS version 27. Descriptive statistics in the form of frequencies and percentages were used to identify most occurring perceptions, beliefs and attitudes, barriers and enablers, types of policies and prevention programs used in schools.

3.3.3 Qualitative Phase

3.3.3.1 Data Collection

Responses from the quantitative phase were used to guide the development of semi structured open-ended interview questions for the qualitative phase. The interviews were conducted using Zoom cloud meeting between December 2020 and February 2021. Each interview session lasted approximately 30–60 min. Interviews were recorded and transcribed for textual analysis. This phase of the study was intended to foster in-depth understanding of the participants' perceptions on the main enablers and barriers to prevention of adolescent obesity, and recommendations on what they perceive would work best within their context in the prevention of adolescent obesity. The semi-structured interview guide used for this phase of the study is provided in Appendix C.

3.3.3.2 Data Analysis

The qualitative data was analysed using NVivo 12 plus, guided by inductive thematic analysis approach (Yin, 2009). Coding and analysis of interview data was performed at two levels: within each case and across the cases (Yin, 2009). The different participant stories were considered as cases in order to better understand the contextual differences between participant groups (Ayres et al., 2003). Analysis of the interview transcripts included multiple readings to aid the identification of major emerging themes (Fereday & Muir-Cochrane, 2006). Transcripts were explored for meanings in participants' words and language. During the iterative coding stage, transcripts were independently examined by two researchers (KB and BMA) for patterns of similarities and divergence to establish themes. Identified themes as well as patterns of similarity were discussed and confirmed, with discrepancies resolved in a consensus meeting. Trustworthiness and credibility of findings were established through member checking, and cross matching of emerging themes by the researchers (Creswell & Clark, 2017). Verbatim quotations are presented for illustration of the emerging themes.

3.4 Results

3.4.1 Quantitative Phase

Overall, 90 school stakeholders consented to participate in this phase of the study. However, only 60 of them completed the online survey, with a 67% response rate. Table 3.1 presents the profile of the survey respondents. There were 60 participants, and 47 (78%) of them were females. Respondents' roles were heads of department (5, 8%), senior teachers (3, 5%) and subject teachers (52, 87%). Most respondents were from public schools (70%), worked full-time (67%) and had a Bachelor's degree (63%), while 32% had a Master's degree or higher.

Table 3.1: Demographic profile of participants for the quantitative phase of the study (n = 60).

		Frequency	Percent (%)
Gender	Male	13	22
	Female	47	78
Role	Head of Department	5	8
	Senior Teacher	3	5
	Teacher	52	87
Education	Bachelor's degree	38	63
	Master's degree	15	25
	Doctorate degree	4	7
	Technical college	2	3
	Associate degree	1	2
Employment	Full-time	40	67
	Permanent part-time	14	23
	Contract	4	7
	Daily relief/supply	2	3
Motivation for physical activity	Strongly motivated	10	17
	Motivated	27	45
	Slightly motivated	17	28
	Not motivated	6	10
Physical activity engagement	Occasionally	12	20
	Once a week	6	10
	Twice a week	12	20
	3-4 times a week	21	35
	Daily	9	15

3.4.1.1 Participants' Perception of obesity

Table 3.2 portrays participants' top three agreement responses and the least agreed response in relation to their perceptions and beliefs about the causes, enabling and hindering factors of adolescent obesity and the health priorities considered in their schools. Majority (98%) of the participants reported poor eating behaviour as the major cause of adolescent obesity, followed by sedentary lifestyle and excessive calorie consumption (93%). Peer pressure was rated as the least likely (39%) possible cause of adolescent obesity.

3.4.1.2 Participants' beliefs

Most participants (87%) believed that adolescent obesity is becoming more prevalent and that having a healthy weight is very important for adolescents. About two-thirds (68%) of the participants believed that adolescent obesity is a significant cause of peer rejection, and only 3% believed that only youths who are likely to succeed in a weight loss program should be part of a treatment plan (see Table 3.2).

3.4.1.3 Perceived Enabling factors in adolescent obesity prevention

When asked what they thought could be enabling factors for schools in supporting the prevention of adolescent obesity, 86% of the participants indicated parental support, regular evaluation of available intervention programs and elimination of 'junk' food machines. Availability of special low-calorie healthy lunches during lunch hour was also considered a key factor for preventing adolescent obesity by 86% of the participants. Supportive government policies and ease of access to fitness equipment during recess were also perceived (by 78% of the respondents) to be enabling factors. Two thirds of the participants (65%) felt that community involvement could also help in enabling the school to prevent adolescent obesity (Table 3.2).

3.4.1.4 Perceived Barriers to adolescent obesity prevention

The majority of the participants (82%) felt that busy school timetable was the main barrier to adolescent obesity prevention, followed by shortage of trained staff and insufficient funding (78%), the absence of thoroughly implemented intervention plans (75%) and insufficient motivation of learners to participate in obesity prevention programs (70%). Only 32% perceived short school day as a barrier (see Table 3.2).

3.4.1.5 Health priorities in schools

The study findings in Table 3.2 show that emotional and mental health were the main health priorities of the school as indicated by 90% of the participants, followed by relational and social skills (48.3%). Two-fifths of the participants (40%) reported physical fitness as a priority and only one participant indicated that tobacco use was the main health focus at their school.

Table 3.3 presents the interventions and strategies currently used by schools for physical health and wellness. The predominant (78%) strategy used was health and physical education (HPE), 45% of the participants indicated that there were other forms of physical activity programs offered besides HPE. Nutrition education and promotion was reported by 35% of the participants as a strategy used by their school. Nutrition standards for meals (12%) and BMI tracking/reporting (2%) seemed to be unpopular strategies in schools.

Table 3.2: Queensland school stakeholders’ perceptions and beliefs of the causes, enabling and hindering factors of adolescent obesity (n = 60).

Construct	Top 3 and 1 least agreement response	Frequency	Percent (%)
Causes of adolescent obesity	Poor eating behaviors	59	98
	Sedentary lifestyle	56	93
	Excess calorie consumption	55	93
	Peer pressure	23	39
Stakeholder beliefs of adolescent obesity	Youth obesity is becoming more prevalent	52	87
	Being a normal weight is very important to health of youth	52	87
	Youth obesity is a significant cause of peer rejection	41	68
	Only youth who are likely to succeed in a weight loss program should be part of a treatment	2	3
Enabling factors for preventing adolescent obesity in schools	Parental support	51	86
	Regular evaluation of interventions in place	51	86
	Elimination of ‘junk’ food machines	51	86
	Special low-calorie healthy lunches should be available during lunch hour	50	86
	Easily accessible fitness equipment during recess	47	78
	Supportive government	47	78
	Community involvement	39	65
Barriers to preventing adolescent obesity in schools	Busy timetable	49	82
	Shortage of trained staff	47	78
	Insufficient program funding		
	The intervention programs are not formally introduced nor thoroughly implemented	45	75
	Insufficient motivation of learners to participate in obesity prevention programs	42	70
	Short school day	19	32
Health priorities in schools	Emotional and mental health	54	90
	Relational and social skills	29	48
	Physical fitness	24	40
	Tobacco use	1	0.02

Table 3.3: Interventions and strategies currently used in Queensland schools for physical health and wellness as reported by school stakeholders.

Currently offered school-based interventions	Number of Responses	Percentage (%)
Health and Physical Education (HPE)	47	78
Physical activity outside of Health and Physical education (HPE)	27	45
Nutrition education and promotion	21	35
School garden	15	25
Nutrition standards for school meals	7	12
BMI tracking and reporting	1	2
Others	2	3

3.4.2 Qualitative Phase

As shown in Table 3.4, 14 school stakeholders, who were predominantly females (n=11) and between the ages of 25 and 60 years participated in the interviews. Eight (n=8) of the participants were teachers in public state high schools, while 6 were from independent high schools. The participants had predominantly teaching roles, all of them had a first degree and had between 3-50 years of teaching experience.

Thematic analysis of the interview data presented three emergent themes namely: barriers schools encounter in the prevention of obesity; need for stakeholder collaborations and enabling strategies to improve outcomes. These three major themes are described below and presented with verbatim illustrative quotes, each quote is depicted using participant's name and school type (PS = public school and IS = independent school). The study findings were used to develop a model for the prevention of adolescent obesity (see Figure 3.1)

Table 3.4: Demographic profile of participants for the qualitative phase of the study (n = 14)

Participant name* and number	Gender	Age Range	Qualification	Role	Teaching Experience (years)	Type of High School
1. Angelica	Female	40-45	MS, First Degree	Subject Coordinator, Teacher	10	Public
2. Carol	Female	40-45	First Degree	Teacher	19	Public
3. Chantelle	Female	35-40	First Degree	Teacher	3	Independent
4. Hebron	Male	45-50	First Degree	Teacher	25	Independent
5. Janelle	Female	25-35	MS, First Degree, Grad Cert	Teacher	3	Independent
6. Jesse	Male	35-40	PhD, First Degree, Post Grad Dip	Teacher	3	Independent
7. Jessica	Female	60-75	First Degree	Teacher	50	Public
8. Raphael	Male	55-60	First Degree	Teacher	12	Public
9. Rebecca	Female	35-40	First Degree	Teacher	3	Public
10. Ruth	Female	55-60	MS, First Degree	Teacher	19	Independent
11. Sage	Female	45-50	MS, First Degree	Teacher	13	Public
12. Samantha	Female	45-50	First Degree	Teacher	33	Public
13. Sonia	Female	35-40	MS, First Degree	Teacher	14	Independent
14. Vanya	Female	45-50	First Degree	Teacher	15	Public

*Pseudonyms

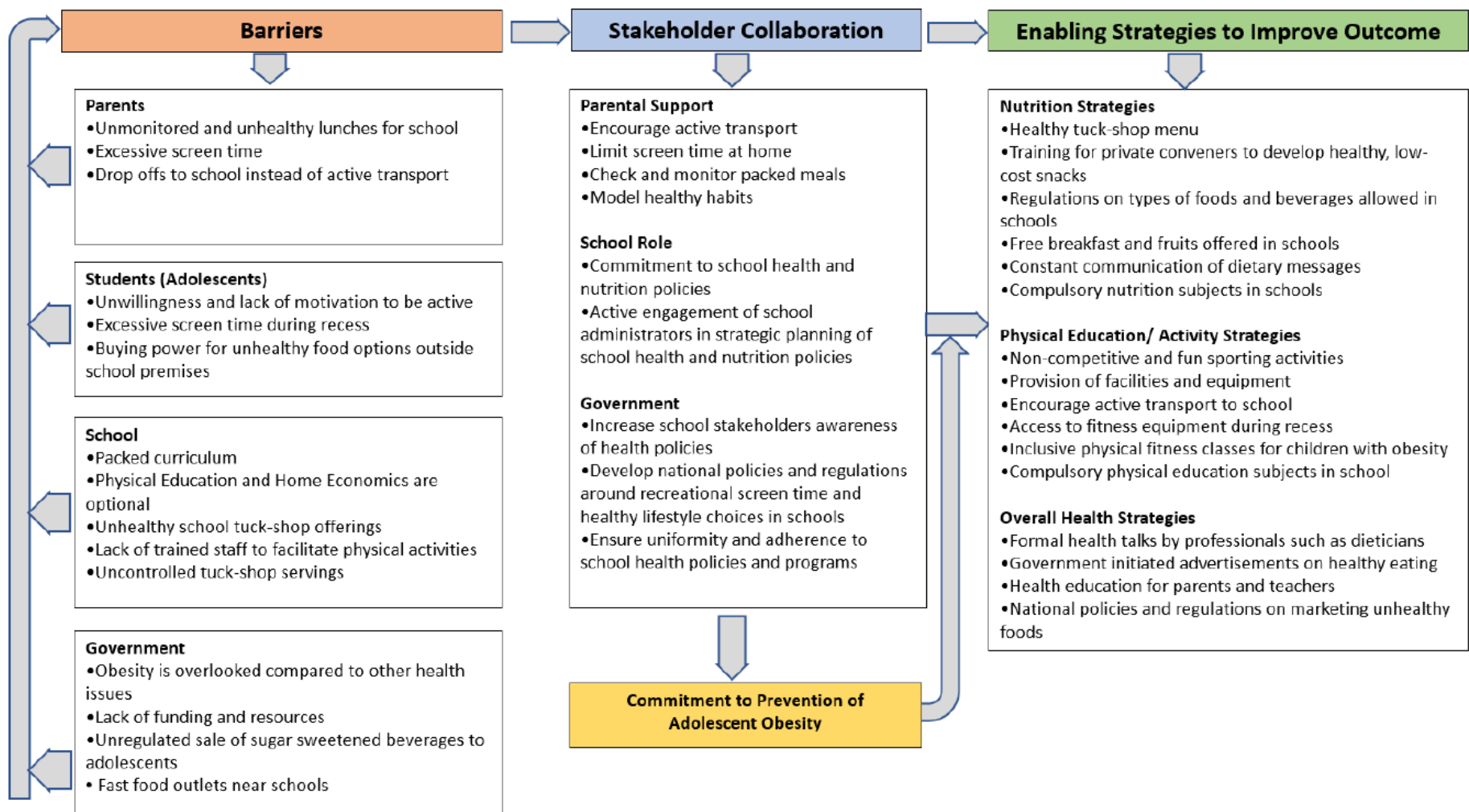


Figure 3.1: Model for the prevention of adolescent obesity representative of Queensland school stakeholders' perceptions.

3.4.2.1 Barriers schools encounter in the prevention of obesity

As portrayed in Figure 1, participants indicated that prevention of adolescent obesity is usually hindered by four (4) major stakeholder groups, namely: parents, students, the school and the government.

3.4.2.1.1 Barriers associated with parents

Participants felt some parents encouraged their children and wards to engage in unhealthy eating habits and lifestyle. Parents were considered too busy to prepare and pack healthy lunches for their teenage children. Participants also reported that adolescents indulge in excessive screen time more at home, where they are usually unmonitored by parents.

'If parents habitually indulge in junk food, children are going to mimic that, and they are going to think it's fine and the pattern will be hard to remedy in later life.' Ruth, IS

'Ideally parents should have a great contribution because they are the ones who buy the food for the household, which the students are eating two-thirds of the time, with only one main meal a day at school. But a couple of things come into play, a lot of parents are time poor. I think it's much more a thing that parents prepare lunchboxes for little ones, but once they [kids] get to high school, it stops.' Jessica, PS

'I think that unmonitored screen time mostly is even more rampant at home than at school, because you know these kids sit down and play video games and go on social media or whatever it is [called].' Jesse, IS

3.4.2.1.2 Barriers associated with students

Students' unwillingness and lack of motivation to be active, especially if they are overweight, were seen as major obstacles. Students were also reported to spend enormous amount of time on electronic devices during recess instead of engaging in physical activities.

'Students shy away from activities like swimming because they feel ashamed of being seen in swimmers if they are overweight or obese', Sonia, IS

'During the breaks you find every child looking at a screen, whether sitting in a group or alone [when] they could spend more time talking and engaging in other activities', Raphael, PS

'There's not much that would make the children think it's worth their while to participate unless they really enjoyed healthy eating or they enjoyed physical activity, before they came to the school', Janelle, IS.

The participants also felt that adolescents often had part-time jobs that gave them access to pocket money, which gave them 'buying power' to engage in unhealthy food choices as observed in the foods they ordered from the canteen or the lunches from home.

'In the school canteen, students pass through a line and there's a section of cold food, [another] section of hot food, and they get given whatever they want, so students could choose six pieces of pizza, if they wanted to and get handed that with no problem [monitoring]' Angelica, PS

'Quite often the kids have part time jobs, or they've got pocket money, and they can buy whatever they choose to.' Jessica, PS

'We can't really control the food that they bring in, or what they choose to eat, or the choices they make once they leave the school grounds, either.' Janelle, IS

3.4.2.1.3 Barriers associated with the school

A major school level barrier identified was busy or 'crowded curriculum' which makes it challenging to offer physical activities regularly.

'Doing those kinds of activities with students outside the curriculum is a challenge because the curriculum is too saturated already.' Sonia, PS

'The push in the curriculum to do this and this and this and this, in addition to the core subjects. And so, those blocks of time that used to be for physical education or Wednesday afternoon sports for 70 minutes have been eroded.' Jessica PS

Schools' close proximity to fast food outlets was another identified barrier. Unhealthy school tuck shop menu where serves and portions are not controlled for students was also seen as a major drawback, particularly in public schools. To help students make better food choices, participants felt subjects like Home Economics and HPE could be made compulsory.

'Even if the school only provides healthy options, some of them [students] will sneak down to the service station and get soft drink and stuff like that or bring it from home.' Jessica, PS

'The number of healthy items they sell at the school tuck shop is quite low in comparison to the number of unhealthy items.' Angelica, PS

'I know there's government policies that they've implemented as to what tuck shop sells but I'm not aware of the specific rules.' Samantha, PS

'Home Economics, HPE and food and nutrition subjects should be made compulsory subjects in school from grade seven to grade 12.' Sage, PS

Lack of trained staff to facilitate physical activities was also identified as a barrier, especially in public schools. Interestingly, most of the participants indicated that there were inconsistencies across Queensland schools, and they were unaware of available national policies on prevention of adolescent obesity in schools.

'I took my Year 7s down to the oval for HPE and that was really awful. I said I wouldn't take them again because I had kids rolling around the hill and then somebody got kicked and started crying, and then somebody else got pushed over and started crying. And I didn't really have the experience to manage that situation very well so we're not going down to the oval again.' Rebecca, PS

'In Queensland it's up to the individual school, except if there is a system I am not aware of. I wouldn't say that if we're following clear intervention policies that I have been made aware of them', Janelle, IS

3.4.2.1.4 Barriers associated with the government

The major barrier identified at this level was laxity on the part of the government in implementing policies that help curb adolescent obesity.

'We still see a lot of food that are being sold that are not very healthy in the tuck shops so we need stricter guidelines and policies from the government and making sure that all schools, not just some schools, all schools [adhere] to the policies where they don't sell unhealthy foods in the tuck shop. They [government] also make home economics policy where all students learn about nutrition and about healthy eating habits.' Sonia, IS

Participants felt that the lack of funding and resources, particularly in public schools, make it challenging to run activities for the prevention of adolescent obesity compared to other health issues like mental health.

'I think particularly public schools, which is where I've had most of my experience, are trying to do the best we can with very limited funding. I think we're trying but there's definitely work still to be done and there's only so much you can do without additional resources to help.' Janelle, IS

3.4.2.2 Stakeholder Collaboration

Participants indicated that stakeholder collaboration between the school, the government and the parents is needed, stressing that it is not the sole responsibility of the school to facilitate the prevention of adolescent obesity.

3.4.2.2.1 Parental support

Participants indicated that parents, as a stakeholder group, could encourage active transport to school and sign up their children for sporting activities at school. Responses also pointed to limiting screen time at home, checking and monitoring packed meals for school lunches. Educating parents to model healthy habits was emphasized as a way of ensuring that children do not mimic unhealthy habits.

'Parents can also show support by making sure their children play school sports or signing them up to a sporting club as well.' Vanya, PS

'I think parental support is very important, because formative years of a child begins at home; particularly limiting screen time, nutrition, what they eat.' Raphael, PS

'Parental role in educating and modelling good eating habit is vital in encouraging a healthy lifestyle for their children, and other aspects such as their diet, to support prevention of adolescent obesity.' Jesse, IS

3.4.2.2.2 School role

Participants indicated that the school could play a more active role in this collaboration by ensuring that there is whole of organization commitment to health and nutrition policies and programs, participation in strategic planning and decision-making to advance the prevention of adolescent obesity. Participants expressed the need for the school to educate and empower parents to make better lifestyle choices for themselves and their children.

'But what we really need to be doing as a school is giving education and empowering parents to make better choices and backing them up on those choices.' Angelica, PS

'I think educating parents can be very helpful. You know, like we get news items going up from school and things of concern. It goes to all parents, so they don't feel like they are being targeted or victimized or in any way ostracized.' Raphael, PS

They also emphasized the importance of educating students and promoting compulsory sporting/physical activities in all schools.

'In terms of promoting physical activity, some schools I've been at in the past have made sports compulsory. At my current school, the kids didn't do sports for the past year 10. So, I had to do PE [with the students] at lunchtime.' Sage, PS

'Wherever possible in our syllabus and curriculum if you can talk about that. That's helpful as well. I mean I had the opportunity to do that when I taught HPE. So, I used that as a platform to talk about the importance of a good diet.' Raphael, PS

'Participation is not that optional. Everyone is supposed to participate in extracurricular activities.' Hebron, IS

3.4.2.2.3 Government role

Participants indicated that the government could enact policies that ensure uniformity in educational programs and policies across schools and implement phone usage policy to regulate recreational screen time in schools.

'The government is the one that streamlines the curriculum, and provides funding for schools, obviously, the government can play a good role to support schools', Jesse, IS.

'The government should come up with strict policy on what the Tuck Shop can sell and what they can't.' Sonia, IS

'To address screen time, I think there should be more firm rules around that. My opinion is that the phones should be banned for the entire day at school unless emergencies, but I know there's a lot of debate in the education community about that.' Janelle, IS

Participants pointed out that the government should reintroduce programs like 'Smart Moves', which actually helped to promote and enforce physical activity programs, as well as acceptable food policies that clearly state what types of food and drinks are allowed or prohibited in schools. Participants also felt that the government could enforce media advertisement of healthy food instead of junk food and subsidize or give free vouchers for sporting activities to make them affordable for young adults.

'The government could reintroduce Smart Moves, which actually helped to promote physical activities like doing sports and exercise.' Sage, PS

'I think a lot of that is dictated by government regulations. I remember a few years ago they categorized food into red and yellow and green. I think those colour codes meant red was the junk food and you could have the occasional red day, and green was healthy foods. Yellow was not as healthy as green but not as bad as the red, and I think you're allowed to sell a certain amount of red, but not a lot. And you could have the occasional red day where there would be more junk food available. I'm not sure if it's followed in this school but I'm pretty sure that there has to be regulations they follow as to what they sell at the school, as well as for prevention of obesity.' Samantha, PS *'The government can pay the media to advertise healthy food instead of junk food.'* Ruth, IS

3.4.2.3 Enabling Strategies to Improve Health Outcomes

Participants in this study recommended standardized implementation of enabling strategies. Major areas of focus included nutrition, physical education activities and overall health and well-being.

3.4.2.3.1 Nutrition strategies

The nutrition strategies predominantly related to tuck shop menu. Participants suggested a move towards national implementation of food and beverage policy within schools to monitor types of food and drinks students can/cannot bring to school. Other nutrition-related strategies to improve outcome included the provision of free fruits and breakfast to students, compulsory nutrition subjects and constant communication of dietary messages within schools.

'The school administration should look into what food options are healthy for the tuck shop.' Hebron, IS

3.4.2.3.2 Physical Education/Activity strategies

Participants recommended social, enjoyable and non-competitive sporting activities to improve outcomes in adolescent obesity prevention. Government funding and provision of accessible fitness equipment/facilities would also improve outcomes.

'I think social sport, that's compulsory and all it's there for all levels, not necessarily competitive sport but more like social sport would be great.' Chantelle, IS

'Students have to choose across the four terms at least something to do with physical activity, but that's not the system at the moment as students just get to choose whatever they want to', Angelica, PS

3.4.2.3.3 Overall Health and well-being strategies

Participants pointed out that formal health talks 'with health experts like dietitians and nutritionists can be organized to educate students and their parents about healthy lifestyle. Another strategy identified was targeted government-sponsored advertisements on healthy eating.

'I think definitely speaking about these things and holding sessions where health experts like dietitians and nutritionists can come in and educate the students,' Ruth, IS

'I think government plays a part in making sure that advertising continues to happen regarding what a healthy diet looks like, and how much physical activity people should be getting.' Vanya, PS

3.4.3 Triangulation/ Integration of findings

Table 3.5 portrays a summary of the integrated findings and representative participant quotes. The findings from the quantitative phase are compared with the findings from the qualitative phase of the study to provide a clearer understanding of participants’ responses.

Table 3.5: Triangulation of findings from both the quantitative and qualitative phases of the study.

Stakeholder levels	Main themes	Quantitative findings	Qualitative findings	Synthesis of findings
Parents	Barriers	Poor eating behaviours indicated by 98% participant as a hindrance to preventing adolescent obesity	<p>Tendency of ‘decreased supervision’ on adolescents by parents on what they're doing’ was viewed as a barrier due to no control over ‘choices that they eat.’ (Janelle, IS) and poor modelling as ‘parents habitually indulge in junk food’ which children could ‘mimic then find it hard to remedy in later life’, (Ruth, IS.) were perceived as barriers.</p> <p><i>‘I know with adolescence comes I guess, decreased supervision on what they're doing and that could potentially impact on the choices that they eat.’ Janelle, PS</i></p> <p><i>‘Parental support is important because if parents habitually indulge in junk food, children are going to mimic that, and they are going to think it's fine and the pattern will be hard to remedy in later life.’, Ruth, IS.</i></p>	This implies that if there is laxity by parents in supervising and modelling healthy dietary lifestyles this can encourage poor eating habits among adolescents.
		Sedentary lifestyle indicated as a major barrier by 93% of the participants.	<p>Participants think sedentary activities among students like ‘screen time’ (Jesse, IS) are a problem parents need to address at home.</p> <p><i>‘. talking about screen time I think that screen time mostly is even more rampant at home than at</i></p>	Parents’ failure to monitor screen time at home encourages sedentary lifestyle.

			<i>school, because kids sit down and play video games or go on social media are whatever they like if parents do not keep an eye' Jesse, IS.</i>	
	Stakeholder collaboration	Parental support was viewed as a major enabling factor by 86% of the participants	<p>Parental support was seen as very important because 'formative years' of a child begin at home; particularly stressing 'limiting screen time', (Raphael, PS.), 'modelling' healthy lifestyle by parents for their children.', and 'Diet control' (Rebecca, PS). Encouraging their children to 'play school sports or signing them up to a sporting club.', (Vanya, PS), talking about 'healthy habits' to their children at home', (Chantelle, IS) and 'teaching their children how to eat healthy and making sure that they exercise' (Sonia, IS) were other ways participants suggested parents can contribute.</p> <p><i>'I think parents that eat healthy and are more active can model the behaviour for their children.'</i>, Rebecca, PS.</p>	This implies that parents have a huge role to play in setting good examples to their children by leading a healthy lifestyle, limiting sedentary activities encouraging healthy eating and physical activity
	Strategies to improve outcome	Parental support was indicated as a major enabling factor by 86%	<p>Paving the way forward through 'educating parents about a healthy lifestyle.', (Raphael, PS), encouraging their children to be active in 'school sports.', (Vanya, PS.), and 'particularly limiting screen time, nutrition- monitoring what they eat.' (Raphael, PS) were suggested as strategies to improve outcome by participants.</p> <p><i>'I think educating parents would help because you find students coming to school in the morning, they're drinking soda like coke, you know as part of breakfast or something, you know, and that's not healthy.'</i> Raphael, PS</p>	The implication is that educating parents about healthy lifestyles is strategy that can help parents to be better role models to their adolescent children.

Students	Barriers	Sedentary lifestyle indicated as a by 93% of the participants.	<p>Excessive screen time as ‘every child looking at a screen, whether it is sitting in a group or alone’ was viewed as preventing students from ‘talking to each other or engaging in other activities’, Raphael, PS.</p> <p><i>‘During lunch breaks students just sit lazily and go on their phones.’ Carol, PS</i></p> <p>The concern is that students <i>‘are not actively involved in anything, so they are not burning off the calories at the oval for example and kicking a ball’</i>, Sonia, IS</p> <p><i>‘Students play games on computers during breaks than getting up to play’ Chantelle, IS</i></p> <p><i>‘During the breaks you find every child looking at a screen, whether sitting in a group or alone [when] they could spend more time talking and engaging in other activities’</i>, Raphael, PS.</p>	The consensus is that there is a high tendency of students to be on their screen devices which prevents them from being active during break times.
		Insufficient motivation of learners to participate in obesity prevention programs was seen as a barrier by 70% of the participants	<p>Adolescents were seen as an ‘age group that is hard to hard to motivate.’, (Carol, PS) and are ‘not too bothered to participate, or a bit lazy maybe.’, (Rebecca, PS)</p> <p><i>‘The kids are not too bothered to participate, or a bit lazy maybe.’, Rebecca, PS</i></p>	The implication is that are generally unwilling to participate in program due to lack motivation or are lazy hence obesity intervention programs should be designed is such a way that they capture the interest of adolescents
		Poor eating behaviours indicated by 98% participant as a hindrance to preventing adolescent obesity	<p>According to the participants, students are seen with ‘big bottles of coke’ and ‘family sized packets of potato chips’ (Jessica, PS) indicating their poor food choices and eating habits</p> <p><i>‘Certainly, you see students in the playground with these big bottles of coke and big family sized packets of potato chips like 200-gram packs,</i></p>	The tendency of students to indulge in the wrong choice of food in large servings is a challenge in dealing with adolescent obesity.

			<p><i>instead of the little 20-gram, individual serve packs. I even see many with whole packet of biscuits that's meant to serve eight or 10 people, and they're eating that. Quite often the kids have part time jobs, or they've got pocket money, and they can buy whatever they choose to.'</i> Jessica, PS</p>	
	Strategies to improve outcome	Physical activity was sighted at a priority by 40% of the participants.	<p>There are some recommendations for ways to maximize physical activity by participants for example making sure that sporting activities are <i>'fun, social and non-competitive in nature'</i> (Ruth, IS) so that all students <i>'feel included'</i>, (Samantha, PS)</p> <p><i>'I think one of the things that will help promote physical activity is to not make all sports competitive; to let students play just for the fun of it.'</i> Raphael, PS</p>	Though physical activity is not a priority in schools, there is room for encouraging students to be more engaged by changing the approach to physical activities by not focusing on excelling students only but involving all student is a more enjoyable manner.
School	Barriers	A busy timetable was cited as a major barrier by 82% of the participants	<p>A <i>'crowded curriculum'</i> was believed to make it <i>'impossible.'</i>, (Rebecca, PS) to have students engage in more physical activities unless staff volunteered.</p> <p><i>'Ideally physical activity should be several times a week, but the crowded curriculum makes it impossible.'</i> Rebecca, PS</p> <p><i>'Because it's a voluntary activity, it depends on whether teachers free and willing to do it.'</i>, Carol, PS</p>	The school timetable seems to be too busy to accommodate more physical activity unless there are volunteers who could handle such activities outside working hours as the school day is also short.
		Shortage of trained staff was seen as a barrier by	Lack of trained staff and staff availability were seen as barriers as one respondent indicated she lacked skills to <i>'manage students at the oval'</i> and	The findings imply that though some teachers may want to encourage physical activity, they find it challenging when they do not have the

		78% of the participants	<p>that I she was ‘trained’ she could make another attempt (Rebecca, PS)</p> <p><i>‘it depends on what teachers free and willing to do it. I mean, perhaps the school can give more guidance about it’, Carol, PS</i></p> <p><i>‘If there could be enough trained HPE teachers, trained nutritionists in the schools that contributes, in a positive way to prevent adolescent’, Jesse, IS</i></p>	skills for activities and that trained teachers are not always available which is also a challenge.
		Excess calorie consumption indicated by 93%	<p>Laxity in monitoring portions for students means excess consumption is encouraged as students are not regulated on how many serves of food they can buy from the tuck shop.</p> <p><i>‘Students are given whatever they want to purchase so they could choose six pieces of pizza, if they wanted to then get handed that.’ Angelic, PS</i></p>	The school tuck shop seems to be very liberal with portion sizes or number of serves per student at the tuck shop encouraging excess calorie consumption.
		75% indicated that lack of formal introduction of intervention programs and thorough implementation is a barrier	<p>Participants are not aware of what they can implement for ‘health and wellness’ they are meant to be ‘following’.</p> <p><i>‘I don’t remember any staff meeting I’ve ever been to, that’s focused on how to get messages to the students on healthy living or how to model the lifestyle’ Jessica, PS.</i></p> <p><i>‘I wouldn’t say that if we’re following clear intervention policies that I have been made aware of them’, Janelle, IS</i></p>	Lack of awareness of interventions related to prevention of adolescent obesity indicate that there is lack of formal introduction and thorough implementation of such interventions.
		86% participants indicated elimination of ‘junk’ food	<p>Participants indicated that it is ‘not necessary’ (Angelica, PS) to have drink dispensing machine in schools and that they should be done with to control what student drink.</p>	The implication is that if the schools get rid of vending machines it can facilitate control over what students can drink in school.

		machines was as a major enabling factor	<i>'I think there's also a drink machine, where students can get soft drinks and I think that's run to raise money for a program of some kind, but it doesn't seem necessary to have the machine.'</i> , Angelica, PS	
	Stakeholder collaboration	Regular evaluation of interventions in place was another major factor the school needs to consider doing by 86% of the participants	There is uncertainty among participants about policies and 'interventions' are in place currently, (Janelle, IS) <i>'I wouldn't say that if we're following clear intervention policies that I have been made aware of them'</i> , Janelle, IS	Participants' lack of awareness of interventions in place indicates that the interventions are dormant or that there are no interventions followed by schools altogether.
		40% of the participants indicated Physical fitness as a school priority as compared to emotional and mental health which was seen as a priority by 90% of the participants	Participants are saying that the focus on mental health has been tremendous as compared to adolescent obesity which 'the government has 'not flagged', (Jesse, IS) adolescent obesity as a problem. <i>'I think there's been a lot done within Australia to make awareness of where students can go to get help for depression and if they're struggling, stigmatized or being bullied, I think, more than ever, over the last 10 years. But I don't know if we are doing enough in the same respect of adolescent obesity and physical exercise'</i> Samantha, PS <i>'Zoom into adolescent obesity as a problem. Get it flagged as a problem'</i> Jesse, IS	Adolescent obesity needs to be considered as a problem of concern just like other health concerns faced by adolescents so as to sufficiently address it.
	Strategies to improve outcome	86 % thought Special low-calorie healthy lunches should be available during lunch hour	There are strong recommendations for ways to improve the tuck shop menu by 'offering healthy foods in the menu' (Jessica, PS) and having support from the 'school administration' to lead in the decision making on 'what food options are healthy for the tuck-shop' (Hebron, IS)	From the findings, the implication if healthy food items are made available at the tuck shop, boundaries set on what can or cannot be sold, that can be a good nutrition strategy for improvement.

			<p><i>'Some schools have banned certain items like chips, candies or soft drinks. The number of healthy items they sell at the school tuck shop is quite low in comparison to the number of unhealthy items, but they can prepare for salads instead' Angelica, PS</i></p> <p><i>'Another way is to have a deliberate effort to provide healthy options at the canteen' Jesse, IS</i></p>	
Government	Barriers	Insufficient program funding was thought to be a barrier by 78% of the participants.	<p>Participants are saying that schools are doing their best with 'with very limited funding' (Janelle, IS) to 'run activities that could prevent adolescent obesity' and 'that lack of funds is a challenge' (Jesse, IS)</p> <p><i>'I think schools are trying to do the best we can with very limited funding' Janelle, IS.</i></p> <p><i>'Lack of the funding, you know for those activities and that could prevent adolescent obesity is a challenge' Jesse, IS</i></p>	This implies that though schools could make efforts to run some activities to deal with adolescent obesity, such activities are mostly hindered by lack of funding.
		Excess calorie consumption indicated by 93% of the participants	<p>It was indicated from findings that students have formed a habit of buying extra food from 'fast food outlets near the school' (Sonia, IS)</p> <p><i>'Students habitually walk across the road to purchase buy big serves of junk food like fries and soft drinks at a fast food near the school' Sonia, IS</i></p>	This shows that some schools are located near fast food outlets which increases the amount of food students would normally consume.
		Presence of 'junk' food machines in schools was indicated by	Participants revealed that the school had a 'drink machine, where students can get soft drinks' so as 'to raise money for a program of some kind, but it doesn't seem necessary to have the machine' (Angelica, PS)	Fund raising using junk food inhibits progress in preventing adolescent obesity and there is no control over how much students purchase from the machine.

		86% participants as a major inhibiting factor	<i>'I think there's also a drink machine, where students can get soft drinks and I think that's run to raise money for a program of some kind, but it doesn't seem necessary to have the machine.'</i> , Angelica, PS	
		75% indicated that in lack of formal introduction of intervention programs and thorough implementation is a barrier.	Adolescent obesity is not necessarily pinpointed as a problem that the teachers need to really deal with, per se. <i>'It is not clearly stated in their roles as teachers, they do not necessarily feel the burden to deal with adolescent obesity'</i> , Jesse, IS. <i>'I think there has been a lot done within Australia to make awareness of where students can go to get help for depression and if they're struggling, stigmatized or being bullied, I think, more than ever, over the last 10 years. But I don't know if we're doing enough in the same respect of adolescent obesity and physical exercise'</i> , Samantha, PS	From the participants' perspective, mental health has thrived because programs were put in place while adolescent obesity is not seen as a burden hence lack of formality in dealing with it as a health concern.
	Stakeholder collaboration	Supportive government was indicated by 78%	Participants thought that the government can formulate strict policy on what the tuck shop can sell and what they can't'(Sonia, IS) Another way of support from the government as pointed out from findings is to pay the media to advertise more healthy food than junk food to young people'(Ruth, PS) and encourage healthy eating in school. (Sonia, IS) <i>'The government can pay the media to advertise healthy food instead of junk food.'</i> Ruth, IS <i>'I think a lot of that is dictated by government regulations. I remember a few years ago they</i>	This implies that a stronger stance from the government is needed to establish school food policy and to promote advertisement of healthy food.

			<i>categorized food into red and yellow and green I'm not sure if it's followed in this school but I'm pretty sure that there has to be regulations they follow as to what they sell at the school, as well as for prevention of obesity.' Samantha, PS</i>	
	Strategies to improve outcome	Easy access to fitness equipment during recess was indicated by 78% as an enabler	Availability of fitness equipment is determined by 'funding from the government', (Jesse, IS) and to encourage active participation in physical activities 'if there are enough facilities like showers and change rooms' (Jessica, PS) <i>'The government can provide funding and fitness equipment, showers and changing rooms for those who cycle to freshen up.'</i> Jessica, PS	The implication is that if the fitness is readily available where students can easily access them, there will more likelihood to increase physical activity.

3.5. Discussion

This study investigated school stakeholders' beliefs and perceptions about the barriers and enablers currently experienced by schools and their recommendations for preventing adolescent obesity. The study findings are summarized into a model for the prevention of adolescent obesity in schools (Figure 3.1). Barriers currently experienced by the school towards preventing adolescent obesity were explored and classified into four stakeholder levels: the students, parents, school and government. These findings show that stakeholder collaboration is the missing link that is essential to dealing with adolescent obesity. Recommendations of what the parents, the school and the government can do in their respective roles to help prevent adolescent obesity were identified. The participants emphasized the adoption of strategies that have the potential to increase physical activity, reduce screen time and promote healthy eating habits among adolescents. Overall, the findings show that the school cannot deal with the burden of adolescent obesity alone, and that complimentary collaborative efforts from all three major stakeholder groups (the school, parents and government) are required to combat adolescent obesity.

The school has been identified as an ideal place for adopting and implementing strategies to tackle adolescent obesity, because majority of adolescents attend school, providing an opportunity for longer contact periods during school days (Al-Mutairi et al., 2015; Clarke et al., 2013; Story, 1999; Lambrinou et al., 2020). However, it is quite evident in this study that obesity prevention efforts will be futile if the adolescents themselves are not motivated. The participants made a general observation that adolescents are often unwilling and uninterested in taking part in physical activities. This finding confirms a recent report that emphasizes adolescents' indifference to physical activity if it competes with other interests such as hanging out with friends or doing screen-based activities (Fock & Khoo, 2013; Guthold et al., 2020; Mikaelsson et al., 2020).

Nonetheless, if the teachers are unaware of relevant policies and have insufficient skills needed to facilitate outdoor activities, they will not feel confident to assist with promoting activities that aid prevention of adolescent obesity. It is evident in this study that teachers lack skills in facilitating outdoor physical activities and are also not aware of what policies to follow for such activities. Teachers need to be aware of current policies and actively engage in strategic planning and decision-making processes within the school for better implementation of policies (Lanier et al., 2012). School administrators are encouraged to involve teachers in the development of such policies and frequently give policy reminder talks at least once per semester to foster awareness and facilitate implementation of the strategies set in the policies.

The findings also indicate that school tuck shops seem to be encouraging unhealthy eating habits among adolescents are consistent with the report by Ronto and colleagues (2017) that an unhealthy tuck shop menu promotes bad eating habits among students. The majority of participants in this study indicated that students generally purchase lunches and snacks from the tuck shop, and that whatever is available on the menu majorly influences the students' dietary choices. A New Zealand study (Utter et al., 2007) indicated that close to two-thirds of students purchased lunches from the tuck shop, which was worrisome because of the high calorie, fat dense and high sugar food options. Another study (Woods et al., 2014) assessed the compliance of Australian schools by state and territory to set policies guiding the tuck shop menu; the findings indicated that Western Australia was the most compliant with 62% of menu items qualifying for healthy choices, while Queensland was in the bottom three. In this same study, high schools offered more unhealthy food and at lower cost than healthy salads. Even though most tuck shops are run by private conveners and predominantly profit oriented (Ronto et al., 2017), healthy eating policies should be adhered to. The onus therefore lies with the schools to ensure that whatever is sold in the tuck shops is healthy.

It is also imperative that the government ensures consistency in the adherence to regulatory guidelines across schools in Australia for healthier tuck shop options.

The proximity of schools to fast food outlets and unhealthy packed lunches from home by students were also identified as barriers in this study. Grier and Davis (2013) established that proximity to fast food outlets has a negative impact on the weight of adolescents, particularly those in urban areas and those from low -socio-economic backgrounds. When healthy food items are available at an affordable price, students are more likely to buy them, but their final decision is likely to be influenced by lots of other factors (such as craving, motivations, taste preferences and emotional needs) besides price. Studies have shown that early-life experiences in family systems that reinforce good dietary habits have a role in promoting healthy eating in future life, and this is considered as one of the fundamental ways of addressing adolescent obesity (Scaglioni et al., 2018). It is evident in the current study that unhealthy food is competitively cheaper than healthy food encouraging students to fall into the trap of buying unhealthy food due to its affordability. Government funding is needed for sourcing healthy food items and making them available locally, particularly to disadvantaged populations. Constant review of policies governing health promotion in schools is required. This can be made possible through government-regulated food policies as rightly highlighted by participants in this study.

With regards to physical activity, there has been a growing number of students who attend schools very far from their catchment areas (AHKA, 2015). This study has indicated that this makes active transport less possible as parents must drop off their children to school and pick them up afterwards. This finding resonates with other studies and indicates that parents could be concerned about the safety of their children, therefore not encouraging active transport to school (Mikaelsson et al., 2020; Carver et al., 2010). This implies that schools will need to maximize their physical

activity programs to engage students as much as possible to meet the daily requirements for physical activity. The projected (Lobstein & Jackson, 2016) increase in obesity in this age group may even be higher looking at the prevailing rate of COVID-19, which has worsened sedentary lifestyle and increased screen time among adolescents recently (Xiang et al., 2020). This calls for the government to provide more fitness equipment in schools as well as more bikeways and safe footpaths to encourage students to cycle or walk to school. Queensland weather can be hot; hence, the recommendation in this study that the government could provide funding for more facilities like change rooms and showers for freshening up and changing to fresh clothes on such days for students who cycle to school.

Obviously, students' access to mobile phones has increased over time and this contributes to the worrisome students' tendency to replace physical activity with games or activities on their electronic devices (Xiang et al., 2020). It has been established that peers influence each other in being physically active or inactive (Martin et al., 2018), highlighting the need to consider the impact of peer support in developing future interventions. It was highlighted in this study that strict rules on screen time during school hours and inclusion of more enjoyable non-competitive physical activities could help curb excessive screen time. This result corroborates findings from previous studies and confirm that to get adolescents to be engaged, activities must be enjoyable and pitched at an appropriate skill set level (Ketteridge & Boshoff, 2008).

Interestingly, the participants noted that unhealthy school tuck shop menu, limited funding and lack of trained staff to facilitate physical activities were more prevalent barriers in public schools compared to independent schools. There are significant differences in funding opportunities between these two entities, as public schools are government-funded institutions, while independent schools are privately funded, and this may be a possible reason for the observed

differences. The finding also portrays possible differences in the two school environments, likely with different social classes of students and parents. Environment and SES are certainly major contributors to the prevalence of obesity. Higher SES is usually associated with healthy lifestyle behaviour, while low SES is associated with less leisure time, physical activity and the consumption of nutrient-poor, energy-dense diets (Ruiz et al., 2019; McLaren, 2007; Tomiyama et al., 2018). This result indicates that the government needs to do more to better support public schools in combating adolescent obesity. It is important to note that, despite promising initiatives raised by schools, if funding and resources are not available, this can only lead to failure and disappointment because such initiatives cannot be sufficiently implemented or sustained.

The novel addition of this study to existing literature is the development of a reliable model that proposes a multi-pronged stakeholder collaborative approach in developing targeted strategies that foster a supportive ecosystem in combating adolescent obesity and enhancing the achievement of more generalizable health outcomes. Stakeholder collaboration provides a powerful approach to responding to complex problems that isolated efforts cannot solve because it focuses on building and maintaining long-term relationships between key stakeholders (Salvage et al., 2010). This is where the tripartite collaboration between the government, parents and school is needed. The government's major contribution would be to promote the development of adequate legislation and ensure its enforcement in order to protect adolescents from the marketing and sale of unhealthy foods. School administrators would need to ensure that appropriate school staff are trained to facilitate fun and engaging physical activities, while parents support their children by role modelling healthy lifestyle choices and monitoring screen time at home.

Student mental health and well-being have been reported to be a major priority in schools with persuasive campaigns to normalize asking for help to deal with mental health issues, with

promising results in reducing depression among students (Merry et al, 2012). As expressed by participants in this study, the same effort can be exerted towards the prevention of adolescent obesity. With its increasing prevalence, adolescent obesity cannot be continuously relegated to the background (Abarca-Gomez et al., 2017). The current social climate of ‘fatphobia’ and use of shame-based communications, particularly within high-income countries, emphasizes the need to implement better support strategies for adolescents with obesity (Tomiyama et al., 2018). Adolescents affected by this problem should feel comfortable to get help without feeling any prejudice or discrimination.

3.5.1 Strengths and Limitations

The major strength of this study is the utilization of the views of school stakeholders in a mixed-methods study to develop a model for the prevention of adolescent obesity. However, the findings should be interpreted with caution as the study focuses only on a Queensland, Australia context, which may not be applicable to other settings. Additionally, the development of the model for the prevention of adolescent obesity was primarily based on school stakeholders’ perspectives. The perspectives of students, parents and the government were not explored. Furthermore, the collection of data during COVID-19 restrictions limited the response rate and could have caused sampling bias, as participants were only reachable via online platforms.

3.5.2 Implications for Practice and Recommendations for Future Research

Lack of motivation on the part of students and the importance of health education for teachers, students and parents were raised as major areas for consideration in this study. Therefore, the model developed from this study can be used as a guide to support the development of policies and interventions, such as inclusive physical activities for adolescents with obesity and effective strategies for training private tuck shop conveners in the development of a healthy tuck shop menu.

Furthermore, school administrators, parents and the government can leverage participants' suggestions on better ways of incorporating nutritional programs, physical education and overall health strategies that promote the effective prevention of adolescent obesity. Future research from diverse settings and involving the views of students, parents and government are warranted to substantiate the findings from this study and provide perspectives from these important stakeholder groups. Further research is also necessary to aid the development of effective educational interventions.

3.6 Conclusions

Despite being a prevailing public health concern that needs to be addressed, adolescent obesity seems to be overlooked as compared to other health problems such as mental health. There are many factors that are at play in dealing with adolescent obesity. The barriers encountered at different stakeholder levels need to be specifically addressed. A tripartite collaboration between all stakeholders is key to effectively addressing adolescent obesity. Practical strategies focusing on nutrition, physical activity and overall health can be employed to improve health outcomes for adolescents. Collaborative stakeholder engagement could include parental education on health, formal health talks in schools by health professionals and better-targeted government funding on advertisements encouraging healthy lifestyle choices. These strategies are instrumental to complementing efforts already made by the school despite its current challenges, which include grappling with a crowded curriculum and limited funding for health promotion interventions against adolescent obesity.

Chapter 4: General Discussion

4.1 Chapter Overview

This chapter is a general discussion of the thesis key findings in relation to current knowledge in the field of adolescent obesity. The chapter also highlights the novel additions of the research to existing literature. The practical implications of the findings are also broadly contextualized while acknowledging the strengths and limitations of the research.

4.2 Research Findings and Novel Contributions

The overarching objective of this thesis was to investigate the role of the school in the prevention of adolescent obesity. This was achieved by addressing specific aims: first, to assess school-based interventions used in the past decade to gain a clearer insight into the efficacy of these interventions; secondly, to investigate school stakeholders' knowledge and beliefs about adolescent obesity as well as their perceptions of the factors affecting effectiveness of school-based obesity preventative measures. This culminated in synthesizing recommendations from stakeholders for preventing adolescent obesity as well as for future research.

The investigation described in Chapter 2 of this thesis found that although the efficacy of school-based obesity interventions is generally limited, implementation success can be improved when interventions combine physical activity, nutrition regimes and an alignment to one or more theoretical frameworks. This finding corroborates previous studies that suggest that multicomponent school interventions that are guided by a theory are more effective (e.g., Chen & Wilkosz, 2014). The incorporation of physical activity and psychological interventions has also been associated with effective prevention of adolescent obesity strategies (Sobol-Goldberg et al., 2013). These findings underscore the importance of a multi-pronged approach in which students

are provided a range of opportunities in a supportive ecosystem towards combating adolescent obesity.

The major findings presented in Chapter 3 posit that schools cannot adequately address the adolescent obesity epidemic alone, as the problem is multifaceted in nature. Study participants emphasized the point that because schools already have a busy timetable, they cannot realistically deal with the burden of adolescent obesity alone, and that complimentary collaborative efforts from three major stakeholder groups (the school, parents and government) are required to combat adolescent obesity. Moreover, the study found that the school is already grappling with other challenges and barriers like lack of resources, a busy curriculum, and a shortage of trained staff. Therefore, the involvement of the government and parents alongside the school's efforts is a crucial approach for potentially better results in the prevention of adolescent obesity. The collaboration is important in maximizing the use of the school as a suitable and strategic place to target when it comes to the prevention of adolescent obesity (Al-Mutairi et al., 2015; Clarke et al., 2013; Story, 1999; Lambrinou et al., 2020). However, the school is only one component of a multi-level approach to combatting adolescent obesity, therefore a collaborative or coordinated approach is required. The Social Ecological model adopts a multilayered approach where individual factors, interpersonal interactions, community, and societal factors are taken into consideration in preventing problems such as adolescent obesity (Green et al., 1996). Thus, in this case, all levels of influence, i.e., starting with the interpersonal factors and then broadening to the family, the community, the institutions and schools, and the government policy and other regulatory bodies must all be taken on board for a desirable outcome. It is clear with this model that the effort or inactivity at each level affects the overall health outcomes either positively or negatively, hence the emphasis on the need for active collaborative participation from each stakeholder group.

4.4 Practical Implications of findings

One of the findings from this study was the perception that there was low learner motivation when it comes to participating in programs that promote good health. This calls for a deliberate creation of an attractive inclusive and non-discriminatory environment that encourages student participation. Studies have shown that adopting a non-discriminatory approach so that students do not feel discriminated or targeted could yield better participation, particularly given that the social climate in the western world has a sense of ‘fat-phobia’ (Chen and Wilkosz, 2014). Given that Australian adolescents are already not meeting the physical activity recommendations, better strategies of mobilizing students to be more active like installing stationary bikes, transforming ovals and sport halls should be considered (Jacobs et al., 2021). The state of Queensland is generally hot and humid, therefore provision of accessible facilities like showers and change rooms could motivate physical activity among students. Environmental factors (including facilities) were specifically cited by participants in this study, that they can either motivate or discourage learners from being active. Government funded initiatives could also include increasing indoor sporting facilities and spaces for a range of games such as futsal, table tennis, volleyball, netball, handball, basketball etc., as well as accessibility to fitness gyms.

Employing constructs from the Health Belief Model can be used particularly in educating young people and their parents on the health complications associated with being obese. The Health Belief Model proposes that individuals are more likely to engage in physical activity if they appreciate their vulnerability to a condition (e.g. obesity) and its adverse implications. For example, lifestyle education, food habits and appropriate physical activity based on the Health Belief Model was reported to be efficacious in improving obesity related behaviours among the mothers of students who were obese children and their children through an educational program

in America (Abdeyazdan et al., 2017; Cason et al., 2006). A significant improvement in healthy habits and lifestyle among adolescents in Iran was also achieved following this model (Sabet-Sarvestani et al., 2008). Therefore, a program targeted at adolescents and their guardians to educate and create awareness about the current status-quo of adolescent obesity in QLD (and Australia as a whole), as well as the health implications is highly encouraged.

Unhealthy tuck-shop menu was identified as one of the barriers that encourage unhealthy eating. Several states and territories including Queensland have been shown to be lagging in following regulatory policies that govern the tuck-shop menu (Woods et al., 2014). This calls for a revolutionary change in the school food and drink policies to ensure a thorough modification of the food environment to address the inconsistencies in implementation emphasized by the participants in this study. In line with the Social Ecological model's levels of influence, the government appears to be at a vantage point of influence in bringing about this revolutionary change. For example, this could be achieved by mandating phasing out vending machines in schools and strict regulation of the sale of sugary drinks and energy dense foods in schools by the government through policies. The school role would be to facilitate and implement the initiative by communicating the changes to food committees and tuck-shop conveners. Many students depend on the tuck-shop for all their meals at school, therefore the tuck-shop menu determines what they purchase (Kim et al., 2012; Utter et al., 2007). About 81% of high school students participating in a study exploring secondary school tuck-shop menu options indicated that they would purchase healthy food if it was offered at the school tuck-shops (Ada & Chu, 2017). This shows that the modification of the school environment has the potential to influence healthy food choices. The menu should also be affordable yet appetising for students. However, a study by Ohri-Vachaspati et al. (2015) showed that even though all stakeholder levels had some influence,

parental perceptions and parental education was a stronger predictor of adolescent obesity. Low socio-economic status (SES) has also been shown to be a significant predictor of obesity (Ruiz et al., 2019; McLaren et al., 2007; Braveman et al., 2010). This underscores the importance of educating parents/guardians and improving government financial support particularly to public schools as more students from low SES background are more likely to attend public schools. The government occupies a higher level of influence according to the Social Ecological model and as shown in the model for the prevention of adolescent obesity, which was developed in this thesis, therefore efforts by the government have the potential to bring a significant change. The government can be proactively involved in tackling adolescent obesity in measurable ways by promoting development and infrastructure projects that support healthy lifestyles, reforming approaches to nutrition, exercise and health in schools and influencing the food and beverage industry to facilitate healthy habits.

Participants in this study decried the general lack of prioritization of obesity related issues when compared with other problems like mental health. This is in spite of the fact that the WHO has identified adolescent obesity as a serious health pandemic that has far reaching implications for many nations, particularly in the developed world. Clearly as shown in the study findings presented in Chapter 3, mental health has the highest ranking among school priorities (Merry et al, 2012). Physical activity is highlighted where it is offered as a subject (HPE) and in relation to that, school stakeholders were of the opinion that other more interesting social and non-competitive sport and physical activities can be used to promote the prevention of adolescent obesity in schools. The model developed from this study can be used as a guide to support the development of policies and interventions, such as inclusive physical activities for adolescents with obesity and effective strategies for training private tuck shop conveners in the development of a healthy tuck shop menu.

4.5 Strengths and Limitations of the Research

The systematic review presented in this thesis is the first to provide a review of the efficacy of the school-based interventions in Australian schools specifically focusing on adolescents. Several other obesity studies combine research on adolescents and younger children despite the evidence that adolescent obesity is on the rise while childhood obesity has plummeted (Abarca-Gómez, 2017). In addition, reviewed articles included studies were RCTs and quasi-experimental research designs and they were judged to be appropriate because they provided a high level of reliable evidence. A strong attribute of the primary research in this thesis is that the views of school stakeholders were investigated in a mixed-methods study to develop a model for the prevention of adolescent obesity. The developed model for the prevention of adolescent obesity emphasises the importance of stakeholder collaboration approach and could be used as a framework to engage all stakeholders in round-table discussions that focus on developing effective action plans towards eliminating adolescent obesity.

Nonetheless, caution should be applied in generalizing the research findings in this thesis to other settings. First, the inclusion and exclusion criteria used for the systematic review, could have limited the scope of reviewed articles. In addition, a meta-analysis of the findings was also not possible due to the variability in the interventions implemented by the studies considered. Additionally, both the review and primary research presented in this thesis were limited to an Australian context. Another limitation is that the development of the model for the prevention of adolescent obesity was primarily based on the responses from school stakeholders who participated in the study; the perspectives of students, parents and the government did not inform the development of this model. Furthermore, collection of data primarily using online platforms due to COVID-19 restrictions could have resulted in sampling bias and potentially limited the response rate.

Chapter 5. Conclusions and Recommendations

5.1 Chapter Overview

This chapter provides a summary of the take home messages from this research. It also outlines recommendations and prospects for future research that were informed by the findings of the study. Overall, this research focused on identifying the role of the school in prevention of adolescent obesity. The research was conducted in two phases which included a systematic review and a mixed methods study. The systematic review aided the evaluation of the efficacy of currently used interventions in Australian high schools while the mixed methods study investigated the views, knowledge, and beliefs of school stakeholders about adolescent obesity and recommended prevention strategies. This approach facilitated the development of a multi-pronged model for the prevention of adolescent obesity.

5.2 Summary of Research findings

First, the systematic review in this research has identified the interventions used in Australian high schools and an analysis of the efficacy of these interventions provided weak evidence. The results however indicated that a multi-component approach with the inclusion of physical activity, nutrition and alignment to one or more theories in the development of obesity interventions can yield significant results. Secondly, in the mixed method study, the exploration of the views and perceptions of school stakeholders on adolescent obesity indicated that the main perceived causes of adolescent obesity were poor eating habits and a sedentary lifestyle. Thirdly, the main barriers to preventing adolescent obesity were reported to be related to four main stakeholders: the students, the parents, the school and the government. A busy timetable, shortage of trained staff and funding, lack of robustness in the introduction and implementation of school interventions and insufficient

motivation of learners to participate in obesity prevention programs are the main highlighted barriers. The school stakeholders were of the view that addressing the barriers through a collaborative approach among the main stakeholders would be a more productive way of mitigating adolescent obesity rather than relegating the sole responsibility to the school.

Fourthly, with regards to strategies for improved adolescent health outcomes, these were categorized into three main practical outcomes, physical activity, nutrition and overall health strategies. These strategies included parental education on health, healthy lifestyle promoting advertisements and professional-led school health talks towards the improvement of the health of adolescent. Finally, the enabling factors highlighted include supportive government policies, elimination of sugary drinks from vending machines, provision of healthier school tuck-shop menu, parental support and easy access to fitness equipment during recess. The overall findings were summarized into a model with a multicomponent approach for the prevention of adolescent obesity which is a novel contribution of this research.

5.3 Recommendations

From the discussion of the main findings of this study, a number of actionable recommendations can be deduced, and they are relevant to the various stakeholder levels indicated in the model developed from the study.

5.3.1 Practical steps for the school

Participating school stakeholders raised a concern that they were unaware of the strategies and policies that they are meant to follow in the promotion of the prevention of adolescent obesity. They also indicated that whatever policies are in place are not formally introduced nor thoroughly implemented. It is therefore important for schools to assume a more active role by making sure that policies and programs in place are adhered to. It is imperative for schools to ensure

involvement of all school staff in strategic decision-making to raise awareness and to ensure there is organisational commitment to contributing their role in the prevention of adolescent obesity. The school can also take advantage of various platforms like parents and teachers' meetings to communicate health and wellness messages to the parents hence educating and empowering them to make better personal lifestyle choices for themselves and their children. Motivational speakers, nurses and dietitians can be invited during these meetings to educate teachers, students and also parents about healthy dietary and lifestyle choices that support optimal health and wellbeing. These health talks combined with the use of relevant policies for healthy tuck-shop menu will also enhance the prevention of adolescent obesity.

5.3.2 Practical strategies for Parents

Parents are important stakeholders who have a significant part to play in the prevention of adolescent obesity. Given that they are the primary care providers, they can control the home environment and regulate their children's eating behavior and lifestyle. There are several recommendations from this study that parents can utilize in supporting the prevention of adolescent obesity. For instance, it is important for parents to know that even though adolescents are no longer children, they are transitioning to adulthood, therefore parents still need to supervise them by limiting screen time and monitoring packed meals. In addition, parents need to model and encourage healthy and active lifestyles. Children will most likely follow unhealthy habits if they see parents habitually consuming unhealthy food and leading a predominantly sedentary lifestyle. Parents can also encourage and support their children to take part in sporting activities available in schools.

5.3.3 Practical steps for the Government and Policy Makers

There are a number of recommendations on practical steps that the government can utilise in fulfilling its responsibility in the prevention of adolescent obesity. Firstly, the government is urged to ensure enactment and implementation of comprehensive policies that will ensure consistency and uniformity in regulating food and drinks sold in schools. The government can formulate clear guidelines that empower schools to monitor screen time for recreational purposes. The government can also facilitate the running of educational campaigns on social media and other platforms to sensitize parents and their children on the impact of screen time and on the choice of an active lifestyle. Other developments could be the provision of facilities to engage students with fun and social activities that promote good health. In addition, there are regulatory programs which have become dormant and inactive that need to be resuscitated. Programs such as Smart Moves is seen to have been instrumental in the promotion of physical activity. Diet related programs like Smart Food Choices (which promoted increased consumption of fresh fruit and vegetables and reduction of intake of sugar sweetened beverages) gave clear guidance on what food and drinks were allowed or prohibited in the school. Also, active transport and more physical activity can be encouraged by the government through the provision of more safe bikeways, footpaths and recreational facilities. Facilities like showers and change rooms can also be constructed in schools so that students can freshen up after bike rides when they arrive in school and after physical activities during recess. Finally, the government needs to invest in advertisements promoting healthy lifestyle choices and monitoring advertisements and cost of unhealthy food choices in the multimedia. However, cultural acceptability of such monitoring and costs of monitoring/regulation need to be put into consideration.

5.4 Directions for future research

Given that the current study focused on Queensland and the perceptions of only school stakeholders, future research could be conducted from diverse settings in other states and territories of Australia to enable the exploration of the views of students and parents to substantiate the findings from this study. Further research is also necessary to aid the development of effective educational interventions. Australian adolescents are already falling below the national recommendations for daily physical activity. It is also important that future research should focus on exploring the perceptions of students on activities that can be sustained, enjoyable and social in nature in order to help expand and understand better the views of school stakeholders provided in this study. The challenges of time constraints and crowded curricula have been reported in this study, therefore future research may consider how physical activity initiatives, nutrition education and other school-based obesity prevention strategies can be prioritised and implemented.

The views of parents and the wider community in the prevention of adolescent obesity and the challenges they face also need to be explored in future studies in order to bridge the disconnect between the school environment and the home which has been highlighted as contributing to the decline in healthy food choices. More research may also be needed to aid understanding of impact of legislation focused on the promotion of healthy lifestyles. Finally, considering that the COVID-19 restrictions and quarantine requirements have significantly contributed to sedentary lifestyle and increased screen time, future research could explore the extent to which this has affected the prevalence of adolescent obesity particularly in Australian regions which were subjected to more lockdowns.

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APPENDICES

Appendix A: Ethics approval

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Appendix B: Quantitative data collection - Survey questions

Section A: Demographics and background

Please tick/write responses in each box appropriately

1. Age

2. Gender Male Female Other

3. Highest level of education attained

High school

Technical College (e.g., TAFE)

Associate degree (e.g., AA, AS)

Bachelor's degree (e.g., BA, BS)

Master's degree (e.g., MA, MS, MEd)

Professional degree (e.g., MD, DDS, DVM)

Doctorate degree (e.g., PhD)

4. What is your current role in the school? (e.g., School Principal, Science teacher, School Nurse)

5. How many years of experience in your current role Section B Personal Attitude

How often do you engage in physical activity?

Never	Occasionally	Once a week	Twice a week	a	3-4 times a week	Daily
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. How motivated are you to engage in physical activity?

Strongly motivated	Motivated	Slightly motivated	Not motivated

Section B: Obesity perceptions and knowledge

To what extent do you agree that each factor below contributes to obesity? Please TICK your response below.

Factors	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Prevalence of junk food machines					
Psychological problems					
Cultural factors					
Low socioeconomic status					
Heredity					
Peer pressure					
Hormone problems					
Poor eating behaviors					
Sedentary lifestyle					
Excess calorie consumption					
Lack of self-control					
Lack of parental concern					

Section C: Obesity beliefs

To what extent do you agree with the following beliefs about youth obesity? Please TICK your best response below.

Beliefs	Strongly Disagree	Disagree	Not sure	Agree	Strongly agree
Youth obesity is becoming more prevalent					
Being normal weight is very important to the health of youth					
Youth obesity is a significant cause of peer rejection					
With proper guidance, most obese youth can lose significant amounts of weight					
With proper guidance, most obese youth who lose weight can maintain their weight loss					
Failure to lose weight in a weight loss program will likely reinforce youths' belief that there is little chance they can lose weight.					

Bulimia and anorexia are more serious problems in the schools than obesity.					
Most youth will outgrow their obesity.					
Only youth who are likely to succeed in a weight loss program should be part of a treatment					

Section D: Enablers and Hindrances to school-based youth obesity prevention

Enablers of school-based youth obesity prevention

To what extent do you believe the following factors enable the school in preventing youth obesity?

Please TICK your response

Possible enabling factors	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
Supportive government					
Staff training for intervention programs in place					
Program participation incentives for students					
Willingness of school leadership to lead implementation of obesity prevention intervention					
Easily accessible fitness equipment during recess					
Clear role assignment in intervention program implementation					
Regular evaluation of interventions in place					
Employing more teachers to reduce academic workload and spare more time for health-related activities					
Parental support towards school obesity intervention programs					
Community involvement					

Are there any additional enabling factors to preventing youth obesity not mentioned above?

YES NO

If you ticked YES above, please write the additional enabling factors on the spaces provided below.

Hindrances to school-based youth obesity prevention

Possible Hindrances	Strongly Disagree	Disagree	Not sure	Agree	Strongly agree

Insufficient funding for programs					
Shortage of trained staff					
Busy school timetable					
Parents are not supportive					
Insufficient motivation of learners to participate in obesity prevention programs					
School leadership is not supportive					
The school day is short					
The programs are not formally introduced nor thoroughly implemented					
Intervention Programs are too broad rather than specific					
No one is accountable for program implementation					
Interventions programs in place are not mandatory to students					

Are there any additional hindrances not mentioned above? YES NO

If you ticked YES above, please write down the additional hindrances on the spaces below.

Section E: Perceptions about the role of the school in preventing adolescent obesity

The following statements are suggestions about the role of the school in preventing adolescent obesity.

To what extent do you believe the following factors enable the school in preventing adolescent obesity? Please TICK your best response below.

School role suggestions	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
A comprehensive health curriculum that contains units on nutrition and weight control should be available in all schools.					
Special low-calorie lunches should be available during lunch hours.					
Schools are not doing enough to help alleviate youth obesity.					

Weight control programs specifically for treating obese youth should be available in all schools.					
The elimination of all 'junk food' machines from the schools should be required.					
Schools would be an ideal place to prevent weight problems in youth					
Parents would not be supportive of schools becoming a place for the treatment of youth obesity					
What role should school personnel play in treating youth obesity?					

What kind of role do you think the following school stakeholders have in the prevention of adolescent obesity?

School stakeholders	Major role	Minor role	No role
School Principals			
School Nurses			
Physical Education Teachers			
School Counsellors			
School Teachers			

Section F: School Intervention Programs

What do you think are the top three health concerns for your student population? Choose from list below. Please TICK 3 below.

- Alcohol and/or drug use
- Cognitive development
- Chronic and communicable diseases
- Emotional and mental health
- Physical fitness/physical inactivity
- Nutrition
- Overweight/obesity
- Relational and social skills
- Safety (i.e., injuries)
- Sexual health
- Tobacco use
- Violence

What is the approximate proportion of students in your school who are overweight or obese? It's OK to estimate if you are unsure of

exact numbers.

- 0%–25%
- 25%–50%
- 50%–75%
- >75%

What is the approximate proportion of students in your school who you think might have eating disorders? It's OK to estimate if you are unsure of exact numbers.

- 0%–25%
- 25%–50%
- 50%–75%
- >75%

Does your school offer any wellness or obesity prevention programs and interventions? (please tick)

YES _____ NO _____

Does any of the following apply as wellness or obesity prevention programs available in your school? (please tick)

- BMI tracking and reporting _____
- Nutrition education and promotion _____
- Nutrition standards for school meals _____
- Physical activity outside of Health and Physical education (HPE) _____
- Health and Physical Education (HPE) _____
- School garden _____
- Others _____

Does your school offer any other wellness or obesity prevention programs to students that are not included in the list above?

YES _____

NO _____

If you responded YES above, please LIST some of the school-based wellness or obesity prevention programs

How successful do you feel your school-based wellness or obesity prevention programs are?

- Very successful _____
- Generally successful _____
- Marginally successful _____
- Neither successful nor unsuccessful _____
- Marginally unsuccessful _____
- Generally unsuccessful _____
- Very unsuccessful _____

How did your school select the currently offered programs? (please tick)

- Other schools in the region use the program _____
- The regional office recommended the program _____
- School administrators recommended the program _____
- Members of the school community recommended the program _____
- The programs were identified from review of scientific literature _____
- The program was identified from review of education literature _____
- Grant funding specified the adoption of the program _____
- Other (please write) _____

Have you evaluated the success of your school-based wellness or obesity prevention programs?

YES _____

NO _____

How did you evaluate your programs? Please tick any below or write relevant response.

- Data collected from students
- Data collected from teachers
- Observation of students
- Discussion with students
- Other _____

What factors have led to the success or failure of your school's wellness or obesity prevention programs?
If you do not have any of the wellness or obesity prevention programs, what factors impacted the decision not to have them

What are your comments concerning school-based wellness or obesity prevention programs?

Section G: Policies

What impact have the policy implementation achieved in your school on the following?

Issues	Increased	No impact	Decreased
Bullying			
Eating disorders			
Parent engagement			
Student engagement			
Staff stress levels			
Student stress levels			
Teacher satisfaction			
Student-teacher communication			
Teasing based on appearance			
Teasing based on weight			
Unhealthy weight management behaviors			

Appendix C: Oral interview questions

Participant details.

1. Please tell me about yourself.
 - Your role in the school e.g., teacher, HOD
 - How many years in this role?
 - The type of school where you are employed e.g., independent, private or state school
2. Can you please share your opinion on the role schools play in the prevention of adolescent obesity?
3. Explore the following with regards to prevention of adolescent obesity from your own point of view
 - Parental contribution
 - Government contribution
4. What are the general barriers experienced by your school in preventing adolescent obesity?
5. Can you please discuss briefly about ways that schools could be enabled in promoting the prevention of adolescent obesity?
6. How can you as a school stakeholder be involved in preventing adolescent obesity?
Probes: diet, physical activity, and screen time.
7. Do you think schools are doing enough to prevent adolescent obesity? Explain further
8. Within the school, whose responsibility is it to ensure that the interventions and policies in place are implemented and why?
9. What are the adolescent obesity prevention interventions and policies followed by your school?
10. How did your school develop these policies and interventions?
11. Can you please score the implementation rate on a scale of 10 and justify your rating?
12. How effective are the interventions and policies in your school? Elaborate further
13. Are all student year levels taking part in interventions or is participation optional? Are there any ways you think participation can be maximized?
14. Are there policies governing the school tuck-shop menu? Please enumerate and elaborate
15. What are your recommendations of what schools should do to prevent adolescent obesity?

Appendix D: QATSDD Criteria

Item number	QATSDD Criteria
1	Explicit theoretical framework
2	Statement of aims/objectives in main body of report
3	Clear description of research setting
4	Evidence of sample size considered in terms of analysis
5	Representative sample of target group of a reasonable size
6	Description of procedure for data collection
7	Rationale for choice of data collection tool(s)
8	Detailed recruitment data
9	Fit between stated research question and method of data collection (Quantitative only
10	fit between research question and format and content of data collection method (Qualitative only) EXCLUDED
11	Fit between research question and method of analysis (Quantitative only)
12	Good justification for analytical method selected
13	Assessment of reliability of analytical process (Qualitative only); EXCLUDED
14	Strengths and limitations critically discussed
15	Evidence of use involvement in design
16	Statistical assessment of reliability and validity of measurement tools