Socioeconomic status and self-reported oral health in Iranian adolescents: the role of selected oral health behaviours and psychological factors

Ravaghi, Vahid

The copyright of this thesis rests with the author and no quotation from it or information derived from it may be published without the prior written consent of the author.

For additional information about this publication click this link. https://qmro.qmul.ac.uk/jspui/handle/123456789/605

Information about this research object was correct at the time of download; we occasionally make corrections to records, please therefore check the published record when citing. For more information contact scholarlycommunications@qmul.ac.uk
Socioeconomic Status and Self-reported Oral Health in Iranian Adolescents: the Role of Selected Oral Health Behaviours and Psychological Factors

by

Vahid Ravaghi

A dissertation submitted in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY

Centre for Health Sciences
Barts and The London
School of Medicine and Dentistry
Queen Mary University of London, UK

July 2010
Abstract

Health inequality according to socioeconomic status has been established. There is evidence for inequality for self-reported oral health outcomes. There has been interest in exploring the factors that explain general health inequality such as health behaviours and psychological factors. However, few studies have examined whether oral health behaviours and psychological factors explain oral health inequality among adults from industrialised countries. The aim of this thesis is to investigate whether oral health behaviours and psychological factors explain inequality in self-reported oral health among Iranian adolescents. This study tested four conditions according to the hypothesis of mediation; the final condition is that adjusting for the mediating factors attenuates the relationship between socioeconomic status and oral health. A questionnaire was used to collect data on four sets of variables from 639 males and females aged 15-17 studying at secondary schools in Sanandaj, Iran: socioeconomic status, oral health behaviours, psychological factors, and self-reported oral health outcomes. Indicators of socioeconomic status were subjective socioeconomic status, wealth index, mother’s education and father’s education. Oral health behaviours were toothbrushing, dental flossing, and visiting dentist. Psychological factors were self-esteem, depression, and anxiety. Self-reported oral health outcomes were single item self-rated oral health, and the experience of dental pain. Several regression models were conducted to examine the four conditions of the hypothesis of mediation. This study found a graded relationship between indicators of socioeconomic status and self-reported oral health outcomes, but no strong evidence to support the hypothesis that oral health behaviours and psychological factors mediate oral health inequality for self-reported oral health outcomes. Adjustment for oral health behaviours and
psychological factors led to only small changes in the associations between socioeconomic status and self-reported oral health outcomes. In conclusion, oral health behaviours and psychological factors explained a little extent of oral health inequality for self-reported oral health outcomes.
Dedication

This PhD thesis is dedicated to the people of Iran, who, after the presidential election in 2009, fought for justice, equality, and freedom, without guns. You are always in my thoughts.
Acknowledgement

I have been able to accomplish this research with the support of countless numbers of individuals. My greatest appreciation is towards my research supervisors, Professor Sandra Eldridge, Dr Valeria Marinho, and Professor Martin Underwood. Their scientific guidance and unconditional support has been essential in allowing me to utilise my knowledge and to explore new challenges. Anytime I faced a new challenge, their approach allowed me to find the best solutions on my own, maximising my learning experience. The experience I have gained from completing this study will stay with me for the rest of my life; it would not have been possible without their encouragement and support. I am also thankful to Professor Wagner Marcenes for helping me in difficult circumstances.

The gathering of the data for this scientific research study was made possible with the help of the staff at the Medical University of Kurdistan. I am especially grateful to Dr Nahid Ghotbi and Mr Fardin Gharibi for facilitating the data collection. I am also extremely thankful to the educational administration authorities in the province of Kurdistan, as well as the head teachers and classroom teachers of the schools. Their permission allowed me to collect data for this research. I am deeply grateful to all secondary school students who participated in this study.

I could not have made it through my training without the support and commitment of my friends. I appreciate their support, their friendship, their advice and their constant love as I know I could not have gotten through this process without them. First of all, I would like to thank Dr Atousa Goudarzi for all the support that she gave me while I have been working on this thesis. She always listened to me during moments of joy
and frustration. I wish to thank, in no particular order, Dr Alireza Sadr, Dr Mohammad Mehdi Mokhtari Ardakan, and Dr Bahar Molanaei. I apologise in advance for not having enough space to name you all.

This research was supported by the Tabriz University of Medical Sciences. I am thankful to the people of Iran, whose money enabled me to live and study abroad.

Finally, my deepest gratitude goes to my family for their unconditional love and support throughout my life. My mother, Zahra, undoubtedly, has been the most important person in my life. Her passion, patience, determination, and dedication are beyond description. Also, I would like to remember my father who sacrificed his life for the sake of justice and humanity when I was only two. I thank my sister, Faezeh, who was always available with words of encouragement. I am sincerely grateful to my uncle, Professor Ali Ravaghi, the prominent Iranian scholar, who introduced me to the world of science and research when I was not even able to read and write. He has been a role model for me to follow unconsciously. Lastly, I am indebted to my grandma. Her presence made my childhood more pleasant.
Table of contents

Abstract ........................................................................................................................................2

Dedication.......................................................................................................................................4

Acknowledgement........................................................................................................................5

Table of contents..............................................................................................................................7

Table of tables ................................................................................................................................12

Table of figures ...............................................................................................................................13

Preface ...........................................................................................................................................14

Chapter 1. Introduction and literature review ............................................................... 15

1.1 General introduction.................................................................................................................16

1.2 Literature review ....................................................................................................................16

1.2.1 Introduction to health inequality .......................................................................................17

1.2.1.1 Definition of terms ........................................................................................................17

1.2.1.2 History of research on health inequality .................................................................22

1.2.1.3 Health inequality: the concept ....................................................................................23

1.2.1.4 Explaining health inequality ......................................................................................26

1.2.1.5 Behavioural and psychological explanations for health inequality ...........28

1.2.2 Oral health inequality ........................................................................................................37

1.2.2.1 Self-reported oral health ............................................................................................37

1.2.2.2 Oral health behaviours and psychological factors in relation to oral health 39
1.2.2.3 Oral health inequality among adolescents ........................................... 42
1.2.2.4 Behavioural and psychological explanations for oral health inequality . 47
1.2.2.5 Oral health studies of Iranian adolescents ..................................... 53
1.2.3 Framework for explaining health inequality ........................................ 57
1.2.3.1 Introduction .................................................................................. 57
1.2.3.2 History and concept of mediation ................................................. 58
1.2.3.3 Framework and assessment of the mediation ................................ 59
1.2.3.4 Application of hypothesis of mediation: study design .................. 62
1.2.4 Aim, objectives and study framework .............................................. 64
1.2.4.1 Aim .............................................................................................. 64
1.2.4.2 Objectives .................................................................................... 65
1.2.4.3 Framework of the study ............................................................... 65

Chapter 2. Methods and materials ......................................................... 67

2.1 Setting ............................................................................................... 68
2.1.1 Study design .................................................................................... 68
2.1.2 Geographic location of the study ..................................................... 68
2.1.3 Study population ............................................................................ 69

2.2 Developments of the study instruments .......................................... 70
2.2.1 Indicators of socioeconomic status ................................................. 70
2.2.1.1 Subjective socioeconomic status ................................................ 71
2.2.1.2 Wealth index ............................................................................... 73
2.2.1.3 Mother’s and father’s education .................................................. 79
2.2.2 Oral health behaviours .................................................................... 79
2.2.3 Psychological factors ...................................................................... 80
2.2.3.1 Self-esteem ................................................................................. 81
2.2.3.2 Depression and anxiety ................................................................. 81
2.2.4 Self-reported oral health ................................................................. 82
2.2.4.1 Single item self-rated oral health ............................................... 83
2.2.4.2 Experience of dental pain ........................................................... 83
2.3 Ethical issue ....................................................................................... 84
2.3.1 Obtaining required approvals ......................................................... 84
2.3.2 Participant’s consent forms ............................................................. 85
2.3.3 Guardian’s consent form and information sheet .............................. 85
2.3.4 Security of the data ........................................................................ 86
2.4 Sampling, sample size calculation, and data collection ...................... 87
2.4.1 Sampling ......................................................................................... 87
2.4.2 Sample size calculation ................................................................. 87
2.4.3 Data collection ................................................................................ 88
2.5 Treatment of data ............................................................................... 89
2.5.1 Statistical software ......................................................................... 89
2.5.2 Data cleaning .................................................................................. 89
2.5.3 Treatment of missing data .............................................................. 89
2.5.4 Data analysis .................................................................................. 90
2.5.4.1 Descriptive analyses ................................................................ 90
2.5.4.2 Testing the hypothesis of mediation ......................................... 91

Chapter 3. Results .................................................................................. 95

3.1 Study sample ...................................................................................... 96
3.1.1 Sampling characteristics ............................................................... 96
3.1.2 Distribution of the sample according to the variables of the study .... 97
| 3.1.3 | Distribution of the sample according to gender .............................................. 104 |
| 3.2  | Testing the hypothesis of mediation................................................................. 108 |
| 3.2.1 | Socioeconomic status and self-reported oral health outcomes...................... 108 |
| 3.2.2 | Socioeconomic status and hypotheses mediators .............................................. 112 |
| 3.2.2.1 | Socioeconomic status and oral health behaviours........................................... 112 |
| 3.2.2.2 | Socioeconomic status and psychological factors ............................................. 116 |
| 3.2.3 | Hypothesised mediators and self-reported oral health outcomes................. 118 |
| 3.2.3.1 | Oral health behaviours and self-reported oral health outcomes.................. 118 |
| 3.2.3.2 | Psychological factors and self-reported oral health outcomes.................. 120 |
| 3.2.4 | Socioeconomic status and oral health: Adjusted models for hypothesised mediators 122 |
| 3.2.5 | Summary of the testing of the hypothesis of mediation.............................. 126 |

**Chapter 4. Discussion ................................................................. 129**

| 4.1  | Main findings ....................................................................................................... 130 |
| 4.2  | Relationship with other literature ........................................................................................................ 133 |
| 4.2.1 | Explanation for oral health inequality ................................................................. 133 |
| 4.2.2 | Distribution of the variables across the sample.................................................. 134 |
| 4.2.3 | Gender differences ............................................................................................................. 138 |
| 4.2.4 | Relationship between socioeconomic status and self-reported oral health outcomes 141 |
| 4.2.5 | Relationship between socioeconomic status and oral health behaviours .......... 144 |
| 4.2.6 | Relationship between socioeconomic status and psychological factors 145 |
4.2.7 Relationship between oral health behaviours and self-reported oral health outcomes 146
4.2.8 Relationship between psychological factors and self-reported oral health outcomes 147
4.2.9 Relationship between socioeconomic status and oral health: Adjusted models for hypothesised mediators ........................................................................................................ 148
4.3 Strengths and limitations ........................................................................................................ 149
4.4 Implication for future research ................................................................................................... 157
4.5 Implication for policy ............................................................................................................... 158

References .................................................................................................................................. 161

Appendices .................................................................................................................................. 180

Appendix 1 Validation of the Persian Short Version of the Oral Health Impact Profile (OHIP-14) ........................................................................................................................................ 180

Appendix 2 Comparison of the COHIP and OHIP-14 as measures of the oral health-related quality of life of adolescents ........................................................................................................ 193

Appendix 3 Questionnaire .............................................................................................................. 208

Appendix 4 Expert opinions ............................................................................................................. 214

Appendix 5 Guardian’s information sheet ...................................................................................... 218
Table of tables

Table 1 Summary of selected studies that examined behavioural and psychological explanations for health inequality ......................................................... 30
Table 2 Summary of the studies which examined behavioural and psychological explanations for oral health inequality ................................................................. 52
Table 3 Summary of the studies of reporting oral health of Iranian adolescents......... 56
Table 4 Calculated values for building the wealth index ........................................ 78
Table 5 Distribution of sample according to indicators of socioeconomic status ...... 99
Table 6 Distribution of sample according to oral health behaviours ........................ 100
Table 7 Description of the sample according to psychological factors .................. 102
Table 8 Distribution of sample according to self-reported oral health .................... 102
Table 9 Distribution of socioeconomic status, oral health, and self-reported oral health outcomes according to gender ................................................................. 106
Table 10 Mean scores of psychological factors according to gender ....................... 107
Table 11 The relationship between indicators of socioeconomic status and self-reported oral health outcomes ................................................................. 111
Table 12 The relationship between indicators of socioeconomic status and oral health behaviours ................................................................. 115
Table 13 The relationship between indicators of socioeconomic status and psychological factors ................................................................. 117
Table 14 The relationship between oral health behaviours and self-reported oral health outcomes adjusted for indicators of socioeconomic status ............... 119
Table 15 The relationship between psychological factors and self-reported oral health outcomes adjusted for indicators of socioeconomic status .......... 121
Table 16 The relationship between indicators of socioeconomic status and self-reported oral health outcomes; adjusted models for hypothesised mediators ........ 125
Table 17 Summary of the results on mediation ......................................................... 127
### Table of figures

- **Figure 1** Mortality rate ratios by employment grade ................................................................. 25
- **Figure 2** Path diagram for mediation effect .................................................................................. 61
- **Figure 3** Schematic framework of the study showing interrelationships between socioeconomic status and oral health outcomes and the hypothesised mediators: oral health behaviours and psychological factors ............................................................................. 66
- **Figure 4** Geographical location of the study ................................................................................... 69
- **Figure 5** The MacArthur Scale of Subjective Social Status - Youth Version .............................. 72
- **Figure 6** Distribution of subjective socioeconomic status and wealth index before collapsing into quartiles .................................................................................................................. 101
- **Figure 7** Histograms and normality lines for psychological factors ............................................. 103
- **Figure 8** The diagrams showing the relationship between indicators of socioeconomic status and self-reported oral health outcomes ........................................................................ 110
- **Figure 9** The diagrams showing the relationship between indicators of socioeconomic status and oral health behaviours .............................................................................................. 114
Preface

The initial idea of studying social aspects of health was conceived in 2003 when I was working as a dentist in the city of Bam, a deprived area of Iran which had recently been stricken by an earthquake. The bitter but eye-opening experience of dealing with an underprivileged people prompted me to look at health more broadly rather than from the perspective of a dental practitioner doing usual work related activities. Being sponsored by an Iranian university, I was inclined to investigate oral health inequality in Iran. At the same time, I was aware of several limitations associated with performing this study in Iran, such as lack of financial resources, and bureaucratic restrictions. Eventually, in April 2008 I collected data on socioeconomic status, selected oral health behaviours, psychological factors, and self-reported oral health outcomes from secondary school students in Iran.

Nevertheless, my research activities in the field of oral health during my PhD studies were not limited to this PhD thesis. Alongside the main study, I attempted to facilitate the oral health research by conducting various studies. Of those, two were accepted for publication in peer-reviewed journals. The first paper reports on the validity of the Persian version of OHIP-14 as an important indicator for assessing oral health related quality of life (OHRQoL), and the second paper compared the appropriateness of two measures of oral health related quality of life (OHRQoL) in adolescents’ oral health surveys (Appendix 1&2).
Chapter 1.  Introduction and literature review
1.1 General introduction

The difference in the health status of people according to their socioeconomic status is well established (Marmot et al. 1991; Wilkinson et al. 2006), with those of a lower socioeconomic status having worse health compared to those of a higher socioeconomic status. Investigating health differences according to socioeconomic status has become the focus of attention in the last three decades following the publication of landmark reports in England (Black et al. 1980; Marmot et al. 1984; Marmot et al. 1991). Since then, efforts have been made to explore various factors which may explain differences in health according to socioeconomic status. Health behaviours and psychological factors are among the factors which have been investigated in terms of their role in health inequality. This study explores how oral health behaviours such as toothbrushing and psychological factors such as self-esteem may explain the relationship between socioeconomic status and self-reported oral health.

1.2 Literature review

The literature review consists of four sub-sections. The first section is an introduction to health inequality research (see 1.2.1 Introduction to health inequality). This section introduces the relevant terms, the concept of health inequality, explaining health inequality, and behavioural and psychological explanations for health inequality. The second section is an overview of evidence from oral health literature (see 1.2.2 Oral health inequality). In this section, I review self-reported oral health, oral health behaviours and psychological factors in relation to oral health, oral health inequality
among adolescents, behavioural and psychological explanations for oral health inequality, and oral health studies of Iranian adolescents. The third section describes the framework for explaining health inequality (see 1.2.3 Framework for explaining health inequality). In this section, I review the history and concept of mediation, the framework and assessment of hypothesis of mediation and the application of the hypothesis of mediation according to study design. The fourth section introduces the aim, objectives, and the frameworks of the study (see 1.2.4 Aim, objectives and study framework).

1.2.1 Introduction to health inequality

This introduction consists of five sections. The first section defines the relevant terms to this study. The second section introduces the history of research on health inequality. The third section describes the concept of health inequality. The fourth section looks at the literature on explaining health inequality. Finally, the fifth section documents the behavioural and psychological explanations for health inequality.

1.2.1.1 Definition of terms

The variation in the pattern of the relationship between socioeconomic status and health is usually referred to as ‘health inequality’. However, there is little consensus on the definition of the term ‘health inequality’. Carter-Pokras and Baquet (2002) identified a number of proposed definitions for ‘health inequality’. Despite the variety of definitions, they all had in common the key notion of differences in health status across population groups, whether defined by race or ethnicity, gender, social class,
or geographic location (Carter-Pokras et al. 2002). Kawachi indicates that ‘in the absence of a universally agreed-upon definition, health disparities [inequalities] may therefore be thought of as a generic descriptive term to refer to differences or variations in health status between defined population groups’ (Kawachi et al. 2005). Despite this broad definition, ‘health inequality’ is usually understood in the health literature as the differences according to social groups. ‘Health inequality’ has different implications in American and non-American studies. American studies have used the term ‘health inequality’ to refer to differences in health status according to both racial background and social position whereas European studies have mainly used ‘health inequality’ to refer to health differences according to social position typically measured as income, educational attainment, and occupational characteristics (Braveman 2006). Therefore, it is not infrequent to find that the studies have also used the phrase ‘social inequality in health’ to refer to the health inequality according to social position.

One of the confusing terms that has been sometimes erroneously used to refer to ‘health inequality’ is ‘health inequity’. It is important to highlight the difference between ‘health inequality’ and ‘health inequity’ as they are conceptually different. Similar to ‘health inequality’, various definitions are proposed for ‘health inequity’. Braveman has reviewed some of the existing definitions (Braveman 2006). According to Braveman, the most well-known definition for health equity and its opposing term, ‘health inequity’ was suggested by Whitehead in the early 1990s. Whitehead defines ‘health inequity’ as differences in health that ‘are not only unnecessary and avoidable but, in addition, are considered unfair and unjust’ (Whitehead 1992). Also, the most recent definition suggests that health inequities are ‘potentially avoidable differences
in health between groups of people who are more and less advantaged socially; these differences systematically place socially disadvantaged groups at further disadvantage on health’ (Braveman 2006). Definitions of ‘health inequity’ are concerned with the ‘justness’ and ‘fairness’ of the health distribution, political and policy making related issue. In fact, the focus of ‘health equity’ is not in examining how health distributes across social groups; rather it is concerned with the morality and the responsibility of the policies. Kawachi et al have clearly addressed the difference between ‘health inequality’ and ‘health inequity’ in their glossary for health inequalities. They indicate that ‘inequality and equality are dimensional concepts, simply referring to measurable quantities. Inequity and equity, on the other hand, are political concepts, expressing a moral commitment to social justice’ (Kawachi et al. 2002).

Another issue is that some studies have used the term ‘health disparity’ to refer to ‘health inequality’. In fact, the literature does not suggest that they are conceptually distinct. Rather, it seems that the term ‘health disparity’ is more popular in American studies while studies from Europe and other regions of the world are more likely to use the term ‘health inequality’ (Carter-Pokras et al. 2002).

Another potential confusion arises from using the term ‘health inequality’ to refer to differences in health related variables such as access to health care. Although differences in other health related variables such as health care could be an underlying determinant of ‘health inequality’ (Starfield 2007), they are not exactly the same.
The above challenges are not the only issues in the terminology of ‘health inequality’ research. Explaining how ‘health inequality’ emerges has been an interesting topic for researchers since the research on ‘health inequality’ became popular. Kawachi describes the efforts to explain ‘health inequality’ as ‘the most interesting and challenging aspects of health disparities research to date’ (Kawachi et al. 2005). Development of research in this field consequently led to the introduction of a number of terms which are associated with explaining ‘health inequality’. For example, the use of terms such as ‘pathway’ and ‘mechanism’ to describe the situation in which some factors explain health inequality is not infrequent across the literature. Bartley, in her book titled ‘Health inequality: An introduction to theories, concepts and methods’, indicates that terms such as ‘pathway’ encompass detailed understanding of the interrelationship between social and economic circumstances over time and they may be ascertained using complex methods such as path models and growth models (Bartley 2004). Therefore, the application of terms such as ‘pathway’ and ‘mechanism’ should be considered carefully as they may imply specific conceptual and methodological meaning.

Also, it is sometimes seen that the term ‘mediator’ and affiliated terms such as ‘mediation’, and ‘mediational’ are used to refer to factors which explain health inequality. Strictly speaking, these terms have methodological implications and a number of conditions should be met before describing a factor as ‘mediator’. These conditions will be described later in this thesis (see 1.2.3 Framework for explaining health inequality).
Being aware of the aforementioned challenges in the terminology of ‘health inequality’ research, a number of decisions were made in regard to the use of terms in this document.

- The focus of this PhD thesis is ‘health inequality’ rather than ‘health inequity’. This means that this PhD thesis is concerned with the scientific assessment of health differences between social groups; it does not intend to explore the moral and political implication of health differences between groups.

- The term ‘health inequality’ was preferred to ‘health disparity’ given that all the procedures that led to the production of this PhD thesis were performed in the UK.

- ‘Health inequality’ across this document is used to describe health differences between socioeconomic groups and not racial or gender groups, unless otherwise stated.

- ‘Health inequality’ is used to refer to differences in the status of health and not other health related factors, unless otherwise stated.

- For describing the factors that account for ‘health inequality’, I avoided using those terms that might have conceptual and methodological meaning such as
pathway or mechanism, unless otherwise stated. Eventually, the factors which account for health inequality were assumed to explain health inequality.

- The term ‘mediator’ is used in the context of specific methodology, which is described later (see 1.2.3.2 History and concept of mediation).

The next section looks at the history of research on health inequality.

1.2.1.2 History of research on health inequality

One historical review of research on health inequality stated that ‘the issue of social inequalities generally and social inequalities in health were conspicuously muted in the sociology and medical sociology of the 1950s and early 1960s’ (House 2002). Possibly the first compelling evidence concerning health inequality emerged from a review by Antonovsky in 1967, revealing an inverse relationship between socioeconomic status and mortality in a review of more than 30 studies (Antonovsky 1967). Following developments in epidemiology during the second half of the 20th century, attention was paid to the social perspectives of health and health inequality. However, research on health inequality owes most to the landmark reports which emerged in the late 1970s and early 1980s in England: the report of the Working Group on Inequalities in Health (better known as the Black report) (Black et al. 1980) and the Whitehall studies of the health of British civil servants (Marmot et al. 1984; Marmot et al. 1991). The Whitehall studies were started by Geoffrey Rose and, later, continued and expanded by Michael Marmot. These studies drew attention to
the concept of health inequality. In the next section, I review the concept of health inequality.

1.2.1.3 Health inequality: the concept

A large body of literature has emerged which establishes the relationship between socioeconomic status and health (Wilkinson et al. 2006). Health inequality according to socioeconomic status follows a particular pattern in which the effects of socioeconomic status occur across the whole range of the socioeconomic status hierarchy (Marmot et al. 1984; Marmot 2007). Those who benefit from relatively better social position have better health outcomes and this runs from the top to the bottom of the socioeconomic hierarchy (Marmot et al. 1999; Marmot 2003). In other words, differences in health do not only exist between those at the very bottom of the socioeconomic status hierarchy and those who are at the top; in fact, there is an association between increasing socioeconomic status and improving health at all levels of socioeconomic status.

An example from the Whitehall study of British civil servants might help clarify the concept of health inequality. The study of the British Civil Service employment hierarchy consists of four categories: administrative (highest), professional/executive, clerical, and ‘other’ (lowest). Figure 1 shows those ranked higher in socioeconomic status hierarchy have better health outcomes compared to those in lower socioeconomic status. This relationship was observed not only for total mortality rate but for several cause specific mortality rates across 25 years of follow-up (van Rossum et al. 2000). This pattern of distribution of health across categories of
socioeconomic status implies that the effects of socioeconomic status on health should be investigated in a broader way rather than just on the impacts of absolute poverty (Adler et al. 1994).

Interestingly, the presence of health inequality is not limited to developing countries but has also been documented in industrialised countries (Marmot et al. 1991; McDonough et al. 1997; Lynch et al. 1998; Walberg et al. 1998; Adler et al. 1999; Chiang 1999; Marmot 2007). The notion that health is distributed unequally across citizens of wealthy countries suggests that health inequality should be dealt with as a global issue. Further, health inequality is not observed only for specific health outcomes; rather, it has been demonstrated for various health outcomes such as premature mortality, cardiovascular mortality, death from all causes (Marmot et al. 1984; Kunst et al. 1994; Mackenbach et al. 1997; Wilkinson et al. 2008), morbidity outcomes such as cardiovascular disease (Kaplan et al. 1993; Gonzalez et al. 1998; van Rossum et al. 2000; Andersen et al. 2003) and self-reported health outcomes (Power et al. 1996; Power et al. 1998).
Figure 1 Mortality rate ratios by employment grade
Source: van Rossum et al., 2000: reprinted with permission from author
In summary, it seems that health inequality is a major challenge which, to a varying extent, affects the health of the individuals with different socioeconomic status. Also, health inequality appears to be a global challenge that has an influence on various aspects of health. All of the aforementioned evidence suggests that thorough understanding of health inequality is an important challenge for health research. It is not surprising that an extensive body of evidence has emerged to explain health inequality. In the next section, I describe the efforts to explain health inequality.

1.2.1.4 Explaining health inequality

Despite strong evidence supporting the presence of health inequality, much remains to be understood about how to explain health inequality. Explaining health inequality is important in that it facilitates the planning of targeted interventions for reducing the health consequences of socioeconomic stratification. Identifying the factors which explain health inequality has been indicated as an important challenge for health policy makers (Adler et al. 1999) and as a requirement for better understanding of health inequality in 21st century (House 2002).

Various explanations have been proposed for health inequality, implying that the pathways of health inequality are not limited. In one of the first efforts, the authors of the Black Report proposed three explanations: materialist interpretations, cultural-behavioural explanations, and theories of natural and social selection (Black et al. 1980). With the growth of knowledge and the emergence of new studies, it became apparent that the above explanations could not thoroughly explain health inequality; for example, some possible explanations, such as a genetic explanation, were
Bartley modified the earlier explanations and proposed new categories of explanation for health inequality. She introduced the following four explanations: material, cultural-behavioural, psychosocial, and life course (Bartley 2004). Researchers continue to propose new explanations from different points of view. Adler and Newman listed environmental exposure, social environment, health care, and behaviour/lifestyle as possible explanations for health inequality that have implications for policymakers (Adler et al. 2002). Another study suggested selection effects, lifestyle patterns, exposure to life stresses, differences in psychosocial resources, and differential access to health care as possible explanations for health inequality (Ettner et al. 2003). Others named personal choices, health care, and the environment (Kawachi et al. 2005) as explanations, while others identified human capital, social capital, and the direct psychosocial effects of social comparisons (Kawachi et al. 1999) as possible explanations for health inequality. Nevertheless, possible explanations for health inequality are numerous.

Investigating the explanations for health inequality might be facilitated by using appropriate frameworks. There are several hypothetical models which theorise the complex interrelationships that link social context to health status (Andersen 1995; Brunner et al. 1999; Kaplan et al. 1999; Kaplan et al. 2000; Adler et al. 2003; Gallo et al. 2003). Regardless of the differences in these models, they acknowledge the role of health behaviours and psychosocial factors in the relationship between social context and health status.
In summary, several factors are suggested as possible explanations for health inequality; among these explanations, the role of behavioural and psychological factors were emphasised in the literature. The next section discusses the theoretical reasons for assuming that the differences in health behaviours and psychological factors are responsible for health inequality. Also, I review some of the studies which assessed behavioural and psychological explanations for health inequality.

1.2.1.5 Behavioural and psychological explanations for health inequality

The interrelationships between socioeconomic status, health behaviours, psychological factors, and health outcomes suggest that health behaviours and psychological factors may explain health inequality.

Those who are well off in terms of socioeconomic status tend to exercise more, smoke less, and generally lead healthier lifestyle than those less privileged (Winkleby et al. 1990; Osler 1993; Wister 1996; Lynch et al. 1997; Droomers et al. 1998; Frankish et al. 1998). Further, there is evidence for the correlation between health behaviours and health outcomes (McGinnis et al. 1993).

Psychological factors are also suggested as potential factors which explain socioeconomic status and health (Kaplan 1995; Adler et al. 1999; Baum et al. 1999; Gallo et al. 1999; Taylor et al. 2002; Gallo et al. 2003). Socioeconomic status is linked to various psychological factors such as depression, anxiety and hostility (Gallo et al. 2003), and these psychological factors are
associated with health outcomes (Hayward 1995; Glassman et al. 1998; Kubzansky et al. 1998; Rozanski et al. 1999).

The above mentioned interrelationships have prompted researchers to investigate whether health behaviours and psychological factors explain health inequality. As a result, several such studies have emerged in health inequality research to assess the effects of various health behaviours and psychological factors on distinct health outcomes.

A number of studies which examined behavioural and psychological explanations for health inequality are summarised in Table 1. I looked at their study design, study population, indicator of socioeconomic status, health outcome, and examined explanations.
Table 1 Summary of selected studies that examined behavioural and psychological explanations for health inequality

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design and study population</th>
<th>Indicator of socioeconomic status</th>
<th>Health outcomes</th>
<th>Examined explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Lynch et al. 1996)</td>
<td>Longitudinal study of Finnish men aged 25 and older</td>
<td>Personal income</td>
<td>All-cause mortality</td>
<td>Health behaviours: alcohol consumption, smoking, and physical activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cardiovascular mortality</td>
<td>Psychological factors: depression, hopelessness, and cynical hostility</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Acute myocardial infarction (AMI)</td>
<td>Biologic factors: plasma fibrinogen, lipoproteins, cholesterol, blood haemoglobin, blood leukocyte count, serum ferritin, serum copper, hair mercury, baseline blood glucose level, body mass index, and cardio respiratory fitness</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Social factors: social connectedness, organisation membership, quality of social relationship, and marital status</td>
</tr>
<tr>
<td>(Fiscella et al. 1997)</td>
<td>Longitudinal study of American adults aged 25-74</td>
<td>Family income</td>
<td>Mortality</td>
<td>Psychological factors: hopeless affect, hopeless outlook, depression, and life dissatisfaction</td>
</tr>
<tr>
<td>(Lantz et al. 1998)</td>
<td>Longitudinal study of American adults aged 25 years or older</td>
<td>Education</td>
<td>All-cause mortality</td>
<td>Health behaviours: cigarette smoking, alcohol drinking, body mass index, and physical activity</td>
</tr>
<tr>
<td>(Levenstein et al. 1998)</td>
<td>Longitudinal study of American adults aged 17-59</td>
<td>Income</td>
<td>Ulcer incidence</td>
<td>Health behaviours: smoking, alcohol, skipping breakfast, and sleeping habitually</td>
</tr>
<tr>
<td>(Cohen et al. 1999)</td>
<td>Cross-sectional study of American (18 years and older), and Finnish (aged 42, 48, 54, and 60 years): adults</td>
<td>Income</td>
<td>Self-rated health</td>
<td>Psychological factors: psychological stress, personal control, anger/hostility, depression, and social support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Education</td>
<td></td>
<td>Health behaviours: smoking, alcohol consumption, and exercise</td>
</tr>
<tr>
<td>(Lantz et al. 2001)</td>
<td>Longitudinal study of American adults aged 25 years and older</td>
<td>Income</td>
<td>Self-rated health</td>
<td>Health behaviours: cigarette smoking, alcohol drinking, body mass index, and physical activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Education</td>
<td>Functional status</td>
<td>Psychological factors: chronic stressors, recent life events, and job strain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Education</td>
<td>Functional limitation</td>
<td>Psychological factors: self-esteem, mastery, depressive symptoms, and neuroticism</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chronic conditions</td>
<td>Psychological factors: self-esteem, mastery, depressive symptoms, and neuroticism</td>
</tr>
<tr>
<td>Study</td>
<td>Study design and study population</td>
<td>Measures of socioeconomic status</td>
<td>Health outcomes</td>
<td>Examined explanations</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------</td>
<td>---------------------------------</td>
<td>-----------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>(Ferrie et al. 2005)</td>
<td>Longitudinal study of male adults aged 35–55 in England</td>
<td>Economic difficulties (consisted of items reflecting difficulty in payment of bills and purchasing food or clothing)</td>
<td>Three measures of incident coronary; Myocardial infarction (MI), MI plus definite angina, fatal and non-fatal MI</td>
<td>Health behaviours: alcohol, exercise, and smoking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Biological risk factors: blood components (fibrinogen, HDL cholesterol, triglyceride, LDL cholesterol, serum insulin, and plasma glucose), oral glucose tolerance, insulin resistance, blood pressure, waist and hip circumference, and body mass index</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Psychosocial factors: control and demands at work</td>
</tr>
<tr>
<td>(Khang et al. 2005)</td>
<td>Longitudinal study of South Korean adults aged 30 and older</td>
<td>Annual household income</td>
<td>All-cause mortality</td>
<td>Health behaviours: cigarette smoking, alcohol consumption, and exercise behaviour</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Psychosocial factors: feelings of sadness, depression, perceived level of stress, and marital status</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Biological risk factors: body mass index, blood pressure, serum total cholesterol and glucose levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Early life exposure variables: education and adulthood height</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Health behaviours: physical activity, smoking status</td>
</tr>
<tr>
<td>(Thurston et al. 2006)</td>
<td>Longitudinal study of American adults aged 55–74</td>
<td>Education</td>
<td>Incident CHD (coronary heart disease)</td>
<td>Psychological factors: depressive and anxious symptoms</td>
</tr>
<tr>
<td>(Orpana et al. 2007)</td>
<td>Longitudinal study of Danish adults aged 20 years and older</td>
<td>Household income</td>
<td>Self-rated health</td>
<td>Psychological factors: recent life events, chronic stressors, and job strain</td>
</tr>
<tr>
<td>(Prescott et al. 2007)</td>
<td>Longitudinal study of Danish adults aged 20 years and older</td>
<td>Education</td>
<td>Metabolic syndrome</td>
<td>Health behaviours: tobacco consumption, alcohol consumption, and leisure time physical activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Psychological factors: vital exhaustion, perceived stress, and social network</td>
</tr>
</tbody>
</table>
Lynch and colleagues tested whether the following four sets of variables explain health inequality: health behaviours, psychological, biological, and social factors. When the association between socioeconomic status and health outcomes was adjusted simultaneously for the four sets of variables, the relative risk in the lowest income quintile was reduced for all health outcomes. Simultaneous adjustment for all factors eliminated statistical significance of the relationship between socioeconomic status and at least two examined health outcomes. Among investigated factors, biologic risk factors such as body mass index explained the larger proportion of health inequality in comparison to behavioural, psychological, and social factors (Lynch et al. 1996).

Fiscella and Franks examined whether three domains of psychological distress could explain inequality in mortality. When they adjusted the relationship between income and mortality for all psychological factors, the relationship was reduced minimally and did not change the statistical significance of the relationship. The authors concluded that psychological distress is not a ‘major contributor to socioeconomic disparities’ (Fiscella et al. 1997).

Lantz and colleagues analysed whether health behaviours explain inequality in all-cause mortality. When the relationships between indicators of socioeconomic status and mortality were individually controlled for each of the health behaviours, only a small proportion of the relationship was explained and the relationship between socioeconomic status and mortality remained significant. Adjusting for all health behaviours simultaneously, there was still strong and significant inequality in mortality. The authors concluded that the influence of major health risk behaviours explained a ‘modest proportion’ of the relationship between socioeconomic status and mortality (Lantz et al. 1998).
Levenstein and Kaplan explored whether or not health behaviours and psychological factors account for inequality in ulcer incidence. This study also assessed whether explanations for health inequality are different among women and men. After adjustment for health behaviours, the relationship between education and health outcome lost its statistical significance and odds ratios reduced dramatically, particularly among men. On the other hand, adjustment for psychological factors explained health inequality among women more than men. The authors concluded that ‘psychosocial stress seemed to explain social inequality in health better in women, whereas health risk behaviours played a greater role in men’ (Levenstein and Kaplan 1998).

Cohen and colleagues analysed the data from two different samples: American (Harris poll study) and Finnish adults (KIHD study). Behavioural and psychological explanations for health inequality were tested for self-rated health outcome. In both populations, health behaviours and psychological factors explained the relationship between socioeconomic status and self-rated health to some extent. However, the explained extent was larger when psychological factors were taken into account (Cohen et al. 1999).

Lantz and colleagues tested the role of health behaviours in health inequality when health was measured as self-rated health and functional status. Adjustment for health behaviours slightly attenuated the relationship between socioeconomic status and both self-rated health/functional status. However, these relationships remained statistically significant and strong. The authors concluded that ‘the higher prevalence of major health-risk behaviours among those in lower socioeconomic strata is not the dominant mediating mechanism that can explain socioeconomic disparities in health’ (Lantz et al. 2001).
Orpana and Lemyre tested the role of three psychological stressors in health inequality when health was measured as self-rated health. The extent to which these psychological factors explain health inequality among women and men was also compared. This study found that psychological stressors may explain health inequality better among men than among women. The authors suggested that their findings support ‘partial mediation of the differences between the highest and lower socioeconomic groups by stressor exposures’ (Orpana et al. 2004).

Schnittker tested whether four psychological factors may explain health inequality when health was measured as self-rated health, functional limitation, and chronic conditions. Adjustment for psychological factors did not remarkably reduce the relationship between socioeconomic status and health outcomes. The author suggested that ‘the results provide weak support for the idea that psychological factors are mechanisms behind social inequality in health’ (Schnittker 2004).

Ferrie and colleagues examined whether health behaviours, biological factors, and work related psychosocial characteristics explain inequality in cardiovascular health. Adjustment for all three sets of risk factors did not explain health inequality thoroughly. The authors concluded that investigated risk factors ‘partially’ explain health inequality (Ferrie et al. 2005).

One study from a non-western country investigated explanations for inequality in all-cause mortality rates in South Korea. Results of this study suggested that investigated biological risk factors and health behaviours made only small contributions to health inequality, while early life exposure risk factors had a larger effect (Khang et al. 2005).
Lever and colleagues assessed whether psychological factors explain health inequality when health was measured as subjective well-being. This study suggested that psychological factors had an indirect impact on the relationship between social position and well-being. The authors concluded that ‘the relationship between indicator of socioeconomic status and subjective well-being is explained by the intervention of a number of psychosocial variables’ (Lever et al. 2005).

Barger examined whether health behaviours and psychological factors explain health inequality when health was measured as self-rated health. This study suggested that the greater extent of health inequality was explained by health behaviours. Further, this study did not support the hypothesis that psychological factors explain the relationship between education and self-rated health (Barger 2006).

Thurston and colleagues examined whether psychological factors explain health inequality when the health outcome was coronary heart disease (CHD). In terms of the effect of education on the incidence of coronary heart disease (CHD), depressive symptoms accounted for only 4.8% and anxiety symptoms for less than 1%. The authors concluded that depressive and anxiety symptoms do not largely explain health inequality (Thurston et al. 2006).

Orpana and colleagues have investigated the role of three stress related psychological factors in health inequality when health was estimated as self-rated health. Investigated stressors were found responsible for a small but important part of the observed association between income and self-rated health. The authors concluded that the stressors may be one of the mechanisms contributing to poorer health among poorer people (Orpana et al. 2007).
Prescott and colleagues investigated whether or not health behaviours and psychological factors explain health inequality when health was measured as metabolic syndrome. The authors suggested that their study ‘does not support the hypothesis that the connections between education and the metabolic syndrome are mediated through those psychosocial or behavioural factors’ (Prescott et al. 2007).

Summary: In this section, I reviewed a number of relevant studies which examined behavioural and psychological explanations for health inequality. These studies used both cross-sectional and longitudinal data to examine a wide range of health behaviours and psychological factors for both clinically assessed and self-reported health outcomes. The findings of these studies regarding the explained extent by each of behavioural and psychological factors were widely different. While some studies suggested that health behaviours and psychological factors largely explain health inequality, the others provided weak evidence to show such influence. Inconsistency in findings could generally be attributed to variety in settings of the studies, such as characteristics of the population, measurement methods, and health outcomes. Further, the contradictory findings regarding behavioural and psychological explanations for health inequality suggest that possible explanations for health inequality have yet to be fully explored.

In the next section, I will move to oral health literature to introduce the indicators of self-reported oral health, oral health behaviours and psychological factors in relation to oral health, evidence for oral health inequality, the behavioural and psychological explanations for oral health inequality, and the status of oral health research in an Iranian context.
1.2.2 Oral health inequality

The review of oral health literature consists of five sub-sections. I initially introduce the indicators of self-reported oral health (see 1.2.2.1 Self-reported oral health). These indicators were given particular attention as they will be used to estimate oral health status in this study. The second section presents the evidence on oral health behaviours and psychological factors in relation to oral health (see 1.2.2.2 Oral health behaviours and psychological factors in relation to oral health). The third section is an overview of the literature on oral health inequality among adolescents; with particular attention to self-reported oral health outcomes (see 1.2.2.3 Oral health inequality among adolescents). The fourth section summarises the current studies investigating the behavioural and psychological explanations for oral health inequality (see 1.2.2.4 Behavioural and psychological explanations for oral health inequality). Finally, the fifth section looks at the status of oral health research on Iranian adolescents (see 1.2.2.5 Oral health studies of Iranian adolescents)

1.2.2.1 Self-reported oral health

A person’s oral health can be measured in two fundamentally different approaches: in a clinical examination by a dental professional or by the person himself. The concept of measuring oral health led to the introduction of self-reported oral health outcomes. Self-reported oral health outcomes reflect an individual's perception of their oral health status and are assumed to be reasonable markers of health status. In oral health, similar to general health, there has been a movement from the biomedical paradigm, which equates health with the absence of disease, to more holistic models of illness, and consequently the measurement of health has moved towards subjective measures, with increasing focus on patient-centred measures. Application of the subjective oral health indicators in addition to clinical measures
of oral health status is recommended (Locker et al. 1994; Corson et al. 1999) as they reflect the perceived need for oral health care and may help health planning. There has been ongoing interest in exploring the correlation between self-reported oral health and clinical outcomes. However, to date the evidence has been contradictory (Brunswick et al. 1975; Kononen et al. 1986; Axelsson et al. 1995; Atchison et al. 1997; Unell et al. 1997; Robinson et al. 1998; Pitiphat et al. 2002; Gilbert et al. 2007). The results of these studies ranged from weak to strong correlations between self-reported oral health and clinical indicators. Nevertheless, it seems necessary to regard self-reported oral health as a distinct and independent measure of oral health rather than using these indicators as a replacement for clinical outcomes because self-reported oral health is conceptually different.

A wide range of self-reported oral health outcomes are commonly used in oral health studies to estimate the oral health status of the population from different perspectives. There are two main categories of self-reported oral health outcomes: single item and multidimensional indicators of oral health. Some of the single item self-reported oral health indicators estimate the overall status of oral health, dental treatment needs, satisfaction with oral health, satisfaction with the appearance of teeth and mouth and experience of dental pain. These single item questions can be answered using dichotomised or ordinal categories of responses. The second category of self-reported oral health outcomes consists of multidimensional measures known as measures of oral health related quality of life (OHRQoL). Oral health related quality of life (OHRQoL) is a subset of health related quality of life. These measures were introduced to dentistry following the development of a theoretical model for oral health by David Locker (Locker 1988). A number of measures have been developed to investigate oral health related quality of life (Slade 1997).
Oral health behaviours and psychological factors in relation to oral health

Oral health behaviours such as toothbrushing, dental flossing, and visiting dentist are among the most frequently investigated variables in oral health research. The maintenance of good oral hygiene is regarded as a fundamental issue in dental health promotion (Loe 2000).

Major dental associations recommend the daily toothbrushing and dental flossing (American Dental Association & British Dental Association). There is strong evidence to show that toothbrushing is associated with various oral health outcomes. Honkala and Freeman (1988) reviewed several studies from different European countries concerned with oral health behaviours. The authors concluded that toothbrushing frequency affects the incidence of gingivitis and periodontal disease (Honkala et al. 1988). Similarly, toothbrushing frequency was linked to periodontal health in other studies (Sakki et al. 1995; Nicolau et al. 2003; Teng et al. 2003). Toothbrushing is also linked to experience of dental caries (Chestnutt et al. 1998), and self-reported oral health (Perera et al. 2008). In terms of dental flossing, evidence exists for the beneficial effect of use of professional dental flossing in preventing dental caries (Hujoel et al. 2006; Longbottom 2006). Also, regular use of dental floss or comparable inter dental hygiene measures are believed to be a key factor in preventing periodontal diseases (Jackson et al. 2006).

Dental service use and visiting dentists in relation to oral health is largely debated. There are two major questions around dental service use and visiting dentists: (a) whether regular dental service use helps to improve oral health and (b) what the suitable ‘recall interval’ is. The ’recall interval’ is the time period, usually specified in months or years, between visiting dental services or dentists. There has been a debate on whether regular dental attendance
enhances oral health. It has been suggested that regular dental attendance is associated with improved oral health, resulting in less untreated disease, higher numbers of functioning teeth, lower rates of tooth loss, and less acute symptoms (Murray 1996). On the other hand, Sheiham argues that regular attendees may not experience a major advantage over irregular attendees in terms of their total disease experience and that regular visits do not help to prevent the onset of oral disease (Sheiham et al. 1985). Further, interesting results were found in the analysis of Chinese adolescents’ self-reported oral health (Jiang et al. 2005) and that of UK adults (Baker 2009). Analysis indicated that not attending the dentist in the last 12 months was linked to better self-reported oral health. The justification was that the recent visit may be due to presence of symptoms; therefore, those who visited a dentist were more likely to report poor oral health. As a whole, the empirical evidence to date regarding oral health status and visits to dentist/dental services is contradictory. Further, there has been discussion about the optimal length of the recall interval to prevent oral diseases (Kay 1999; Sheiham 2000; Lahti et al. 2001). A recent Cochrane Review looked at the effect of different fixed recall intervals for dental check-ups. This review did not identify sufficient evidence to support or refute the practice of encouraging patients to attend dental check-ups at usually recommended six-month intervals (Beirne et al. 2007). In the UK, the National Institute for Health and Clinical Excellence (NICE) produced a guideline on recall intervals for dental practices (National Institute for Health and Clinical Excellence). This guideline put emphasis on making a decision for about recall interval on the basis of oral health history and examination rather than returning at intervals set by group or service considerations (Tabiat-Pour et al. 2008).

Psychological factors are also believed to influence oral health. Psychological status may influence health and oral health via two main ways. Undesirable psychological status and consequent stress may negatively affect lifestyle and performance of healthy behaviours, which indirectly has an influence on health (Mayne 1999). In the context of oral health, close
relationships between psychological factors and oral health related behaviours, such as toothbrushing, flossing, and the pattern of dental visiting (Ylostalo et al. 2003; Savolainen et al. 2005; Anttila et al. 2006; Mettovaara et al. 2006; Dorri et al. 2010) imply that the indirect effect of psychological factors on oral health behaviours is plausible. Psychological status may also directly influence health via biological determinant and immune response. For instance, there are reports from both animal and human studies attributing the effects of psychological factors on periodontal cellular immune response and neuro-immunological pathways (Houri-Haddad et al. 2003; Johannsen et al. 2006; Johannsen et al. 2007).

A large number of studies investigated the relationship between psychosocial factors and oral health outcomes. Among oral health outcomes, it seems that the oral health research is more concerned about periodontal health. It is reported that different psychosocial factors such as depression, anxiety, stress, loneliness, negative life events, daily strain, occupational stress, life satisfaction, type-A personality and coping behaviours were associated with periodontal health (Freeman et al. 1993; Genco et al. 1999; Locker et al. 2000; Persson et al. 2003; Dolic et al. 2005; Newton 2005; Ng et al. 2006). Peruzzo et al. performed a systematic review of the evidence on the relationship between psychological factors such as depression, anxiety, and stress and periodontal health (Peruzzo et al. 2007). The authors came to the conclusion that ‘most studies showed a positive relationship between stress/psychological factors and periodontal disease’.

There has been less effort to explore how psychological factors may be related to dental caries. One such study examined the relationship between depressive symptoms and number of decayed tooth surfaces among 55-year-old Finnish adults. This study reported that ‘depressive symptoms were not associated with the number of decayed tooth surfaces’ (Anttila et al. 2001). The number of decayed teeth was not shown to be related to GHQ scores
as a marker of psychological well-being in a study of a population of Japanese adults (Ide et al. 2006). Despite these, there is evidence to associate depressive symptoms and increased lactobacillus counts, which suggests that individuals with depressive symptoms are more likely to be at risk for dental caries (Anttila et al. 1999). In a more recent study of dental caries, cynical hostility as a marker of lack of confidence in, or bitterness with other people was linked to the number of decayed teeth in Finnish adults (Suominen-Taipale et al. 2009). Psychological variables are not only associated with clinically assessed oral health outcomes: various indicators of self-reported oral health outcomes are shown to be closely related to psychological factors such as self-esteem (Benyamini et al. 2004; Locker 2009), depression (Anttila et al. 2006; Locker 2009), anxiety (Anttila et al. 2006), life satisfaction (Benyamini et al. 2004; Sanders et al. 2005; Locker 2009), and stress (Sanders et al. 2005).

In summary, both behavioural and psychological variables are related to oral health status to different extents, but the strength of the relationship may vary between studies depending on the outcome measures.

1.2.2.3 Oral health inequality among adolescents

In order to review the evidence on oral health inequality, I initially searched the literature for review studies on the relationship between socioeconomic status and oral health. At the time, at least three such review studies had been published (Watt et al. 1999; Locker 2000; Reisine et al. 2001). Watt and Sheiham have summarised the evidence from the UK oral health reports regarding the relationship between socioeconomic status and oral health outcomes such as dental caries, periodontal disease, dental trauma, and oral cancer in different age groups. This review study suggests that oral health inequality generally exists for various oral health
outcomes among different age groups. However, the starkest oral health inequality is present for dental caries among pre-school children (Watt et al. 1999). The second review study, published by Reisine and Psoter, reviews the relationship between socioeconomic status and incidence/prevalence of dental caries among different age groups. This summary suggests that the magnitude of oral health inequality varies according to age groups. Altogether, this study suggests that oral health inequality is more apparent among children compared to other age groups (Reisine et al. 2001). The third review paper, published by David Locker, reviews the application of specific indicators of socioeconomic status known as area-based measures of deprivation in dentistry. This study might have more relevance to UK researchers as these indicators have been mainly used in the UK (Locker 2000).

Although these three review studies provide insight into oral health inequality in general, each of these studies provides limited information in different aspects. Watt and Sheiham focused on evidence from the UK (Watt et al. 1999); Reisine and Psoter looked at specific oral health outcome (Reisine et al. 2001); and Locker reviewed oral health inequality emphasising on certain categories of indicators of socioeconomic status (Locker 2000). Further, the aforementioned review studies have specifically looked at oral health inequality when oral health was estimated using clinically assessed indicators, while the studies with self-reported data are not included.

For this PhD, I decided to focus on oral health inequality and self-reported oral health outcomes in adolescents. This independent investigation of adolescents is vital for two reasons. Firstly, I did not identify any review study of oral health inequality which has specifically considered self-reported oral health outcomes. Secondly, as I will mention in the discussion chapter, the evidence on health inequality among adolescents seems to be inconclusive when compared to robust evidence from the population of children and adults.
(West 1997; Starfield et al. 2002). Therefore, the evidence on oral health inequality for adolescents requires particular investigation.

I review a number of oral health studies of adolescents which presented data on the relationship between socioeconomic status and two self-reported oral health outcomes: single item self-rated oral health and experience of dental pain. Earlier, I explained that self-reported oral health outcomes are important indicators of oral health (see 2.2.4 Self-reported oral health). The single item self-rated oral health, also called ‘global self-assessment of oral health’, is a valid indicator (Jones et al. 2004) which has been used, although with different wordings, in several oral health surveys. Some of the main nationally representative health surveys of adults which have used this indicator are the National Dental Telephone Interview Survey in Australia (Carter et al. 2003) and the National Health and Nutrition Examination Survey in the United States (Gift et al. 1998). Dental pain is also an important indicator of oral health in that it negatively affects the quality of life (Ratnayake et al. 2005) and may indicate the treatment need of the population (Pau et al. 2008).

At least five oral health studies of adolescents have presented data on the relationship between indicators of socioeconomic status and single item self-rated oral health in Tanzania, China, India, Brazil, and Sri Lanka (Astrom et al. 2002; Jiang et al. 2005; David et al. 2006; Pattussi et al. 2007; Perera et al. 2008).

Astrom and Mashoto examined Tanzanian secondary school students (mean age 15.7 years). Socioeconomic status was measured as father’s education. This study found that those with a higher father’s education reported better oral health status on single item self-rated oral health (Astrom et al. 2002). Jiang and colleagues studied 11, 13, and 15 year old Chinese adolescents. Socioeconomic status was measured as parental education and family income.
The single item self-rated oral health was statistically significantly related to parental education but not to family income (Jiang et al. 2005). David and colleagues studied 12 year-old Indian adolescents. Socioeconomic status was measured as family wealth. This study did not find the relationship between single item self-rated oral and family wealth (David et al. 2006). Pattussi and colleagues studied 14–15 year old Brazilian adolescents. Socioeconomic status was measured using a composite indicator of socioeconomic status which considered both the ownership of household assets and the education of the head of the household. Socioeconomic status was statistically significantly related to single item self-rated oral health (Pattussi et al. 2007). Perera and Ekanayake investigated 15-year-old Sri Lankan adolescents. Household income was related to single item self-rated oral health (Perera et al. 2008).

In terms of the experience of dental pain, at least four oral health studies of adolescents have presented data on the relationship between various indicators of socioeconomic status and experience of dental pain in China, Brazil, Greece, and Pakistan (Jiang et al. 2005; Goes et al. 2007; Pau et al. 2007; Pau et al. 2008).

During a period of 12 months, Jiang and colleagues examined the relationship between socioeconomic status and ‘dental pain and symptoms’ among 11, 13, and 15 year old Chinese adolescents. Socioeconomic status was measured as parental education and family income. The prevalence of ‘dental pain and symptoms’ was not statistically significantly related to either parental education or to family income (Jiang et al. 2005). Goes and colleagues presented data on the relationship between socioeconomic status and prevalence/severity of dental pain among 14-15 year old Brazilian adolescents during a six month period. Socioeconomic status defined ‘by the participation of the head of the family in the distribution and production processes’ was found to be statistically significantly related to prevalence/severity of dental pain (Goes et al. 2007).
Pau and colleagues examined the relationship between socioeconomic status and prevalence of ‘oral pain’ among 12-year-old Greek children during a four week period. Socioeconomic status estimated according to parents’ employment status was not associated with the prevalence of dental pain (Pau et al. 2007). The relationship between socioeconomic status and prevalence of ‘dental pain’ in a one month period was examined among 11–14 year old Pakistani adolescents. Socioeconomic status measured as parental employment status and car ownership was not statistically significantly related to dental pain (Pau et al. 2008).

Summary: A number of studies appear to have investigated oral health inequality among adolescents for two self-reported oral health outcomes: single item self-rated oral health and experience of dental pain. Considering single item self-rated oral health, the majority of the reviewed studies have associated various indicators of socioeconomic status such as the ownership of household assets, household income, and parental education with single item self-rated oral health (Astrom et al. 2002; Jiang et al. 2005; Pattussi et al. 2007; Perera et al. 2008). However, two studies found that single item self-rated oral health was not related to family income (Jiang et al. 2005) and family wealth (David et al. 2006). In terms of dental pain, one study related socioeconomic status to dental pain (Goes et al. 2007), but the majority of the reviewed studies failed to relate parental education, family income, parental employment status, and car ownership to dental pain (Jiang et al. 2005; Pau et al. 2007; Pau et al. 2008).

In the next section, I will review the oral health studies which have evaluated the role of oral health behaviours and psychological factors in explaining oral health inequality.
1.2.2.4 Behavioural and psychological explanations for oral health inequality

At least two papers have summarised the theoretical basis of oral health inequality (Petersen 1990; Sisson 2007). The earlier paper by Petersen discussed the possible explanations for oral health inequality by summarising relevant studies from Denmark (Petersen 1990). The latter paper by Sisson has looked at studies that examined four explanations for oral health inequality: materialist, cultural/behavioural, psychosocial, and life course perspective (Sisson 2007). Among possible factors that explain oral health inequality, oral health behaviours and psychological factors received more attention. Studies emerged to investigate whether oral health behaviours and psychological factors explain oral health inequality. In here, I review eight such studies. Table 2 provides a summary of these studies in terms of their study design/population of the study, indicator of socioeconomic status, oral health outcomes, and the explanation for oral health inequality. Four out of eight reviewed studies focused on oral health behaviours (Sanders et al. 2006; Wamala et al. 2006; Donaldson et al. 2008; Sabbah et al. 2008) and four others have investigated the role of psychological factors (Sanders et al. 2007; Sabbah et al. 2008; Locker 2009; Sabbah et al. 2009) in oral health inequality.
Sanders and colleagues evaluated whether oral health behaviours such as dental visiting and dental self-care explain oral health inequality when oral health was measured as the number of missing teeth and oral health related to quality of life (OHRQoL). The relationship between socioeconomic status and oral health outcomes did not change markedly when the relationships were simultaneously adjusted for two aspects of oral health behaviours. The authors finally concluded that investigated oral health behaviours do not appear to account for oral health inequality (Sanders et al. 2006).

Wamala and colleagues tested whether health behaviours such as access to dental care services and lifestyle factors (daily smoking, daily snuffing, high alcohol consumption, dietary habits and physical inactivity) explain inequality in single item self-rated oral health and self-reported periodontal disease. Access to dental care and lifestyle factors explained oral health inequality to some extent; however, access to dental care services was a stronger explanation compared to lifestyle factors (Wamala et al. 2006).

Donaldson and colleagues analysed whether dental attendance may explain inequality in oral health. Oral health was estimated as the number of sound teeth. The authors suggested that the association between socioeconomic status and the number of sound teeth is partially explained by dental attendance (Donaldson et al. 2008).

Sanders et al. analysed the data from a survey of adults in metropolitan Adelaide to explore how perceived stress may transfer the effects of socioeconomic status to the oral health outcome of the study as retention of fewer than 20 teeth. Two components
of stress, coping and distress, were investigated. The relationship between socioeconomic status and oral health outcomes did not lose its statistical significance after adjustment for both components of stress. However, the strength of the relationship reduced as a result of adjustment and the extent of reduction was more apparent for coping rather than distress. The authors concluded that ‘findings only partly supported the hypothesis that psychological stress mediates the relationship between socioeconomic position and tooth loss’ (Sanders et al. 2007).

Sabbah and colleagues analysed the data from the US Third National Health and Nutrition Examination Survey (NHANES III) to examine the role of health behaviours (Sabbah et al. 2008) and psychological factors such as allostatic load (Sabbah et al. 2008) and cognitive ability (Sabbah et al. 2009) in oral health inequality. Oral health was measured as periodontal health, number of missing teeth, and single item self-reported oral health. The relationship between socioeconomic status and oral health outcomes remained statistically significant after adjustment for oral health behaviours, implying that investigated oral health behaviours do not remarkably account for this relationship (Sabbah et al. 2008). When the relationship between socioeconomic status and oral health outcomes was adjusted for allostatic load (Sabbah et al. 2008) and cognitive ability (Sabbah et al. 2009), there was a modest attenuation in the relationships, implying that oral health inequality may be partially explained by these psychological factors. It is worth mentioning that allostatic load was investigated as a marker of stress in the study of Sabbah and colleagues (Sabbah et al. 2008). However, assessment of seven components of allostatic load such as high blood pressure and high plasma glucose suggest that
allostatic load may more appropriately indicate the biological status rather than psychological stress.

Locker and colleagues tested the role of several psychological factors in oral health inequality when oral health was measured using indicators of self-reported oral health. Although the relationship between socioeconomic status and self-reported oral health outcomes reduced adjusting for all psychological factors, it still remained statistically significant. The authors suggested that adjusting for psychological factors does not eliminate oral health inequality (Locker 2009).

Summary: I reviewed selected studies which have examined behavioural and psychological explanations for oral health inequality. Summary of the studies in table 2 shows that these studies used cross-sectional data, and recruited from adult populations in developed countries. This suggests the need for testing behavioural and psychological explanations for oral health inequality among populations which have not been explored yet. In terms of investigated oral health outcomes, both self-reported oral health outcomes and clinically assessed oral health outcomes have been examined. However, reviewed studies either examined the role of oral health behaviours (Sanders et al. 2006; Wamala et al. 2006; Donaldson et al. 2008; Sabbah et al. 2008) or psychological factors (Sanders et al. 2007; Sabbah et al. 2008; Locker 2009; Sabbah et al. 2009) in explaining oral health inequality. In other words, simultaneous examination of behavioural and psychological explanations for oral health inequality seems to be missing from the literature. Findings of those studies which assessed oral health behaviours do not strongly support the argument that these factors strongly explain oral health inequality. This review indicates that oral health
behaviours only partially explain oral health inequality (Sanders et al. 2006; Wamala et al. 2006; Donaldson et al. 2008). Similarly, those studies which evaluated psychological explanations for oral health inequality suggest that investigated psychological factors partially explain oral health inequality (Sanders et al. 2007; Sabbah et al. 2008; Sabbah et al. 2008; Locker 2009; Sabbah et al. 2009).

The next section looks at studies which have reported on the oral health status of Iranian adolescents.
Table 2 Summary of the studies which examined behavioural and psychological explanations for oral health inequality

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design/Population of the study</th>
<th>Indicator of socioeconomic status</th>
<th>Oral health outcomes</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Sanders et al. 2006)</td>
<td>Cross-sectional study of Australian adults aged 18 to 91</td>
<td>Index of Relative Socioeconomic Disadvantage (IRSD)</td>
<td>Numbers of missing teeth</td>
<td>Oral health behaviours: dental visiting and dental self-care behaviours</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oral health related quality of life</td>
<td></td>
</tr>
<tr>
<td>(Wamala et al. 2006)</td>
<td>Cross-sectional study of Swedish adults aged 16–84 years</td>
<td>The socioeconomic disadvantage index (SDI)</td>
<td>Single item self-rated oral health</td>
<td>Oral health behaviours: access to dental care services, lifestyle factors</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Self-reported periodontal disease</td>
<td>(daily smoking, daily snuffing, high alcohol consumption, dietary habits</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>with less fruit and vegetables and physical inactivity)</td>
</tr>
<tr>
<td>(Donaldson et al. 2008)</td>
<td>Cross-sectional study of adults in the UK</td>
<td>Weekly household income</td>
<td>Number of sound teeth</td>
<td>Oral health behaviours: dental attendance</td>
</tr>
<tr>
<td>(Sabbah et al. 2008)</td>
<td>Cross-sectional study of US adults aged 17 years and older</td>
<td>Poverty-income Ratio</td>
<td>Periodontal disease</td>
<td>Oral health behaviours: smoking, frequency of dental visits, frequency of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Years of education</td>
<td>Missing tooth surfaces</td>
<td>eating fresh fruits and vegetables</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Self-rated oral health</td>
<td></td>
</tr>
<tr>
<td>(Sanders et al. 2007)</td>
<td>Cross-sectional study of adults in Australia</td>
<td>According to eligibility for government funded</td>
<td>Retention of teeth</td>
<td>Psychological variable: perceived Stress (distress, coping)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>health care</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Sabbah et al. 2008)</td>
<td>Cross-sectional study of US adults aged 17 years and older</td>
<td>Poverty-income ratio</td>
<td>Periodontal disease</td>
<td>Psychological variable: allostatic load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Years of education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Sabbah et al. 2009)</td>
<td>Cross-sectional study of US adults aged 17 years and older</td>
<td>Poverty-income ratio</td>
<td>Periodontal disease</td>
<td>Psychological variable: cognitive ability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Years of education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Locker 2009)</td>
<td>Cross-sectional study of Canadian citizens aged 20 years and</td>
<td>Annual household Income</td>
<td>Self-rated oral health: single item and 13-item scale</td>
<td>Psychological variables: self-esteem, depression, sense of belonging to a</td>
</tr>
<tr>
<td></td>
<td>older</td>
<td></td>
<td>Having extracted teeth</td>
<td>community, life satisfaction, and severity of life stress</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wearing denture</td>
</tr>
</tbody>
</table>
1.2.2.5 Oral health studies of Iranian adolescents

I searched Medline to identify those studies that have reported at least one oral health outcome from Iranian adolescents. In the review of oral health studies of Iranian adolescents, particular attention was paid to how socioeconomic status, oral health behaviours and psychological factors are investigated in relation to oral health. Table 3 summarises these studies in terms of their date of data collection, sample size, and measures of oral health.

I found nine papers, all published in English between 2005 and 2008, which presented data on the oral health status of Iranian adolescents. Looking at the date of data collection, the earliest data was collected in 1999 (Momeni et al. 2006) while the latest data collection occurred in 2005 (Hamissi et al. 2008). Due to the inclusion criteria, the age range of participants was between 12 and 19 years of age. The sample size of the studies varied from 506 (Yazdani et al. 2008) to 4448 participants (Hessari et al. 2008).

In terms of oral health outcomes, eight out of nine studies have reported clinically assessed oral health outcomes such as dental caries (Daneshkazemi et al. 2005; Momeni et al. 2006; Meyer-Lueckel et al. 2007; Hamissi et al. 2008; Hessari et al. 2008; Yazdani et al. 2008), periodontal health (Hessari et al. 2008; Kazemnejad et al. 2008; Yazdani et al. 2008), orthodontic status/malocclusions (Danaei et al. 2007; Yazdani et al. 2008), and enamel hypoplasia (Daneshkazemi et al. 2005). Only one paper reported on self-reported oral health using single item self-reported oral health (Yazdani et al. 2008).
In terms of socioeconomic status, five studies investigated the relationship between at least one indicator of socioeconomic status and oral health outcomes (Daneshkazemi et al. 2005; Momeni et al. 2006; Danaei et al. 2007; Hessari et al. 2008; Kazemnejad et al. 2008; Yazdani et al. 2008). Of those, the majority estimated socioeconomic status using parental education/occupation (Daneshkazemi et al. 2005; Danaei et al. 2007; Hessari et al. 2008; Kazemnejad et al. 2008), two studies estimated socioeconomic status according to wealth status of the family (Yazdani et al. 2008), and one study used the profile of the school (Momeni et al. 2006). The relationship between indicators of socioeconomic status and oral health outcomes was established in some studies with clinical oral health outcomes (Momeni et al. 2006; Hessari et al. 2008; Kazemnejad et al. 2008; Yazdani et al. 2008) and in the only study with self-reported oral health (Yazdani et al. 2008).

In terms of investigating oral health behaviours and psychological factors, two studies explored oral health behaviours such as frequencies of toothbrushing/dental flossing and patterns of visiting a dentist in relation to oral health outcomes (Daneshkazemi et al. 2005; Kazemnejad et al. 2008), whereas no study explored psychological factors in relation to oral health outcomes.

Summary: Data on the oral health of Iranian adolescents from community-based studies was absent in the literature until the last few years. Recently, a few studies emerged to report the oral health status of Iranian adolescents; of those, the majority have assessed clinical oral health outcomes rather than self-reported oral health outcomes. Socioeconomic status was assessed in relation to oral health status in the
majority of the studies using parental education/occupation. Oral health behaviours, however, have been rarely examined in relation to oral health outcomes and no study has explored psychological factors in relation to oral health outcomes.

In the next section, I will introduce the framework for testing the factors which explain health inequality.
Table 3 Summary of the studies of reporting oral health of Iranian adolescents

<table>
<thead>
<tr>
<th>Study</th>
<th>Location / Date of data collection</th>
<th>Age group / sample size</th>
<th>Oral health outcome</th>
<th>Investigated covariates</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Meyer-Lueckel et al. 2007)</td>
<td>2003/ Tehran &amp; Semnan &amp; Dibaj</td>
<td>12 and 15 year olds / 593 (290 Male &amp; 303 Female)</td>
<td>Dental caries (DMFT, Caries free)</td>
<td>Gender, city</td>
</tr>
<tr>
<td>(Daneshkazemi et al. 2005)</td>
<td>2001/ Yazd &amp; Hadishahr</td>
<td>12 year olds / 1223 (654 Male &amp; 569 Female)</td>
<td>Dental caries (DMFT, Caries free)</td>
<td>Gender, toothbrushing frequency, dental flossing frequency, number of siblings, Parental occupation/education, enamel hypoplasia</td>
</tr>
<tr>
<td>(Momeni et al. 2006)</td>
<td>1999/ Tehran &amp; rural area surrounding Esfahan</td>
<td>12 year olds / 1102 (unknown male &amp; female)</td>
<td>Dental caries (DMFT, Caries free)</td>
<td>Location of the school in the city (as a proxy for socioeconomic status)</td>
</tr>
<tr>
<td>(Yazdani et al. 2008)</td>
<td>2004/ Tehran</td>
<td>15 year olds / 506 (260 Male &amp; 246 Female)</td>
<td>Dental caries (DMFT, Caries free)</td>
<td>Gender, parental education</td>
</tr>
<tr>
<td>(Hessari et al. 2008)</td>
<td>2002/ National health survey</td>
<td>18 year olds / 4,448 (Male 2,021 &amp; female 2,427)</td>
<td>Dental caries (DMFT, Caries free)</td>
<td>Gender</td>
</tr>
<tr>
<td>(Kazemnejad et al. 2008)</td>
<td>2004/ Tehran</td>
<td>15-19 year olds / 867 (446 Male &amp; 421 Female)</td>
<td>Periodontal disease (community periodontal index)</td>
<td>Gender, father’s and mother’s education, toothbrushing frequency, dental flossing frequency, pattern of dental visit, having extracted teeth</td>
</tr>
<tr>
<td>(Yazdani et al. 2008)</td>
<td>2004/ Tehran</td>
<td>15 year olds / 506 (260 Male &amp; 246 Female)</td>
<td>Periodontal disease (community periodontal index)</td>
<td>Gender, parental education</td>
</tr>
<tr>
<td>Hessari, Vehkalahti et al. (2008)</td>
<td>2002/ Iran (National health survey)</td>
<td>18 year olds / 4,448 (Male 2,021 &amp; 2,427 Female)</td>
<td>Periodontal disease (community periodontal index)</td>
<td>Level of education, place of residence</td>
</tr>
<tr>
<td>(Yazdani et al. 2008)</td>
<td>2004/ Tehran</td>
<td>15 year olds / 506 (260 Male &amp; 246 Female)</td>
<td>Orthodontic status/malocclusions (Index of orthodontic treatment need)</td>
<td>Gender, family size, parental education, father’s occupation</td>
</tr>
<tr>
<td>(Danaei et al. 2007)</td>
<td>2004/ Shiraz</td>
<td>12-15 year olds / 900 (450 Male &amp; 450 Female)</td>
<td>Orthodontic status/malocclusions (dental Aesthetic Index)</td>
<td>Gender, toothbrushing frequency, dental flossing frequency, number of siblings, parental occupation/education, DMFT</td>
</tr>
<tr>
<td>(Daneshkazemi et al. 2005)</td>
<td>2001/ Yazd &amp; Hadishahr</td>
<td>12 year olds / 1223 (654 Male &amp; 569 Female)</td>
<td>Enamel hypoplasia (Developmental Defect of Enamel Index)</td>
<td>Gender, parental education, wealth status of the family</td>
</tr>
<tr>
<td>(Yazdani et al. 2008)</td>
<td>2004/ Tehran</td>
<td>15 year olds / 509 (260 Male &amp; 249 Female)</td>
<td>Self-reported oral health</td>
<td>Profile of the school</td>
</tr>
</tbody>
</table>

Clinically assessed oral health

Self-reported oral health
1.2.3 Framework for explaining health inequality

1.2.3.1 Introduction

The relationship between two variables cannot be thoroughly understood except in the context of all the others. Therefore, there has been a surge of interest in going beyond establishing the relationship between variables by identifying a ‘third’ variable that affects the relationship. Exploring the role of a ‘third’ variable provides an opportunity to obtain a more sophisticated understanding of the relationship between two variables. Identifying the variables which affect the relationship between two variables is of practical importance for policy makers who wish to design an intervention to manipulate the important predictors. Therefore, disregarding the role of the third variable might result in a disappointing result from costly and time-consuming randomised clinical trials and interventional health programmes.

Superficially, the contribution of a third variable to the relationship between two other variables might seem simple; however, the three-variable systems can be very complicated. This is because there is more than one way that the third variable could be related to the relationship between two other variables. There are several possible relations that a third variable such as Z may affect the relation between X and Y. Some of these possible relationships are mediation, moderation, and overlapping (Kraemer et al. 2001).
Among these, the mediation hypothesis is one popular way for testing whether the third variable explains the relationship between two other variables. In the next section, I describe the history and concept of mediation.

1.2.3.2 History and concept of mediation

The mediation model was developed to explain how the relationship between two other variables is being affected by a third variable. Despite being discussed in the literature during the 1950s, before the 1980s the term ‘mediation’ was almost being used colloquially rather than with reference to its methodological meaning, (Rozeboom 1956). Nevertheless, attention was drawn to the hypothesis of mediation following its introduction in 1979 by David Kenny and publication of a landmark paper in the Journal of Personality and Social Psychology (Baron et al. 1986). The study of mediation owes much to the publication of this paper in which Baron and Kenny proposed conceptual, strategic, and statistical definitions of this model. Since then, this method has been an attractive approach to the exploration of intermediate factors in the behavioural and health sciences; as evidence of this attractiveness, the paper has received more than 13,000 citations. A brief history of the hypothesis of mediation and its application in research has been recently documented by one of the developers (Kenny 2008).

The mediation hypothesis has been widely applied in the literature; however, there is still ongoing debate about meaning and the proper analysis of mediation (MacKinnon et al. 2008; Gelfand et al. 2009). Nevertheless, there is agreement that two conditions should be considered for testing a third variable as a mediator: temporal precedence
and association. In other words, temporal precedence and association are two essential pre-requirements for suggesting that a third variable could be a potential mediator (MacKinnon 2008). Temporal precedence refers to the causal relationships between variables; association indicates the strength of correlation. The issue of temporal precedence seems to be more crucial in that it has been sometimes disregarded by studies. Despite the importance of considering and acknowledging the temporal precedence, Gelfand and colleagues found ‘a lack of attention to important assumptions underlying associational causal modelling’ in their review of the studies which have employed the hypothesis of mediation since 2002 (Gelfand et al. 2009). In fact, the mediation model is, by nature, a causal model because it proposes directional inferences (Rose et al. 2004); therefore, temporal precedence of the variables in the framework should be addressed.

In the next section, I will explain the framework for explaining health inequality and discuss the hypothesis of mediation.

1.2.3.3 Framework and assessment of the mediation

According to Baron and Kenny, a variable M is a mediator of the relationship between X and Y if M helps to explain how or why X is related to Y (Baron et al. 1986). Mediation is also simply defined as the relation such that an independent variable causes a mediating variable, which then causes a dependent variable (MacKinnon 2008). In other words, a mediator (M) is a third variable that links an independent (X) and dependent variable (Y). This implies the addition of a third variable to the X → Y relation, whereby X causes the mediator, M, and M causes Y,
so X→ M → Y. MacKinnon, who has published major works on mediation, indicated that ‘…mediating variables are behavioural, biological, psychological, or social constructs that transmit the effect of one variable to another variable. Mediation is one way that a researcher can explain the process or mechanism by which one variable affects another. Mediation represents the consideration of how a third variable affects the relation between two other variables’ (MacKinnon et al. 2007).

Figure 2 demonstrates the graphical illustration of mediation. According to this model, independent variable (X) is related to dependent variable (Y) via path c. When the effect of X on Y is mediated by mediating variable (M), the variable X may still directly affect Y via path c’. After adding M to the relationship between independent variable (X) and dependent variable (Y), X still has an effect on the mediator, denoted as a, and in turn, the mediator has an effect on Y denoted as b. In fact, mediator (M) plays dual roles in a causal relationship. On the one hand, a mediator is the dependent variable for X; on the other hand, it acts like an independent variable for Y. Path c is called the total effect, path c’ is called the direct effect, and the extent of the relationship mediated by hypothesised mediators is determined by the attenuation in total effect. If hypothesised mediator (M) completely mediates the X-Y relationship, the effect of X on Y controlling for (M) (path c’) should be zero. However, this is not usually the case and mediation could be partial.
More than one method has been proposed for analysing the mediation model. Some of these models have been summarised in a recent review of the literature (Wu et al. 2008). However, the classic work by Kenny and colleagues (Baron et al. 1986) continues to be the most popular and prevalent approach (Collins et al. 1998; Spencer et al. 2005). The method proposed by Baron and Kenny for analysing the mediation is more flexible to study designs compared to alternative models in that it could be applied for observational data while the others might be inappropriate (Kraemer et al. 2001; Wu et al. 2008). Briefly, then, this model presents a four-step data analytic method to establish a mediation effect. According to this model, four conditions should be tested in order to show that M is the mediator of the relationship between independent variable (X) and dependent variable (Y). These four conditions are:

- Independent variable (X) is related to the dependent variable (Y)
- Independent variable (X) is correlated with the mediator (M)
• Mediator (M) is related to dependent variable (Y) after adjustment for the independent variable (X)
• The impact of the independent variable (X) on dependent variable (Y) attenuates (partial mediation) or is removed (complete mediation) after controlling for hypothesised mediator (M)

While testing the third condition, it is important to control for independent variable (X) to ascertain the unique effect of the mediator on the dependent variable. This is because it might be that both the hypothesised mediator and the dependent variable are caused by the independent variable (X→ M and Y) rather than specification by the mediation model (X→ M → Y).

Application of the model proposed by Baron and Kenny is subject to several limitations which should be addressed. It has been stated that ‘meeting all four steps does not conclusively establish that the hypothesized mediation model has occurred because there are other alternative models that meet the above specification’ (Wu et al. 2008). For example, a reverse hypothesis that the dependent variable causes the mediator is not ruled out, especially when observational data are being used.

1.2.3.4 Application of hypothesis of mediation: study design

The causal nature of the relationships between variables might raise questions regarding the appropriateness of its application by observational and cross-sectional studies. For example, the mediation model assumes that independent variable (X) comes before mediator (M), which comes before dependent variable (Y), while
establishing such relationships with cross-sectional data is technically impossible. In other words, for using this model in cross-sectional studies, establishing the temporal precedence of the variables is the challenging issue when the data for the independent, mediator and dependent variable is being collected at one point in time. Failure to consider the causal nature of this model has been widely observed in studies which have used the mediation hypothesis in the absence of theoretical background for the causal relationships (MacKinnon et al. 2002; Frazier et al. 2004).

However, the causal nature of this model does not mean that its application is methodologically flawed. Rather, it is useful for the development of theory and the generation of hypotheses (Shrout et al. 2002). Therefore, the use of observational data for testing the hypothesis of mediation is frequent. The review of studies which employed the hypothesis of mediation suggests that many of the studies have employed observational data (Gelfand et al. 2009). Given that a great amount of epidemiological evidence in behavioural and health sciences are based on cross-sectional data, the mediation hypothesis has been widely used by observational and cross-sectional studies. Also, there are circumstances in behavioural and health sciences where collection of longitudinal data is impossible or ethically inappropriate. In order to prevent methodological mistakes in terms of requirements of temporal precedence, using the mediation model should be justified, and necessary considerations should be mentioned. One possible situation that might lessen concerns regarding the shortcoming of cross-sectional studies in establishing temporal precedence was addressed by Smith in 1982. He suggested that sometimes the meaning of the variables measured in a cross-sectional study imply temporal precedence (Smith 1982). Apart from careful consideration of the temporal
precedence while planning the study, findings from cross-sectional data should be interpreted cautiously. MacKinnon has explicitly stated that ‘all studies can shed light on mediational processes including cross-sectional studies. The important point is the quality of the conclusions regarding mediational process’ (MacKinnon 2008).

The aforementioned limitations associated with application of the mediation hypothesis in cross-sectional data may not be present for longitudinal data. For instance, in the real world, it takes some time before the effects of independent variables appear in mediator and independent variables. Collecting data using a longitudinal study allows for such effects while a cross-sectional study does not.

In summary, although longitudinal studies may be the ideal evidence for testing the third variable, there is no objection for using the mediation model in cross-sectional data if the limitations were regarded for justifying the temporal precedence of variables and avoiding causal conclusions when interpreting the findings from cross-sectional data.

1.2.4 Aim, objectives and study framework

1.2.4.1 Aim

There is a gap in our knowledge about the role of oral health behaviours and psychological factors in oral health inequality.
Therefore, this study aimed to investigate whether oral health behaviours and psychological factors explain oral health inequality employing the hypothesis of mediation.

1.2.4.2 Objectives

The objectives of this study are defined to address four conditions of the hypothesis of mediation:

- Socioeconomic status is significantly associated with self-reported oral health
- Socioeconomic status is significantly associated with oral health behaviours/psychological factors
- Oral health behaviours/psychological factors are significantly associated with oral health after adjustment for indicators of socioeconomic status
- The relationship between socioeconomic status and oral health is attenuated after controlling for oral health behaviours/psychological factors

1.2.4.3 Framework of the study

The theoretical framework for the study was derived from psychosocial determinants model (Marmot et al. 1999). The framework of the study was depicted to allow for testing of the hypothesis of mediation (Figure 3).
Figure 3 Schematic framework of the study showing interrelationships between socioeconomic status and oral health outcomes and the hypothesised mediators: oral health behaviours and psychological factors
Chapter 2. Methods and materials
This chapter describes the setting of the study, the study instruments, the sampling, sample size calculation, data collection, ethical issues, and treatment of data.

2.1 Setting

2.1.1 Study design

This was a cross-sectional study which collected data on socioeconomic status, oral health behaviours, psychological factors, and self-reported oral health outcomes. The use of a cross-sectional design is attached to a number of limitations which will be discussed elsewhere.

2.1.2 Geographic location of the study

The study was performed in the city of Sanandaj in the province of Kurdistan, western Iran. Kurdistan, with an area of 28,817 km$^2$ (Statistical Centre of Iran), is located in the West of Iran and is bordered by Iraq to the West and the province of West Azerbaijan to the North (Figure 4). The capital, Sanandaj, had an estimated population of 358,084 in 2006. The citizens of Sanandaj are mainly Kurdish with an Armenian and Jewish minority. Persian is the official language and the language of instruction at schools, while Kurdish is spoken as a local language by the people. There is no governmental report, to my knowledge, on the provision of dental services in Kurdistan. However, I expect that dental services in Sanandaj are mainly provided by the private sector, as it is the case with other Iranian cities (Pakshir 2004). Public water in Sanadaj is not fluoridated according to official authorities at the Medical University of Kurdistan. However, there is no governmental document to
report the fluoride concentration in public water. However, a recent study has reported the fluoride concentration of Sanadaj as 0.31 Mg/L. (Safari et al. 2008), which is below the recommended level set by the World Health Organisation (World Health Organization 1994).

Figure 4 Geographical location of the study

2.1.3 Study population

The study population consisted of 2\textsuperscript{nd} and 3\textsuperscript{rd} grade high school students of both sexes (15-17 year old adolescents). This age group is easily available because studying in elementary and secondary schools is compulsory in Iran. This may guarantee that the participants are a reasonably representative sample of individuals in this age group. This population was selected from those who are enrolled in both public and private schools in urban areas of Sanandaj. The decision to investigate this age group was made for a number of reasons. The accessibility of pupils in this age-group makes them appropriate subjects for future intervention to decrease oral health inequality. The fact that individuals are likely to change their oral health beliefs between adolescence and young adulthood (Broadbent et al. 2006) may be another reason for targeting this age group. Further, adolescence is a transition period in life, marked by
physical, social, as well as psychological changes (Cameron 2003; Dahl 2003). Given this, implementing appropriate interventions in this period may more effectively help to reduce health inequality.

2.2 Developments of the study instruments

This study used questionnaires to collect data on four sets of variables: socioeconomic status, oral health behaviours, psychological factors, and self-reported oral health outcomes (Appendix 3). Development of the questionnaires involved a thorough review of the literature to identify the most suitable scales for estimating the variables of the study. The variables of the study were selected with regard to the aim, objectives, and the schematic frameworks of the study (see 1.2.4 Aim, objectives and study framework).

2.2.1 Indicators of socioeconomic status

Four indicators of socioeconomic status were employed to assess socioeconomic status: subjective socioeconomic status, wealth index, mother’s education, and father’s education.

I recruited more than one indicator of socioeconomic status to examine the distinct domains of socioeconomic status. This decision was made given that various indicators of socioeconomic status reflect different dimensions of social position (Oakes et al. 2003). Further, I considered the appropriateness of the indicators for the age group of the study participants. Traditionally, for investigating socioeconomic
status, people have been classified into a series of layers, each representing different
degrees of socioeconomic status. A lengthy review of the use of indicators of
socioeconomic status in epidemiology found that most indicators are based upon
three related dimensions: occupation, education and income (Liberatos et al. 1988).
However, direct application of these indicators may not be appropriate for estimating
the socioeconomic status of adolescents. This is because adolescents are almost in
equal positions in terms of education and occupation. Also, direct questioning of
family income is not appropriate as it is difficult to obtain information from
adolescents (Currie et al. 1997). Therefore, particular attention was paid to
appropriateness of the indicator of socioeconomic status for the adolescents. Next, I
describe four indicators of socioeconomic status used in this study.

2.2.1.1 Subjective socioeconomic status

Subjective socioeconomic status was measured by how respondents rank the
subjective socioeconomic status of their family in ‘Iranian society’ by modifying the
youth version of the MacArthur Scale of Subjective Social Status (Goodman et al.
2001) (Figure 5).

The youth version of the MacArthur Scale evaluates the subjective socioeconomic
status of adolescents using a ten-rung ladder. The youth version of the MacArthur
Scale of Subjective Social Status (Goodman et al. 2001) was derived from the
original scale examining the subjective socioeconomic status of adults (Adler et al.
2000; Operario et al. 2004). Developers of the youth version of the MacArthur Scale
suggest that it is ‘easy to comprehend and is appropriate for those in grade seven and
higher, approximately age 12 and older’. Measurement of subjective socioeconomic status in oral health surveys is limited to two studies of adults and elderly people in Australia and China (Sanders et al. 2006; Zeng et al. 2008). Employing the youth version of the MacArthur Scale in this study provides additional information on how subjective socioeconomic status is associated with the oral health of adolescents.

In order to use the youth version of the MacArthur Scale in this study, I made minor modifications. Firstly, I changed the wording of the indicator by changing the phrase ‘American society’ to ‘Iranian society’. This modification was necessary given that the original instrument was developed in the United States. Thus, its wording was designed to examine subjective social status in American society. Secondly, this scale originally had an additional ladder which evaluates the position of adolescents among other adolescents studying in the same school. This additional ladder was not used in this study because this study did not aim to compare students within the school.

![Image of the MacArthur Scale of Subjective Social Status - Youth Version]

Figure 5 The MacArthur Scale of Subjective Social Status - Youth Version. Source: Goodman et al., 2001 reprinted with permission from author
Subjective socioeconomic status measures the overall perception of individuals from their position in the society. The idea of measuring the subjective socioeconomic status in a health survey is relatively new. It is suggested that subjective perceptions of relative ranking may be more important determinants of health than objective indicators such as income (Wilkinson 1999). Studies emerged to show that subjective social status was more consistently and strongly related to several health-related factors (Adler et al. 2000; Singh-Manoux et al. 2003; Singh-Manoux et al. 2005).

Scoring: Initially, participants ranked their subjective socioeconomic status from 1 to 10 on the schematic ladder range. For analysing the data, the subjective socioeconomic status reported by participants collapsed into quartiles. The 1st quartile consisted of those who ranked themselves 1-4; the 2nd quartile and 3rd quartile consisted of those who rated themselves 5 and 6, respectively; and those who rated themselves 7-10 fell into the 4th quartile. In other words, individuals within the 1st quartile ranked themselves the lowest while those in the 4th quartile ranked the highest. This approach has been adopted for analysing the data obtained from the indicator of subjective socioeconomic status (Hu et al. 2005; Reitzel et al. 2010).

2.2.1.2 Wealth index

The wealth index was used in this study to classify individuals based on possession of selected household items. These household items were asked about: colour television, radio, washing machine, telephone, car, fridge, freezer, mobile phone, DVD player, computer, vacuum cleaner.
The Wealth Index is described as a ‘composite measure of the cumulative living standard of a household’. The wealth index is calculated using easy-to-collect data on a household’s ownership of selected assets, such as televisions and bicycles, materials used for housing construction, and types of water access and sanitation facilities. The wealth index, as an indicator of socioeconomic status, is shown to be a valid alternative for affluence and income (Ferguson et al. 2003) and its appropriateness for studies of adolescents is confirmed (Wardle et al. 2002).

The basic premise of the wealth index is that wealthier households are more likely to own any given set of household items; of these items, some items are likely to be owned by those in higher social positions (Ferguson et al. 2003). The wealth index based on the possession of household items has been used in several international health surveys in both developed and developing countries (Demographic and Health Survey). A recent report which analysed data from the Demographic and Health Survey (DHS) in Iran has used the same indicator to stratify the population based on their socioeconomic status (Hosseinpoor et al. 2006).

There are theoretical and practical reasons why indicators such as wealth index would be preferred to conventional measures such as direct questioning of income. It is suggested that the use of indicators such as wealth index deters the problems of recall bias which are likely to occur with measures of income (McKenzie 2005; Harper et al. 2007). It is because it is easier to remember the household items that are in constant use. Apart from this, use of indicators such as the wealth index provides researchers with a comparable measure of permanent income across countries. Perhaps for these reasons, the World Health Survey (WHS) - the major survey of
health conditions by the World Health Organization - has purposively asked about household ownership rather than income (WHO Statistical Information System).

For the purpose of building a wealth index in this study, I reviewed several household items while bearing in mind that a broad class of items should be included to allow for differentiation of living standards (McKenzie 2005). The household items that were previously used by the Demographic and Health Survey (DHS) in Iran were carefully evaluated. The household items used by the Iranian survey were the number of rooms, cars, motorcycles, bicycles, fridges, televisions, telephones, and heating devices per capita. For a number of reasons, I did not use exactly similar items. Some modifications seemed necessary because the items which reflected variation among households almost one decade ago may differ from those in the current study. This might be because of rising incomes or falling technology prices. For example, computers were owned by very few households a decade ago, but now a considerable number of households own a computer. In addition, the studied population in this PhD were sampled from urban population while the former Iranian Demographic and Health Surveys were designed to be representative at a national level, including rural areas. It is suggested that the ownership of the items varies between the urban and rural context (Filmer et al. 2001). Therefore, the household items for building a wealth index should be selected with regard to where the study sample comes from.

One controversial issue about the application of a wealth index is its scoring method. Two approaches have been used for stratifying individuals according to ownership of household items. The first approach simply adds up the number of items that the household owns, weighting each item equally and stratifying the participant
categorically (Montgomery et al. 2000). This simple method has previously been used in some health studies for determining socioeconomic status (Bobak et al. 2007). However, it is questionable whether counting the ownership of various items is appropriate while they are not equal in value. The second approach does not allocate equal weight to the items; rather, it uses principal component analysis to weight different values to the items (Filmer et al. 2001). In the principal component analysis, an item which all households own would be given zero weight while the items which are more unequally distributed would be given larger weight. This approach has been a common approach for analysing the data from the Demographic and Health Surveys (Houweling et al. 2007; Van de Poel et al. 2007). The report which was published from the Demographic and Health Surveys in Iran has also used a similar approach (Hosseinpoor et al. 2006).

Scoring: To construct the wealth index (WI), the method introduced by Filmer and Pritchett was followed (Filmer et al. 2001). The wealth index (WI) was calculated for each individual by adding the scores that were calculated for each item. Calculation of the scores for items was done using the guideline published on statistical procedure for the Filmer’s method and the formula proposed by this guideline (Vyas et al. 2006). The value of the ‘ownership of the item’ was considered zero when the item was not owned and it was considered one when the item was owned. The unweighted mean for each item was also calculated. The principal component analysis (PC) was run to calculate the scores from the first principal component analysis. Then, these scores represented the weight derived from the first principal component (PC) in the formula when the ownership of 10 household items was taken into account. The calculated values inserted to the formula are presented in table 4. Eventually,
Participants were classified into quartiles using their sum of wealth index. Those who had higher wealth scores, representing a higher social position, were classified within the 1st quartile, and those with the lowest wealth scores lay in the 4th quartile.

\[
\text{Item's score} = \frac{\text{Ownership of the item - unweighted mean of item}}{\text{unweighted mean of item}} \times \text{PC score}
\]
Table 4 Calculated values for building the wealth index

<table>
<thead>
<tr>
<th>Item</th>
<th>Unweighted mean of item</th>
<th>Household score if the item is owned</th>
<th>Household score if the item is not owned</th>
<th>PC Scores obtained from first principal component analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour TV</td>
<td>0.98</td>
<td>0.10</td>
<td>-4.89</td>
<td>0.678</td>
</tr>
<tr>
<td>Car</td>
<td>0.57</td>
<td>0.28</td>
<td>-0.37</td>
<td>0.325</td>
</tr>
<tr>
<td>Computer</td>
<td>0.47</td>
<td>0.38</td>
<td>-0.33</td>
<td>0.354</td>
</tr>
<tr>
<td>CD player</td>
<td>0.89</td>
<td>0.15</td>
<td>-1.23</td>
<td>0.442</td>
</tr>
<tr>
<td>Fridge</td>
<td>0.97</td>
<td>0.12</td>
<td>-4</td>
<td>0.700</td>
</tr>
<tr>
<td>Vacuum cleaner</td>
<td>0.91</td>
<td>0.20</td>
<td>-2.04</td>
<td>0.631</td>
</tr>
<tr>
<td>Washing machine</td>
<td>0.61</td>
<td>0.39</td>
<td>-0.61</td>
<td>0.491</td>
</tr>
<tr>
<td>Freezer</td>
<td>0.71</td>
<td>0.26</td>
<td>-0.64</td>
<td>0.407</td>
</tr>
<tr>
<td>Telephone</td>
<td>0.95</td>
<td>0.15</td>
<td>-2.90</td>
<td>0.637</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>0.88</td>
<td>0.16</td>
<td>-1.18</td>
<td>0.435</td>
</tr>
</tbody>
</table>
2.2.1.3 Mother’s and father’s education

The nature of the educational attainment of the participants’ parents was asked in this study. Participants could report parental education in four categories: illiterate, primary school, guidance/high school, and university. The categories of responses were derived from the Iranian Demographic and Health Survey (Iranian Ministry of Health 2001).

Parental education is among the most frequently used conventional indicators of socioeconomic status in health of adolescents (Currie et al. 1997). It was shown that adolescents are able to provide valid responses to questions on parental education and occupation as an indicator of socioeconomic status (Lien et al. 2001).

Scoring: Mother’s education and father’s education were analysed as a 4-level categorical variable.

2.2.2 Oral health behaviours

Three aspects of oral health behaviours were questioned in this study: toothbrushing, dental flossing, and visiting a dentist. For exploring the frequencies of toothbrushing and dental flossing, participants were asked how often they brush their teeth and use dental floss. Participants were also asked if they had visited a dentist in the past year.

Toothbrushing and dental flossing are the most commonly performed oral health behaviours and they have been linked to oral health (Gilbert et al. 1993). Despite the
potential for bias, previous studies confirm that adolescents can provide adequately valid responses for questions on health behaviours (Brener et al. 2003).

Scoring: Initially, participants reported the frequencies of toothbrushing and using dental floss by selecting one of the following answers: never, less than once a week, once every few days, once a day, twice a day, and more than twice a day. Eventually, frequencies of toothbrushing and using dental floss were dichotomised into ‘once a day and more’ and ‘less than once a day’. This classification is sensible because toothbrushing once a day is recommended for better oral health. Participants reported whether they had visited a dentist in the past year using a Yes/No question.

2.2.3 Psychological factors

Three psychological factors were investigated in this study: self-esteem, depression, and anxiety. Self-esteem was measured using the Rosenberg Self-esteem Scale (Rosenberg 1965), and depression and anxiety were measured by use of the Hospital Anxiety and Depression Scale (Zigmond et al. 1983).

Self-reported oral health outcomes have been associated with self-esteem (Benyamini et al. 2004; Locker 2009), depression (Anttila et al. 2006; Locker 2009), and anxiety (Anttila et al. 2006). For exploring three psychological factors of this study, availability of the valid Persian scales was carefully regarded.
2.2.3.1 Self-esteem

Self-esteem was measured using the 10-item Rosenberg Self-esteem Scale (Rosenberg 1965). This scale measures feelings about self worth using items such as ‘I feel I am a person of worth, at least equal to others’. This scale was originally developed to measure adolescents' feelings of self-worth or self-acceptance. The Persian version of the Rosenberg Self-esteem Scale has been validated for Iranian adolescents (Shapurian et al. 1987).

Scoring: The 10-item Rosenberg Self-esteem Scale could be answered on a four point Likert scale (Strongly agree=0, agree=1, disagree=2, strongly disagree=3). Positively worded statements were reversed. Scale scores for each participant were calculated by summing the responses to all the items; therefore, the sum of scores could potentially range from 0 to 30 with those scored higher representing higher self-esteem.

2.2.3.2 Depression and anxiety

Depression and anxiety were measured by the 14-item Hospital Anxiety and Depression Scale. Depression and anxiety were ascertained by items such as ‘I feel as if I am slowed down’ and ‘I feel restless as if I have to be on the move’, respectively. The Hospital Anxiety and Depression Scale (HADS) is an appropriate scale for measuring symptoms of depression and anxiety among adolescents (White et al. 1999; Jorngarden et al. 2006). The HADS is brief and widely used. Although the HADS was primarily developed for hospital based studies (Zigmond et al. 1983) as an instrument for assessing the symptom severity of anxiety disorders and depression
(Herrmann 1997), its validity for use in the general population has been established (Bjelland et al. 2002). Validity and reliability of the HADS has been formerly established for Persian speakers residing in Iran (Montazeri et al. 2003).

Scoring: The Hospital Anxiety and Depression Scale (HADS) contains 14 items and consists of two subscales (seven items for anxiety and seven items for depression). Each item was rated on a four-point scale, giving a minimum score of 0 and maximum score of 21 for each of the anxiety and depression subscales. The scores obtained from the anxiety and depression subscales of The Hospital Anxiety and Depression Scale (HADS) were treated as interval variable.

2.2.4 Self-reported oral health

Oral health status was measured in this study using two self-reported oral health outcomes: single item self-rated oral health and experience of dental pain. The decision to use self-reported oral health outcomes in this study was made for a number of reasons. As I discussed in an earlier chapter (see 1.2.2.1 Self-reported oral health), there has been a surge of interest in using self-reported oral health outcomes in the last few decades. These indicators are convenient and reasonable indicators of oral health which have been used in nationally representative oral health surveys in Australia and the United States (Gift et al. 1998; Carter et al. 2003). Further, given that performing a clinical examination was not feasible in this study, application of self-reported oral health outcomes was a suitable approach for estimating oral health status.
2.2.4.1 Single item self-rated oral health

I used the single item self-rated oral health. The single question asked participants the following question: ‘generally speaking, would you say that your oral health is excellent/very good/good/fair/poor’ (Pattussi et al. 2007). Previous to this study, numerous other oral health studies of adolescents in different countries have used a single item self-rated oral health scale to estimate the level of oral health status (Ostberg et al. 1999; Ostberg et al. 2001; Astrom et al. 2002; Ostberg 2002; Ostberg et al. 2003; Ostberg et al. 2003; Farsi et al. 2004; Okullo et al. 2004; Jiang et al. 2005; David et al. 2006; Pattussi et al. 2007; Perera et al. 2008; Petersen et al. 2008).

Scoring: Single item self-reported oral health is measured as categorical responses to five categories. It has been a common practice to dichotomise the responses into two categories of ‘good’ versus ‘poor’ health. It was shown that adopting this approach does not lead to fundamental loss of data (Manor et al. 2000). To facilitate the data analysis and interpretation of the findings, the common approach was followed by dichotomising the responses into excellent/very good/good versus fair/poor. Collapsing the responses into these particular groups has been a common practice in oral health studies of various populations (Locker et al. 2005; Pattussi et al. 2007; Turrell et al. 2007; Blumenshine et al. 2008; Sabbah et al. 2008; Locker 2009).

2.2.4.2 Experience of dental pain

The experience of dental pain was ascertained by a simple ‘Yes/No’ question: ‘Have you experienced toothache in the last month?’
One issue associated with use of dental pain in oral health surveys is making decisions about the ‘recall period’. In order to reduce the effects of recall bias, I decided to examine the prevalence of dental pain within the ‘past month’. Previous studies have questioned the prevalence of dental pain using various recall periods such as ‘four weeks’ (Pau et al. 2007), ‘past month’ (Pau et al. 2008), ‘past three months’ (Mashoto et al. 2009), ‘last six months’ (Goes et al. 2007), and ‘previous 12 months’ (Jiang et al. 2005).

Scoring: Experience of dental pain was treated as binary categorical variables based on whether or not the participants had reported the experience of dental pain in the past month.

### 2.3 Ethical issue

I took the following steps to obtain required approvals, seek consent, and assure the security of the questionnaires and data.

#### 2.3.1 Obtaining required approvals

At the first step, ethical clearance was obtained from the Queen Mary University of London Research Ethics Committee. Secondly, the Research Committee of the Medical University of Kurdistan was approached and this committee reviewed the proposal favourably. This committee is in charge of health research in the province and all proposals for health surveys should be approved by them prior to data
collection. They have liaised on my behalf with the educational administrative authority whose permission was necessary for running school-based studies across the province. A letter from the educational administrative authority enabled me to access adolescents at schools. At each selected school, I consulted with the head teacher face to face to seek permission for carrying out the study. Also, I informed the classroom teachers about the presentation of the study to classes; however, no permission was required.

2.3.2 Participant’s consent forms

In the process of data collection, I introduced the participants to the general objectives of the study by providing an information sheet as well as verbal explanation. All participants were given an informed consent statement and their approval to participate in the study was obtained by asking them to assent to a statement on an information sheet that says ‘My completion of this anonymous survey is an indication of my agreement to participate in this study’. They were reminded that their participation is entirely voluntary and they may refuse to participate or withdraw from the study at any time.

2.3.3 Guardian’s consent form and information sheet

The Iranian ethics committee of the Kurdistan Medical School confirmed that above the age of 15 pupils do not need guardian consent and an information sheet. Therefore, participants in our study were able to decide about their participation. This issue was brought to the attention of the QMUL ethics committee. However, the
QMUL ethics committee insisted that guardian consent should be sought and an information sheet provided. In order to resolve the conflict, the QMUL ethics committee agreed to seek expert views. Dr Anne-Marie Slowther (Director of the Clinical Ethics Support Project at Ethox, University of Oxford) and Professor Richard Ashcroft (School of Law, Queen Mary University of London) kindly provided us with their expert opinions on the necessity of obtaining parental consent (see Appendix 4). After reviewing the expert opinions, the QMUL ethics committee reviewed the earlier decision by agreeing that guardian consent was not required. However, the QMUL ethics committee emphasised that parents should be given a detailed ‘information sheet’ to explain the procedure of the study.

I therefore replaced a copy of the guardian information sheet to abide by the decision of the QMUL ethics committee (Appendix 5). Later, Iranian authorities at the site of the study commented that students’ consent suffices for the purpose of the study and informing the parents is unnecessary. Eventually, parents were neither informed nor their permission sought.

2.3.4 Security of the data

All questionnaires were anonymous; however, hard copies of the questionnaires were kept in a safe place. The questionnaires were not carried to the UK but were kept in a safe place in Iran to abide by the recommendations of the QMUL ethics committee. Only myself and approved members of the supervising team were allowed to access the data. Data were entered on a personal computer and was secured by username and password.
2.4 Sampling, sample size calculation, and data collection

2.4.1 Sampling

A two-stage cluster sampling method was chosen as the sampling framework of the study. The list of all schools in Sanandaj was obtained through educational administration of the province. Educational administration in Iran has two characteristics: single sex education, and existence of public and private schools. Therefore, schools were divided into four main strata: public girls' school (43 schools), public boys' school (39 schools), private girls' school (9 schools), and private boys' school (8 schools). Finally, 13 schools were randomly selected: five public boys' school, six public girls' school, one private girls' school, and one private boys' school. In the second stage, I obtained two classes from each selected school by simple random sampling; one second year and one third year class (second stage units) were selected. All students from the chosen classes were invited to participate in the study.

2.4.2 Sample size calculation

For sample size calculation, I decided to consider single item self-rated oral health as the primary outcome because this indicator may be more comprehensive in that it reflects the overall oral health status. When I calculated the sample size, I was aware of two studies which reported the distribution of single item self-rated oral health in the Iranian adult population. According to these two studies, 37-38% of the participants reported good/very good versus very poor/poor/fair oral health (Dorri et
al. 2007; Ravaghi et al. In Press). Given that these studies were conducted on adults, I assumed that the oral health of the adolescents in this study would be better, for say 50%. With a sample size of 600, I would have 80% power to detect a difference in oral health of 12% (for example 44% to 56%) between two equally sized groups in the study. Furthermore, I estimated that a sample of 600 students would allow me to safely include at least 15 independent variables in the multivariate regression analyses, depending on the nature of the regression.

2.4.3 Data collection

Data collection took place between April and May 2008. I approached the students during normal school hours. I provided the students with a brief instruction on how to fill out the questionnaire in writing. Then, I explained the steps verbally. While students were filling out the questionnaires, I made sure that all students had completed each section before moving to the next. In case some students were falling behind, they were given enough time to keep up with the others. Teachers were present in the classrooms at the time of data collection; however, they were asked not to approach students for any reason. This decision was made to ensure that the students’ responses would not be affected by the fear of being exposed to the teacher. Students were also asked to avoid communication during the session to protect their privacy.
2.5 Treatment of data

This section introduces the statistical software and the procedure of data cleaning, treatment of missing data, and data analysis.

2.5.1 Statistical software

The majority of the data analysis was performed using the Statistical Package for Social Sciences (SPSS for Windows, version 13.0). Also, STATA software was used for some parts of the data analysis (see 2.5.4.1 Descriptive analyses).

2.5.2 Data cleaning

In order to prepare the data for analysis, I examined the data to identify outliers. Frequency tables and boxplots were used to identify mistyped values. Less than 20 mistyped values were identified, which seems to be negligible while we had approximately 80,000 entered values. However, the questionnaires were not available to replace the mistyped values because the questionnaires were not taken to the UK so as to abide by the recommendation of the ethics committee. So, I set these values to ‘missing’.

2.5.3 Treatment of missing data

I used the default procedure in SPSS to deal with missing data rather than complicated data imputation methods. Pairwise deletion was preferred to listwise
deletion for bivariate and regression analyses in order to make the most of the data. While listwise deletion eliminates an entire observation or case if there are any missing data in the defined variables, the pairwise deletion removes the specific missing values from the analysis and not the entire case.

2.5.4 Data analysis

In this section, I describe the methods of data analysis in two main sections: descriptive analyses and testing the hypothesis of mediation.

2.5.4.1 Descriptive analyses

Descriptive analyses consist of three sections: distribution of the variables in the population and distribution of variables according to gender, and preliminary analyses for regression analysis.

The frequency distributions of indicators of socioeconomic status, oral health behaviours, psychological factors, and self-reported oral health outcomes were assessed to explore the characteristics of the sample. The data on some variables which were later dichotomised or modified is presented before and after modification.

The frequency distributions of the variables across genders were also presented. Evaluating gender differences within the sample was facilitated using parametric and non-parametric statistical tests such as chi-squared test, chi-squared test for trend, and T-test wherever appropriate, and P values were presented.
To facilitate testing of the regression analysis, I made two assumptions regarding indicators of socioeconomic status and psychological factors. Then, I conducted preliminary analyses to examine whether these assumptions were accurate. These assumptions were as follows: appropriateness of treating the ordinal indicators of socioeconomic status as interval data, and normality and homogeneity of the psychological factors.

Before entering the four-level indicators of socioeconomic status into regression analysis, I examine whether or not regarding the change in outcome is the same for each step up in the ordinal variable. This is done using a statistical method proposed by Long and Frees (Long et al. 2003) which was earlier used in health inequality research (Barger 2006). Conducting this statistical analysis using the STATA, it was found that the change in outcome is the same for each step up in the ordinal variable because the categories of indicators of socioeconomic status are evenly spaced; therefore, this would not cause the loss of information.

Psychological variables of the study were tested for normality and homogeneity before performing regression analysis. For testing the normality of the data, both normality curves and Kolmogorov-Smirnov statistical tests (Table 7) were employed. The homogeneity was tested using the Levene’s test.

2.5.4.2 Testing the hypothesis of mediation

Earlier, I mentioned that the interrelationship between indicators of socioeconomic status, oral health behaviours, psychological factors, and self-reported oral health
outcomes should be tested to examine the hypothesis of mediation (see 1.2.3.3 Framework and assessment of the mediation). Here, I describe the data analysis methods which I used for testing each condition. I will discuss in the next chapter how there is some evidence for gender differences in oral health behaviours, psychological factors, and self-reported oral health (see 4.2.3 Gender differences). Therefore, it is appropriate to test whether the relationships vary according to gender. Interaction analysis was performed to evaluate whether the relationships exist to address this. An effect of interaction occurs when a relation between (at least) two variables is modified by (at least one) other variable. These analyses tell us whether the strength relationships vary between genders.

I evaluated the distribution of self-reported oral health outcomes across the categories of socioeconomic status using appropriate diagrams. Then, I performed logistic regression to evaluate the relationships between indicators of socioeconomic status and self-reported oral health outcomes without adjustment for oral health behaviours and psychological factors. The P values, unadjusted odds ratios and confidence intervals were presented. Also, the interactions between gender and indicators of socioeconomic status are examined.

Unadjusted relationships between indicators of socioeconomic status and oral health behaviours were evaluated employing logistic regression analysis. P values, unadjusted odds ratios and confidence intervals were presented. Also, the interactions between gender and indicators of socioeconomic status were examined.
Linear regression was used to evaluate the relationship between indicators of socioeconomic status and interval values of psychological factors. The values of Beta, standardised beta which represents the extent of change in the outcome variable as a result of increasing one unit in independent variable, as well as P values were presented. Also, the interactions between gender and indicators of socioeconomic status were examined.

Logistic regression analysis was used to evaluate the relationships between oral health behaviours/psychological factors and dichotomised self-reported oral health outcomes. As it was mentioned earlier, adjustment for indicators of socioeconomic status was essential for testing this condition (see 1.2.4.3 Framework of the study). Therefore, the relationships were adjusted for all indicators of socioeconomic status. Adjusted odds ratios, confidence intervals, and P values were calculated. Also, the interactions between gender and oral health behaviours status were examined.

Logistic regression models were generated to assess the effects of oral health behaviours and psychological factors on the relationships between indicators of socioeconomic status and self-reported oral health outcomes. This analysis was considered only for those pairs of the relationships which were shown to be statistically significantly related.

In order to assess the effects of oral health behaviours and psychological factors, five logistic regression models were constructed. Model 1 predicted self-reported oral health outcomes before adjustment; model 2 adjusted for gender; model 3 adjusted for oral health behaviours plus gender; model 4 predicted self-reported oral health
outcomes controlling for all psychological factors plus gender; and model 5 adjusted for oral health behaviours, and psychological factors plus and gender. Odds ratios and confidence intervals as well as reduction of odds ratios after adjustment were calculated wherever appropriate.

In this section, I described the setting, development of the study instruments, ethical issues, sampling and data treatment. In the next chapter, I present the findings of the study.
Chapter 3. Results
This chapter presents the findings of the study. Initially, the study sample is described in terms of sampling characteristics, distribution of the variables, and distribution of variables according to gender. This is followed by the findings of the study regarding the hypothesis of mediation. Each condition of the hypothesis of mediation is presented individually.

### 3.1 Study sample

This section describes the sampling characteristics, distribution of variables, and distribution of variables according to gender.

#### 3.1.1 Sampling characteristics

Altogether, 13 schools (five public boys' school, six public girls' school, one private girls' school, and one private boys' school) were invited to participate. All schools agreed to take part. According to the sample size calculation (see 2.4.2 Sample size calculation), approximately 600 participants were required. Assuming a 10% refusal rate, I approached 654 students (323 boys and 331 girls); of those 15 students (2%) either refused to take part or did not return the questionnaires (8 boys and 7 girls). Accordingly, 98% of students approached agreed to participate. Finally, data are analysed for 639 participants (315 boys and 324 girls).
3.1.2 Distribution of the sample according to the variables of the study

Table 5, 6, and 8 describe the distribution of participants within the categories of indicators of socioeconomic status, oral health behaviours, and self-reported oral health outcomes. Table 7 presents the measures of central tendency for psychological factors.

Regarding the indicators of socioeconomic status, a majority of the participants ranked themselves in the middle categories of subjective socioeconomic status, with 26% and 21% choosing the 5th and 6th rung of the ladder, respectively (Figure 6). The distribution of scores for the wealth index is also shown in Figure 6. Considering parental education, participants reported relatively higher educational attainment for their fathers compared to their mothers. 17% of the fathers are reported as ‘illiterate’ versus 33% of mothers. Furthermore, 12% of the fathers are reported to be educated at the level of ‘university’ versus 5% of the mothers (Table 5).

In terms of oral health behaviours, 67% of the participants reported brushing their teeth at least once a day; 17% reported use using dental floss at least once a day, and 33% reported visiting dentist in the previous year (Table 6)

With regard to psychological factors, mean scores (SD) for self-esteem, depression, and anxiety were 18.48 (4.75), 6.64 (3.87), and 10.31 (4.13), respectively. The higher scores on these measures represent higher self-esteem, depression, and anxiety. Because the psychological variables of the study had interval value, they were tested for normality and homogeneity before performing regression analysis. Visual
observation of the normality curves is in favour of normal distribution of these variables (Figure 7) while testing statistical significance indicates these variables are not normally distributed (Table 7). It is proposed that the visual observation of the normality curves should be preferred to the results of statistical tests for normality when the sample size is relatively large (Field 2009). In other words, when a visual observation and statistical tests contradict, the visual observation should be trusted because small variance for large samples is not of practical importance. As this study benefitted from relatively a large sample size, the psychological factors are normally distributed. Therefore, parametric methods could be appropriately used. Also, performing Levene’s test for homogeneity suggested that these variables are homogenous.

Considering self-reported oral health outcomes, almost one fifth of participants (19%) reported poor/fair oral health and one third (31%) reported experiencing dental pain in the past month (Table 8).
### Table 5 Distribution of sample according to indicators of socioeconomic status

<table>
<thead>
<tr>
<th>Variables</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subjective Socioeconomic Status</strong></td>
<td></td>
</tr>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Group (Lowest social position)</td>
<td>147 (23.6)</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Group</td>
<td>160 (25.7)</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Group</td>
<td>130 (20.9)</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; Group (Highest social position)</td>
<td>185 (29.7)</td>
</tr>
<tr>
<td><strong>Quartiles of Wealth Index</strong></td>
<td></td>
</tr>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; Group (Lowest social position)</td>
<td>161 (25.3)</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Group</td>
<td>154 (24.2)</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Group</td>
<td>164 (25.8)</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; Group (Highest social position)</td>
<td>157 (24.7)</td>
</tr>
<tr>
<td><strong>Mother's education</strong></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>207 (32.8)</td>
</tr>
<tr>
<td>Primary school</td>
<td>242 (38.4)</td>
</tr>
<tr>
<td>Guidance/high school</td>
<td>151 (23.9)</td>
</tr>
<tr>
<td>University</td>
<td>31 (4.9)</td>
</tr>
<tr>
<td><strong>Father's education</strong></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>104 (17.2)</td>
</tr>
<tr>
<td>Primary school</td>
<td>201 (33.2)</td>
</tr>
<tr>
<td>Guidance/high school</td>
<td>230 (38.0)</td>
</tr>
<tr>
<td>University</td>
<td>71 (11.7)</td>
</tr>
</tbody>
</table>
Table 6 Distribution of sample according to oral health behaviours

<table>
<thead>
<tr>
<th>Variables</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Toothbrushing frequency</strong></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>28 (4.5)</td>
</tr>
<tr>
<td>Less than once a week</td>
<td>77 (12.3)</td>
</tr>
<tr>
<td>Once every few days</td>
<td>100 (16)</td>
</tr>
<tr>
<td>Once a day</td>
<td>279 (44.6)</td>
</tr>
<tr>
<td>Twice a day</td>
<td>124 (19.8)</td>
</tr>
<tr>
<td>More than twice a day</td>
<td>18 (2.8)</td>
</tr>
<tr>
<td><strong>Dental flossing frequency</strong></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>310 (49.9)</td>
</tr>
<tr>
<td>Less than once a week</td>
<td>117 (18.8)</td>
</tr>
<tr>
<td>Once every few days</td>
<td>88 (14.1)</td>
</tr>
<tr>
<td>Once a day</td>
<td>72 (11.6)</td>
</tr>
<tr>
<td>Twice a day</td>
<td>20 (3.2)</td>
</tr>
<tr>
<td>More than twice a day</td>
<td>15 (2.4)</td>
</tr>
<tr>
<td><strong>Visiting dentist (past year)</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>205 (32.8)</td>
</tr>
<tr>
<td>No</td>
<td>420 (67.2)</td>
</tr>
</tbody>
</table>
Figure 6 Distribution of subjective socioeconomic status and wealth index before collapsing into quartiles
Table 7 Description of the sample according to psychological factors

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Median</th>
<th>Mode</th>
<th>Range (Potential range)</th>
<th>P Value&lt;sup&gt;a&lt;/sup&gt; (Kolmogorov-Smirnov test for normality)</th>
<th>P Value&lt;sup&gt;b&lt;/sup&gt; (Levene’s test for homogeneity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-esteem</td>
<td>18.48 (4.8)</td>
<td>18.50</td>
<td>17</td>
<td>3-30 (0-30)</td>
<td>0.015</td>
<td>0.84</td>
</tr>
<tr>
<td>Depression</td>
<td>6.64 (3.9)</td>
<td>6.00</td>
<td>8</td>
<td>0-20 (0-21)</td>
<td>0.001</td>
<td>0.82</td>
</tr>
<tr>
<td>Anxiety</td>
<td>10.31 (4.1)</td>
<td>10.00</td>
<td>9</td>
<td>0-21 (0-21)</td>
<td>0.001</td>
<td>0.75</td>
</tr>
</tbody>
</table>

<sup>a</sup> P value>0.5 indicates the normality

<sup>b</sup> P value>0.5 indicates the homogeneity

**Bold:** statistically significant relationships are highlighted in bold

Table 8 Distribution of sample according to self-reported oral health

<table>
<thead>
<tr>
<th>Variable</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-reported oral health outcomes</td>
<td></td>
</tr>
<tr>
<td>Single item self-rated oral health</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>8 (1.3)</td>
</tr>
<tr>
<td>Fair</td>
<td>107 (17.2)</td>
</tr>
<tr>
<td>Good</td>
<td>306 (49.1)</td>
</tr>
<tr>
<td>Very good</td>
<td>147 (23.6)</td>
</tr>
<tr>
<td>Excellent</td>
<td>55 (8.8)</td>
</tr>
<tr>
<td>Dichotomised single item self-rated oral health</td>
<td></td>
</tr>
<tr>
<td>Poor health (Poor/Fair)</td>
<td>115 (18.5)</td>
</tr>
<tr>
<td>Good health (Excellent/very good/good)</td>
<td>508 (81.5)</td>
</tr>
<tr>
<td>Experience of dental pain in the past month</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>193 (30.9)</td>
</tr>
<tr>
<td>No</td>
<td>432 (69.1)</td>
</tr>
</tbody>
</table>
Figure 7 Histograms and normality lines for psychological factors

- Self-esteem
- Anxiety
- Depression
3.1.3 Distribution of the sample according to gender

Table 9 and Table 10 show the distribution of variables according to gender. Table 9 shows the distribution of female and male participants across the categories of indicators of socioeconomic status, oral health behaviours, and self-reported oral health outcomes. Table 10 shows the mean scores of psychological factors for boys and girls. The gender differences were tested wherever appropriate using the chi-squared and the chi-squared for trend, and the t-test.

According to the Table 9, girls reported higher socioeconomic status compared to boys for all indicators of socioeconomic status. However, gender difference was not statistically significant for wealth index. Looking at the oral health behaviours, girls in general were more likely to have more frequent toothbrushing, dental flossing, and visiting dentist. However, gender differences were not statistically significant for dental flossing frequency. Of the girls, 82% brush their teeth ‘once a day and more’ versus 53% of the boys. In terms of dental flossing, 21% of the girls use dental floss ‘once a day and more’ compared to 13% of the boys. Considering visiting to the dentist, 41% of the girls visited the dentist in the past year versus 25% of the boys. Girls rated their self-reported oral health relatively poorer than boys; however, these differences were not statistically significant. With regard the self-reported oral health outcomes, 20% of the girls reported ‘poor/fair’ oral health versus 17% of the boys on single item self-rated oral health. In terms of the prevalence of dental pain in the past month, 34% of the girls reported dental pain in the past month versus 28% of the boys.
Table 10 compares the mean scores of psychological factors between girls and boys. Girls, in general, were more likely to report less desirable psychological status. Girls reported lower scores on self-esteem (mean=18.2 for girls versus mean=18.8 for boys) and higher scores on both depression (mean=6.9 for girls versus mean=6.4 for boys) and anxiety (mean=11.4 for girls versus mean=9.2 for boys).
Table 9 Distribution of socioeconomic status, oral health, and self-reported oral health outcomes according to gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female (%)</td>
<td>Male (%)</td>
</tr>
<tr>
<td>Indicators of socioeconomic status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartiles of Subjective Socioeconomic Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1(^{st}) Quartile (Lowest social position)</td>
<td>13.7</td>
<td>33.3</td>
</tr>
<tr>
<td>2(^{nd}) Quartile</td>
<td>26.7</td>
<td>25.1</td>
</tr>
<tr>
<td>3(^{rd}) Quartile</td>
<td>23.8</td>
<td>18.1</td>
</tr>
<tr>
<td>4(^{th}) Quartile (Highest social position)</td>
<td>35.8</td>
<td>23.5</td>
</tr>
<tr>
<td>Quartiles of Wealth Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1(^{st}) Quartile (Lowest social position)</td>
<td>21.8</td>
<td>28.9</td>
</tr>
<tr>
<td>2(^{nd}) Quartile</td>
<td>24.0</td>
<td>24.4</td>
</tr>
<tr>
<td>3(^{rd}) Quartile</td>
<td>27.1</td>
<td>24.4</td>
</tr>
<tr>
<td>4(^{th}) Quartile (Highest social position)</td>
<td>27.1</td>
<td>22.2</td>
</tr>
<tr>
<td>Mother's education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>27.1</td>
<td>38.7</td>
</tr>
<tr>
<td>Primary school</td>
<td>42.4</td>
<td>34.2</td>
</tr>
<tr>
<td>Guidance/high school</td>
<td>26.8</td>
<td>21.0</td>
</tr>
<tr>
<td>University</td>
<td>3.7</td>
<td>6.1</td>
</tr>
<tr>
<td>Father's education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>13</td>
<td>21.5</td>
</tr>
<tr>
<td>Primary school</td>
<td>33.4</td>
<td>32.9</td>
</tr>
<tr>
<td>Guidance/high school</td>
<td>44.5</td>
<td>31.2</td>
</tr>
<tr>
<td>University</td>
<td>9.1</td>
<td>14.4</td>
</tr>
<tr>
<td>Oral health behaviours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toothbrushing frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than once a day</td>
<td>18.1</td>
<td>47</td>
</tr>
<tr>
<td>once a day and more</td>
<td>81.9</td>
<td>53</td>
</tr>
<tr>
<td>Dental flossing frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than once a day</td>
<td>78.8</td>
<td>86.7</td>
</tr>
<tr>
<td>once a day and more</td>
<td>21.2</td>
<td>13.3</td>
</tr>
<tr>
<td>Visiting dentist (past year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>41.2</td>
<td>24.5</td>
</tr>
<tr>
<td>No</td>
<td>58.8</td>
<td>75.5</td>
</tr>
<tr>
<td>Self-reported oral health outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dichotomised single item self-rated oral health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor health (Poor/Fair)</td>
<td>19.8</td>
<td>17.1</td>
</tr>
<tr>
<td>Good health (Excellent/very good/good)</td>
<td>80.2</td>
<td>82.9</td>
</tr>
<tr>
<td>Experience of dental pain in last month</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>33.5</td>
<td>28.3</td>
</tr>
<tr>
<td>No</td>
<td>66.5</td>
<td>71.7</td>
</tr>
</tbody>
</table>

\(^{a}\) Chi-squared test for trend

\(^{b}\) Chi-squared test

**Bold:** statistically significant relationships are highlighted in bold
Table 10 Mean scores of psychological factors according to gender

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>P value a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female Mean (SD)</td>
<td>Male Mean (SD)</td>
</tr>
<tr>
<td>Self-esteem</td>
<td>18.2 (5.09)</td>
<td>18.8 (4.14)</td>
</tr>
<tr>
<td>Depression</td>
<td>6.9 (4.14)</td>
<td>6.4 (3.6)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>11.4 (4.02)</td>
<td>9.2 (4)</td>
</tr>
</tbody>
</table>

a T-test

**Bold:** statistically significant relationships are highlighted in bold
3.2 Testing the hypothesis of mediation

According to the framework of the study, the interrelationships between indicators of socioeconomic status, oral health behaviours, psychological factors, and self-reported oral health outcomes are investigated in this section by testing four conditions of the mediation hypothesis.

3.2.1 Socioeconomic status and self-reported oral health outcomes

Figure 8 displays the distribution of self-reported oral health outcomes across the categories of socioeconomic status. In general, the frequency of ‘excellent/very good/good’ oral health on single item self-rated oral health, and the reporting of ‘no dental pain’ is higher at higher levels of socioeconomic status. Considering subjective socioeconomic status, the frequency of ‘excellent/very good/good’ oral health on single item self-rated oral health increased with increasing socioeconomic status. Similarly, the frequency of reporting ‘no dental pain’ rose with increasing subjective socioeconomic status. Regarding the wealth index, those in wealthier quartiles were generally more likely to report ‘excellent/very good/good’. A similar pattern was observed for dental pain although the frequency of ‘no dental pain’ decreased when moving from the 2nd quartile to the 3rd quartile of wealth index. Regarding mother’s education, oral health generally improved with increasing education for both single item self-rated oral health and dental pain. For father’s education, oral health generally improved with increasing education for both self-rated oral health and dental pain although oral health decreased when moving from the primary school to the guidance/high school category.
Table 11 shows the unadjusted relationships between indicators of socioeconomic status and self-reported oral health outcomes. Some, but not all, pairs of relationships between indicators of socioeconomic status and self-reported oral health outcomes were of statistical significance. Subjective socioeconomic status is statistically significantly related to both single item self-rated oral health (OR=1.28, 95% CI: 1.07, 1.54 P= 0.007) and dental pain (OR=1.25, 95% CI: 1.07, 1.45 P= 0.004). Wealth index is not associated with either single item self-rated oral health (OR=1.17, 95% CI: 0.97, 1.40 P=0.096) or dental pain (OR=1.16, 95% CI: 1, 1.38 P=0.053). Mother’s education is statistically significantly related to dental pain (OR=1.25, 95% CI: 1.02, 1.52 P= 0.033) but not to single item self-rated oral health (OR=1.14, 95% CI: 0.9, 1.44 P=0.283). Father’s education is not associated with either single item self-rated oral health (OR=1.13, 95% CI: 0.90, 1.42 P=0.299) or dental pain (OR=1.04, 95% CI: 0.85, 1.26 P=0.726). There was no statistically significant interaction between gender and any of the indicators of socioeconomic status.
Figure 8 The diagrams showing the relationship between indicators of socioeconomic status and self-reported oral health outcomes

**Subjective socioeconomic status and oral health**
- Solid line = the percentages of ‘excellent/very good/good’ on single item self-rated oral health
- Dashed line = the percentages of ‘no dental pain’

**Wealth index and oral health**

**Mother’s education and oral health outcomes**

**Father’s education and oral health**

*Solid line* = the percentages of ‘excellent/very good/good’ on single item self-rated oral health  
*Dashed line* = the percentages of ‘no dental pain’
Table 11 The relationship between indicators of socioeconomic status and self-reported oral health outcomes

<table>
<thead>
<tr>
<th>Indicators of socioeconomic status</th>
<th>Single item self-rated oral health (Excellent/very good/good)</th>
<th>Dental pain (No pain)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P Value</td>
<td>Unadjusted OR (CI)</td>
</tr>
<tr>
<td>Subjective socioeconomic status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender × Subjective socioeconomic status</td>
<td>0.007</td>
<td>1.28 (1.07, 1.54)</td>
</tr>
<tr>
<td></td>
<td>(0.649)</td>
<td></td>
</tr>
<tr>
<td>Wealth index</td>
<td>0.096</td>
<td>1.17 (0.97, 1.40)</td>
</tr>
<tr>
<td>Gender × Wealth index</td>
<td>(0.682)</td>
<td></td>
</tr>
<tr>
<td>Mother’s education</td>
<td>0.238</td>
<td>1.14 (0.90, 1.44)</td>
</tr>
<tr>
<td>Gender × Mother’s education</td>
<td>(0.135)</td>
<td></td>
</tr>
<tr>
<td>Father’s education</td>
<td>0.299</td>
<td>1.13 (0.90, 1.42)</td>
</tr>
<tr>
<td>Gender × Father’s education</td>
<td>(0.898)</td>
<td></td>
</tr>
</tbody>
</table>

*95% confidence interval

**Bold**: statistically significant relationships are highlighted in bold
3.2.2 Socioeconomic status and hypotheses mediators

This section examines the relationship between the indicators of socioeconomic status and hypothesised mediators of the study: oral health behaviours and psychological factors.

3.2.2.1 Socioeconomic status and oral health behaviours

Figure 9 shows the distribution of oral health behaviours across categories of socioeconomic status. In general, the prevalence of brushing more than once a day, using dental floss more than once a day, and visiting a dentist in the past year, in general, increases with increasing socioeconomic status.

Table 12 shows the unadjusted relationship between indicators of socioeconomic status and oral health behaviours. Some, but not all, pairs of relationships between indicators of socioeconomic status and oral health behaviours were of statistical significance. Subjective socioeconomic status was statistically significantly associated with toothbrushing frequency (OR=1.18, 95% CI: 1.01, 1.36 P= 0.034) and dental flossing frequency (OR=1.23, 95% CI: 1.02, 1.49 P= 0.03) but not with visiting dentist (OR=1.14, 95% CI: 0.99, 1.33 P=0.078). Wealth Index was statistically significantly related to dental flossing frequency (OR=1.61, 95% CI: 1.31, 1.97 P <0.0001) and visiting dentist (OR=1.24, 95% CI: 1.07, 1.45 P= 0.005) but not to toothbrushing frequency (OR=1.14, 95% CI: 0.98, 1.32 P=0.099). Mother’s education was statistically significantly related to toothbrushing frequency (OR=1.37, 95% CI: 1.12, 1.68 P= 0.002) and dental flossing frequency (OR=1.46, 95% CI: 1.16,
Father's education was statistically significantly associated with dental flossing (OR=1.31, 95% CI: 1.03, 1.67 P= 0.026) but not with toothbrushing frequency (OR=1.20, 95% CI: 0.99, 1.46 P=0.06) and visiting dentist (OR=1.15, 95% CI: 0.95, 1.40 P=0.146). There were no statistically significant interaction between gender and any of the indicators of socioeconomic status.
Figure 9 The diagrams showing the relationship between indicators of socioeconomic status and oral health behaviours

**Subjective socioeconomic status and oral health behaviours**

- Solid line: the percentages of toothbrushing ‘once a day and more’;
- Dashed line: the percentages of dental flossing ‘once a day and more’;
- Dotted line: the percentage of visiting dentist in the past year

**Wealth index and oral health behaviours**

**Mother's education and oral health behaviours**

**Father's education and oral health behaviours**
<table>
<thead>
<tr>
<th>Indicators of socioeconomic status</th>
<th>Gender × Subjective socioeconomic status</th>
<th>P Value</th>
<th>Unadjusted OR (CI)*</th>
<th>Gender × Wealth index</th>
<th>P Value</th>
<th>Unadjusted OR (CI)*</th>
<th>Gender × Mother’s education</th>
<th>P Value</th>
<th>Unadjusted OR (CI)*</th>
<th>Gender × Father’s education</th>
<th>P Value</th>
<th>Unadjusted OR (CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toothbrushing frequency</td>
<td>'once a day and more'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P Value</td>
<td>0.034</td>
<td>1.18 (1.01, 1.36)</td>
<td>0.03</td>
<td>1.23 (1.02, 1.49)</td>
<td>0.078</td>
<td>1.14 (0.99, 1.33)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted OR (CI)*</td>
<td>(0.925)</td>
<td></td>
<td>(0361)</td>
<td>(0.425)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dental flossing frequency</td>
<td>'once a day and more'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visiting dentist</td>
<td>'visited in the past year'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted OR (CI)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 95% confidence interval           | Bold: statistically significant relationships are highlighted in bold

Table 12 The relationship between indicators of socioeconomic status and oral health behaviours
3.2.2.2 Socioeconomic status and psychological factors

Table 13 shows the relationship between indicators of socioeconomic status and psychological factors. Indicators of socioeconomic status were related to psychological factors to varying extent. For example, while subjective socioeconomic status was statistically significantly related to all psychological factors, either positively or negatively, father’s education was not related to any of them. In detail, subjective socioeconomic status was positively related to self-esteem (Beta=0.97, P Value <0.0001), and negatively related to depression (B= -0.54, P Value <0.0001) and anxiety (B= -0.36, P Value=0.01). Wealth index was positively associated with self-esteem (B= 0.51, P Value=0.003) and negatively associated with depression (B= -0.46, P Value=0.001), but it was not associated with anxiety (B= -0.24, P Value=0.1). Mother’s education was positively related to self-esteem (B= 0.51, P Values=0.02) but not to depression (B= -0.25, P Value=0.16) and anxiety (B= -0.2, P Value=0.29). Father’s education was not related to self-esteem (B= 0.4, P Values=0.07), depression (B= -0.31, P Value=0.08), and anxiety (B= -0.17, P Value=0.35). There were no statistically significant interactions between gender and any of the indicators of socioeconomic status.
Table 13 The relationship between indicators of socioeconomic status and psychological factors

| Indicators of socioeconomic status | Self-esteem | | | Depression | | | | Anxiety | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Beta | Standardised beta | P value | Beta | Standardised beta | P value | Beta | Standardised beta | P value |
| Subjective socioeconomic status | 0.97 | 0.23 | | -0.54 | -0.16 | | -0.36 | -0.1 | 0.01 |
| Gender × Subjective socioeconomic status | | | | | | | | | | |
| Wealth index | 0.51 | 0.12 | 0.003 | -0.46 | -0.13 | 0.001 | -0.24 | -0.07 | 0.1 |
| Gender × Wealth index | | | | | | | | | | |
| Mother’s education | 0.51 | 0.09 | 0.02 | -0.25 | -0.06 | 0.16 | -0.2 | -0.04 | 0.29 |
| Gender × Mother’s education | | | | | | | | | | |
| Father’s education | 0.40 | 0.08 | 0.07 | -0.31 | -0.07 | 0.08 | -0.17 | -0.04 | 0.35 |
| Gender × Father’s education | | | | | | | | | | |

Bold: statistically significant relationships are highlighted in bold
3.2.3 Hypothesised mediators and self-reported oral health outcomes

This section examines how two hypothesised mediators of the study, oral health behaviours and psychological factors, are related to self-reported oral health outcomes: single item self-rated oral health and the reporting of dental pain.

3.2.3.1 Oral health behaviours and self-reported oral health outcomes

Table 14 shows the association between three oral health behaviours and self-reported oral health outcomes after adjustment for indicators of socioeconomic status. The majority of oral health behaviours were not related to either single item self-rated oral health or dental pain. Toothbrushing is not statistically significantly related to either single item self-rated oral health (OR=1.28, 95% CI: 0.82, 2.02 P= 0.28), or dental pain (OR=1.28, 95% CI: 0.87, 1.88 P= 0.21). The frequency of dental flossing is not related to either single item self-rated oral health (OR=0.77, 95% CI: 0.43, 1.37 P= 0.37) or dental pain (OR=1.67, 95% CI: 0.96, 2.90 P= 0.71). Visiting a dentist is not associated with single item self-rated oral health (OR=1.06, 95% CI: 0.67, 1.68 P=0.81) but it was statistically significantly associated with experience of dental pain (OR=0.57, 95% CI: 0.39, 0.84 P= 0.004). There were no statistically significant interaction between gender and any of the oral health behaviours.
Table 14: The relationship between oral health behaviours and self-reported oral health outcomes adjusted for indicators of socioeconomic status

<table>
<thead>
<tr>
<th>Oral health behaviours</th>
<th>Single item self-rated oral health (Excellent/very good/good)</th>
<th>Dental pain (No pain)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P Value&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Adjusted OR (CI)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Toothbrushing frequency</td>
<td>0.28</td>
<td>1</td>
</tr>
<tr>
<td>Less than once a day</td>
<td>1.28 (0.82, 2.02)</td>
<td>(0.562)</td>
</tr>
<tr>
<td>Once a day and more</td>
<td></td>
<td>(0.861)</td>
</tr>
<tr>
<td>Gender × Toothbrushing frequency</td>
<td>(0.562)</td>
<td></td>
</tr>
<tr>
<td>Dental flossing frequency</td>
<td>0.37</td>
<td>1</td>
</tr>
<tr>
<td>Less than once a day</td>
<td>0.77 (0.43, 1.37)</td>
<td>(0.148)</td>
</tr>
<tr>
<td>Once a day and more</td>
<td></td>
<td>(0.550)</td>
</tr>
<tr>
<td>Gender × Dental flossing frequency</td>
<td>(0.148)</td>
<td></td>
</tr>
<tr>
<td>Visiting dentist (Last year)</td>
<td>0.81</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>1.06 (0.67, 1.68)</td>
<td>(0.646)</td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td>(0.096)</td>
</tr>
<tr>
<td>Gender × Dental service utilization (Last year)</td>
<td>(0.646)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Chi squared test

<sup>b</sup> Adjusted for indicators of socioeconomic status

**Bold:** statistically significant relationships are highlighted in bold
3.2.3.2 Psychological factors and self-reported oral health outcomes

Table 15 displays the links between three psychological factors and self-reported oral health outcomes after adjustment for indicators of socioeconomic status. All psychological factors were statically associated, either negatively or positively, with both single item self-rated oral health and dental pain. Self-esteem was positively and statistically significantly related to both single item self-rated oral health (OR=1.15, 95% CI: 1.1, 1.21 P<0.0001) and dental pain (OR=1.05, 95% CI: 1.01, 1.1 P=0.02). Depression was negatively and statistically significantly related to both single item self-rated oral health (OR=0.85, 95% CI: 0.80, 0.90 P<0.0001) and dental pain (OR=0.93, 95% CI: 0.88, 0.97 P=0.002). Anxiety was negatively and statistically significantly related to both self-rated oral health (OR=0.84, 95% CI: 0.80, 0.89 P<0.0001) and dental pain (OR=0.94, 95% CI: 0.90, 0.99 P=0.009). There were no statistically significant interactions between gender and any of the psychological factors.
Table 15 The relationship between psychological factors and self-reported oral health outcomes adjusted for indicators of socioeconomic status

<table>
<thead>
<tr>
<th>Psychological factors</th>
<th>Single item self-rated oral health (Excellent/very good/good)</th>
<th>Dental pain (No pain)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P Value</td>
<td>Adjusted OR (CI)*</td>
</tr>
<tr>
<td>Self-esteem</td>
<td>&lt;0.0001</td>
<td>1.15 (1.1, 1.21)</td>
</tr>
<tr>
<td>Gender × Self-esteem</td>
<td>(0.779)</td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>&lt;0.0001</td>
<td>0.85 (0.8, 0.90)</td>
</tr>
<tr>
<td>Gender × Depression</td>
<td>(0.672)</td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>&lt;0.0001</td>
<td>0.84 (0.80, 0.89)</td>
</tr>
<tr>
<td>Gender × Anxiety</td>
<td>(0.983)</td>
<td></td>
</tr>
</tbody>
</table>

*a Adjusted for indicators of socioeconomic status

Bold: statistically significant relationships are highlighted in bold
3.2.4 Socioeconomic status and oral health: Adjusted models for hypothesised mediators

In this section, different models were constructed to evaluate the effects of hypothesised mediators, oral health behaviours and psychological factors, on the relationship between indicators of socioeconomic status and self-reported oral health outcomes. I evaluated three pairs of the relationships between indicators of socioeconomic status and self-reported oral health outcome which met the first condition of mediation (see 3.2.1 Socioeconomic status and self-reported oral health outcomes). These pairs are (1) the relationship between subjective socioeconomic status and single item self-rated oral health, (2) the relationship between subjective socioeconomic status and dental pain, and (3) the relationship between mother’s education and dental pain.

In Table 16, Model 1 predicts self-reported oral health outcomes on the basis of socio-economic factors. Model 2 additionally adjusts for gender. Model 3 adjusts for gender and all oral health behaviours. Model 4 predicts self-reported oral health outcomes controlling for all psychological factors plus gender. Model 5 controls for oral health behaviours, psychological factors, and gender. Reduction of odds ratios after adjustment for oral health behaviours, psychological factors and combination of psychological factors and oral health behaviours were calculated and compared with the unadjusted model as the baseline.

In general, adjustment for oral health behaviours and psychological factors, individually or simultaneously, did not fundamentally change the strength of the
relationships between indicators of socioeconomic status and self-reported oral health outcomes. The highest change in odds ratio was recorded when the relationship between subjective socioeconomic status and single item self-rated oral health was adjusted for psychological factors (8%) and the lowest reduction was seen when the relationship between mother’s education and dental pain was adjusted for both oral health behaviours and psychological factors. The relationships lost their statistical significance for some pairs.

Subjective socioeconomic status was related to single item self-rated oral health in both unadjusted (OR = 1.28; 95% CI 1.07, 1.54) and gender adjusted models (OR = 1.33; 95% CI 1.10, 1.60). Adding all oral health behaviours to Model 3 increased the odds ratio for reporting ‘excellent/very good/good’ from 1.28 in the unadjusted model to 1.37 (7% increase) and the statistical significance of the relationship persists (OR = 1.37; 95% CI 1.12, 1.68). Following the addition of all psychological factors to Model 4, the odds ratio for reporting ‘excellent/very good/good’ oral health reduced from 1.28 in the unadjusted model to 1.18 (8% reduction) and the association between subjective socioeconomic status and self-rated oral health lost its statistical significance (OR = 1.18; 95% CI 0.95, 1.45). Entering both oral health behaviours and psychological factors with gender in Model 5 reduced the odds ratio for ‘excellent/very good/good’ from 1.28 in the unadjusted model to 1.22 (5% reduction) and the relationship lost its statistical significance (OR = 1.22; 95% CI 0.98, 1.52).

Subjective socioeconomic status was related to dental pain in both unadjusted (OR = 1.25; 95% CI 1.07, 1.45) and gender adjusted models (OR = 1.30; 95% CI 1.11, 1.52). Adding all oral health behaviours to Model 3 increased the odds ratio from
1.25 in the unadjusted model to 1.31 (5% increase) and the relationship remained statistically significant (OR = 1.31; 95% CI 1.11, 1.54). Following the addition of all psychological factors to Model 4, the odds ratio for reporting ‘excellent/very good/good’ reduced from 1.25 in the unadjusted model to 1.23 (2% reduction) and the association between subjective socioeconomic status and dental pain remained statistically significant (OR = 1.23; 95% CI 1.05, 1.46). Entering both psychological factors and oral health behaviours along with gender in Model 5 reduced the odds ratio from 1.25 in the unadjusted model to 1.26 (1% reduction) but the statistical significance of the relationship persists (OR = 1.26; 95% CI 1.06, 1.50).

Mother’s education was related to dental pain in both unadjusted (OR = 1.25; 95% CI 1.02, 1.52) and gender adjusted models (OR = 1.26; 95% CI 1.03, 1.55). Adding oral health behaviours to the Model 3 reduced the odds ratios for having no dental pain from 1.25 in the unadjusted model to 1.22 (2% reduction) and the statistical significance of the relationship disappears (OR = 1.22; 95% CI 0.98, 1.51). The addition of all psychological factors to Model 4, increased the odds ratio for experience of dental pain (1% increase) and the association between mother’s education and dental pain persists its statistical significance (OR = 1.26; 95% CI 1.02, 1.56). Entering oral health behaviours and psychological factors along with gender in Model 5, the odds ratio for having no dental pain did not change but the relationship lost it statistical significance (OR = 1.25; 95% CI 1, 1.55).
Table 16 The relationship between indicators of socioeconomic status and self-reported oral health outcomes; adjusted models for hypothesised mediators

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (CIs)</td>
<td>OR (CIs)</td>
<td>OR (CIs)</td>
<td>OR (CIs)</td>
<td>OR (CIs)</td>
</tr>
<tr>
<td>The relationship between Subjective socioeconomic status and single item self-rated oral health</td>
<td>1.28 (1.07, 1.54)</td>
<td>1.33 (1.10, 1.60)</td>
<td>1.37 (1.12, 1.68)</td>
<td>1.18 (0.95, 1.45)</td>
<td>1.22 (0.98, 1.52)</td>
</tr>
<tr>
<td>The relationship between subjective socioeconomic status and dental pain</td>
<td>1.25 (1.07, 1.45)</td>
<td>1.30 (1.11, 1.52)</td>
<td>1.31 (1.11, 1.54)</td>
<td>1.23 (1.05, 1.46)</td>
<td>1.26 (1.06, 1.50)</td>
</tr>
<tr>
<td>The relationship between mother’s education and dental pain</td>
<td>1.25 (1.02, 1.52)</td>
<td>1.26 (1.03, 1.55)</td>
<td>1.22 (0.98, 1.51)</td>
<td>1.26 (1.02, 1.56)</td>
<td>1.25 (1, 1.55)</td>
</tr>
</tbody>
</table>

Model 1: unadjusted
Model 2: adjusted for gender
Model 3: adjusted for gender, and oral health behaviours (toothbrushing frequency, dental flossing frequency, and visiting dentist)
Model 4: adjusted for gender, and psychological factors (self-esteem, depression, anxiety)
Model 5: adjusted for gender, psychological factors (self-esteem, depression, anxiety), and oral health behaviours (toothbrushing frequency, dental flossing frequency, and visiting dentist)

a 95% confidence interval

**Bold: statistically significant relationships are highlighted in bold**
3.2.5 Summary of the testing of the hypothesis of mediation

Four conditions of mediation were tested. The first condition identified those pairs of the relationships where indicators of socioeconomic status and self-reported oral health outcomes were related. Then, the relationships between indicators of socioeconomic status and hypothesised mediators were evaluated. Further, the relationship between hypothesised mediators and self-reported oral health outcomes were analysed after adjustment for indicators of socioeconomic status. Finally, the relationship between socioeconomic status and self-reported oral health outcomes was assessed after adjustment for hypothesised mediators and the changes of odds ratios after adjustment were calculated.

The summary of the testing of all conditions is presented in Table 17. According to this table, oral health behaviours do not appear to mediate the relationships between indicators of socioeconomic status and either single item self-rated oral health or dental pain. Adjustment for oral health behaviours and psychological factors, individually or simultaneously, brought little reduction to the relationship. There was not convincing evidence to support that psychological factors mediate the relationship between subjective socioeconomic status and single item self-rated oral health.
Table 17 Summary of the results on mediation

<table>
<thead>
<tr>
<th>Hypothesised mediators</th>
<th>Condition 1</th>
<th>Condition 2</th>
<th>Condition 3</th>
<th>Condition 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>The relationship between Subjective socioeconomic status and single item self-rated oral health</td>
<td>Subjective socioeconomic status was related to single item self-rated oral health</td>
<td>Subjective socioeconomic status was related to two out of three investigated oral health behaviours</td>
<td>None of oral health behaviours were related to single item self-rated oral health after adjustment for indicators of socioeconomic status</td>
<td>The relationship remained statistically significant after adjustment for oral health behaviours</td>
</tr>
<tr>
<td>Oral health behaviours</td>
<td>Subjective socioeconomic status was related to single item self-rated oral health</td>
<td>Subjective socioeconomic status was associated with all psychological factors</td>
<td>All psychological factors were related to single item self-rated oral health adjusting the relationship for indicators of SES</td>
<td>Little change in odds ratio (7%) following adjustment for oral health behaviours</td>
</tr>
<tr>
<td>Psychological factors</td>
<td>Subjective socioeconomic status was related to single item self-rated oral health</td>
<td>Subjective socioeconomic status was associated with all psychological factors</td>
<td>All psychological factors were related to single item self-rated oral health adjusting the relationship for indicators of SES</td>
<td>The relationship between subjective socioeconomic status and single item self-rated oral health lost its statistical significance after adjustment for psychological factors</td>
</tr>
<tr>
<td>The relationship between subjective socioeconomic status and dental pain</td>
<td>Subjective socioeconomic status was related to dental pain</td>
<td>Subjective socioeconomic status was related to two out of three investigated oral health behaviours</td>
<td>One out of three oral health behaviours were related to dental pain</td>
<td>The relationship between subjective socioeconomic status and dental pain remained statistically significant after adjustment for dental pain</td>
</tr>
<tr>
<td>Oral health behaviours</td>
<td>Subjective socioeconomic status was related to dental pain</td>
<td>Subjective socioeconomic status was associated with all psychological factors</td>
<td>All psychological factors were related to dental pain after adjustment for indicators of socioeconomic status</td>
<td>Little change in odds ratio (5%) following adjustment for oral health behaviours</td>
</tr>
<tr>
<td>Psychological factors</td>
<td>Subjective socioeconomic status was related to dental pain</td>
<td>Subjective socioeconomic status was associated with all psychological factors</td>
<td>All psychological factors were related to dental pain after adjustment for indicators of socioeconomic status</td>
<td>The relationship between subjective socioeconomic status and dental pain remained statistically significant after adjustment for psychological factors</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Little change in odds ratio (2%) following adjustment for psychological factors</td>
</tr>
<tr>
<td>Hypothesised mediators</td>
<td>Condition 1</td>
<td>Condition 2</td>
<td>Condition 3</td>
<td>Condition 4</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>The relationship between mother’s education and dental pain</td>
<td>Oral health behaviours</td>
<td>Mother’s education was related to dental pain</td>
<td>Mother’s education was related to two out of three oral health behaviours</td>
<td>One out of three oral health behaviours were related to dental pain</td>
</tr>
<tr>
<td>Psychological factors</td>
<td>Mother’s education was related to dental pain</td>
<td>Mother’s education was related to one out of three psychological factors</td>
<td>All psychological factors were related to dental pain after adjustment for indicators of socioeconomic status</td>
<td>The relationship between mother’s education and dental pain remained statistically significant after adjustment for psychological factors</td>
</tr>
</tbody>
</table>

Condition 1: Socioeconomic status is significantly associated with self-reported oral health outcomes
Condition 2: Socioeconomic status is significantly associated with hypothesised mediators
Condition 3: Hypothesised mediators are significantly associated with oral health after adjustment for indicators of socioeconomic status
Condition 4: The impact of socioeconomic status on oral health decreased after controlling for hypothesised mediators
Chapter 4. Discussion
4.1 Main findings

In this study, I tested four conditions of the hypothesis of mediation to examine whether or not selected oral health behaviours and psychological factors explain oral health inequality. This study did not find strong evidence to support that oral health behaviours and psychological factors mediate oral health inequality for self-reported oral health outcomes of the study. Oral health behaviours did not meet all the conditions for being a mediator of oral health inequality for any pair of the relationships, and psychological factors weakly mediated oral health inequality for only one pair of the relationship. Adjustment for oral health behaviours and psychological factors led to a small change in the association between socioeconomic status and self-reported oral health outcomes. Further, the extent of oral health inequality explained by oral health behaviours and psychological factors did not vary greatly.

My first objective in this study was testing the relationships between socioeconomic status and self-reported oral health outcomes. In general, there was a graded relationship between socioeconomic status and self-reported oral health outcomes, with those standing in higher socioeconomic status reporting better oral health. However, findings of this study partially supported the relationship between socioeconomic status and self-reported oral health outcomes. Some, but not all, indicators of socioeconomic status were related to self-reported oral health outcomes of the study.
The second objective was testing the relationships between indicators of socioeconomic status and the following hypothesised mediators of the study: oral health behaviours and psychological factors. In general, there was a graded relationship between increasing socioeconomic status and oral health behaviours, with those in higher socioeconomic status more likely to brush their teeth, use dental floss, and visit a dentist more often. However, the relationships were not of statistical significance for all indicators of socioeconomic status and oral health behaviours.

The third objective was testing the relationships between oral health behaviours/psychological factors and self-reported oral health outcomes after adjustment for indicators of socioeconomic status. With one exception, oral health behaviours were weakly related to self-reported oral health outcomes whereas all psychological factors were fairly strongly related to self-reported oral health outcomes.

The fourth objective was evaluating the effect of adjusting the relationship between indicators of socioeconomic status and self-reported oral health outcomes for oral health behaviours/psychological factors. Adjusting the relationship between socioeconomic status and self-reported oral health outcomes for oral health behaviours and psychological factors, both individually and simultaneously, did not bring remarkable change to the odds ratios. Following the addition of oral health behaviours, the odds ratios for the relationship between indicators of socioeconomic status and self-reported oral health outcomes changed from 2% to 7% in comparison to the adjusted model. When the models were adjusted for psychological factors, the odds ratios changed from 1% to 8%. However, the relationships between
socioeconomic status and self reported oral health outcome lost their statistical significance in some cases.

Possible differences between girls and boys were regarded at all stages of data analysis by testing the gender differences for variables of the study as well as the interaction effect.

Girls, generally, reported better socioeconomic status for a majority of the socioeconomic indicators. This could be justified in two ways. Firstly, it could be that the girls were sampled from a more privileged section of the population despite efforts to ensure the equal chance for boys and girls in the sampling framework. The second justification, which is more likely, is that the more privileged girls were overrepresented in the sampled schools. It is plausible to assume that girls from a lower social position cannot go to school, despite it being compulsory, due to social values and cultural characteristics of Iranian society. In this study, girls were more likely to have better oral health behaviours in terms of tooth brushing and dental service use; however, there was no gender difference in terms of the frequency of dental flossing. With regard to psychological factors, there was no gender difference in terms of self-esteem and depression, but girls reported higher scores on anxiety. In terms of self-reported oral health, this study found no significant difference between boys and girls for either single item self-reported oral health or dental pain. Nevertheless, despite some gender differences in the variables of the study, the interactions analysis did not find gender difference in the relationship. Also, gender adjusted models did not yield fundamentally different findings. Altogether, these suggest that the findings of the study regarding the role of oral health behaviours and
psychological factors in explaining oral health inequality are valid for both genders. However, this study might not have the statistical power to detect gender differences in interaction analysis. I did not consider testing the interaction for age as all participants were within the narrow age range.

4.2 Relationship with other literature

4.2.1 Explanation for oral health inequality

The finding that oral health behaviours and psychological factors contribute little to oral health inequality concurs with those of other researchers. Earlier studies, similarly, suggested that oral health behaviours (Sanders et al. 2006; Wamala et al. 2006; Donaldson et al. 2008; Sabbah et al. 2008) and psychological factors (Sabbah et al. 2008; Locker 2009; Sabbah et al. 2009) explain a modest part of oral health inequality. Further, when the aggregate effects of oral health behaviours and psychological factors were controlled for, it did not add to the explanation of oral health inequality. This finding contradicts the findings of others in which the attenuation of the relationship after adjustment for health behaviours and psychological factors was larger than either set alone being adjusted (Cohen et al. 1999; Barger 2006). This may have been caused by the overlapping effects between oral health behaviours and psychological factors in this study.
4.2.2 Distribution of the variables across the sample

Regarding the distribution of the sample according to socioeconomic status, a majority of the participants ranked themselves in the middle groups, which is identical to previous uses of this measure (Singh-Manoux et al. 2005). Regarding parental education, there is an apparent difference between fathers’ and mothers’ level of education with fathers being more educated. This may reflect the cultural circumstances of Iranian society in which traditionally the men have been the breadwinner. Therefore, they are more inclined to study in order to enter the job market.

Regarding the distribution of the sample according to the oral health behaviours, two thirds of the participants (67%) in this study reported brushing their teeth at least once a day; this was similar to the corresponding prevalence from a study of Iranian adolescents residing in Tehran (66%) (Yazdani et al. 2008) and lower than the prevalence of tooth brushing among those Iranian adolescents residing in Mashhad (80%) (Dorri et al. 2009). The prevalence of tooth brushing from studies of adolescents in this study was lower than several other regions of the world, such as Saudi Arabia (84%) (Farsi et al. 2004), Chile (96%) (Lopez et al. 2006), Ghana (96%) (Blay et al. 2000), and the UK (98%) (Al-Dlaigan et al. 2002). Altogether, it is apparent that the prevalence of tooth brushing in this study is remarkably lower than those of adolescents from industrialised as well as neighbouring Middle Eastern countries.

In this study, the prevalence of reported dental flossing was fairly low with 17% flossing at least once a day. Earlier studies of Iranian adolescents reported even lower daily flossing (7%) (Kazemnejad et al. 2008). The prevalence of dental flossing in
this study is similar to those of Saudi Arabia (19%) (Farsi et al. 2004), and Kuwaiti (17%) (Honkala et al. 2007). The limited use of dental floss among adolescents has also been reported from several European countries (Kuusela et al. 1997), Canada (Ma 2007), and the UK (Macgregor et al. 1998). This confirms that flossing has not become a commonly adopted practice among adolescents (Honkala et al. 2007).

Nearly one third (33%) of participants in this study visited a dentist in the past year. Earlier studies have not recorded the prevalence of visiting dentists in Iran. It is important to acknowledge that, across the literature, visiting a dentist has been labelled differently, with terms such as ‘visiting dental services’ or ‘dental service use’ being preferred. Therefore, the definition might slightly vary from study to study. For the purposes of this study, I presented the findings of others without distinguishing the terms they have used for dentist visits. The prevalence of dentist visits in the past year in this study was lower than those of Chilean (53%) (Lopez et al. 2006), Saudi Arabian (57%) (Farsi et al. 2004), Jordanian (60%) (Al-Omiri et al. 2006), and American (68%) (Yu et al. 2001) adolescents. On the other hand, the prevalence of dentist visits in the past year in this study was higher than those of Mexican (15%) (Pontigo-Loyola et al. 2007), Chinese (26%) (Petersen et al. 2008), Sri Lankan (30%) (Perera et al. 2008), and Brazilian adolescents (34%) (Goes et al. 2007). Generally, the prevalence of dentist visits in the past year in this study is moderately lower than some developing countries. Nevertheless, as I discussed earlier (see 1.2.2.2 Oral health behaviours and psychological factors in relation to oral health), there is a debate as to whether more frequent dental visits indicate better oral health. Therefore, the lower or higher prevalence of dentist visits should not be interpreted erroneously. It might be that the prevalence was higher in a community.
because of higher levels of dental problems. For this, the reason for visiting dental services is investigated along with the frequency of visiting dental services. However, in this study, I investigated only the frequency of visiting dental services rather than the reason for visiting dental services.

For a number of reasons such as absence of valid cut-off points, I did not classify participants into various groups based on their scorings on psychological factors. Accordingly, it is hard to compare the findings of this study in terms of psychological factors with those of others because the mean scores do not necessarily provide a valid basis for such comparison in studies from different cultures. Nevertheless, I am not aware of any Iranian study measuring self-esteem using the Rosenberg Self-esteem Scale or any other scale. The mean scores obtained in this study for depression and anxiety are very similar to the scores recorded in previous applications of the HADS among Iranian adults (Montazeri et al. 2003).

With regard to self-reported oral health, almost one out of five participants reported their oral health as ‘fair/poor’ in this study when asked how they would rate their oral health status in general. The prevalence of poor self-reported oral health in this study is lower than those of adolescents from Sri Lanka, India, Brazil, Uganda, Tanzania, and China. In studies of adolescents, 21% of Sri Lankan (Perera et al. 2008) and 44.6% of Brazilian (Pattussi et al. 2007) rated their oral health as fair/poor. Also, 28% and 48% of adolescents rated their oral health as ‘average/poor/very poor’ in Uganda (Okollo et al. 2004) and Tanzania (Astrom et al. 2002), respectively. Further, 23% of Indian adolescents rated the status of their teeth as ‘bad/very bad’ (David et al. 2006) and 12% of Chinese adolescents reported their oral health as ‘poor/very poor’ (Jiang et
A comparison of the findings of this study with those of others should be made cautiously because these studies have used different approaches for collapsing individuals into the categories of poor and good oral health. Further, the wordings of the questions used for estimating self-reported oral health varies. It has been previously shown that self-reported indicators of oral health may yield different results depending on the wording of the indicators (Locker et al. 2005). The self-reported oral health outcome I used in this study was identical to those of studies of Brazilian and Sri Lankan adolescents (Pattussi et al. 2007; Perera et al. 2008).

The prevalence of dental pain in this study is relatively high, with nearly one third of the participants (30.9%) reporting dental pain in the past month. The finding of this study regarding the prevalence of dental pain in the past month is similar to those of Pakistani adolescents. Studies of Pakistani adolescents found a prevalence of 30.4% for experiencing pain in the tooth or teeth in the past month (Pau et al. 2008). Other studies of adolescents have employed various recall periods and description for dental pain. The prevalence of ‘oral pain’ in the previous four weeks was 37.4% among Greek adolescents (Pau et al. 2007); 36.4% of Tanzanian adolescents reported ‘dental pain’ in the past three months (Mashoto et al. 2009), and 33.6% of Brazilian adolescents had ‘dental pain’ in the last six months (Goes et al. 2007). There was also a 41% prevalence of ‘toothache or symptoms’ during the previous 12 months among Chinese adolescents (Jiang et al. 2005). Comparison of the findings of this study, in regard to dental pain, with those of others is problematic for two reasons. Firstly, studies have used various recall periods for the experience of dental pain. Secondly, dental pain was being investigated across the literature using different definitions and terms.
4.2.3 Gender differences

In terms of tooth brushing, girls were more likely to brush their teeth more frequently in this study. This finding corroborates the findings of previous studies of adolescents from several European countries (Kuusela et al. 1997; Maes et al. 2006), Chile (Lopez et al. 2006; Lopez et al. 2006), Kuwait (Honkala et al. 2007), Sudan (Darout et al. 2005), Finland (Sakki et al. 1998), Ghana (Blay et al. 2000), Iraq (Ahmed et al. 2007), Iran (Yazdani et al. 2008; Dorri et al. 2009), Scotland (Levin et al. 2008), the UK (Al-Dlaigan et al. 2002), Saudi Arabia (Farsi et al. 2004), Sweden (Ostberg et al. 1999), Canada (Ma 2007), and the USA (Vallejos-Sanchez et al. 2008).

The frequency of dental flossing was not related to gender in this study. This finding is in accordance with an oral health survey of Kuwaiti adolescents in which gender did not predict flossing behaviour (Honkala et al. 2007). However, there is some evidence from oral health studies of adolescents to show higher prevalence of dental flossing among girls in several European countries (Kuusela et al. 1997), Saudi Arabia (Farsi et al. 2004), Canada (Ma 2007), the UK (Maegregor et al. 1998), and Sweden (Ostberg et al. 1999).

This study found that girls were more likely to visit a dentist in the past year. This finding is in concordance with several oral health studies of adolescents in which adolescent girls reported more frequent use of dental services in Scotland (Attwood et al. 1993), the US (Yu et al. 2001; Dasanayake et al. 2002), Sri Lanka (Ekanayake et al. 2001), Chile (Lopez et al. 2006), Uganda (Okullo et al. 2004), and China (Petersen et al. 2008).
In summary, with the exception of dental flossing, girls were more likely to be engaged in healthier oral health behaviours, which is in line with previous findings from the literature. Gender differences in health behaviours are not limited to those aspects of health behaviour which were investigated in this study. The prevalence of healthy behaviours in terms of diet, drinking, and smoking is believed to be more common among females compared to males in both adolescents (Bergman et al. 2001) and adults (Liang et al. 1999; Courtenay et al. 2002; Wardle et al. 2004; Tseng et al. 2008).

In terms of self-esteem, there was no significant gender difference in this study. This finding is in accordance with those of Turkish and Chinese adolescents, in which no gender difference was found in regard to self-esteem (Kavas 2009). Despite this, evidence exists to show that male adolescents score relatively higher on self-esteem (Chubb et al. 1997; Quatman et al. 2001; Frost et al. 2004; Mahaffy 2004; Birndorf et al. 2005). Also, meta-analytic review of the gender difference in self-esteem suggested that men score slightly higher on self-esteem (Twenge et al. 2002).

There was no significant gender difference in terms of depression in this study. The gender difference in depression appears to emerge in early adolescence, with girls scoring higher in depression (Hankin et al. 2001; Twenge et al. 2002; Wade et al. 2002). Accordingly, the majority of studies propose that, during adolescence, females report greater depression (Avison et al. 1992; Marcotte et al. 2002; Bennett et al. 2005).
Girls scored significantly higher on anxiety in this study, which is in line with previous literature (Lewinsohn et al. 1998; Breton et al. 1999; Costello et al. 2003; Merikangas 2005; Adewuya et al. 2007; Van Oort et al. 2009).

The psychological factors of this study have not been investigated among Iranian adolescents, to my knowledge. However, recent investigation of mental health in Iran suggests that female adolescents have worse mental health compared to boys (Emami et al. 2007). The authors have attributed gender difference in mental health to ‘more controls and limitations exerted by society and also by families over the various aspects of the behaviour and life of girls compared with boys’.

In terms of single item self-rated oral health, this study found no significant difference between boys and girls. This finding is in accordance with Sri Lankan (Perera et al. 2008), Swedish (Ostberg et al. 2003), and Tanzanian studies (Astrom et al. 2002). In contrast, there is some evidence to show that girls rated their oral health more poorly compared to boys among Brazilian (Pattussi et al. 2007), Indian (David et al. 2006), and Chinese (Jiang et al. 2005) adolescents. Further, adolescent girls were more likely to be dissatisfied with the appearance of their teeth, although they did not differ from boys in terms of self-rated oral health (Astrom et al. 2002; Ostberg et al. 2003).

In terms of experience of dental pain, this study found no significant difference between boys and girls. This finding is in accordance with those of Pakistani (Pau et al. 2008), Greek (Pau et al. 2007) and Brazilian (Goes et al. 2007) adolescents in which the prevalence and severity of dental pain were not associated with gender.
However, at least one study has reported higher prevalence of ‘dental pain and symptoms’ among adolescent girls (Jiang et al. 2005). It is proposed that gender may not predict the prevalence of dental pain despite the presence of gender difference for other types of pain (Bassols et al. 1999).

4.2.4 Relationship between socioeconomic status and self-reported oral health outcomes

Only subjective socioeconomic status was related to single item self-rated oral health in this study. The assessment of the relationship between single item self-rated oral health and various indicators of socioeconomic status in studies of adolescents have yielded contradictory findings (Jiang et al. 2005; Pattussi et al. 2007; Perera et al. 2008). Single item self-rated oral health, in studies of adolescents, has been related to parental education (Astrom et al. 2002; Jiang et al. 2005), household income (Perera et al. 2008), and composite indicators of socioeconomic status estimated as both household assets and education of the head of the household (Pattussi et al. 2007). In contrast, other studies of adolescents did not establish the relationship between single item self-rated oral health and either family income (Jiang et al. 2005) or family wealth (David et al. 2006).

Subjective socioeconomic status and mother’s education were associated with dental pain in this study. Earlier oral health studies of adolescents have reported contradictory findings regarding the relationship between socioeconomic status and dental pain. Dental pain was associated with indicators of socioeconomic status among Brazilian adolescents where socioeconomic status was defined as ‘the participation of the head of the family in the distribution and production processes’
(Goes et al. 2007). Also, the experience of dental pain was related to wealth index among Tanzanian adolescents (Mashoto et al. 2009). On the contrary, dental pain was not related to parents’ employment status (Pau et al. 2007), parental employment status/car ownership (Pau et al. 2008), and parental education/family income (Jiang et al. 2005) in other studies of adolescents.

Different indicators of socioeconomic status were related to self-reported oral health outcomes to a varying extent. While some indicators of socioeconomic status were strongly related to oral health outcomes, the others were only weakly related. Two major justifications may be presented for the contradictory findings on the relationship between socioeconomic status and self-reported oral health outcomes in this study. Firstly, I discuss how the relationship between socioeconomic status and health could vary according to indicators of socioeconomic status. Secondly, I argue that the relationship between socioeconomic status and health among the adolescent population is not as robust as it is for the adult population.

There is evidence to show that the indicators of socioeconomic status reflect different dimensions of social position (Oakes et al. 2003). Therefore, the indicators of socioeconomic status are, to a varying extent, related to health outcomes. One study compared the strength of relationship between three indicators of socioeconomic status and mortality rate. This study found that wealth and family income were more strongly associated with health than education and occupation (Duncan et al. 2002). The varying extent of the relationship between indicators of socioeconomic status and health has also been recorded among adolescents. For example, it is suggested that adolescents’ health is more closely related to material deprivation compared to
conventional indicators of socioeconomic status such as parental education and occupation (Currie et al. 1997). Koivusilta analysed the data from a Finnish adolescent’s health survey to compare the relationship between health and various indicators of socioeconomic status such as familial social position, family affluence, and adolescent’s personal social position. This study found that health inequality was only partly related to the traditional indicators of familial social position such as father's social position and parents' education (Koivusilta et al. 2006).

Further, the relationship between socioeconomic status and health among the adolescent population requires particular attention as this relationship is not as robust as what the literature suggests for adults. While health inequality is consistently documented in early childhood (Chen et al. 2002) and adulthood (Adler et al. 1994), there are speculations that health inequality may not exist during adolescence. Perhaps the greatest support for absence of health inequality during adolescence comes from review studies of West and his colleagues (West et al. 1990; West 1997). In response to West’s hypothesis, Starfield reviewed a large number of studies of adolescents and suggested that the failure to identify health inequality in some studies of adolescents is a result of ‘the differences in conceptualisation and measurement of social position and outcome measures’ (Starfield et al. 2002). Others attributed the lack of consensus on health inequality during adolescence to increasing the autonomy of adolescents (Williams et al. 1997). This is because adolescence is a transition period in life, marked by physical, social, as well as psychological changes (Cameron 2003; Dahl 2003).
4.2.5 Relationship between socioeconomic status and oral health behaviours

In this study, subjective socioeconomic status and mother’s education were associated with tooth brushing frequency. Recently, two studies have presented data from Iranian adolescents on the relationship between socioeconomic status and tooth brushing frequency (Yazdani et al. 2008; Dorri et al. 2009). Dorri found that the frequency of tooth brushing was related to father’s education but not mother’s education (Dorri et al. 2009). Yazdani related tooth brushing frequency to parental education and wealth status of the family (Yazdani et al. 2008). Also, there is a great deal of evidence from international studies associating upper socioeconomic status to more frequent tooth brushing. Studies of adolescents from several European countries linked tooth brushing frequency to material deprivation (Maes et al. 2006) and perceived socioeconomic status (Kuusela et al. 1997). The tooth brushing frequency of Chilean adolescents was also positively related to household size, type of housing, number of cars owned by the family, parental education and parental income (Lopez et al. 2006). Further, the tooth brushing frequency of adolescents was linked to family affluence scale (Levin et al. 2008), perception of the financial status (Honkala et al. 2007), and mother’s education (Darout et al. 2005).

Regarding dental flossing, all indicators of socioeconomic status were related to the frequency of dental flossing in this study. This concurs with findings of earlier studies of adolescents in which dental flossing was linked to family income (Peres et al. 2007) and perception of financial status (Honkala et al. 2007).
Regarding visiting dentist, in this study, wealth index was associated with more frequent visits while subjective socioeconomic status and parental education were not. The relationship between wealth index - as a marker of family income - and visiting a dentist in this study is in accordance with previous studies of adolescents from China (Petersen et al. 2008), Brazil (Lopez et al. 2007), and the US (Yu et al. 2001). However, the findings of this study contradict those studies of adolescents from China (Petersen et al. 2008), Chile (Lopez et al. 2007), Uganda (Okullo et al. 2004), and the US (Yu et al. 2001), in which visiting a dentist was related to parental education.

4.2.6 Relationship between socioeconomic status and psychological factors

Some, but not all, indicators of socioeconomic status were statistically significantly related to psychological factors in this study.

Self-esteem, in this study, was related to all indicators of socioeconomic status except father’s education, with those from higher socioeconomic status reporting higher self-esteem. This finding is in agreement with a meta-analytic review of the literature in which the association between self-esteem and socioeconomic status among adolescents was established (Twenge et al. 2002). It is proposed that the relationship between socioeconomic status and self-esteem may vary depending on the indicators of socioeconomic status and self-esteem (Francis et al. 1996).

Depression, in this study, was related to subjective socioeconomic status and wealth index, but it was not significantly related to mother’s and father’s education. Those
from higher socioeconomic status reported lower depression scores. An inverse relationship between various indicators of socioeconomic status and depression among adolescents is demonstrated in numerous studies (Roberts et al. 1995; Costello et al. 1996; Bergeron et al. 2000; Goodman et al. 2002; Goodman et al. 2003; Goodman et al. 2003; Kubik et al. 2003; Undheim et al. 2005). Such relationship was also confirmed by evidence from a systematic review (Lemstra et al. 2008).

Anxiety, in this study, was only related to subjective socioeconomic status, with those from higher socioeconomic status reporting lower scores on anxiety. There is also evidence from studies of adolescents relating higher socioeconomic status to lower anxiety (Bergeron et al. 2000; Lemstra et al. 2008).

4.2.7 Relationship between oral health behaviours and self-reported oral health outcomes

For the purpose of testing the hypothesis of mediation, the relationships between hypothesised mediators and self-reported oral health outcomes were presented after adjustment for indicators of socioeconomic status. In this study, a majority of oral health behaviours were not related to either self-reported oral health outcomes of the study.

Single item self-rated oral health was not significantly related to any of the investigated oral health behaviours: tooth brushing frequency, dental flossing frequency, and visiting dentist. The findings of this study contradict the findings of a study of Sri Lankan adolescents in which more frequent tooth brushing was linked to better self-rated oral health (Perera et al. 2008). On the other hand, the findings of this
study are in agreement with findings on Brazilian adolescents, in which the use of dental services was not related to self-rated oral health (Pattussi et al. 2007). Evidence is not inclusive in regard to the relationship between dental service use and perception of oral health. There is some evidence from studies of Chinese and Indian adolescents to show that the more frequent use of dental services is linked to worse perception of oral health (Jiang et al. 2005; David et al. 2006). In contrast, the study of Sri Lankan adolescents associates more frequent dental service use to better perception of oral health (Perera et al. 2008).

In regard to experience of dental pain, neither tooth brushing nor dental flossing were significantly related to dental pain. The findings of this study contradict studies of Greek (Pau et al. 2007) and Finnish (Honkala et al. 2001) adolescents in which tooth brushing frequency was linked to experience of dental pain. However, visiting a dentist was positively associated with the experience of dental pain. Those who used dental services in the past year were more likely to experience dental pain. Others have also reported that using dental services is associated with higher prevalence of dental pain among adolescents in China (Jiang et al. 2005) and Brazil (Goes et al. 2007). This finding may indicate the symptom oriented pattern of dental service use among Iranian adolescents. The fact that dental service is mostly privately based in Iran (Pakshir 2004) may explain the symptom oriented pattern of dental service use.

4.2.8 Relationship between psychological factors and self-reported oral health outcomes

All psychological factors were significantly related to both single item self-rated oral health and dental pain in this study.
In regard to single item self-rated oral health, evidence is overwhelming from studies of the adult population to relate self-rated oral health to several psychological factors such as self-esteem (Benyamini et al. 2004; Locker 2009), depression (Anttila et al. 2006; Locker 2009) and anxiety (Anttila et al. 2006), life satisfaction (Benyamini et al. 2004; Sanders et al. 2005; Locker 2009), and stress (Sanders et al. 2005). However, I did not find any study which evaluated the relationship between psychological factors of this study and single item self-rated oral health.

In regard to experience of dental pain, I did not identify any study which examined how self-esteem, depression, and anxiety are related to experience of dental pain. The absence of evidence in regard to the relationship between dental pain and psychological factors is surprising while other types of pain such as ‘cancer pain’ (Velikova et al. 1995; Laird et al. 2009), and ‘neck pain’ (Reichborn-Kjennerud et al. 2002; Blozik et al. 2009) are closely related to psychological factors.

4.2.9 Relationship between socioeconomic status and oral health: Adjusted models for hypothesised mediators

Three studies have used regression models to evaluate the effect of adjusting the relationship between socioeconomic status and oral health for oral health behaviours (Sanders et al. 2006; Wamala et al. 2006; Sabbah et al. 2008) Only one of these studies reported substantial reduction in the relationship as a result of adjusting for oral health behaviours (Wamala et al. 2006). Further, three studies have tested how adjustment for psychological factors may influence the relationship between indicators of socioeconomic status and oral health outcomes (Sabbah et al. 2008;
Regarding the role of psychological factors, the finding of this PhD study is in agreement with these studies in that adjustment for psychological factors modestly reduces the relationship between socioeconomic status and oral health outcome.

4.3 Strengths and limitations

This study had a number of strengths as well as limitations. A number of these are mentioned below.

The framework of the study was derived from psychosocial determinants model by Marmot and Wilkinson (Marmot et al. 1999). However, the unique aspect of this study is the simultaneous investigation of oral health behaviours and psychological factors. Simultaneous investigating of oral health behaviours and psychological factors within the framework of this study allowed for a greater understanding of the complexity of oral health inequality. The fact that both oral health behaviours and psychological factors explain almost similar extent of oral health inequality suggests that thorough understanding of oral health inequality is difficult if one of them is disregarded. Previous efforts to explain oral health inequality have either considered oral health behaviours (Sanders et al. 2006; Wamala et al. 2006; Donaldson et al. 2008; Sabbah et al. 2008) or psychological factors (Sabbah et al. 2008; Locker 2009; Sabbah et al. 2009). Also, this is the first study to look at the population of adolescents to examine whether oral health behaviours and psychological factors explain oral health inequality in a developing country. Previous such studies have focused on population of adults from industrialised countries.
Using the hypothesis of mediation for explaining oral health inequality is also the
strength of this study. I believe this study is unique in that it tested four proposed
conditions of the hypothesis of mediation. A majority of the previous attempts to
explain oral health inequality (Sanders et al. 2006; Wamala et al. 2006; Sabbah et al.
2008; Sabbah et al. 2008; Locker 2009; Sabbah et al. 2009) either have not tested four
conditions or they make inferences merely based on the reduction of the oral health
inequality as a result of adjustment for proposed factors. However, employing the
hypothesis of mediation for cross-sectional data is controversial; therefore, some
explanations are required. I argue that employing the hypothesis of mediation in this
study, despite being challenging, is theoretically justifiable. The major challenge is
around justifying the temporal precedence of the socioeconomic, oral health
behaviours, and psychological variables over oral health outcomes. The hypothesis of
mediation requires clarifying the temporal precedence of the variables while cross-
sectional data offers the least information about temporal order. In this study,
predicting the temporal precedence was possible for a number of relationships, which
allowed utilisation of the hypothesis of mediation. The main challenge, probably, is
demonstrating the precedence of socioeconomic status over oral health outcomes. In
fact, there has been a long-standing debate around whether low socioeconomic status
causes poor health or poor health causes low socioeconomic status (Adda et al. 2003).
As a result of this debate, two hypotheses of ‘social causation’ and ‘social drift’
emerged. The hypothesis of social causation suggests that socioeconomic status
influences health status whereas social drift proposes that health status contributes to
socioeconomic status (Adler et al. 1999). Nevertheless, these theories should not be
considered mutually exclusive. There is evidence to show that the relationship
between socioeconomic status and health is not unidirectional; rather, it is the result of a reciprocal causal connection between the two (Mulatu et al. 2002). However, the possibility of social drift is more relevant to studies of adults where socioeconomic status and health are constantly interacting. In contrast to the population of adults, adolescents’ health is unlikely to affect their socioeconomic status. Accordingly, it is proposed that studies of health inequality in adolescence have the potential for providing better understanding of explanations of health inequality (Starfield et al. 2002). The same justification could be presented for the relationship between socioeconomic status and hypothesised mediators: oral health behaviours and psychological factors. However, it is important to acknowledge that the temporal precedence of the relationships between oral health behaviours/psychological factors and self-reported oral health outcomes could not be established; therefore, reverse causality cannot be fully ruled out. Although the temporal precedence of socioeconomic status over other variables was justified, such ordering does not imply a causal effect due to use of cross-sectional data.

The other limitation originating from the cross-sectional design of the study is the ‘one-time measurement of time-varying variables’. Health is being determined by the interaction of variables within a long period. However, in cross-sectional studies such as this study, variables are measured at one point. There was no information in this study about socioeconomic status, oral health behaviours and psychological factors and oral health of the individuals in an earlier stage of life. This limitation could not be removed unless prospective data were collected.
The sample was selected from adolescents who were studying at secondary schools. Therefore, the participants of this study are not representative of the general population of adolescents in Sanandaj. It is very likely that a number of adolescents in this age-group were incapable of studying at secondary school for a number of reasons, including financial limitation. Frankly, general population surveys of adolescents are difficult to conduct in Iran and sampling from secondary schools is a logical resolution to make these studies occur.

For analysing data, I used regression models to test the hypothesis of mediation. Building regression models has been a popular approach for testing the hypothesis of mediation following the suggestion of Baron and Kenny (Baron et al. 1986). In regard to health inequality research, this approach has been the dominant method for explaining health inequality (Bartley 2004). In regard to oral health inequality research, a majority of studies, as expected, have employed the regression models for analysing data (Sanders et al. 2006; Wamala et al. 2006; Sabbah et al. 2008; Sabbah et al. 2008; Locker 2009; Sabbah et al. 2009). However, building regression models is not the only approach for testing the hypothesis of mediation in health research and oral health research. In my review of the literature of studies explaining oral health inequality (see 1.2.2.4 Behavioural and psychological explanations for oral health inequality), there was one example of using structural equation modelling (SEM) rather than regression analysis (Donaldson et al. 2008). Employing structural equation modelling is recommended for better appreciation of the complex interrelationship between social determinants of oral health (Newton et al. 2005). In fact, the complexity of the interrelationships in mediation models and the shortcomings of regression models in testing hypothetical frameworks urge for going beyond
regression models. Therefore, it is not surprising that structural equation modelling (SEM) is gaining popularity for testing mediation hypothesis (Brown 1997). Some researchers have gone even further, suggesting that structural equation models for mediations are not merely an alternative to the regressions analysis but should supplant the regressions (Iacobucci et al. 2007). However, the use of structural equation modelling (SEM) should not be considered as an ultimate solution, particularly in health surveys. Baker has recently acknowledged some of the limitations which may cause problems when using structural equations modelling in health surveys. She asserts that health surveys often collect data of various natures such as categorical and dichotomised while modelling such data is problematic and less informative compared to continuous data (Baker 2009).

This study is a quantitative attempt to investigate explanations for oral health inequality. The quantitative approach, simply, tells to what extent what variables are related to each other, while it gives little information about fundamental issues such as how and why oral health behaviours and psychological factors contribute to oral health inequality. In other words, the puzzle still misses important pieces about how and why these factors play a role in health inequality. Why do people from various social positions adopt different health behaviours? How does the psychological status vary between people from various social positions? How does the interaction between psychological and behavioural factors influence health inequality? There are several such questions which might not be easily answered using quantitative methods. Of course, one should not neglect these questions. Answering the above questions and several other questions regarding theoretical explanations of oral health inequality require more than the usual statistical modelling of the data. Using qualitative
methods may help to find the missing pieces of the puzzle. The need for a qualitative approach in addition to quantitative methods in an oral health context has been highlighted in order for better appreciation of the complex relationship between social determinants and oral health (Newton et al. 2005; Sisson 2007). The qualitative approach in understanding oral health inequality has received little attention comparatively. Newton and Bower have asserted that the wide use of qualitative methods in epidemiology has yet to be reflected in oral epidemiology (Newton et al. 2005).

The findings of this study are restricted to the variables that have been tested in this study. It means that the results should not be extrapolated to other oral health behaviours and psychological factors. Although this study measured some of the important oral health behaviours and psychological factors, these are not the only variables that could have been potentially investigated. Nevertheless, this limitation would be present even if a larger number of variables were included. In other words, including a larger number of variables can reduce this limitation but might not address it fully. Some limitations are attached to measuring oral health behaviours in this study. In fact, investigated aspects of oral health behaviours in this study are among the most frequently studied oral health behaviours. However, dental literature has frequently examined additional oral health behaviours such as smoking, alcohol drinking, and diet. As I mentioned in an earlier section, I could not collect data on smoking, and the drinking of alcohol. Regarding psychological variables, I initially set out to explore a larger number of psychological variables such as optimism, coping, self efficacy beliefs along with self-esteem, depression, and anxiety. However, the Persian versions of related instruments were not available for some of
these variables. It was finally decided to include self-esteem, depression, and anxiety. It is possible that other psychological factors such as optimism, coping, self-efficacy beliefs might be more appropriate as mediators, therefore, explain a larger extent of oral health inequality. One issue which is worth mentioning is that, at some point, I considered the possibility of using the Beck depression Inventory (BDI) to estimate depression. However, the American publisher which holds the copyright to the scale deterred its administration among the Iranian population because they believed that due to the current US embargo on Iran they cannot grant permission for use of any of their products in Iran. As I mentioned in an earlier chapter (see 2.2.3.2 Depression and anxiety), depression was finally estimated using a subscale of the Hospital Anxiety and Depression Scale (HADS). However, it is unlikely that the replacement of the measures had a negative impact on our study because the replaced scale is also shown to be valid for this age group. In regard to measuring oral health, ideally, I wished to include indicators of clinical oral health along with the current self-reported indicators of oral health. However, this was not possible due to a number of reasons such as lack of financial resources and time limitation. Also, I mentioned earlier that the clinical and self-reported oral health outcomes are not necessarily correlated (see 1.2.2.1 Self-reported oral health). Therefore, the findings of this study could not be generalised to clinical oral health outcomes.

One issue that is worth discussing is the statistical treatment of the variables of the study. Two indicators of socioeconomic status, subjective socioeconomic status and wealth index, were collapsed into quartiles whereas mother’s and father’s education were measured on a 4-level categorical scale. Regarding subjective socioeconomic status, due to discrete scale, in the process of collapsing individuals into quartiles,
some did not exactly form one fourth of the population. Two of the oral health behaviours (tooth brushing and dental flossing) measured on an ordinal scale which was dichotomised to allow for logistic regression, and visiting dentist was measured on a dichotomised scale. Despite being a common practice in dental studies, dichotomising oral health behaviours might have reduced the power of the study. Psychological variables of the study were analysed as a numerical variable. It was decided not to collapse these variables into categories for two main reasons. Firstly, collapsing the psychological variables measured on a numerical scale results in lost information; therefore, this should be avoided unless such a decision is made based on statistical necessity (Streiner 2002). Secondly, one common reason behind collapsing psychological variables using specific cut-off points is that it facilitates the interpretation and decision making for a clinician. Clearly, this was not the purpose this study. More importantly, it was methodologically inappropriate to collapse participants into categories using cut-off points for any of the psychological factors. Regarding self-esteem, ‘there are no discrete cut-off points to delineate high and low self-esteem’ according to the developers (University of Maryland Department of Sociology). Regarding depression and anxiety, specific cut-off points are suggested for the population of British adolescents (White et al. 1999); however, using these cut-off points for Iranian adolescents was unjustifiable. Eventually, all psychological factors were analysed as numerical variables. Dichotomising the indicators of self-reported health is a common practice in general and dental health literature. The frequent use of this approach in health inequality research, in particular, has drawn the attention of researchers to investigate whether using this method is justifiable when self-rated health is investigated against socioeconomic status. At least two studies attempted to address whether dichotomisation lead to fundamental loss of
information in oral health inequality research. Manor and colleagues compared the efficiency of dichotomising self-rated health against alternative methods for ordinal variables when it is examined in association with socioeconomic status. This study suggested analysing dichotomised self-rated health yields similar results to those of various ordinal models (Manor et al. 2000). Barger also found that analysing the data on self-rated health as ordinal or dichotomised does not make fundamental changes to the results in regard to its association with socioeconomic status (Barger 2006). These findings ensure that the dichotomisation of self-rated oral health in this study does not fundamentally harm the findings, although some biases due to misclassifications is predictable.

A number of biases are connected with the use of self-reported data in this study. One of these limitations is that all the variables of this study are collected using self-reported data. This could result in “common method variance” (Frese, 1985; Spector, 1987; Williams, Cote & Buckley, 1985). This implies that when relating the self-reported outcomes to each other, there is a chance to have a positive bias leading to overestimation of the real associations. Another limitation which is associated with use of self-reported data is ‘reporting bias’. Adolescents might have been inclined to present a favourable image in terms of socioeconomic status, oral health behaviours, psychological factors, and oral health.

4.4 Implication for future research

Future studies are advised to address the shortcomings of this study. Using longitudinal data is essential in order to overcome the limitations caused by the cross-
sectional design of this study, such as reverse causality and one-time measurement of time-varying variables. Sampling from representatives of the general population, rather than students, is also recommended. In terms of study design, using a qualitative approach is fundamental for better appreciation of the factors that explain oral health inequality. In terms of variables, a wider range of oral health behaviours and psychological factors, which potentially explain oral health inequality, should be tested in future studies. Further, factors that explain oral health inequality for clinical oral health outcomes should be considered.

4.5 Implication for policy

Theoretically, the ultimate elimination of health inequality would occur if there are no differences in socioeconomic status. Needless to say, bringing such fundamental changes to society is impossible. Accordingly, health inequality research is concerned with modifying the factors that contribute to development of health inequality. The findings of this study are important in that they demonstrate (a) whether or not action is required to reduce oral health inequality, and (b) what variables should be manipulated to reduce oral health inequality.

Before describing the exact policy implication of the findings of this study, I highlight the importance of considering oral health inequality within the framework of oral health promotion programmes. The fact that oral health inequality persists even in industrialised nations despite general improvement in oral health status (Watt 2007), suggests that health promotion and reducing health inequality are not synonymous. It is simplistic to assume that those interventions that help improve the
overall oral health status of the population necessarily reduce oral health inequality. For example, a dental health education campaign led to promotion of oral health status on aggregate but those from higher social classes benefitted from the programme more than the deprived group (Schou et al. 1994). This important finding suggests that the success of oral health promotion programmes in raising the overall oral health status not only may not reduce oral health inequality; it may also deteriorate the condition in terms of health inequality. Accordingly, oral health promotion programmes should take into account oral health inequality.

Nevertheless, this study has important implications for policy makers. The presence of oral health inequality for some self-reported oral health outcomes requires particular attention. Oral health inequality, in this study, has two specific characteristics: (a) it has graded shape; (b) it is present regardless of the gender. These two characteristics imply that future oral health promotion programmes should not focus on a particular gender or social group; rather, the emphasis should be on approaching the whole population. The availability of adolescents at this age-group prepares the grounds for school-based oral health programmes. Given that oral health inequality was also established for a number of clinical oral health outcomes among other samples from Iranian adolescents (see 1.2.2.5 Oral health studies of Iranian adolescents), it is reasonable to speculate that oral health inequality is a potential challenge for health policy makers in Iran. Further, the fact that oral health inequality exists for self-reported oral health outcome immediately turns the attention to the factors that explain inequality in oral health for developing health policy. The findings of this study suggest that oral health behaviours and psychological factors explain a small part of oral health inequality. Therefore, future interventions, targeting the
investigated variables of this study, are expected to have minor achievements in reducing oral health inequality. However, the findings of this study should not be misinterpreted in regard to the role of oral health behaviours and psychological factors in explaining oral health inequality. It may be that other oral health behaviours and psychological factors better explain oral health inequality, which is not investigated in this study.
References

Statistical Centre of Iran from http://www.sci.org.ir
University of Maryland Department of Sociology from http://www.bsos.umd.edu/socy/research/rosenberg.htm. Last accessed May 2010
World Health Organization (1994). Fluorides and oral health: Expert Committee on oral health status and fluoride use


Baum A, Garofalo JP and Yali AM (1999). Socioeconomic status and chronic stress - Does stress account for SES effects on health? Socioeconomic Status and
Health in Industrial Nations - Social, Psychological, and Biological Pathways 896: 131-144.


Gallo LC and Matthews KA (1999). Do negative emotions mediate the association between socioeconomic status and health? Socioeconomic Status and Health in Industrial Nations - Social, Psychological, and Biological Pathways 896: 226-245.


168


Long JS and Freese J (2003). Regression models for categorical dependent variables using Stata. College Station, Tex., Stata Press.


Appendices

Appendix 1 Validation of the Persian Short Version of the Oral Health Impact Profile (OHIP-14)

V. Ravaghi 1, MSc
N. Farrahi-Avval 2, MSc
D. Locker 2, PhD
M. Underwood 3, MD FRCGP

1 Centre for Health Sciences, Barts and The London, Queen Mary University of London, United Kingdom
2 Community Dental Health Services Research Unit, Faculty of Dentistry, University of Toronto, Canada.
3 Health Sciences Research Institute, Warwick Medical School, University of Warwick, United Kingdom

Keywords: oral health, epidemiology, OHIP, validation, oral health impact profile, quality of life
Abstract

Purpose: The Oral Health Impact Profile (OHIP) questionnaire measures oral health related quality of life and is widely used for assessing subjective oral health status. We describe the translation and validation of the shortened 14-item OHIP for native Persian (Farsi) speakers.

Materials and Methods: We translated The OHIP-14 into Persian (OHIP-14-P), followed by back-translation into English, after which the Persian version was revised and modified. We administered the questionnaire to native Persian speaking clients at a university-based dental clinic in Tehran, Iran (n = 240, 123 female and 117 male, mean age 39, range 18-76). We examined convergent validity and discriminative validity of OHIP by analyzing their association with various self reported health outcomes. We evaluated test-retest reliability by administering the instrument to 37 patients a second time. We analysed the internal consistency and reliability using Interclass Correlation Coefficients (ICC) and the Cronbach’s reliability coefficient respectively.

Results: The associations between scores of OHIP-14-P and its subscales with self-reported general (rSpearman range 0.38-0.52) and oral health (rSpearman range 0.25-0.45) confirmed convergent validity. Discriminative validity was confirmed through the significant relationship between OHIP-14-P scores with both the experience of pain and satisfaction with oral health (P < 0.001). The instrument’s test-retest reliability (Intraclass correlation coefficients: 0.75-0.88), and internal consistency (Cronbach’s α: 0.45-0.73 and Cronbach’s α if subscale deleted: 0.88-0.85) were satisfactory.

Conclusion: The Persian version of OHIP-14 was found to be valid and reliable and appropriate to be used among native Persian speakers attending a dental clinic.
Introduction

Oral health related quality of life (OHRQoL) is a subset of health related quality of life. The subject was introduced to dentistry following the development of a theoretical model for oral health (Locke 1988). A number of measures have been developed to investigate oral health related quality of life (Slade 1997). The Oral Health Impact Profile (OHIP) is one such instrument and is based on the World Health Organization’s International Classification of Impairments, Disabilities, and Handicaps. The OHIP was first developed as a 49 question instrument (OHIP-49), capturing seven dimensions related to oral health: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap (Slade and Spencer 1994). This was subsequently shortened to 14 items (OHIP-14) (Slade 1997). The OHIP-14 asks participants to rate impact of their oral health on different dimensions of their lives. For each of the OHIP-14 questions subjects are asked how frequently they have experienced an impact in the preceding time interval using the Likert scale coded [0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often and 4 = very often]. Therefore, higher grades of OHIP-14 represent more negative effects of oral health on Quality of Life (QoL). The OHIP-14 has been the popular measure of oral health related quality of life in epidemiological studies. For example, the OHIP-14 was used as an oral health outcome in nationally representative surveys such as UK Adult Dental Health Survey and the Australian National Dental Telephone Interview Survey (Slade et al, 2005). Further, the OHIP-14 has gained popularity as an oral health outcome in clinical trials (McGrath et al, 2003; Ozcelik et al, 2007; Shugars et al, 2006). The brevity of the OHIP-14 makes it an appropriate instrument for studying oral health in large health surveys. Using shorter instruments in health surveys is important for being less time consuming and more cost-effective. This particularly applies to developing countries where resources are limited for health research. Producing translated version of the OHIP-14, therefore, remove the obstacles for its wider application in investigations of impacts of oral health as well as clinical practice.

To our knowledge, the short and long versions of OHIP have been translated to Chinese (Wong et al, 2002), German (John et al, 2006; John et al, 2002), Sinhalese (Ekanayake and Perera 2003), Swedish (Larsson et al, 2004), Hebrew (Kushnir et al, 2004), Malaysian (Saub et al, 2005), Spanish (Lopez and Baelum 2006), Hungarian (Szentpetery et al, 2006), Japanese (Ide et al, 2006), Portuguese (Pires et al, 2006), Arabic (Al-Jundi et al, 2007), Korean (Bae et al, 2007), Croatian and Slovenian (Rener-Sitar et al, 2008), and Dutch (van der Meulen et al, 2008). The aim of this study was to validate and adapt the OHIP-14 for Persian (Farsi) speakers living in Iran (OHIP-14-P), for use in a cross-sectional study of OHRQoL. The translated version of the OHIP-14 to Persian was also tested for validity and reliability.

Methods

Oral health impact profile

Responses to the 14 items of OHIP were recorded in a five-point Likert scale: never=0, hardly ever=1, occasionally=2, fairly often=3, very often=4). The scores range from zero to 56.
Translation

We translated the OHIP-14 to Persian (Farsi) in the manner described by Beaton et al. (Beaton et al, 2000). This included forward and backward translations, synthesis and review of the translations by a committee of experts, and pre-testing of the final version. The main objective of the translation was to produce a cross-culturally equivalent translation that was conceptually equivalent to the original English version. An informed translator (NF) with expertise in public health dentistry and an uninformed translator who was not familiar with OHIP, both native Persian speakers and fluent in English, preformed the forward translations separately and later combined, resolved discrepancies and revised them into a single report. The parallel back translations were performed by two native English speakers, fluent in Persian, who were blind to the English version of OHIP-14. The differences between the original English version and the back translation were discussed. Produced translations were combined following the resolution of discrepancies and variations. All translators reached an agreement over final version (Appendix 1).

Subjects

We recruited individuals aged eighteen and over, visiting the dental clinic associated with Shahid Beheshti Medical University, Tehran, Iran. The Ethics Committee of Shahid Beheshti Dental School and the Research Ethics Committee of Queen Mary University of London provided ethical review of this study. Of 256 people approached 240 (94%) agreed to participate; 123 females, 117 males, mean age 39, range 18 to 76. Consenting participants completed the questionnaire whilst waiting to consult. For OHIP-14-P questions, participants were asked how frequently they had experienced the impact in the last month. Mainly these were self completed; for some participants who were unable to self-complete the questionnaire was administered verbally by one researcher (VR). Participants who were not attending for a painful dental condition, and who had not had a dental procedure were invited to complete the questionnaire again after two weeks to allow test/retest reliability to be assessed.

Sample size

For the purpose of validation and cross cultural adaptation, a sample size of 100 – 200 using a convenience sample population of the population is needed (Abeles et al, 1994). Although convenience sampling was adopted, we attempted to recruit individuals from all age groups and both genders.

Validity

Our questionnaire was translated from the original English version; therefore it had undergone previous content analysis. In terms of construct validity, we investigated convergent validity and discriminative validity. Convergent validity is supported when different methods of measuring the same construct provide similar results. Convergent validity was evaluated by examining the association between self-reported general and oral health (very good, good, fair, and poor) with OHIP-14. We hypothesised that individuals with worse rated general and oral health are more likely to report higher oral impacts. Discriminative validity is confirmed when a measure of one underlying construct can be differentiated from another construct. To investigate
discriminative validity of the scale, we predicted that subjects with no experience of pain and more satisfaction with their oral health are more likely to have lower OHIP-14-P scores. We did validity analysis for the convergent validity using Spearman’s correlation coefficient and discriminative validity using a Mann Whitney U test.

Reliability

We used Cronbach's alpha to assess internal reliability and the extent of agreement between subscales and OHIP-14-P (Cronbach 1951). The Cronbach’s alpha for the OHIP subscales is the correlation of subscale with the total of others in the scale. To measure internal consistency, Cronbach’s ‘α if subscale deleted’, and for the individual; OHIP-14-P subscales were calculated. ‘α if subscale deleted’ was used to determine whether the removal of subscale would increase the instrument’s reliability. Normally, it is expected that ‘α if subscale deleted’ would not be greatly higher than the overall Cronbach’s alpha following the removal of a particular subscale. If a subscale was not well fitted to scale, the value of α would increase greatly if it were deleted from the scale.

Test/re-test reliability

We examined the test-retest reliability using a two-way random model intraclass correlation coefficient (ICC).

Data analysis:

All the analyses of the study were done using the SPSS version 13.1 (SPSS Inc., Chicago, IL, USA).

Results

Translation

The committee agreed on minor differences between the English and the Persian versions. For instance, the words “self-conscious” and “painful aching” were translated as “embarrassed” and “feeling pain” in both the forward and the backward translations, respectively. Such variations were deemed acceptable as they maintained the original construct of the instrument.

Validity

Testing for convergent validity, we found that both self rated general health (r_s = 0.60) and self rated oral health (r_s = 0.50) converge with level of oral health impacts. Spearman’s rank correlation coefficients of subscales for self rated general health and oral health ranged from (0.38-0.52) and (0.25-0.45), respectively. A statistically significant association was observed for the scale and its subscales (P < 0.01) (Table 1). Testing for discriminative validity, we found a statistically significant relationship (P < 0.001) between experience of pain in last month and the OHIP-14-P. Satisfaction with oral health was significantly related to oral health impact (P < 0.001) (Table 2). Those who experienced pain in last month and were less satisfied with their oral...
health reported higher impacts and consequently worse oral health related quality of life.

Reliability

The Cronbach’s alpha value was 0.88 and it ranged from 0.45 to 0.73 for the seven subscales. Cronbach’s $\alpha$ if subscale deleted was less than the overall alpha ($\alpha = 0.88$) for subscales except for “functional limitation” (Table 3). The values for $\alpha$ if subscale was deleted ranged from 0.85 to 0.88. Thirty seven respondents completed test-retest study. The overall intraclass correlation coefficient (ICC) was 0.83 and ranged from 0.75 to 0.88 for the subscales (Table 3). This indicated excellent test-retest reliability.

Discussion

We found our Persian version of the Oral Health Impact Profile (OHIP-14-P) to be a valid and reliable instrument with psychometric properties similar to the original version (Slade 1997). We followed a rigorous translation procedure to retrieve a culturally equivalent instrument targeted semantic and conceptual agreement between the original and the translated version. The cross-cultural adaptation of the quality of measures can be problematic (Allison et al, 1999; Corless et al, 2001). Guidelines have been published to facilitate the development of conceptually equivalent quality of life measures (Beaton et al, 2000; Guillemin et al, 1993). We followed standard procedures for the translation that have been frequently used for translation of both quality of life and oral health related quality of life measures. (Beaton et al, 2000).

As expected, the scores of OHIP-14-P and its subscales correlated significantly with self rated general health and self rated oral health indicating convergent validity. Convergence of OHIP-14-P scores with self rated oral health in our study, was similar to that found in validity studies of other versions of OHIP (Al-Jundi et al, 2007; Ekanayake and Perera 2003; Ide et al, 2006; Lopez and Baelum 2006; Rener-Sitar et al, 2008; Saub et al, 2005; Szentpetery et al, 2006; van der Meulen et al, 2008; Wong et al, 2002). The correlation of OHIP-14-P scores with self rated oral health in our study ($r_s = 0.50$) was of moderate strength and similar to that of other versions such as the Hungarian ($r_s = 0.45$) (Szentpetery et al, 2006), the German ($r_s = 0.56$) (John et al, 2002), the Malaysian ($r_s = 0.52$) (Saub et al, 2005), the Chinese ($r_s = 0.57$) (Wong et al, 2002), and the Arabic ($r_s = 0.59$) versions (Al-Jundi et al, 2007). In the absence of agreed-upon clinical criteria, or “gold standards” for validation of oral health related quality of life measures, and because the association between OHIP scores and clinical indicators is weak, using single item self rated oral health indicators is popular in validation studies (Locker and Slade 1994). In the analysis of discriminate validity, we found that OHIP-14-P scores can differentiate between individuals based on their satisfaction with their oral health and experiencing pain in last month.

Cronbach's $\alpha$ (0.88), shows quite good reliability of OHIP-14-P. This is similar to original English version ($\alpha$=0.88) (Slade 1997), Malaysian version ($\alpha$=0.89) (Saub et al, 2005), and Hebrew version ($\alpha$=0.88) (Kushnir et al, 2004). However, Cronbach's alpha in our study was slightly less than that of Sinhalese version ($\alpha$=0.93) (Ekanayake and Perera 2003) and two Korean short forms of OHIP.
Cronbach’s alpha for seven subscales ranged from 0.45 for “functional limitation” to 0.73 for “handicap” and “psychological discomfort”. Only the “functional limitation” fell below significance (0.5). A similar finding was reported in a validation study of OHIP-14 in Scotland (Fernandes et al, 2006). Also, “functional limitation” has shown the lowest Cronbach’s α for subscales in the German version of the OHIP-49 (John et al, 2002). To examine whether the removal of any subscale might improve the overall alpha, Cronbach’s α if subscale deleted (functional limitation) was calculated; this did not affect the result (0.88), and not affect internal consistency. This also supported the internal consistency of the scale. Nevertheless, the removal of each subscale from the scale did not remarkably affect the internal consistency. This has been the case with the validation study of the Hebrew version of OHIP-14 (Kushnir et al, 2004). This indicates that subscales reflect almost the same construct, proposing the use of OHIP-14-P scores as a whole rather than using the subscales. We are unable to compare our findings with those of others as the Cronbach’s ‘α if subscale deleted’ has not been frequently reported within validation studies of OHIP-14. The OHIP-14-P showed excellent test-retest reliability (ICC=0.83) which is similar to that of Malaysian version (ICC=0.89) (Saub et al, 2005) and higher than either two Korean versions (ICC=0.63, ICC=0.64) (Bae et al, 2007). One possible explanation for these could be the variety of time intervals between the administration and re-administration of the instrument. The time interval in our study was similar to that of Malaysian study (15 days) and much shorter than Korean study (3 months). Also, recall period and differences in population might contribute to this discrepancy between studies.

In this study we established the appropriateness of the Persian version of OHIP-14 for estimating the impacts of oral health in population survey. We have not assessed the responsiveness of the OHIP-14-P. Testing the responsiveness to change, for example after dental treatment was beyond the resources available for this validation study and unnecessary for our planned population study. Ideally, responsiveness should be assessed before it is used in either a cohort study or a clinical trial. We are, however, reassured that the English (Fernandes et al, 2006), German (John et al, 2006), Croatian and Slovenian (Rener-Sitar et al, 2008) versions have already been show to be responsive to change.

In conclusion, we found the Persian version of OHIP-14 to be a valid and reliable measure to be used among native Persian speakers. In this study we have examined the validity and the reliability of the OHIP-14-P among the dental patients and further investigations are warranted to achieve validity and reliability of the OHIP-14-P for the general population.

Acknowledgments

We are grateful for the help of Nick Argasi, Natalie Sarkissians, Sara Masoumi, and Naghmeh Tehrani for their efforts and contributions to the translation of the original English version to Persian. We are also thankful to the staff of “Shahid Ghazi Dental Clinic” and Department of Community Oral Health, Shahid Beheshti Medical
University, Tehran, Iran. This is a part of PhD thesis of Vahid Ravaghi in Barts and the London, Queen Mary University of London. This study was sponsored by Iranian Ministry of Health.
References:

Table 1. OHIP-14-P Spearman’s rank correlation coefficients between the OHIP subscale scores and self rated general health / self rated Oral health

<table>
<thead>
<tr>
<th></th>
<th>All participants mean (95% CI)</th>
<th>Self rated general health</th>
<th>Self rated Oral health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional limitation</td>
<td>1.5 (1.3, 1.7)</td>
<td>0.38&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.31&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Physical pain</td>
<td>3.0 (2.7, 3.2)</td>
<td>0.52&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.41&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Psychological discomfort</td>
<td>3.4 (3.1, 3.7)</td>
<td>0.46&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.41&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Physical disability</td>
<td>1.8 (1.5, 2)</td>
<td>0.47&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.39&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Psychological disability</td>
<td>2.4 (2.1, 2.6)</td>
<td>0.53&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.45&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Social disability</td>
<td>1.5 (1.2, 1.7)</td>
<td>0.47&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.25&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Handicap</td>
<td>1.5 (1.3, 1.7)</td>
<td>0.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.34&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>OHIP-14</strong></td>
<td><strong>15 (13.7, 16.2)</strong></td>
<td><strong>0.60&lt;sup&gt;a&lt;/sup&gt;</strong></td>
<td><strong>0.50&lt;sup&gt;a&lt;/sup&gt;</strong></td>
</tr>
</tbody>
</table>

<sup>a</sup> Correlation is significant at the 0.01 level

<sup>b</sup> 95% confidence interval for the mean
Table 2. OHIP mean score by satisfaction with oral health and experience of dental pain

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>OHIP-P score mean (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>123</td>
<td>18.1 (16.2, 19.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No</td>
<td>117</td>
<td>11.7 (10.1, 13.3)</td>
<td></td>
</tr>
<tr>
<td><strong>Satisfaction with oral health</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>98</td>
<td>9.7 (8.3, 12.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No</td>
<td>142</td>
<td>18.6 (16.9, 20)</td>
<td></td>
</tr>
</tbody>
</table>

a Mann–Whitney test.

b 95% confidence interval for the mean
Table 3. Internal consistency (Cronbach’s Alpha), Cronbach’s Alpha if subscale deleted, and Intraclass correlation coefficients (ICCs)

<table>
<thead>
<tr>
<th></th>
<th>Internal consistency (Cronbach’s Alpha)</th>
<th>Cronbach’s Alpha if subscale deleted</th>
<th>ICC (95% CI) (n=37)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional limitation</td>
<td>0.45</td>
<td>0.88</td>
<td>0.76 (0.59, 0.87)</td>
</tr>
<tr>
<td>Physical pain</td>
<td>0.65</td>
<td>0.86</td>
<td>0.84 (0.72, 0.91)</td>
</tr>
<tr>
<td>Psychological discomfort</td>
<td>0.73</td>
<td>0.85</td>
<td>0.75 (0.57, 0.86)</td>
</tr>
<tr>
<td>Physical disability</td>
<td>0.65</td>
<td>0.86</td>
<td>0.87 (0.76, 0.93)</td>
</tr>
<tr>
<td>Psychological disability</td>
<td>0.72</td>
<td>0.85</td>
<td>0.79 (0.64, 0.89)</td>
</tr>
<tr>
<td>Social disability</td>
<td>0.69</td>
<td>0.85</td>
<td>0.75 (0.58, 0.87)</td>
</tr>
<tr>
<td>Handicap</td>
<td>0.73</td>
<td>0.85</td>
<td>0.88 (0.78, 0.94)</td>
</tr>
<tr>
<td><strong>OHIP-14</strong></td>
<td><strong>0.88</strong></td>
<td></td>
<td><strong>0.83 (0.70, 0.91)</strong></td>
</tr>
</tbody>
</table>
Appendix 2 Comparison of the COHIP and OHIP-14 as measures of the oral health-related quality of life of adolescents

V. Ravaghi 1
M.M. Mokhatry Ardakan 2
S. Shahriari 2
N. Mokhtari 3
M. Underwood 4

1 Centre for Health Sciences, Barts and The London, Queen Mary University of London, United Kingdom
2 Department of Endodontics, Hamedan University of Medical Sciences, Iran
3 Department of Operative Dentistry, Shahid Beheshti University of Medical Sciences, Iran
4 Health Sciences Research Institute, Warwick Medical School, University of Warwick, United Kingdom

Keywords: oral health, oral health related quality of life, Adolescent, Epidemiology
Abstract

Aim: To compare the validity and reliability of the Oral Health Impact Profile-14 (OHIP-14) and the Child Oral Health Impact Profile (COHIP) for investigating oral health related quality of life (OHRQoL) of adolescents.

Method: We studied 234 adolescents from two publicly funded schools in Hamedan, Iran. Participants completed questionnaires and had a clinical examination. We compared convergent and discriminative validity of instruments by analyzing their association with self reported health indicators and number of decayed teeth.

Results: Both instruments showed good convergence with self-rated health and self-rated oral health. Those who perceived dental treatment needs, who had experienced dental pain in last month, were more dissatisfied with their oral health, or had more decayed teeth scored higher on both OHIP-14 and COHIP. The discriminative validity of two instruments varied slightly and inconsistently when the number of decayed teeth examined. The convergent and discriminative validity of both instruments were established independent of their scoring methods by calculating the area under the curve (AUC) for both measures using alternative scoring methods. Conclusion: Both the OHIP-14 and COHIP were valid and reliable measures for investigating OHRQoL among 15-17 year old adolescents. The COHIP is preferable when the aim is identifying more impacts. Both measures have shown good convergent and discriminative validity, however, for practical reasons; the shorter instrument (OHIP-14) may be more suitable for epidemiological studies.
Introduction

Oral health-related quality of life (OHRQoL) is an important outcome of oral health surveys and clinical trials in dentistry and several measures have been developed for assessing this. The Oral Health Impact Profile (OHIP-49) (Slade and Spencer, 1994), the short-form Oral Health Impact Profile (OHIP-14) (Slade, 1997), and the Oral Impacts on Daily Performance (OIDP) (Adulyanon and Sheiham, 1997) are the most well known. More recently measures of children’s oral health-related quality of life have also been developed; these include, child’s version of Oral Impacts on Daily Performances (CHILD-OIDP) (Gherunpong et al., 2004), the Child Perception Questionnaire (CPQ11-14) (Jokovic et al., 2002), and the Child Oral Health Impact Profile (COHIP) (Broder and Wilson-Genderson, 2007).

It cannot be assumed that either child or adult measures are appropriate for use in adolescents. Inconsistent findings are reported, in the few studies of the validity of OHRQoL instruments for adolescents. One study of 14 year olds in Myanmar found the OHIP-14 to have better validity than OIDP, although both instruments were criticized for their shortcomings in detecting impacts of oral health (Soe et al., 2004). Two other studies of 12-17 year old American and 12-21 year old Chilean participants support the validity of the OHIP (Broder et al., 2000; Lopez and Baelum, 2006). However, a more recent pilot study in Sweden did not find the OHIP-14 to be valid in 19 year olds (Oscarson et al., 2007). We are not aware of any validation work on the COHIP in adolescents.

To inform our choice of oral health related quality of life (OHRQoL) measure for a cross-sectional study of oral health in adolescents, we have compared the validity and reliability of the OHIP-14 (Slade, 1997) and COHIP (Broder et al., 2007) amongst an adolescent population.

Materials and method

Study procedure

We used a convenience sample of 15-17 year old adolescents studying at two publicly funded high schools in Hamedan, west of Iran. Hamedan is the capital of Hamedan province; it has a population of around 480,000 in 2005 (http://www.sci.org.ir). High school education is free in Iran; (and there are few privately funded schools.), our sample is, therefore, representative of the Iranian population of this age. We approached 241 students from six classes: three from a girls school and three from a boys school. Students were invited to take part in the study by both completing the questionnaires and attending for a clinical examination. The self-administered questionnaire was completed by students. The questionnaires were filled in the classrooms after a brief instruction. Parental consent to take part was not required because, in Iran, this age group is deemed competent to make their own decisions whether to take part in such studies. The consent to take part in the study was obtained by stating that “My completion of this anonymous questionnaire is an indication of my agreement to participate in this study”. Ethical approval was primarily obtained from the Ethics Committee of Dental School, Hamedan University of Medical Sciences. Then, the educational administration of Hamedan province provided us with an approval letter that enabled us to get access to the schools.

Measures
Measures of oral health related quality of life

The oral health impact profile (OHIP-14): The OHIP was first developed as a 49 question measure (OHIP-49) (Slade and Spencer, 1994) and was subsequently shortened to 14 items (OHIP-14) (Slade, 1997). The OHIP-14 asks participants to rate impact of their oral health on different dimensions of their lives capturing seven dimensions related to oral health, functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. We have recently shown the Persian (Farsi) version of the OHIP-14 to be valid and reliable in adults attending a dental clinic (Ravaghi et al.).

The Child Oral Health Impact Profile (COHIP) consists of 34 items forming five subscales: oral health, functional well-being, social/emotional well-being, school environment and self-image. We translated this into Persian (Farsi) for the purpose of this study. We did forward and backward translations, synthesis and review of the translations by bilingual translators who were invited from university students in the UK. The objective of the translation was to produce a cross-culturally equivalent translation that was conceptually equivalent to the original English version. The differences between the original English version and the back translation were deemed acceptable as they maintained the original construct of the instrument. Produced translations were combined following the resolution of discrepancies and variations.

Oral health indicators

Perceived (oral) health indicators: To compare the psychometric properties of the OHRQoL instruments we included global measures of self-rated health (SRH) and self-rated oral health (SROH). We used the single questions ask participants ‘Generally speaking, would you say that your (oral) health is excellent/very good/good/fair/poor’ and the variable is finally dichotomized into good health (excellent/very good/good) and poor health (fair/poor). Additionally we asked about satisfaction with oral health, experience of dental pain in last month, and perceived dental treatment using a yes/no question.

Clinical indicator: All participants were clinically examined to identify the number of decayed teeth using a standard dental caries examination (Oral health surveys : basic methods, 1997). Clinical examination was performed immediately after completion of the questionnaires by a trained dentist (MMMA) who was blind to the questionnaire data.

Statistical considerations

For the purpose of validating quality of life measures, sample size of 100 – 200 using a convenience sample of the population is typically needed (Abeles et al., 1994). Allowing for some non-response we approached 241 people to take part. All analyses were done using the SPSS version 13.1 (SPSS Inc., Chicago, IL, USA).

For each of the OHIP-14 and COHIP items, subjects are asked how frequently they had experienced an impact in last month using a five point Likert scale coded [never = 0, hardly ever = 1, occasionally = 2, fairly often =3, and very often =4]. We used two methods to score OHIP-14 and COHIP: the additive (ADD) score and simple count method (SC). Additive scores for both the OHIP-14 and COHIP were calculated by summing the response codes for items. Using this method, the OHIP-14 scale ranged from 0 to 56 and the COHIP scale from
0 to 136. Simple count (SC) scores were obtained for both instruments by summing the number of items which indicated presence of impact. In other words, the threshold of “hardly ever” or more often was applied to determine the presence of impact. We chose this low threshold because adolescents would be expected to have generally good oral health. Using simple count methods, scores range from 0 to 14 for OHIP-14 and from 0 to 34 for COHIP. For both scoring methods, scores of the six positively-worded items of the COHIP were reversed. Accordingly, higher scores from either of OHRQoL instruments reflect worse oral health.

Evaluation of validity and reliability

We tested for convergent validity by comparing the OHRQoL scores of those who rated their health poorly with of those who scored well on global measure of self-rated health (SRH) and self-rated oral health (SROH). Convergent validity is supported when different methods of measuring the same construct provide similar results. We tested discriminative validity using dichotomized perceived and clinical indicators of oral health. Discriminative validity is confirmed when a measure of one underlying construct can be differentiated from another construct. We hypothesized that those with perceived dental treatment needs, who were less satisfied with their oral health, those who experienced dental pain within last month, and those with more decayed teeth would have higher scores. The discriminative validity of the instruments for dental caries was tested in two ways. First we compared the scores of those with and without decayed teeth. Then, the number of decayed teeth was dichotomized with the cut-off being the median score of three, so those with zero to two decayed teeth were considered to have fewer dental caries versus those with three or more decayed teeth. For both convergent and discriminative validity, non-parametric tests (Mann-Whitney statistics) were used to compare the statistical significance of the difference between OHRQoL scores of dichotomised categories. Apart from standard statistical significance, additional analysis was performed to test the ability of two instruments to discriminate between those with decayed teeth. The receiver operating characteristic curve (ROC) and area under the curve (AUC) was used to compare the ability of two measures to predict the number of decayed teeth (Hanley and McNeil, 1982; Hanley and McNeil, 1983). In this study, statistical significance was set at P<0.05. We also tested internal consistency using Cronbach’s α (Cronbach, 1951).

Results

The six classes had 241 students, seven students were absent in the day of study. All those present (105 boys, 129 girls) agreed to participate in the study. Of these 87 (37%) rated their oral health as poor/fair which is labelled as ‘poor health’, 33 (14%) rated their general health as poor/fair, 126 (54%) of the subjects perceived dental treatment needs, 61 (26%) had dental pain in last month, and 54 (23%) were dissatisfied with their oral health. In terms of clinical health, 197 (84%) of the participants had at least one decayed tooth and 119 (51%) had three or more decayed teeth (Table 1). The mean number of decayed teeth was 3.23 (SD=2.76).

Neither OHIP-14 nor COHIP scores were normally distributed (Fig.1). The OHIP-14 scores were more skewed than COHIP scores on both scoring methods. The most frequent score (mode) that was recorded from OHIP-14 scores is zero suggesting that the OHIP-14 did not find any impact in considerable number of participants (Table 2). The frequency of the OHIP-14 and COHIP scores showed that only one subject (0.4%) scored zero on COHIP
whereas 43 (18%) scored zero on OHIP-14 indicating that COHIP had better ability to detect oral health impacts (data not shown in table).

Validity and reliability

Assessing the convergent validity, those who rated their health poorly on self-rated health (SRH) and self-rated oral health (SROH) have scored significantly higher scores on both the COHIP and the OHIP-14 (Table 3). Although both instruments were equally related with self rated oral health, they were slightly different when self-rated health was examined. Examining the discriminative validity, those who perceived dental treatment needs, who had experienced dental pain in last month, were more dissatisfied with their oral health, or had more decayed teeth scored more significantly on both OHIP-14 and COHIP (Table 3). The strengths of statistical significance of the OHIP-14 and COHIP differed slightly but inconsistently when the number of decayed teeth was examined. We found statistically significant relationships between the ADD and SC scores of both instruments (OHIP-14 and COHIP) and indicators of oral health (Table 3). Comparing the statistical significance of scoring methods, the strengths significance was gently but irregularly different when the number of decayed teeth was investigated.

Our ROC analysis allowed us to compare the performances of two instruments and two scoring methods in detecting those with decayed teeth. The estimate of the area under the curve (AUC) ranged between 0.67 and 0.72 testing the presence and absence of decayed teeth, and ranged between 0.59 and 0.62 using the cut-off point of three for number of decayed teeth (Table 4). The AUCs for OHIP and COHIP were not greatly different within each level of decayed teeth. However, the AUCs were notably higher when presence and absence of decayed teeth was examined rather than when having three decayed teeth as cut-off. These findings were also confirmed by visual evaluation of the ROC curves (Not presented in this report but available upon request)

Cronbach’s α was 0.89 and 0.90 for OHIP-14 and COHIP, respectively; when we used additive method. Cronbach’s alpha was 0.87 and 0.86 for OHIP-14 and COHIP with simple counting method, respectively.

Intercorrelation of the instruments

The scores of OHIP-14 and COHIP are strongly correlated with each other in both scoring methods (Table 5). Spearman’s rank correlation coefficients of the OHIP-14 and COHIP were r=0.72 and r= 0.76 for additive and simple counting methods, respectively. Further, close correlation between the scores of OHIP-14 was observed when the OHIP-14 was scored in two different methods (r=0.98). Similarly, close correlation was recorded for the scores of COHIP from two scoring methods (r=0.93).

Discussion

In this study we investigated the validity of two instruments of OHRQoL among adolescents. A convenience sample of students from two schools was invited to complete the questionnaires and have a dental examination. The response rate of 100% is not unusual from school-based studies.
The oral health status of the students was poor as measured by both oral health indicators and clinical examination. A vast majority of the participants had at least one decayed tooth, and half of the subjects had three and more decayed teeth. However, caution is needed to extrapolate present findings from this convenience sample to the general population.

In terms of the ability to detect impacts of oral health, the COHIP had a greater ability to detect these, and a less skewed distribution. The better ability of the COHIP in detecting impact might be attributed to the structural differences of the instruments. First, the COHIP was developed for children aged 8–15 (Broder et al., 2007) while the OHIP-14, although commonly used for all ages, was validated among an elderly population (Slade, 1997). It is plausible that the subjects of this study (15-17 years old adolescents) are more likely to report similar impacts to those of children rather than the elderly. Second, the COHIP has more items compared to OHIP-14 which enhance its ability for detecting more impacts. Nevertheless, the scores of OHIP-14 in our study were more skewed comparing with COHIP. The high skewness of OHIP-14 scores supported by others (Soe et al., 2004). The better ability of the COHIP to detect oral health impacts and its output being less skewed may make it the preferred instrument for use in studies of adolescents in which the objective is to detect the more impacts.

Analysis of convergent validity indicates the OHIP-14 and COHIP scores converged with self-rated health (SRH) and self-rated oral health (SROH). However, despite being statistically significant, the links between scores of OHIP-14 and self-rated health (SRH) was slightly weaker in comparison with those of the COHIP and self-rated health (SRH). Both instruments have also demonstrated significant discriminative validity when examined against perceived indicators of oral health and the number of decayed teeth. The strengths of statistical significance were slightly different when number of decayed teeth were examined although was not consistently in favour of the better validity of either the OHIP-14 or COHIP. Therefore, additional ROC curve analysis was employed to examine the performances of the OHIP-14 and COHIP. Using the area under the curve (AUC) as an index of the instruments’ performance, we did not achieve convincing evidence showing that either the OHIP-14 or COHIP was better. The similar characteristics of the OHIP-14 and COHIP were also reflected by their significant correlations tested by Spearman’s rank correlation coefficients.

We also examined whether using additive (ADD) and simple count methods (SC) may affect validity of the instruments. The convergent and discriminative validity of both instruments were established independent of their scoring methods although negligible difference was observed in terms of strength of significance for some health indicators. However, the similar ability of scoring methods was confirmed by additional ROC curve analysis and calculation of area under the curve (AUC). Also, computing the Spearman’s rank correlation coefficients of ADD and SC scores of both instruments suggest that they are nearly perfectly correlated. Altogether, our findings suggest that the calculation of the additive scores do not add additional information.

We believe this is the first validation of the COHIP for adolescents. Establishing the validity of OHIP-14 in our study is consistent with former investigation of adolescents in Myanmar (Soe et al., 2004) and is contrary to pilot study of Swedish adolescents (Oscarson et al., 2007). Both measures are valid for studying OHRQoL among adolescents. However researchers are recommended to consider the purpose of the study before selecting either instrument. If researchers aim to detect more impacts, the COHIP should be given priority to
OHIP-14. For many studies the OHIP-14 may be preferred as it has only 14 items compared to the 34 items in the COHIP reducing the questionnaire burden for participants. The similar performance of both scoring methods in our study corroborated findings of investigations of the OHIP-14 among adolescents (Soe et al., 2004) and the elderly (Locker et al., 2001). Accordingly, we suggest that future studies of adolescents administer the OHIP-14 and the COHIP using dichotomised responses (‘Yes’ or ‘No’) rather than the ordinal Likert-type (never, hardly ever, occasionally, fairly often, and very often) to simplify the completion of the questionnaire, and data analysis.

Cronbach's α showed excellent internal reliability. The Cronbach's α obtained in this study ranged from 0.86 to 0.90 for the instruments being scored in both methods. These are similar to those obtained from the original derivation of the OHIP-14 (alpha=0.88), and the COHIP (alpha=0.91). An exact lower limit does not exist to confirm the reliability of the scales, but a Cronbach's alpha value of 0.70 is considered acceptable (Nunnally, 1978). A potential limitation of this study is that we did not conduct the test-retest reliability of the instruments. This is because the data collection occurred few weeks before exam period and students were not available during the exams and afterward.

Conclusion

Both the OHIP-14 and COHIP are valid and reliable instruments of investigating OHRQoL among 15-17 year old adolescents. The COHIP is superior to OHIP-14 in terms of identifying more impacts. Both measures have shown significant convergent and discriminative validity, however, for practical reasons; one might find the shorter instrument (OHIP-14) more suitable. The administration of the dichotomised rather than ordinal responses is can facilitate the wider application of these instruments in school based studies and clinical setting.

Acknowledgment

This study was supported by research Committee of Dental school, Hamedan University of Medical Sciences. We are thankful to the Ethics Committee of Dental School, Hamedan University of Medical Sciences and educational administration of Hamedan province for providing us with necessary permission to access the schools and all participants for devoting their time to take part in the study. The authors are also grateful to Ms Neda Bayat for her help with data collection at the girls’ school.
References


Table 1 Prevalence of oral health indicators

<table>
<thead>
<tr>
<th>Oral health indicators</th>
<th>N=234</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-rated health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor health (poor/fair)</td>
<td>32</td>
<td>(14)</td>
</tr>
<tr>
<td>Good health (Excellent/very good/good)</td>
<td>202</td>
<td>(86)</td>
</tr>
<tr>
<td><strong>Self-rated oral health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor health (poor/fair)</td>
<td>87</td>
<td>(37)</td>
</tr>
<tr>
<td>Good health (Excellent/very good/good)</td>
<td>147</td>
<td>(63)</td>
</tr>
<tr>
<td><strong>Perceived dental treatment needs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>127</td>
<td>(54)</td>
</tr>
<tr>
<td>No</td>
<td>107</td>
<td>(46)</td>
</tr>
<tr>
<td><strong>Dental pain in last month</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>61</td>
<td>(26)</td>
</tr>
<tr>
<td>No</td>
<td>173</td>
<td>(74)</td>
</tr>
<tr>
<td><strong>Satisfaction with oral health</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfied</td>
<td>181</td>
<td>(77)</td>
</tr>
<tr>
<td>Dissatisfied</td>
<td>53</td>
<td>(23)</td>
</tr>
<tr>
<td><strong>Decayed teeth</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence</td>
<td>197</td>
<td>(84)</td>
</tr>
<tr>
<td>Absence</td>
<td>37</td>
<td>(16)</td>
</tr>
<tr>
<td><strong>Decayed teeth</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2 decayed teeth</td>
<td>116</td>
<td>(49)</td>
</tr>
<tr>
<td>3 and more decayed teeth</td>
<td>118</td>
<td>(51)</td>
</tr>
<tr>
<td></td>
<td>COHIP (ADD)</td>
<td>OHIP-14 (ADD)</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>28 (14.4)</td>
<td>5.9 (6.5)</td>
</tr>
<tr>
<td>Median</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>Mode</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Skewness a</td>
<td>1.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Range (Potential range)</td>
<td>0-82 (0-136)</td>
<td>0-36 (0-56)</td>
</tr>
</tbody>
</table>

*a Higher skewness indicate that the data is more asymmetric
ADD= additive scores; SC= simple count
Table 3 Testing the convergent and discriminative validity of the OHIP-14 and COHIP using Mann-Whitney statistics

<table>
<thead>
<tr>
<th>Scoring method</th>
<th>COHIP</th>
<th></th>
<th>OHIP-14</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>ADD</strong></td>
<td><strong>SC</strong></td>
<td><strong>ADD</strong></td>
<td><strong>SC</strong></td>
</tr>
<tr>
<td></td>
<td>Mean score (95% CI)</td>
<td>P value a</td>
<td>Mean score (95% CI)</td>
<td>P value a</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-rated health</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor health (poor/fair)</td>
<td>35.1 (30.7, 39.4)</td>
<td>&lt;0.001</td>
<td>18.8 (17.0, 20.7)</td>
<td>0.001</td>
</tr>
<tr>
<td>Good health (Excellent/very good/good)</td>
<td>22.8 (20.6, 25)</td>
<td>&lt;0.001</td>
<td>13.9 (12.9, 14.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Self-rated oral health</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor health (poor/fair)</td>
<td>34.7 (31.5, 38)</td>
<td>&lt;0.001</td>
<td>14.6 (13.7, 15.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Good health (Excellent/very good/good)</td>
<td>22.4 (22.1, 26.2)</td>
<td>&lt;0.001</td>
<td>4.8 (3.9, 5.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Perceived dental treatment needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>32.6 (30.5, 35)</td>
<td>&lt;0.001</td>
<td>17.7 (16.7, 18.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No</td>
<td>22.8 (20.6, 25)</td>
<td>&lt;0.001</td>
<td>13.9 (12.9, 14.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dental pain in last month</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>35.1 (31.1, 39.1)</td>
<td>&lt;0.001</td>
<td>18.4 (16.7, 20.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No</td>
<td>25.6 (23.6, 27.6)</td>
<td>&lt;0.001</td>
<td>15.1 (14.3, 15.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Satisfaction with oral health</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissatisfied</td>
<td>38.5 (34.5, 42.5)</td>
<td>&lt;0.001</td>
<td>19.5 (18.1, 20.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Satisfied</td>
<td>25.1 (23.1, 27)</td>
<td>&lt;0.001</td>
<td>14.9 (14.1, 15.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Decayed teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absence</td>
<td>20 (16.5, 23.5)</td>
<td>&lt;0.001</td>
<td>12.8 (11.1, 14.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Presence</td>
<td>29.6 (27.6, 31.7)</td>
<td>&lt;0.001</td>
<td>16.6 (15.8, 17.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Decayed teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2</td>
<td>25.8 (23.3, 28.3)</td>
<td>0.014</td>
<td>14.8 (13.7, 15.8)</td>
<td>0.002</td>
</tr>
<tr>
<td>3 and more</td>
<td>30.4 (27.7, 33.1)</td>
<td></td>
<td>17.1 (16.1, 18.1)</td>
<td></td>
</tr>
</tbody>
</table>

a Mann-Whitney statistics
ADD= additive scores; SC= simple count; (95% CI)= 95% confidence interval
Table 4 Area under the ROC curves (AUC), and their 95% CIs for the COHIP and OHIP-14 scores of individuals with decayed teeth

<table>
<thead>
<tr>
<th>Scoring method</th>
<th>COHIP</th>
<th>OHIP-14</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADD</td>
<td>SC</td>
</tr>
<tr>
<td></td>
<td>AUC</td>
<td>(95% CI)</td>
</tr>
<tr>
<td>Decayed teeth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence</td>
<td>0.72</td>
<td>(0.63, 0.81)</td>
</tr>
<tr>
<td>Absence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2</td>
<td>0.59</td>
<td>(0.52, 0.67)</td>
</tr>
<tr>
<td>3 and more</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ADD= additive scores; SC= simple count; AUC= area under the receiver operating characteristic curve; (95% CI) = 95% confidence interval
Table 5 Spearman’s rank correlation coefficients for COHIP and OHIP-14 scores

<table>
<thead>
<tr>
<th></th>
<th>COHIP (ADD)</th>
<th>OHIP-14 (ADD)</th>
<th>COHIP (SC)</th>
<th>OHIP-14 (SC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COHIP (ADD)</td>
<td>1</td>
<td>0.72*</td>
<td>0.93*</td>
<td>0.71*</td>
</tr>
<tr>
<td>OHIP-14 (ADD)</td>
<td>1</td>
<td>0.75*</td>
<td>1</td>
<td>0.98*</td>
</tr>
<tr>
<td>COHIP (SC)</td>
<td>0.93*</td>
<td>1</td>
<td>0.76*</td>
<td>1</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level
ADD= additive scores; SC= simple count
Appendix 3 Questionnaire

Indicators of socioeconomic status

Subjective socioeconomic status

Think of this ladder as representing where people stand in Iranian society. At the top of the ladder are the people who are the best off, those who have the most money, most education, and best jobs. At the bottom are the people who are the worst off, those who have the least money, least education, and worst jobs or no jobs. The higher up you are on this ladder, the closer you are to people at the very top and the lower you are, the closer you are to the bottom.

Now think about your family. Please tell us where you think your family would be on this ladder. Fill in the circle that best represents where your family would be on this ladder.

Wealth index

Please tell us which items are owned by your household.

- Colour TV
- Radio
- Washing machine
- Telephone
- Car
- Fridge
- Freezer
- Mobile phone
- DVD player
- Computer
- Vacuum cleaner
- Motorcycle

Mother’s education

What is the highest educational attainment of your mother?

- Illiterate
- Primary school
- Guidance/high school
- University

Father’s education

What is the highest educational attainment of your father?

- Illiterate
- Primary school
- Guidance/high school
- University
Oral health behaviours

**Toothbrushing frequency**

How often do you usually brush your teeth?
- Never
- Less than once a week
- Once every few days
- Once a day
- Twice a day
- More than twice a day

**Dental flossing frequency**

How often do you usually floss your teeth?
- Never
- Less than once a week
- Once every few days
- Once a day
- Twice a day
- More than twice a day

**Visiting dentist**

Have you ever visited dentist in last year?
- Yes
- No
Psychological factors

Rosenberg Self-esteem Scale

Below is the list of statements dealing with your general feelings about yourself. Please tick the box that best describes you.

1. I feel that I’m a person of worth, at least on an equal plane with others.
   - Strongly agree  - Agree  - Disagree  - Strongly disagree

2. I feel that I have a number of good qualities.
   - Strongly agree  - Agree  - Disagree  - Strongly disagree

3. All in all, I am inclined to feel that I am a failure.
   - Strongly agree  - Agree  - Disagree  - Strongly disagree

4. I am able to do things as well as most other people.
   - Strongly agree  - Agree  - Disagree  - Strongly disagree

5. I feel I do not have much to be proud of.
   - Strongly agree  - Agree  - Disagree  - Strongly disagree

6. I take a positive attitude toward myself.
   - Strongly agree  - Agree  - Disagree  - Strongly disagree

7. On the whole, I am satisfied with myself.
   - Strongly agree  - Agree  - Disagree  - Strongly disagree

8. I wish I could have more respect for myself.
   - Strongly agree  - Agree  - Disagree  - Strongly disagree

9. I certainly feel useless at times.
   - Strongly agree  - Agree  - Disagree  - Strongly disagree

10. At times, I think I am no good at all.
    - Strongly agree  - Agree  - Disagree  - Strongly disagree
Hospital Anxiety and Depression Scale (HADS)

Below is the list of statements dealing with your general feelings about yourself. Please tick the box that best describes you.

1. I feel tense or wound up
   - Most of the time
   - A lot of the time
   - Time to time, occasionally
   - Not at all

2. I still enjoy the things I used to enjoy
   - Definitely as much
   - Not quite so much
   - Only a little
   - Not at all

3. I get a sort of frightened feeling as if something awful is about to happen
   - Very definitely and quite badly
   - Yes, but not too badly
   - A little, but it doesn’t worry me
   - Not at all

4. I can laugh and see the funny side of things
   - As much as I always could
   - Not quite so much now
   - Definitely not so much now
   - Not at all

5. Worrying thought go through my mind
   - A great deal of the time
   - A lot of the time
   - From time to time but not too often
   - Only occasionally

6. I feel cheerful
   - Not at all
   - Not often
   - Sometimes
   - Most of the time

7. I can sit at ease and feel relaxed
   - Definitely
   - Usually
   - Not often
   - Not at all
8. I feel as if I am slowed down
   □ Nearly all of the time
   □ Very often
   □ Sometimes
   □ Not at all

9. I get a sort of frightened feeling like 'butterflies' in the stomach
   □ Not at all
   □ Occasionally
   □ Quite often
   □ Very often

10. I have lost interest in my appearance
    □ Definitely
    □ I don’t take as much care as I should
    □ I may not take quite as much care
    □ I take just as much care as ever

11. I feel restless as if I have to be on the move
    □ Very much indeed
    □ Quite a lot
    □ Not very much
    □ Not at all

12. I look forward with enjoyment to things
    □ A much as I ever did
    □ Rather less than I used to
    □ Definitely less than I used to
    □ Hardly at all

13. I get sudden feeling of panic
    □ Very often indeed
    □ Quite often
    □ Not very often
    □ Not at all

14. I can enjoy a good book or TV program
    □ Often
    □ Sometimes
    □ Not often
    □ Very seldom
Self-reported oral health

Single item self-rated oral health

Generally speaking, would you say that your oral health is:

☐ Poor
☐ Fair
☐ Good
☐ Very good
☐ Excellent

Experience of dental pain

Have you experienced toothache in last month?
☐ Yes ☐ No
Appendix 4 Expert opinions

Dr Anne-Marie Slowther
Director of the Clinical Ethics Support Project at Ethox, University of Oxford

As a general principle a research project that is sponsored by or involves a UK institution should be conducted according to the ethical standards that would apply should the research be conducted in the UK.

In considering the appropriate process for consent the legal framework governing consent would be the primary source of guidance. Guidelines for researchers such as the MRC document, Medical research involving children (2004) base their advice on current UK law. If the research is being conducted in a different jurisdiction then a consistent approach would be to require researchers to comply with the legislation on consent in the relevant jurisdiction. In the case of this research this would be Iranian law which the researchers have advised sets the legal age of consent at 15 years.

In English law the Mental Capacity Act 2005 would be of relevance. The code of practice to the Act states ‘The Act’s starting point is to confirm in legislation that it should be assumed that an adult (aged 16 or over) has full legal capacity to make decisions for themselves (the right to autonomy) unless it can be shown that they lack capacity to make a decision for themselves at the time the decision needs to be made’.

This means that a person age 16 or over has the right to make decisions (which would include decisions about taking part in medical research without requiring the consent of another person. Indeed under the Act another person would not have legal authority to consent on their behalf. Capacity to make decisions is presumed and the presumption can only be overturned if there is evidence to show that the person lacks capacity, for example if they had severe learning difficulties or a mental disorder affecting their cognition.

For minors under the age of 16 years the Common Law would apply and for the purposes of consent this would be the Gillick judgement under which a competent minor is able to consent to treatment. The case of Axon reiterated the common law view that competent minors had a right to consent to treatment (in that case abortion) and to have their confidentiality respected. While the specific issue of medical research has not been considered by the courts in relation to consent of minors it would seem reasonable that a similar approach would be adopted. The important consideration in treatment decisions is whether the minor has a sufficient understanding of what is proposed. The likely harm of the procedure may influence the assessment of whether they fully understand the procedure but in the case of Axon a procedure such as abortion, which would generally be considered to have a significant risk of harm was considered to be something on which a competent minor could decide without parental consent or indeed knowledge.

There are some special safeguards in relation to minors and medical research, specifically in the context of clinical trials. The Clinical Trials Regulations specify that participation in a clinical trial by a minor under the age of 16 requires parental consent. However this requirement only applies to research governed by the Clinical Trials Regulations. The research being considered here is not a clinical trial.
In conclusion, for children over 16 it would be assumed that they are competent to consent to participation and for those age 15, if the researcher is satisfied that the child is competent to consent then parental consent is not required, and participant confidentiality should be respected. Competence will include the ability to understand any risks associated with the research, but the risk to a participant of completing a questionnaire such as HADS is not likely to be great enough that ability to understand the risk would raise doubts about competence in a 15 year old.

The ethical position in this situation would essentially be the same as the legal position. It would usually be seen as good ethical practice to encourage informing or involving parents in these decisions if the child agreed. Providing a guardian information sheet for the child to give to their parents or guardians seems a very good way of doing this.

Competent children should have the same reassurance regarding confidentiality as any other participants in medical research. This position is supported by English law (Gillick and Axon). It is important in research which may precipitate concerns for the participant that they have access to timely and appropriate support, and that they are aware of this support and how to access it if they wish. This proposal has addressed the issue of appropriate support of this nature.
The position relating to consent by under-18s in English law is somewhat open in regard to non-medical matters, but in regard to medical matters it is rather clear.

16 and 17 years olds are presumed competent to consent to medical treatment, and where they give a competent consent this cannot be overridden by anyone with parental responsibility. And this includes the presumption that they are competent to consent (or refuse) to information being disclosed to their parents in order that the parent try to override their wishes or even just to inform them what is going on. In this they are like any competent adult patient. If the 16 or 17 year old is refusing life-saving treatment the courts can override this. Obviously, for something involving a questionnaire survey, conducted to appropriate ethical standards in terms of confidentiality, data security and care taken over sensitive questions, this would be something any competent adult could consent to, and this would presumptively also be the case for a 16 or 17 year old. What might overturn the presumption would be something exposing the minor to a serious risk (e.g. involving admissions of criminal behaviour), or where the minor is learning disabled, acutely mentally ill, or unusually immature for their age.

Following the Gillick case (which addressed consent by under 16s to medical treatment and along with this their right to confidentiality in their treatment), it has been clear that under 16s can consent to treatment provided that they show (in the words of Lord Scarman in the judgement in the House of Lords) "sufficient understanding and intelligence to enable him or her to understand fully what is proposed", including the necessary emotional maturity. Again, where an under 16 is "Gillick competent" to make this decision (because the judgement of competence is decision- and risk-relative), there is no role for the parent to intervene or even be informed, if the child does not wish it. So again, assuming the questionnaire does not expose the minor to serious risk, and is properly conducted on sound ethical principles, then the child's consent is sufficient. The major difference for under 16s is that we don't presume competence, rather it must be established for each child. But what it takes to establish competence to consent to participate in a questionnaire will probably not be very much. Roughly speaking, there will not be much gap between the intelligence and maturity needed to answer the questionnaire and that needed to give valid consent to answering it - there is some gap, since a child may not appreciate any associated risks of completing the questionnaire (such as possible distress to them, or risks associated with third party disclosure).

In sum then, provided the researcher is satisfied that the child is competent to consent, then at English law, there is no need to involve the parent, in the medical setting. I am not aware of any special considerations that apply to consent in non-medical setting (the Mental Capacity Act does not apply to under 16s except in a couple of cases not relevant here, and gives guidance on the care, treatment and participation in research of children lacking capacity of 16 and 17 but this does not relate to children who presumptively have capacity).

English law aside, which in any event does not apply in Iran, the ethical position is essentially the same as what is prescribed by law. The only slight difference may be that schools have a tendency to want to get parental agreement to things even where this is not essential, so as to preserve good relations with parents and to protect the school's reputation. My view is that
this may be good practice, but there is still plenty of room between telling a parent that this is going on, and asking the parent's permission as a pre-requisite necessary condition on proceeding. And it should be made quite clear that what is in the questionnaire is confidential between student and researcher, and not available to parent or other authority.

I hope this is of assistance. Please don't hesitate to come back to me if I can clarify this at all.
Appendix 5 Guardian’s information sheet

We are sending you this sheet to inform you that your son/daughter is being invited to participate in our study. This study aims to understand oral health in depth. Participation of your son/daughter in this study will help us to improve our knowledge of the psychological and social factors that affect oral health.

The information sheet tells you the purpose of this study and what will happen to your son/daughter during the study. Please ask us if there is anything that is not clear or if you would like more information.

Please contact:
Vahid Ravaghi
Email: v.ravaghi@qmul.ac.uk

**Question: What is the purpose of the study?**

The contribution of psychological and social factors in health is very well documented. However, many things are as yet unknown. The purpose of this study is to determine how the interaction of specific psychological status affects the oral health in the population of adolescents.

**Question: Why has my son/daughter been chosen?**

Your son/daughter has been selected for this study as one of a sample of the adolescents who live in your city.

**Question: Does my son/daughter have to take part?**

Participating in this research is entirely voluntary. It is up to your son/daughter to decide whether he/she will take part or not. Refusal to take part in this study will not have any educational consequences.

**Question: If my son/daughter takes part in this study, what will it involve?**

This is an entirely questionnaire based study. No clinical examination will be performed, no drug will be tested. Your son/daughter will be approached at school by a researcher (VR) after obtaining the necessary permission from head teacher and classroom teachers at their school. Then, they would be asked to complete the questionnaires. Therefore, this study is unlikely to cause pain, discomfort, infection, inconvenience or changes to lifestyle.

**Question: Do my son/daughter need to do anything before the appointment?**

Your son/daughter will not be required to change their regular lifestyle or diet before attending the study.
**Question: Will any of the questions cause any psychological distress?**

Stress is an inevitable part of everybody’s life. We face different levels of stress in our usual life while we are crossing the road, writing a letter to friend, and meeting the deadlines. Therefore, even the happiest days of our life are not free of stress. We believe that our study does not impose an unusual and life threatening level of stress. All the questionnaires being used in this study have been administered by many institutions and have an excellent safety record.

**Question: What are the possible disadvantages and risks of taking part?**

As we mentioned earlier, our methods to study social, psychological and oral health have not been reported to cause any lasting psychological stress in any participants. However, on visiting your son/daughter’s school, we will inform the students that if they experience unexpected and unsettling thoughts after filling the questionnaires, they can contact their school’s medical officer, local mental health care services or counselling services at any time, either on the day they complete the questionnaire or subsequently. We have obtained a list of mental health care services before going to the school and they would be contacted to make sure that they can provide emergency services for adolescents within the time we are visiting schools.

**Question: Will the participation of my son/daughter in this study be kept confidential?**

All information, which is collected about your son/daughter during the course of the research will be kept confidential. The data collected will be stored in a University computer, in an encrypted manner and the computer is password protected. On top of that, to assure the anonymity and confidentiality, no identification will be required.

**Question: What are the possible benefits of taking part?**

There are no clinical or financial benefits from taking part in this study. Your daughter/son will have the opportunity to take satisfaction in the knowledge that he/she have helped in the increasing our understanding of the oral health which may help policy makers to improve health policies.