DISTAL AND PROXIMAL INFLUENCES ON SELF-REPORTED ORAL PAIN AND SELF RATED ORAL HEALTH STATUS IN SAUDI ARABIA, 2017

Naif Nabel F. Abogazalah

Submitted to the faculty of the University Graduate School
in partial fulfillment of the requirements
for the degree
Doctor of Philosophy
in the School of Dentistry,
Indiana University

August 2022

Accepted by the Graduate Faculty of Indiana University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Doctoral Committee

Esperanza Angeles Martinez Mier, DDS, MSD, PhD, Co-Chair

Juan Fernando Yepes, DDS, MD, MPH, MS, DrPH, FDS RCDS(Ed), Co-Chair

May 25, 2022

Constantin T Yiannoutsos, PhD

Naif A. Bindayel, BDS, MS, SM

Armando Ernesto Soto Rojas, DDS, MPH

DEDICATION

This thesis is dedicated to those who without their prayers, love and support, my professional growth would not have been possible: my mother, Halimah, my father, Nabel, and my wife, Laila.

ACKNOWLEDGEMENT

I would like to convey my deepest appreciation and thanks to my mentor, Dr. Martinez. Thank you for being such a great role model.

Next, I would like to convey my deepest appreciation and thanks to my research committee, Dr. Yepes, Dr. Constantin, Dr. Soto, and Dr. Naif Bindayel.

I thank King Khalid University and Saudi Ministry of Education for their financial grant and their support throughout my course of studies.

Also, I would like to thank the Health Center Affairs General Department at the Ministry of Health in the Kingdom of Saudi Arabia for providing the data.

I would like to thank the people without whom this project would not be accomplished. Special thanks to Beverly Musick; Steve Brown; Katie Lane, Department of Biostatistics. R.M. Fairbanks School of Public Health for their work on primary data processing. Also, I thank my friends and colleagues from the Department of Cariology, Operative Dentistry and Dental Public Health.

I would like to extend thanks to fellow classmates for their friendship and support during this program. Special thanks to Dr. Guillermo for helping me with data analysis.

I thank Dr. Gregory for his professionalism and support during my PhD journey.

Finally, I thank my family and friends here in Indiana and at home in Saudi Arabia.

Naif Nabel F. Abogazalah

DISTAL AND PROXIMAL INFLUENCES ON SELF-REPORTED ORAL PAIN AND SELF RATED ORAL HEALTH STATUS IN SAUDI ARABIA, 2017

Although complex phenomena such as oral diseases can be studied using generalizable conceptual frameworks, the differences in the underlying influences across countries necessitate adaptation of existing oral health frameworks to the specific conditions in each country. The aim of this dissertation was to investigate distal (indirect) and proximal (direct) influences of oral health and their interactions with both self-reported oral pain (OP) and self-rated oral health status (SROH) in Saudi Arabia (SA).

Two secondary data analyses were conducted utilizing data from the national demographic and health survey (DHS) of SA in 2017. The objective of the first study was to describe the study design, and the distal and proximal influences reported in the 2017 SA DHS. The objective of second study was to explore associations between proximal and distal factors that affect OP and SROH, using the adapted framework. Path analysis modeling was used to estimate direct, indirect, and total effects.

The 2017 SA DHS used an innovative multistage stratified random-sampling technique to select the population sample by using primary health care centers’ catchment areas as the primary sampling unit. The final analysis included 29,274 adults, 9910 adolescents, and 11653 children. OP in the past year was experienced in 39% in children and, 48.5% for the adolescents, and 47.1% in adults. The proportion of respondents who reported good, very good, or excellent self-rated oral health status was 92.9 % in children, 87.1% in both adolescents and adults. In children group, OP was linked to less tooth brushing, more dental visits and less dental routine examination, while less favorable SROH was linked to less tooth brushing, more dental visits and sweets consumption. In adolescents and adults groups, OP and less favorable SROH were linked to more dental visits, complaint dental visits, less tooth brushing. Many distal influences showed significant effects (direct, indirect, and total) on OP and SROH; however, differences existed among the three age groups.

The studies suggest that future investigations should focus on why Saudi residents perceive their oral health positively while the prevalence of negative oral health influences and OP was high.

Esperanza Angeles Martinez Mier, DDS, MSD, PhD, Co-Chair

Juan Fernando Yepes, DDS, MD, MPH, MS, DrPH, FDS RCDS(Ed), Co-Chair

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: THE SAUDI ARABIAN NATIONAL DEMOGRAPHIC AND HEALTH SURVEY, 2017: STUDY DESIGN AND ORAL HEALTH-RELATED INFLUENCES

Summary

Objective: To describe the study design, and the distal and proximal influences on oral health reported in the national demographic and health survey (DHS) of Saudi Arabia (SA) in 2017.

Methods: The 2017 SA DHS used an innovative multistage stratified random-sampling technique to select the population sample by using primary health care centers' (PHCs) catchment areas as the primary sampling unit. Over 45,000 household heads plus a family member were interviewed. A conceptual framework for distal and proximal oral health influences specific to SA was adapted based on the oral health surveillance model. Cross-tabulation and Chi-square tests were performed with consideration for sample weights to provide estimates representative for the SA population. Frequencies and weighted percentages for each variable reflecting each construct were reported.

Results: The total number of individuals included in the analysis was n = 55,511, ages ranging between 2 and >65 years. Lack of dental care when needed was reported for 22.5% of the population (males= 20.8%/females=24.7%). Proportion of population from Central, West, East, South, and North regions who reported available dental care services when needed was 62.3%, 58.0%, 58.9%, 62.3%, and 60.1%, respectively. PHCs were the most regular source for dental care (55.1%). In total, 48.3% visited the dentist at least once last year (males= 49.4% /females= 46.8%). Dental pain was the most common

reason for last dental visit (69.0%), while only 6.4% reported visited the dentist for routine. Only 15.3% reported brushing their teeth at least twice per day (males= 14.6% /females= 16.4%).

Conclusion: Two major oral health influences previously reported to have a significant negative influence on oral health, namely, limited routine dental check-up visits and inadequate oral hygiene, were present among SA residents. Further inferential study is needed to investigate such influence on oral health status within the SA population.

Introduction

Oral diseases are a major public health problem worldwide, causing pain and reduced quality of life and imposing economic burdens on individuals and countries' healthcare systems. The prevalence of oral diseases varies widely among different countries. Over the last few decades, developed countries have experienced a decrease in the incidence of dental caries and periodontal diseases, but their incidence has shown a sharp rise in middle- and low-income countries, driven mainly by social and economic changes [1, 2]. Oral health can be influenced by exposure to various influences throughout a person's lifetime. These influences can be classified as proximal or distal [3]. Proximal influences can directly or relatively directly lead to adverse oral health outcomes, while distal influences shape the proximal influences and indirectly lead to adverse oral health outcomes (Figure 1) [3].

In Saudi Arabia (SA), data from many regional oral health surveys have demonstrated a high prevalence of oral diseases, especially dental caries, making them a national public health problem. A systematic review investigated the nationwide prevalence of dental caries in SA for studies conducted between 1988 to 2010 and showed that the prevalence of dental caries in the primary dentition of children younger than 6 years ranged between 62% and 84%, while in the permanent dentition, the prevalence varied between 58% and 94% [4]. Poor oral hygiene practices and inadequate dental preventive visits were identified as the main proximal influences on oral health in SA [5-7], while the main distal influences were disadvantaged sociodemographic conditions such as low parental income, low education, and lack of dental insurance [8, 9]. Furthermore, a study showed that adults who regularly underwent dental checkup visits and maintained regular oral hygiene habits such as tooth brushing and flossing (proximal influences) were from the highly educated (distal influence) proportion of the population [10].

In dental public health research, it is important to identify the influences that may result in the development of oral diseases by using a multi-level risk assessment approach to plan effective health promotion programs [11]. In 2017, the ministry of health (MOH) in Saudi Arabia (SA) conducted the largest and most comprehensive nationwide demographic and health survey (DHS). The DHS (2017 SA DHS) provided data that should be instrumental to investigate the population's oral health risk factors in SA at the national level for the first time. The MOH used the catchment areas of primary healthcare centers (PHCs) as the primary sampling unit which, in terms of sampling methodology, was innovative.

Studies of complex phenomena, such as oral diseases, can be facilitated by using conceptual frameworks. However, due to the complexity of oral health conditions and differences in policies, culture, communities, beliefs, social interactions across nations, there is no universal oral health framework that can be readily applied without adaptation. Thus, the primary objective of this study was to describe the proximal and distal influences on oral health according to gender, age group, and region differences at a national level in SA by utilizing data from the 2017 SA DHS. We adapted a conceptual framework for oral health influences in SA (Figure 1) from the World Health Organization (WHO's) model for Oral Health Surveillance [3]. The secondary objective was to describe the study design of the 2017 SA DHS.

Methods

Survey design

The present study used a cross-sectional design for the 2017 DHS SA covering all regions of SA by using multistage stratified random sampling. The target population included all non-institutionalized residents of SA. House-to-house visits were conducted to interview the head of the household or an eligible representative plus a randomly selected family member. The proposed sample size was a target number of 50,000 households, which constitutes approximately (1%) of the nationwide household size [12]. A family member representing each age group was selected within each household.

Sample strategy and distribution

SA is divided into five main geographic regions–North, South, East, West, and Middle. Within the five geographic regions, the MOH delivers health services through twenty regional directorates of health (thirteen administrative regions in addition to seven major governorates). The regional directorates of health run 2282 PHC centers nationwide. Each PHC center has a well-defined geographic area called the catchment area. Based on the population sizes within each PHC catchment areas, they were classified into eight strata representing different population densities and reflecting the socio-demographic nature of the people living in the geographic locations in SA. PHC catchment areas with population sizes of 1-499, 500-999, 1000-4999, 5000-9999, 10000-24999, 25000-49999, 50000-99999, and >99999 were assumed to reflect the geographic nature of satellite areas, small villages, medium-sized villages, mother villages, towns, medium-sized cities, big cities, and metropolitan areas, respectively (Table 1).

In each stratum, a sample of 25% (total number of PHC=571) of the PHC centers within SA were randomly selected by selecting the 4th PHC from a list where PHC catchment areas were ordered by population density from least to highest populous PHC catchment area. The list was available from the MOH registries.

Fifty-thousand households were distributed across the eight strata in proportion to the population size of each stratum (Table 1). The number of households per stratum was calculated based on the following formula:

$$Number\ of\ households\ assigned\ per\ stratum = \frac{50{,}000\ households\ \times proportion\ of\ population\ size\ per\ stratum}{100}$$

The proportion of population size per stratum was calculated as follows:

$$Proportion\ of\ population\ size\ per\ stratum = \frac{Population\ size\ per\ stratum}{total\ population\ size} \times 100$$

The number of households assigned to each stratum was then distributed to the selected 25% PHC centers. Within each household, one family member representing each age group was randomly selected. The third youngest person in each age group was selected. If two persons were available, the second one was selected. If only one person was available, he/she was selected.

The population size per stratum was derived from MOH registries in 2016. The total population size of SA calculated according to the SA 2010 national census data [13].

Overview of the survey

Training was conducted centrally at MOH headquarters (Riyadh, Saudi Arabia) for regional field supervisors and trainers, who, in turn, conducted peripheral training workshops and meetings for the field investigators in their respective regions. In each PHC catchment area, a field investigation team was assigned to cover their area using a cartography map. Consent by the head of the household for the team to enter homes and verbally accept the survey questionnaire was considered as willingness to participate in the survey. The house-to house visits were taken place between February 12, 2017, to May 23, 2017.

The questionnaire included different sociodemographic, environment- and health-related questions. The family head questionnaire covered topics relevant to the household. Other family members' questionnaires covered health specific topics relevant to their age group. Anthropometric measurements, namely, weight and height were obtained. Oral health questionnaire was derived from the World Health Organization oral health assessment tool [14]. A pilot survey was conducted prior to the main survey in eight governates to assess feasibility. Further details about the sample distribution, survey implementation, survey design and tools, and sampling weights are available at the office of Directorate of Primary Health Care Centers (MOH headquarters, Riyadh, Kingdom of Saudi Arabia).

Model adaptation

The conceptual framework (Figure 1) was adapted based on both the WHO's model for Oral Health Surveillance [3] and the available variables reported in the 2017 SA DHS. The framework classified oral health influences into two main categories: distal and proximal. The distal influences consisted of the following constructs: (1) sociodemographic; (2) socioeconomic; (3) home environment; (4) general health; and (5) oral health system & services. The sociodemographic construct included the following variables (Table 2): age, gender, citizenship, geographic region, and marital status for the household. The socioeconomic constructs included completed education level, monthly income, and ownership of residence. The home environment variables were type of residence, residence condition, and residence overcrowding. Residence overcrowding was calculated by dividing the total number of family members by the number of sleeping rooms. The responses were then grouped as follows: one or less person per room, one to two persons per room, or more than two persons per room. The general health construct included the following variables: history of hypertension and diabetes for 10 years and more [15], past accident experience, type of accident, history of physical disability, type of disability, and body mass index (BMI). The oral health system and services construct included the following variables: state of insurance, regular source of dental care, and dental healthcare availability.

The proximal influences consisted of the following two constructs: (1) oral health services use and (2) oral health risk behaviors. Oral health service use consisted of dental visit frequency and reasons for the last dental visit. Oral health risk behavior constructs included oral hygiene, sugary food consumption, and smoking.

Data processing and statistical analysis

A data management plan was prepared by the MOH in collaboration with the Biostatistics Department, Indiana University School of Medicine, Indianapolis, Indiana, USA (IRB protocol number: 1808825963). Three main datasets were received: household head dataset (N = 45,287); adult family member dataset (N = 40,955); and pediatric and adolescent family member datasets (N = 15,585). Each family was assigned a number to track family members to their respective household heads. The household head, adult family member, and pediatric and adolescent family member datasets were merged to track measures to the household head. Among the 45,287 household heads, 20,294 had a valid family number that allowed merging. After merging, data for 55,511 participants were available for analysis.

Cross-tabulation was performed to describe the distal and proximal influences on oral health. SPSS (IBM Corp. Armonk, NY, USA) software was used to perform the analysis. Variable selection was guided by the multi-level conceptual framework (Figure 1). Chi-squared tests were performed to compare sex-related, age-group, and geographic region differences in proximal and distal influences. Analysis was performed with consideration for sample weights to provide estimates representative for SA residents.

Results

Participants aged 25 to 44 years constituted the largest age group (40.7%). There were more female respondents than males, but the weighted estimates indicated that the male population was larger than the female population. Almost one-third of SA residents were non-Saudi citizens. The most populous regions were the Western and Central regions, followed by the Eastern, Southern, and Northern regions, respectively. Almost 90% of the household heads were currently married. Results for proximal and distal influences on oral health for total population are illustrated in Tables 3 and 4.

More female participants (23.5%) had college or higher degrees than males (6.3%). A middle household income of 7,700 to 22,900 SAR was the most frequently reported (38.3% of the sample population). Over half of the population owned their homes. The majority of respondents lived in flats (55.3%) or houses (41.4%), which were either new (34.5%) or in a good condition (57.2%), while less than 10% lived in old decaying housing. Approximately 80% of the respondents shared a bedroom with another family member.

Hypertension was reported as the most common chronic non-communicable disease (26.5%), followed by diabetes (7.3%). Among people who reported a past accident experience, car accidents were the most common type. BMI measures indicated that approximately 31% of the population was overweight and 20% of the population was obese, while only one-third of the participants had a normal weight. There were more males than females in the overweight and obese categories.

Approximately 36% of the household heads and their family members reported that they were covered by health insurance. Also, around 22% of the respondents reported a lack of dental services when needed, with females reporting less availability than males. Elderly (65+ years) and older adults (55-64 years) reported more lack of dental care when needed (around 27%) than the rest of adult age groups (10.7% for 2-4 years old children and between 21.1% - 23.5% for 5-54 years). Tables 5 and 6 shows the distal and proximal influences on oral health based on age groups.

PHCs were reported as the most regular source of dental care, followed by private clinics, which were used by approximately one-third of the population. However, Central region reported the lowest usage of PHCs (37.1%) and the highest for privet clinic (40.7%), while the North region was the highest user of PHC (80.8%) and lowest in privet clinics (10.7%). Northern region reported more lack of dental care when needed (28.6%) followed by West (23.9%), South (23.6%), East (22.6%), and Central (18.9%). Tables 7 and 8 illustrates the distal and proximal influences based on geographic region differences.

Almost half of the respondents visited the dentist at least one time last year, with oral pain as the most common reason for the last dental visit. Only 15.3% reported that they brushed their teeth at least twice daily, with females brushing their teeth slightly more than males. Preschool age children (2-4 years) was the least age group who reported brushing their teeth twice a day, while the highest was for 65+ years age group (17.7 %). Approximately 82% of the participants reported eating sweets and 62.7% consumed soft drinks on a regular basis. Almost 6% of both male and female participants were current smokers.

Discussion

Traditionally, national-level surveys use a multistage cluster sampling design to select their sample. The first stage of this process involves identifying the primary sampling unit by selecting naturally occurring clusters or areas, which are usually census enumeration areas, followed by random household selection [16]. Cluster-sampling designs have limitations, however, the most important of which has to do with less precise estimates of the population parameters due to an increase in sampling error among the clusters [17]. To overcome the limitations of the traditional multistage cluster sampling design, the 2017 SA DHS applied a stratified random sampling design. This was possible because of the universal coverage of all inhabited regions by PHCs. The stratified random sampling design provided more precise estimates of population characteristics because of the reduced sampling error in comparison with a multistage cluster design [17].

Our results indicate that people aged between 25 to 44 years constitute over 50% of the population. As this age group grows older, the proportion of people aged over 65 years is estimated to double by 2030 and triple by 2040 [18]. As people grow older, the cost and demand for dental treatment is expected to increase due to two main reasons: (1) the cumulative effect of constant exposure to risk factors of oral diseases; and, (2) the biological changes occurring as a result of aging itself, such as the ability to perform oral hygiene practices, and changes in salivary flow and buffering capacity that can increase susceptibility to dental caries [19]. To ensure oral health welfare of the growing aging population in SA, oral public healthcare officials need to prepare for these challenges.

SES measurements in SA are not well developed since there is no validated method or index to measure the SES. Therefore, education level, monthly income, and residence ownership were analyzed as proxy measures for SES. Income level was shown to be strongly associated with dental caries [20]. Thirty percent of the surveyed population reported an income of less than 3.800 riyals per month (approximately $1,013) and can be considered to represent a low-income group. Low income can directly and indirectly contribute to poor oral health in individuals. The direct effects include limiting access to or availability of preventive care, while the indirect effects can be attributed to the stress associated with poverty, which leads to unhealthy behaviors such as smoking, poor oral hygiene, increased sugary food consumption, and dental visits due to pain instead of regular checkups [21]. The pathways of association between poor oral health and income in SA need to be further studied.

SA residents are offered several channels to obtain free-of-cost oral healthcare services, including MOH clinics, government dental schools, and employer-based health services, yet 22.5% of the respondents reported that when they needed a dental service, they were unable to obtain it. Barriers to dental health services access were investigated in several regional studies. A study conducted on the elderly population in Riyadh city reported that lack of perceived need, no insurance, cost, and transportation were the main barriers to obtaining dental services [22]. In the Jazan region, adult populations illustrated that delay in appointments, absence of pain, and, dental fear were the most common barriers [23]. In Abha city, transportation and impaired personal physical mobility were the most common barriers among adults [24]. Furthermore, our results showed that only a few participants reported visiting the dentist for routine checkups (6.4%), while the majority (82.9%) reported that the main reason for their last dental visit was pain or dental treatment. This finding agrees with a previous national level study that reported similarly low numbers of Saudis who visited the dentist for a routine checkup [10]. Reasons for seeking dental services among SA's residents were investigated in several studies. A study conducted in Jeddah city on students aged between 11 to 24 years found that the most common reason for not visiting a dentist was the perception of no need to visit the dentist, followed by fear of pain at the dental office [25]. Another study that used a social media sample recruitment approach on adults aged 23 years and older showed that 46.52% reported if there is no pain, there is no need for dental treatment [26]. Oral health access and use is a complex phenomenon that requires a conceptualized understanding of the links between the oral healthcare services systems and the population. Identifying factors such as predisposing, enabling, and need conditions at a conceptual and individual level is crucial to understanding access and use of oral health services [27]. Future investigation is needed to understand oral healthcare access and its use in SA.

This study indicated that the Central region population had the highest insurance coverage and the highest utilization of dental privet clinics as the regular source of dental care. This can be due to the direct results of the SA's government efforts to transform the health care system in the country. SA's government has found that it is difficult to sustain free of charge health care services for the population while maintain an efficient and high quality delivery of care [28]. This is because of the population growth, rise in health care costs, increased life expectancy, changes in disease pattern from communicable diseases to more expensive to manage non-communicable diseases, and the population's increased expectation of high-quality health care services. In 1999, the Kingdom set the foundation of privet health insurance by authorizing labor laws that required privet sector to provide a health insurance for non-citizens employees [29]. Furthermore, in 2003 the Cooperative Health Insurance Act was enacted, and the Council of Cooperative Health Insurance was established. The council recommended a compulsory employment-based health insurance. The application of the Cooperative Health Insurance was intended to be executed through stages. First stage was implemented in 2006 by compels privet sectors employers to provide health insurance to both citizens and non-citizens employees. The second phase, which involves public sector employees, and third phase, which covers all other groups, are expected to be applied [30]. Studies evaluating oral health care access and use in SA are required to evaluate the effectiveness of such reforms on oral health wellbeing among SA's population.

Our study has some important limitations due to the inherent response biases associated with self-reported surveys, such as recall or social desirability biases. The answers to many questions, such as those evaluating the reasons for and frequency of dental visits, were largely dependent on the respondents' ability to recall past experiences. Moreover, social desirability bias may have influenced the responses to the smoking-related questions, since only 6.4% of the respondents reported that they were currently smoking, in comparison with 12.2% in a previous study that was conducted in 2012 [31]. This wide discrepancy in reporting smoking status should be addressed when designing future studies. Another limitation of this survey is the lack of data for clinical oral health outcomes such as previous caries experience. It would be valuable to include data for such measures in future national health surveys.

Conclusion

The 2017 SA DHS provided a comprehensive information about oral health influences in Saudi Arabia for the first time at a substantial national scale due the DHS's large sample size, broad geographic distribution, wide age range, and the extensive social and health information included in the survey that made it an excellent opportunity to extensively investigate the oral health influences in a country that could be recognized as a high income but is yet a developing country. Our adapted conceptual framework worked well to guide the analysis of our data. We believe that the use of this framework would facilitate further studies, discussions, and communication regarding oral health influences in SA among parties of interest, such as oral health policymakers and researchers. Among the investigated oral health influences, two that were previously reported to have a significant negative influence on oral health were identified for the population in SA: infrequent routine dental examination visits and inadequate oral hygiene. Future studies should investigate if they also negatively influence oral health within the conditions and environment of the SA population.

CHAPTER 2: EFFECTS OF DISTAL AND PROXIMAL INFLUENCES ON SELF-REPORTED ORAL PAIN AND SELF-RATED ORAL HEALTH STATUS IN SAUDI ARABIA, 2017

Summary

Objectives: To explore associations between factors that affect oral pain (OP) and self-rated oral health status (SROH), directly (proximal influences) or indirectly (distal influences) in Saudi Arabia, using an adapted conceptual framework.

Methods: This cross-sectional study utilized data from national demographic and health survey conducted by the ministry of health in Saudi Arabia in 2017. The sample included adults (N=29,274), adolescents (N=9910), and children (N=11653). Age, gender, citizenship, region, marital status, completed education level, monthly household income, household crowding, past accident experience, presence of physical disability, body mass index, health insurance, oral health services access, regular source of dental care were considered distal influences; while dental visits frequency, type of dental visit, tooth brushing frequency, smoking, sweets, and soft drinks consumption were considered proximal influences. Path analysis modeling was used to estimate direct, indirect, and total effects of both proximal and distal influences on OP and SROH.

Results: In children group, OP was linked to less tooth brushing, more dental visits and less dental routine examination, while less favorable SROH was linked to less tooth brushing, more dental visits and sweets consumption. In adolescents and adults groups, OP and less favorable SROH were linked to more dental visits, complaint dental visits, less tooth brushing. Sweets consumption was linked to OP in adolescents and

negative SROH in adolescents and adults. However, soft drinks was linked to less OP in adolescents and positive SROH in adolescents and adults. Many distal influences showed significant effects (direct, indirect, and total) on OP and SROH, such as, citizenship, region, and oral health services access. However, differences existed among the three age groups.

Conclusions: Among the Saudi Arabia population in our study, OP and SROH were directly influenced by many proximal influences. Several distal influences had a direct, indirect, or combined influence on OP and SROH.

Introduction

Oral health is essential to general health and for humans' overall well-being. Major oral conditions include dental caries, periodontal diseases, and tooth loss. Between 1990 to 2017, the global burden of these conditions has increased by 38% [32].

In Saudi Arabia (SA), studies have shown an increase in the burden of oral diseases within the last few decades. This was documented by many regional studies conducted since the 1990s [4]. This increase is suspected to be due to transformations in lifestyle such as changes in dietary habits by consuming more sugary food and increased tobacco use [33, 34]. Thus, oral health conditions remain a major public health concern in SA.

Self-reported oral health measures have been used as a subjective indicator for oral healthcare needs and to evaluate individuals' quality of life [35]. It is a cost-effective, time-saving tool that doesn't require clinical training of examiners and settings for data collection. Self-reported oral health can be affected by several influences such as sociodemographic, cultural values and beliefs,[36, 37] socioeconomic factors [38, 39], and existing oral health condition [38, 40].

The Multidimensional Conceptual Model of Oral Health proposed by Gilbert et al [41], states that oral diseases and tissue damage could result in oral pain (OP) and disadvantages in daily living that all will affect self-rated oral health status (SROH). Oral pain can disturb chewing and sleeping [42-44]. Also, it can affect school and work attendance causing a loss of a significant amount of studying and working hours per year [45-48]. Because of these concerns, OP is frequently incorporated into national health surveys. In 1989, it was reported that 14.5% of United States adults experienced oral pain within the past six months [49], while in the United Kingdom, 28% of adults reported oral pain in the past year in 1998 [50].

The use of conceptual frameworks in oral health research can serve as a coherent map to guide the researchers when inquiring about oral health phenomena. Conceptual frameworks can also help researchers include all possible factors that may explain an outcome and aid in designing statistical analyses [51]. Based on already available models for oral health, we developed a multi-level conceptual framework for oral health influences in the KSA (Figure 1) on the self-reported OP and self-rated oral health status SROH among KSA residents. We adapted constructs from the Multidimensional Conceptual Model of Oral Health proposed by Gilbert et al [41], and the World Health Organization (WHO's) Model for Oral Health Surveillance [14] by expanding the concept of proximal (direct) oral health influences on oral health – such as diet and oral hygiene – to include distal (indirect) influences such as socioeconomic determinants. The objective of this study was to perform secondary data analysis to explore how proximal and distal influences on oral health are related to both OP experience and SROH among SA residents utilizing data from a national demographic and health survey (DHS) that was conducted in 2017 in SA. The conceptual framework (Figure 2) was used to guide the analysis.

Methods

Dataset Source

The data source was the DHS conducted by SA's ministry of health (MOH) in 2017. The data were available at the office of the Directorate of Primary Health Care Centers (MOH headquarters, Riyadh, SA). The MOH used a probability multistage stratified random sampling for the DHS. Prepared house-to-house visits were conducted to interview the head of a family or an eligible representative and other specific family members between February 12, 2017, and May 23, 2017. Details on the sampling methodology have been reported in Chapter 1. The participants answered questions related to demographics, environmental, and health-related topics. Eligible datasets were those with complete responses to oral health questions. The data were received in SPSS format, including data set for subjects aged five years old and above. An analysis file was created comprised of selected variables of interest. The data set was divided into three groups of data sets based on age: the first group was for children aged between five to fourteen years; the second group was for adolescents aged between fifteen to twenty-four; the third group was for adults aged twenty-five and older. (for detailed study design, please refer to Chapter 1).

Model

Our conceptual model (Figure 1) stated that OP and SROH were directly influenced by age, gender, citizenship, region, marital status (adults group), completed education level in adults group only, monthly household income, household crowding in children group only, past accident experience, presence of physical disability, body mass index (BMI), health insurance, oral health services access, regular source of dental care, dental visits frequency, type of dental visit, tooth brushing frequency, smoking in adults group only, sweets and soft drinks consumption. Furthermore, OP and SROH were indirectly influenced by age, gender, citizenship, region, marital status (adults group), completed education level (adults group), monthly household income, household crowding (children group), oral health services access, regular source of dental care via dental visits frequency, type of visit, tooth brushing frequency, smoking (adults group), sweets and soft drinks consumption. The past accident experience, the status of physical disability, and BMI indirectly influenced OP and SROH via dental visits frequency, type of visit, and tooth brushing frequency (Figure 2).

Model variables

Model variables were classified into exogenous and endogenous variables. Exogenous variables are the ones that are not affected by other variables in the model (i.e., the distal or indirect influences), while the endogenous variables are the variables affected by other variables in the priori model (i.e. the proximal influences and outcome variables). We included thirteen exogenous variables for the adults group, eleven, and twelve exogenous variables for adolescents, and the children groups, respectively. Eight endogenous variables for the adults, and seven endogenous for the adolescents and children groups, respectively. Each variable and associated measures are summarized as follows:

Exogenous variables (distal influences variables)

Age [52-54] of participants was included as a continuous variable and gender [54, 55] as a binary variable (males/females). Citizenship status was set as a binary variable: citizens and non-citizens. Geographic regions [4] were classified into the East, West, and

Central vs. the North and South. Marital status was dichotomized into currently married and not married. Completed education level [56-59] was categorized as primary, intermediate, high school, intermediate diploma, and college or higher education. Five levels of household monthly income [56-59] were included: lower-class (3,800 Riyals or less), marginal middle-class (3,801-7,699 Riyals), basic middle-class (7,700-22,900 Riyals), upper-middle-class income (22,901-38,200 Riyals), and, upper-class (>38,200 Riyals). Household crowding was calculated by dividing the number of family members by the number of sleeping rooms. The responses were then grouped into four levels: one or less person per room, one to two persons per room, two to three persons per room, and more than three persons per room. Past accident experience was assessed by a binary no/yes response to the question "Have you ever had an accident?". For the status of physical disability, a binary no/yes responses to the question:" Are you disabled?". BMI variable was dichotomized into abnormal and normal (BMI = 18.5-24.9). Health insurance was the binary variable of insured vs. not insured. For oral health services access, responses to question [60-62] "Over the past year, did you need a therapeutic service for your teeth and was unable to obtain it in that time?" were dichotomized into "no/I do not know and yes" responses. Regular sources of dental care were dichotomized into a government clinic and private clinic.

Endogenous variables (proximal influences and outcome variables)

Dental visits frequency [60-62] had four responses to the question "How many times have you visited a dentist in the past year?" Answers were "never visited a dentist/I do not know or do not remember, did not visit the dentist in the past year, once, more than once." For the type of visit, responses were dichotomized for a complaint, and routine examination and treatment [63] For tooth brushing frequency [60, 64-70], individuals responded to the question “How many times do you wash your teeth with brush and toothpaste during the last 30 days?”: with six levels of responses “I have never cleaned my teeth, I clean my teeth some days but not daily, once weekly, many times per week, once daily, twice or more daily.” For smoking status [71, 72], yes/no responses to the question “Do you smoke?” Regarding the frequency of consuming sweets [60, 64-70], individuals responded to the following question “How often do you eat sweets?” as “I don't eat at all, many times per month, once per week, many times per week, once per day, many times per day.” For soft drinks consumption frequency [60, 64-70], “How often do you drink soft drinks?” responses were “I don't drink at all, many times per month, once per week, many times per week, once per day, many times per day.”

For OP [41, 70], the question was phrased as: “How many times during the past year have you felt pain in your teeth?” There were four levels of response “never felt, rarely, sometimes, many times.” For SROH [41, 70], participants were asked, “How would you describe the health of your teeth and gums?” Responses were “bad, acceptable, good, very good, excellent.”

Data Analysis

R software (R Foundation for Statistical Computing, Vienna, Austria.2021) was used to perform the analysis. The missing values were not replaced for this analysis. The first step was to assess multivariate normality for the endogenous variables. Both skewness and kurtosis statistics confirmed endogenous variables did not follow a multivariate normal distribution ($p<0.05$). Due to the presence of non-normal and missing data, we used maximum likelihood estimation to perform path analysis with robust standard errors (Huber-White) and scaled test statistics [73]. The software estimated the direct effect (as hypothesized in our model in (Figure 2) of each oral health influence on both OP and SROH and indirect effects for each exogenous variable on both OP and SROH through a path mediated by each proximal influence on oral health (Figure 2), e.g., gender effect on OP via tooth brushing frequency. Total indirect effects reflected the effect of the path between each exogenous variable on both OP and SROH via all proximal influences on oral health. Total effects comprised the sum of total indirect and direct effects of each distal influence on OP and SROH. A separate model was estimated for each age group – children 5-14 years (Figure 3), adoulescents15-24 years (Figure 4), and adults 25 years and over (Figure 5). Model fit was evaluated using the following fit statistics: robust comparative fit index (RCFI) >0.9, robust Tucker-Lewis index (RTLI) > 0.9, robust root mean square error of approximation (RRMSEA) <0.08, and robust standardized root mean square residual (RSRMR) <0.08 [74].

Results

The final analysis included 29,274 adults over 25 years old (mean age in years = 42.2, SD =12.97), 9910 adolescents aged between 15-24 (mean age in years = 20.4, SD = 2.98), and 11653 children aged between 5 to 14 (mean age in years = 10.58, SD = 2.84). Complete descriptive statistics have been reported in Chapter 1. Table 9 showed descriptive statistics for the model variables for the three age groups. OP in the past year was experienced in 39% in children aged between 5-14 years and, 48.5% for the adolescents aged 15-24 years, and 47.1% in adults aged 25 and older. Regarding SROH, the proportion of respondents who reported good, very good, or excellent self-rated oral health status was 92.9 % in children, 87.1% for both adolescents, and adults.

The model goodness of fit measures showed an acceptable fit to the data, meeting the recommended values for the fit statistics (Table 10) [74].

Proximal influences on oral health effects

Direct effects of proximal influences are reported in Table 11. More tooth brushing frequency was strongly associated with less OP and positive SROH in all groups. More dental visit was associated with more OP and less favorable SROH in all age groups. Routine examination and treatment were linked to less OP all age groups and better SROH in the adults and adolescents group. Sweets consumption was linked to OP in adolescents ($\beta = 0.033$, $P = 0.007$), while it was linked to negative SROH in the children (β -0.086, $P < 0.001$), adolescents ($\beta = -0.079$, $P < 0.001$), and adults ($\beta = -0.068$, $P < 0.001$). Soft drinks were linked to less OP in the adolescents ($\beta = -0.034$, $P = 0.005$). Moreover, soft drinks were associated positively with SROH ($\beta = 0.063$, $P <$

0.001) in the adolescents and adults ($\beta = 0.068$, $P < 0.001$). Smoking was associated with more OP ($\beta = 0.030$, $P < 0.001$) in the adults group.

Distal influences on oral health effects

Tables 11, 12, and 13 illustrate direct, total indirect, and total effects, respectively, of the oral health influences on OP and SROH. Tables 14, 15, and 16 show the direct effects of the distal influences on the proximal influences and the indirect effects of each distal influence on both OP and SROH via each proximal influence.

Age

Increase in age was indirectly linked with OP in children ($\beta = 0.062$, $P < 0.001$) group (Table 12). There was a negative direct effect between age and SROH (Table 11) in both the children ($\beta = -0.044$, $P = 0.001$) and adolescents ($\beta = -0.033$, $P = 0.008$) groups. Total effect (Table 13) of age was found in the children groups for both the OP (positive relation) and the SROH (negative relation). There were no significant effects of age on OP and SROH in the adults group. In the children group, age showed an indirect effect on OP and SROH via dental visits frequency and type of visits (Table 14).

Gender

The direct linkage between females and SROH was negative in children ($\beta = -0.030$, $P = 0.009$). A total indirect negative effect was found between females and OP ($\beta = -0.016$, $P = 0.042$) in the adults group (Table 12). Also, total indirect effect showed females were associated with positive SROH in the children ($\beta = 0.006$, $P = 0.041$) and adults (β 0.006, $P = 0.031$) age groups (Table 12). Total effects showed a negative association with SROH in the children group ($\beta = -0.024$, $P = 0.035$). A positive direct link was found between females and tooth brushing frequency in both children and adults groups. In the same groups the indirect effects of being female was negative with OP and positive with SROH via tooth brushing frequency (Tables 14 and 16).

Citizenship

For non-citizens, the direct ($\beta = -0.081$, $P < 0.001$) and total ($\beta = -0.085$, $P < 0.001$) effects showed a negative association with OP in the children age group, but they had positive association in the adults group ($\beta = 0.023$, $P = 0.016$) through total indirect effect. The direct ($\beta = 0.067$, $P < 0.001$), and the total ($\beta = 0.072$, $P < 0.001$) effects of non-citizen was linked with positive SROH in the children group. However, negative total ($\beta = -0.055$, $P < 0.001$) effect were found between citizenship and SROH in the adults group. No significant direct, indirect, or total effects of citizenship were found for the adolescents age group (Tables 11, 12, and 13).

Regions

Adolescents and adults from the north and south regions were linked to less OP than the east, west and central regions through the total ($\beta = -0.033$, $P = 0.011$ & $\beta = -0.045$, $P < 0.001$) effects pathways (Tables 13). However, OP was positively linked to children from the south and north regions through the total indirect pathway ($\beta = 0.027$, $P < 0.001$). Also, for the same group, the north and south regions were negatively associated with SROH directly ($\beta = -0.081$, $P < 0.001$), total indirect ($\beta = -0.019$, $P < 0.001$) and through the total effect ($\beta = -0.099$, $P < 0.001$). Dental visits frequency, type of visit, and tooth brushing frequency had a significant relationship with regions and an indirect effect with SROH and the region variable through those proximal influences for the children group (Table 14).

Marital status (adults group)

There was no significant direct, total indirect, or total effect of marital status on OP and SROH. However, there was a direct effect of marital status on smoking (Table 16).

Education level (adults group)

Higher education level was associated with positive SROH directly ($\beta = 0.046$, $P = 0.003$) and through the total effect pathway ($\beta = 0.050$, $P = 0.002$), (Tables 11 and 13). Furthermore, higher education was linked with more tooth brushing frequency, and higher education level was linked with less OP indirectly via tooth brushing frequency ($\beta = -0.004$, $P < 0.001$) and positive SROH ($\beta = 0.008$, $P < 0.001$), (Table 16).

Household monthly income

In children group, higher income was associated with less OP through the direct pathway ($\beta = -0.030$, P = 0.021), but higher income was positively associated with OP through the total indirect pathway ($\beta = 0.024$, P = 0.003), (Tables 11 and 12). Furthermore, higher income was positively associated with the SROH through direct ($\beta = 0.073$, P < 0.001) and the total effect pathway ($\beta = 0.070$, P < 0.001), (Tables 11and 13). Moreover, higher income was associated with more tooth brushing frequency, and the indirect effect via tooth brushing frequency on OP was negative ($\beta = -0.002$, P = 0.025) and positive with SROH ($\beta = 0.006$, P = 0.007) for the children age group (Table 14). There were no significant relationships between the household income and both the OP and SROH for the adolescents and adults groups.

Household crowding (children group)

There were no significant direct, indirect, and total effects of household crowding in children group on both OP and SROH (Tables 11, 12, and 13).

Insurance

In the children group, health insurance was associated with less OP through direct (β = -0.36, P = 0.033), total indirect (β = -0.023, P = 0.026), and through the total effect pathways (β = -0.058, P = 0.003). SROH was not linked to insurance in the children group. Insurance was associated positively with OP through the direct pathway in both adolescents (β = 0.051, P = 0.004), and adults (β = 0.042, P < 0.001). Moreover, insurance was linked to less OP indirectly via dental visits frequency in adults (β = -0.028, P = 0.011), (Tables 11, 12, and 13).

Health insurance was negatively linked to SROH directly (β = -0.160, P < 0.001) and through the total effect (β = -0.152, P < 0.001) in the adolescents group as well as in the adults group directly (β = -0.135, P < 0.001) and through total indirect (β = -0.012, P =0.042) and the total effects (β = -0.146, P < 0.001), (Tables 11, 12, and 13).

Oral health services access

In the children group, oral health care access unavailability was linked to more OP and negative SROH thorough direct, total indirect, and total effects (Tables 11, 12, and 13).

In the adolescents group, unavailability was positively associated with SROH through the direct effect (β = 0.045, P = 0.001) and through the total effect pathway (β = 0.050, P < 0.001). In the adults group, oral health care access unavailability was positively linked to SROH through the total indirect pathway (β = 0.009, *P* = 0.002) and the total effects (β = 0.025, *P* = 0.026), (Tables 11, 12, and 13).

Regular sources of dental care

Privet clinics as regular source of care in the children group was associated with more OP and worse SROH directly (for OP: β = 0.053, *P* = 0.001; for SROH: β = -0.136, *P* < 0.001) and through the total effect pathway (for OP: β = 0.039, *P* = 0.033; for SROH: β = -0.124, *P* < 0.001), (Tables 11 and 13). Tooth brushing frequency was the major mediating influence in this group (Table 14). In adults group privet clinics were linked to better SROH through total indirect pathway (β = 0.010, *P* =0.28), (Table 12).

Past accident experience

Past accident experience was associated with OP and worse SROH in children group through direct, total indirect and total effect pathways (Tables 11, 12, and 13). In adolescents group, it was associated with OP through direct and total effects pathway (Tables 11 and 13). In adults group, past accident experience was negatively associated with SROH through direct (β = -0.043, *P* < 0.001) and total effects pathway (β = -0.036, *P* = 0.002), but it was positively associated with SROH through the total indirect pathway (β = 0.008, *P* = 0.010), (Tables 11, 12, and 13).

Physical disability

Disability was linked to OP and negative SROHS in the children group through the total effects pathway (Table 13). In the adolescents group, it was associated with worse SROH through direct (β = -0.078, *P* < 0.001) and the total effect pathway (β = -0.077, *P* < 0.001). In the adults group, disability was associated with more OP and negative SROH through direct and the total effect pathways (Tables 11 and 13).

Body mass index

In children group, normal BMI was linked directly to OP through the direct, total indirect and the total effects pathway (Tables 11, 12, and 13). However, it was linked to better SROH ($\beta = 0.047$, $P < 0.001$) through total effect pathway. In the adolescents group, normal BMI was linked to o less OP and better SROH through the direct and the total effects pathways (Tables 11 and 13).In the adults groups, normal BMI was linked to less OP through total indirect and total effects pathways (Tables 12 and 13) and it was linked to better SROH through the direct and the total effect pathways (Tables 11 and 13).

Discussion

The findings of this study partially supported our adapted conceptual framework for distal and proximal influences on self-reported OP and SROH when applied to Saudi Arabia residents. All proximal influences were associated with OP except sweets and soft dinks consumption in the children and adults groups. Unexpectedly, soft drinks consumption was associated with less OP in the adolescents group, though oral pain was positively associated with sweets consumption. Moreover, all proximal influences were associated with SROH except soft drinks consumption and type of dental visit in the children age group, and smoking in adults group. However, more sweets consumption and more dental visits were negatively associated with SROH, but sof drinks consumption was positively linked to SROH in adolescents and adults groups. Regarding the distal influences, the majority of them showed an association with both OP and SROH through the direct, indirect, and total effects pathways.

This study indicated that the prevalence of OP experience in Saudi Arabia is high. Data from a meta-analysis illustrated that pooled OP prevalence in children and adolescents was 36.2% from twenty different countries [75], which is almost half of the prevalence found in our study in similar age groups (60.2% for children and 67.8% for adolescents). Our results did not agree with the meta-analysis regarding the association of OP with the female population in the children and adolescents groups. However, in the adults group, females were associated with less OP through the total indirect effect pathway, and also indirectly through tooth brushing frequency as adult females showed an association with more frequent tooth brushing than the males (Table S3). Furthermore, the findings from this study differed from National Health and Nutrition Examination

Survey (NHANES) 2015-2018 data [76] on adults aged >30 years in the US as OP was associated with education and income level while in Saudi Arabia it was not.

The findings from this study indicated that dental visits frequency was positively associated with pain and negatively associated with SROH while routine visits were associated with less pain and better SROH in all age groups. It would be expected that more dental visits the better oral health; however, it seems that Saudi residents visit the dentist when they have a complaint such as OP and rarely visit the dentist for a routine check-up. Similar trend has been previously reported in a national [10] and several sub-national studies in Saudi Arabia [24, 26, 77-79]. Also, this lack of interest for routine examination and treatment visits (9.0% of children, 6.2% of adolescents, and 5.4% of adults reported routine dental visits in the past year) can be explained by the optimistic view of the Saudi population about their oral health as 92.9% children, 87.1% adolescents and adults self-rated their oral health as good, very good, or excellent. Infrequent routine visits and optimistic SROH combined with less frequent tooth brushing frequency (87.8% children, 83.1% adolescents and 83.4% adults brush their teeth less than twice a day) is a critical finding meaning Saudi residents do not recognize such risk factors that can harm their oral health. This positive perception of oral health and the high prevalence of risk factors could be due to Saudi residents' culture and beliefs that are reinforced by family and community. Oral health officials and policymakers need to consider educating the public about the importance of oral hygiene and routine dental visits regardless of the population’s SROH status.

This study was cross-sectional, which poses a significant limitation by hindering temporality between the investigated distal and proximal influences with the OP and

SROH; thus, no causal relationship can be determined. However, this study was intended to be an exploratory study using a conceptual framework to guide the analysis with no attempt to identify the cause-effect relationship. To our best knowledge, there is no longitudinal study to measure the change in oral health status in Saudi Arabia, which is needed to determine oral health risk factors specific to the Saudi Arabia population.

Another major limitation is the subjectivity of a self-reported survey over objective clinical evaluation, which would introduce some response biases such as recall bias [80] (e.g., dental visits frequency in the past year) and social desirability bias [81] (e.g., smoking status). Also, such biases may influenced the response to soft drinks consumption question in adolescents group as the more soft drinks consumption was associated with less pain and better SROH, though there is a clear evidence that showed an association between soft drinks consumption and negative oral health conditions in cross-sectional and longitudinal studies.[82] Furthermore, self-reported OP and SROH may not reflect an exact oral health clinical status to some extent because they express a person's perception of the OP and the SROH that can be influenced by psychosocial and cultural factors. For example, NHANES 2003-2004 data from the US (as an example of a multi-cultural country) showed that Latinos reported better SROH than Whites while Latinos had more oral diseases and lower access and use of dental care [83]. This optimistic perception can be passed through generations. [84] Although using self-rated oral health indicators over a clinical measurement may have introduced some reporting bias, it is still a convenient, cost-effective, and expedited method to assess oral health status at a national level with a large sample, and it has shown a positive association with clinical oral health status [85-87]. Self-reported oral health measures have been used in many countries and national surveys such as NAHANES [76, 83] and the Australian National Survey of Adults Oral Health.[88].

Some advantages of this study include the use of data from the 2017 KSA DHS, which applied a random sampling design with a large sample size, wide geographic distribution, and broad age range, which ensured the representation of the findings for Saudi Arabia who can be recognized as a high income but is yet a developing country. The second advantage was the use of the conceptual framework to guide the analysis which was not possible without the use of path analysis method over the traditional multiple regression that allowed to test the direct and indirect effects of different oral health influences on SROH and OP. Also, our conceptual framework can be considered as a good contribution to understanding oral health influences in Saudi Arabia. However, the inclusion of other important oral health influences such as coping skills and social support constructs could have increased the explanatory power of the study [89].

Conclusion

Among Saudi residents, the prevalence of OP was high; however, they perceived their oral health positively. Frequent tooth brushing, low frequency of dental visits, frequent dental routine visits, less consumption of sweets, and non-smoking in adults were linked to less OP and positive SROH. Distal (indirect) influences such as gender, citizenship, region, past accident experience, physical disability, health insurance, and oral health services access had significant effects on OP and SROH through direct, indirect, or total effects pathways, though differences existed among age groups. Our findings suggest that future studies should focus on why Saudi residents perceive their oral health positively while the prevalence of negative oral health influences and OP is high; consequently, carefully planned oral health promotion programs can be developed and implemented effectively and efficiently.

TABLES

Table 1. Sample distribution for the 2017 national demographic and health survey in Saudi Arabia

Strata based on population size	Ministry of health regional directorates	Population size per stratum	Proportion of population size per stratum (%)	Sample size (# of households)	Total # of PHCs within stratum	# of Selected PHCs
1-499 (Satellite areas)	Al Baha – Asir – Bishah – Hafar Al Batin – Hail – Medinah – Najran Northern Borders –Qasim – Riyadh – Taif	45,075	0.21	105	136	34
500-999 (Small villages)	Al Baha – Al Ahsa – Al Qurayyat – Asir – Bishah – Eastern Region – Hafar Al Batin – Hail – Jazan – Jeddah – Medinah – Najran Northern Borders – Qasim – Riyadh – Tabuk – Taif	178,152	0.83	415	231	58
1000-4,999 (Medium-sized villages)	Al Baha – Al Ahsa – Al Qunfudhah – Al Qurayyat – Asir – Bishah – Eastern Region – Hafar Al Batin – Hail – Jawf – Jazan – Jeddah – Makkah – Medinah – Najran – Northern Borders – Qasim – Riyadh – Tabuk – Taif	2,373,930	11.06	5530	917	229
5,000-9,999 (Mother villages)	Al Baha – Al Ahsa – Al Qunfudah – Al Qurayyat – Asir – Bishah – Eastern Region – Hafar Al Batin – Hail – Jawf – Jazan – Jeddah – Makkah – Medinah – Najran – Northern Borders – Qasim – Riyadh– Tabuk – Taif	3,056,480	14.24	7119	417	104
10,000-24,999 (Towns)	Al Ahsa – Al Qunfudhah – Al Qurayyat – Asir – Eastern Region – Hafar Al Batin – Hail – Jawf – Jazan – Jeddah – Makkah – Medinah – Najran – Northern Borders – Qasim – Riyadh – Tabuk – Taif	5,894,044	27.46	13728	374	94
25,000-49,999 (Medium-sized cities)	Al Ahsa – Asir – Eastern Region – Jazan – Jeddah – Makkah – Medinah – Riyadh – Tabuk – Taif	5,159,971	24.04	12018	152	38
50,000-99,999 (Big cities)	Jeddah – Makkah – Riyadh	2,713,063	12.64	6320	41	10
More than 99,999 (Metropolitan areas)	Jeddah – Riyadh	2,045,529	9.53	4765	14	4
Total		21,466,244	100	50,000	2282	571

Note: PHC = Primary healthcare center.

Table 2. Variable list

Variable category	Variable	Description
Sociodemographic variables	Age	Eight age groups: 2-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, and 65+ years old.
	Gender	Males and females.
	Citizenship	The type of citizenship was dichotomized to citizens and non-citizens.
	Region	Included five geographic regions – 1) North (Tabuk, Jawf, Northern Borders, Hail), 2) South (Baha, Asir, Jizan, Najran), 3) East (Eastern province), 4) West (Madinah, Makkah), 5) Central (Riyadh, Qasim).
	Household head marital status	Marital status was dichotomized to currently married and currently not married.
Socioeconomic variables	Completed education level	What is the educational level that you completed? Primary school Intermediate school High school Intermediate diploma College degree Postgraduate degree
	Monthly household income	Total reported monthly income from various sources per each household was combined then classified into five categories: Upper-class (>38,200 Riyals) Upper middle-class income (22,901-38,200 Riyals) Basic middle-class (7,700-22,900 Riyals) Marginal middle-class (3,801-7,699 Riyals) Lower-class (3,800 Riyals or less)
	Ownership of residence	The status of current residence ownership was reported as: Own Rent Other

Table 2. Variable list, continued

Variable category	Variable	Description
Home environment variables	Type of residence	The type of residence was reported as: Flat House Other
	Residence condition	The state of residence condition was reported as: New Old in good condition Old decaying
	Residence overcrowding	We calculated resident overcrowding by dividing the total number of family member by number of sleeping rooms. The responses then grouped into the following categories: One or less person per room One to two persons per room More than two persons per room
General health related variables	Relevant medical conditions	The reported morbidity in the survey was re-classified to report main relevant medical conditions as: History of hypertension History diabetes Other diseases
	Past accident experience	Have you ever had an accident? Yes No
	Type of accident	The following types of accidents were reported: Car accident Electric accident Fall Hot liquid burn Other
	Status of physical disability	Are you disabled? Yes No

Table 2. Variable list, continued

Variable category	Variable	Description
	Type of disability	The following types of disabilities were reported: Movement disability Vision disturbance Hearing disturbances Speech disturbances Other
	Body Mass Index (BMI)	The BMI was categorized as following: Underweight = <18.5 Normal weight = 18.5–24.9 Overweight = 25–29.9 Obesity = BMI of 30 or greater
Oral health system & services variables	State of insurance	Do you have a health insurance? Yes No
	Family state of insurance	Is the rest of your family covered by health insurance? Yes No
	Regular source of dental care	Respondent chose from the following: Primary healthcare center Governmental hospital Private clinic Other
	Dental health care availability when needed	Over the past year, did you need a therapeutic service for your teeth and was unable to obtain it in that time? Yes No Do not remember
Oral health service usage variables	Dental visits frequency last year	How many times have you visited a dentist in the past year? Once More than once

Table 2. Variable list, continued

Variable category	Variable	Description
		Did not visit a dentist in the past year Never visited a dentist I do not know or do not remember
	Reasons for last dental visit	Reasons behind last dental visit was reported as the following: Pain or problem in your teeth or gums or mouth For treatment and follow up Routine examination and treatment I don’t know Other
Dental health risk behavior variables	Tooth brushing frequency	How many times do you wash your teeth with brush and toothpaste during the last 30 days? I have never cleaned my teeth I clean my teeth some days but not daily Once weekly Many times per week Once daily Twice or more daily
	Frequency of eating sugary food	How often do you eat sweets, candy, cookies, cake? I don't eat at all Many times per month Many times per week Once or more per day
	Frequency of drinking soft drinks	How often do you drink soft drinks? I don't drink at all Many times per month Many times per week Once or more per day
	Smoking status	Do you smoke? Yes No

Table 2. Variable list, continued

Variable category	Variable	Description
	Secondhand smoker status	In case if non-smoker, do you sit next to Smoker? Yes No

Table 3. Distal influences on oral health for total population and by gender

Variable	Total			Males			Females			
	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
Sociodemographic										
Age groups										
2-4	4674	2963	5.4	2374	1548	4.9	2300	1415	6.0	<0.001
5-14	11653	9365	16.9	5813	4765	15.0	5840	4600	19.7	
15-24	9910	8435	15.3	4630	4401	13.8	5280	4034	17.2	
25-34	11072	10893	19.7	4514	6202	19.5	6558	4691	20.0	
35-44	8495	11586	21.0	3877	7264	22.8	4618	4322	18.5	
45-54	5066	6921	12.5	2132	4616	14.5	2934	2305	9.8	
55-64	2834	3248	5.9	1311	2084	6.5	1523	1164	5.0	
65+	1807	1843	3.3	968	967	3.0	839	876	3.7	
Gender										
Male	25619	31848	57.6	NA	NA		NA	NA		NA
Female	29892	23406	42.4	NA	NA		NA	NA		
Citizenship										
Citizen	50155	34555	62.5	2285	17642	55.4	27301	16913	72.3	<0.001
Non-citizen	5356	20699	37.5	2765	14206	44.6	2591	6493	27.7	
Region										
North	11447	4002	7.2	5100	2229	7.0	6347	1773	7.6	<0.001
South	17836	8193	14.8	8098	4463	14.0	9738	3730	15.9	
East	11041	8441	15.3	5308	5122	16.1	5733	3319	14.2	
West	10222	18166	32.9	4884	10293	32.3	5338	7873	33.6	
Central	4965	16452	29.8	2229	9742	30.6	2736	6710	28.7	
Marital status										
Married	20785	17546	89.1	8801	9402	89.6	11984	8144	88.6	0.025
Not-married	2036	2140	10.9	666	1092	10.4	1370	1048	11.4	
Socioeconomic										
Completed education level										
Primary school	7633	7446	19.7	3758	4305	20.0	3875	3141	19.2	<0.001

Table 3. Distal influences on oral health for total population and by gender, continued

	Total			Males			Females			
Variable	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
Intermediate school	13648	15107	39.9	9844	12060	56.0	3804	3047	18.7	
High school	9604	8710	23.0	2414	3396	15.8	7190	5314	32.5	
Intermediate Diploma	1508	1427	3.8	217	427	2.0	1291	1000	6.1	
College or higher education	5505	5182	13.7	692	1348	6.3	4813	3834	23.5	
Monthly household income										
(>38,200 Riyals)	172	166	0.6	85	107	0.6	87	59	0.5	<0.001
(22,901-38,200 Riyals)	776	991	3.4	551	849	4.9	225	142	1.2	
(7,700-22,900 Riyals)	12871	11130	38.3	6381	6924	40.1	6490	4206	35.8	
(3,801-7,699 Riyals)	7254	8124	28.0	3264	5229	30.3	3990	2895	24.6	
(3,800 Riyals or less)	8086	8622	29.7	2622	4169	24.1	5464	4453	37.9	
Ownership of residence										
Own	14724	11160	57.6	6088	5578	54.2	8636	5582	61.4	<0.001
Rent	7606	8024	41.4	3175	4616	44.8	4431	3408	37.5	
Other	295	198	1.0	136	102	1.0	159	96	1.1	
Home Environment										
Type of residence										
Flat	12169	10711	55.3	4858	5626	54.6	7311	5085	56.0	0.094
House	10204	8419	43.4	4439	4526	44.0	5765	3893	42.9	
Other	280	251	1.3	108	144	1.4	172	107	1.2	
Residence condition										
New	8518	6754	34.5	3537	3385	32.3	4981	3369	36.9	<0.001
Old in good condition	12566	11216	57.2	5244	6159	58.8	7322	5057	55.4	
Old decaying	1652	1627	8.3	662	925	8.8	990	702	7.7	
Residence overcrowding										
≤1 person per room	4046	3960	21.1	1601	2255	22.2	2445	1705	19.8	<0.001
1-2 person per room	9972	8190	43.7	4028	4257	42.0	5944	3933	45.8	
> 2 person per room	7815	6579	35.1	3594	3623	35.7	4221	2956	34.4	
General Health										

Table 3. Distal influences on oral health for total population and by gender, continued

	Total			Males			Females			
Variable	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
History of medical conditions										
History of hypertension	2859	2859	26.5	1063	1789	27.6	1211	1070	24.9	<0.001
History of diabetes	786	786	7.3	269	420	6.5	359	366	8.5	
Other diseases	7130	7130	66.2	3118	4275	65.9	3668	2855	66.5	
Past accident experience										
Yes	2687	2850	5.5	1872	2197	7.3	815	653	3.0	<0.001
No	50014	49360	94.5	22515	27954	92.7	27499	21406	97.0	
Type of accident										
Car accident	1530	1742	62.9	1263	1544	72.1	267	198	31.5	<0.001
Electric accident	76	65	2.3	50	37	1.7	26	28	4.5	
Fall	688	695	25.1	380	449	21.0	308	246	39.1	
Hot liquid burn	135	137	4.9	40	47	2.2	95	90	14.3	
Other	156	131	4.7	78	64	3.0	78	67	10.7	
History of physical disability										
Yes	823	867	1.7	353	486	1.6	470	381	1.7	0.267
No	51772	51471	98.3	24040	29819	98.4	27732	21652	98.3	
Type of disability										
Movement disability	259	287	37.2	95	156	35.3	164	131	39.6	0.321
Vision disturbance	290	302	39.0	131	170	38.5	159	132	39.9	
Hearing disturbance	61	96	12.5	28	58	13.1	33	38	11.5	
Speech disturbance	45	31	3.9	29	22	5.0	16	9	2.7	
Other	62	57	7.4	28	36	8.1	34	21	6.3	
Body mass index										
Underweight = <18.5	7426	5624	12.7	3530	2845	11.1	3896	2779	14.8	<0.001
Normal weight = 18.5–24.9	17161	16189	36.5	7865	9241	36.1	9296	6948	37.0	
Overweight = 25–29.9	12728	13706	30.9	5896	8248	32.2	6832	5458	29.0	
Obesity = 30 or greater	7561	8863	20.0	3468	5259	20.5	4093	3604	19.2	
Oral health system & services										

Table 3. Distal influences on oral health for total population and by gender, continued

	Total			Males			Females			
Variable	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
State of insurance										
Yes	5635	7108	36.3	2433	4242	40.5	3202	2866	31.4	<0.001
No	17080	12489	63.7	6997	6220	59.5	10083	6269	68.6	
Family state of insurance										
Yes	5277	6648	36.5	2241	3936	39.4	3036	2712	32.9	<0.001
No	15391	11580	63.5	6680	6054	60.6	8711	5526	67.1	
Regular source of dental care										
PHC	19977	16813	55.1	9529	9486	51.5	10448	7327	60.5	<0.001
Governmental hospital	3225	3468	11.4	1378	2097	11.4	1847	1371	11.3	
Private clinic	6260	9036	29.6	2796	5878	31.9	3464	3158	26.1	
Other	779	1209	4.0	427	956	5.2	352	253	2.1	
Dental care availability when needed										
Not available	13028	11178	22.5	5732	5979	20.8	7296	5199	24.7	<0.001
Available	29105	29974	60.2	13442	17369	60.5	15663	12605	59.9	
Do not remember	8036	8598	17.3	3918	5365	18.7	4118	3233	15.4	

[a] Non-weighted frequency. [b] Weighted frequency. [c] Weighted percent. Data were not complete for some variables (missing data from participants). NA= Non applicable.

Table 4. Proximal influences on oral health for total population and by gender

Variable	Total			Males			Females			
	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
Oral health service usage										
Dental visit frequency last year										
Once	11459	11651	23.8	5360	6900	24.3	6099	4751	23.1	<0.001
More than once	11570	11991	24.5	5325	7113	25.1	6245	4878	23.7	
Did not visit a dentist in the past year	19014	18351	37.5	8758	10361	36.5	10256	7990	38.8	
Never visited a dentist	4661	4306	8.8	2255	2499	8.8	2406	1807	8.8	
I do not know or do not remember	2507	2675	5.5	1105	1518	5.3	1402	1157	5.6	
Reasons for last dental visit										
Pain or problem in your teeth or gums or mouth	19762	20478	69.0	9264	12150	69.0	10654	8328	69.0	0.007
For treatment and follow up	3819	4139	13.9	1808	2538	14.4	2011	1601	13.3	
Routine examination and treatment	156	1911	6.4	950	1107	6.3	1079	804	6.7	
I don’t know	2029	2689	9.1	1273	1552	8.8	1468	1137	9.4	
Other	2741	461	1.6	220	256	1.5	240	205	1.7	
Dental health risk behavior										
Tooth brushing frequency										
I have never cleaned my teeth	5845	5656	11.7	2869	3473	12.3	2976	2183	10.8	<0.001
I clean my teeth some days but not daily	13248	12719	26.3	6364	7461	26.5	6884	5258	26.0	
Once weekly	3985	4190	8.7	1898	2544	9.0	2087	1646	8.1	
Many times per week	5679	5518	11.4	2645	3209	11.4	3034	2309	11.4	
Once daily	12477	12838	26.6	5550	7337	26.1	6927	5501	27.2	
Twice or more daily	7217	7417	15.3	3168	4108	14.6	4049	3309	16.4	
Frequency of eating sweets										
I don't eat at all	8460	9162	17.5	3812	5294	17.5	4648	3868	17.5	<0.001
Many times per month	29922	30123	57.5	14041	17718	58.6	15881	12405	56.0	
Many times per week	9148	8540	16.3	4177	4792	15.8	4971	3748	16.9	

Table 4. Proximal influences on oral health for total population and by gender, continued

	Total			Males			Females			
Variable	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
Once or more per day	5225	4584	8.7	2401	2440	8.1	2824	2144	9.7	
Frequency of drinking soft drinks										
I don't drink at all	18800	19575	37.3	8400	11012	36.3	10400	8563	38.8	<0.001
Many times per month	24075	23787	45.4	11357	14117	46.5	12718	9670	43.8	
Many times per week	7109	6744	12.9	3392	3931	13.0	3717	2813	12.7	
Once or more per day	2650	2332	4.4	1256	1289	4.2	1394	1043	4.7	
Smoking status										
Yes	3321	3014	6.4	1494	1748	6.3	3321	1266	6.5	0.286
No	41948	44206	93.6	19263	26075	93.7	41948	18131	93.5	
Secondhand smoker status										
Yes	4684	4780	18.3	2243	3000	19.3	2441	1780	16.8	<0.001
No	20338	21323	81.7	9372	12539	80.7	10966	8784	83.2	

[a] Non-weighted frequency. [b] Weighted frequency. [c] Weighted percent. Data were not complete for some variables (missing data from participants).

Table 5. Distal influences on oral health by age group

	2-4		5-14		15-24		25-34		35-44		45-54		55-64		65+		
Variable	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	*p*
Sociodemographic																	
Gender																	
Male	1548	52.2	4765	50.9	4401	52.2	6202	56.9	7264	62.7	4616	66.7	2084	64.2	967	52.5	<0.001
Female	1415	47.8	4600	49.1	4034	47.8	4691	43.1	4322	37.3	2305	33.3	1164	35.8	876	47.5	
Citizenship																	
Citizen	2376	80.2	7095	75.8	6718	79.6	6501	59.7	4961	42.8	3393	49.0	2003	61.7	1507	81.8	<0.001
Non-citizen	587	19.8	2269	24.2	1718	20.4	4392	40.3	6625	57.2	3528	51.0	1245	38.3	335	18.2	
Region																	
North	260	8.8	773	8.3	690	8.2	752	6.9	805	6.9	405	5.9	189	5.8	129	7.0	<0.001
South	471	15.9	1480	15.8	1404	16.6	1593	14.6	1473	12.7	890	12.9	493	15.2	389	21.1	
East	501	16.9	1360	14.5	1250	14.8	1808	16.6	1848	16.0	1036	15.0	439	13.5	199	10.8	
West	901	30.4	3008	32.1	2689	31.9	3365	30.9	3821	33.0	2416	34.9	1265	39.0	699	37.9	
Central	830	28.0	2744	29.3	2403	28.5	3375	31.0	3639	31.4	2173	31.4	861	26.5	427	23.2	
Marital status																	
Married	NA	NA	NA	NA	NA	NA	3378	85.5	3582	90.4	2163	91.5	1124	85.7	649	80.3	<0.001
Not-married	NA	NA	NA	NA	NA	NA	573	14.5	382	9.6	202	8.5	187	14.3	159	19.7	
Socioeconomic																	
Completed education level																	
Primary School	NA	NA	NA	NA	NA	NA	685	7.8	1099	12.6	1027	21.0	547	28.2	354	49.4	<0.001
Intermediate school	NA	NA	NA	NA	NA	NA	3279	37.2	3314	38.1	1987	40.6	985	50.7	187	26.1	
High school	NA	NA	NA	NA	NA	NA	2497	28.3	2124	24.4	1166	23.8	273	14.1	162	22.6	
Intermediate Diploma	NA	NA	NA	NA	NA	NA	508	5.8	495	5.7	216	4.4	42	2.2	1	0.1	
College or higher education	NA	NA	NA	NA	NA	NA	1853	21.0	1661	19.1	503	10.3	94	4.8	13	1.8	
Monthly household income																	
(>38,200 Riyals)	6	0.4	23	0.5	22	0.6	31	0.5	23	0.4	42	1.0	14	0.8	4	0.4	<0.001
(22,901-38,200 Riyals)	7	0.5	27	0.6	26	0.7	165	2.7	434	6.7	265	6.1	53	2.9	15	1.7	
(7,700-22,900 Riyals)	582	42.1	1602	36.5	1185	32.3	2735	44.9	2597	40.2	1590	36.9	568	31.2	271	30.0	
(3,801-7,699 Riyals)	349	25.2	963	21.9	986	26.9	1804	29.6	2010	31.1	1151	26.7	574	31.5	287	31.7	
(3,800 Riyals or less)	440	31.8	1775	40.4	1453	39.6	1358	22.3	1392	21.6	1265	29.3	611	33.6	327	36.2	
Ownership of residence																	
Own	NA	NA	NA	NA	NA	NA	1867	48.4	1750	45.4	1371	58.2	855	65.9	635	78.7	<0.001

Table 5. Distal influences on oral health by age group, continued

	2-4		5-14		15-24		25-34		35-44		45-54		55-64		65+		
Variable	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	*p*
Rent	NA	NA	NA	NA	NA	NA	1953	50.6	2070	53.7	971	41.2	439	33.8	169	20.9	
Other	NA	NA	NA	NA	NA	NA	38	1.0	38	1.0	12	0.5	4	0.3	3	0.4	
Home Environment																	
Type of residence																	
Flat	790	66.2	1696	50.9	1272	47.3	2439	63.3	2332	60.2	1222	51.8	609	47.3	350	43.7	<0.001
House	388	32.5	1595	47.9	1375	51.2	1358	35.3	1500	38.7	1091	46.2	668	51.9	445	55.6	
Other	16	1.3	38	1.1	40	1.5	54	1.4	42	1.1	46	1.9	11	0.9	6	0.7	
Residence condition																	
New	572	47.7	1242	37.3	941	34.7	1499	38.1	1197	30.3	746	31.6	336	25.6	219	27.2	<0.001
Old in good condition	548	45.7	1868	56.0	1565	57.7	2148	54.6	2419	61.3	1378	58.4	815	62.2	475	58.9	
Old decaying	78	6.5	224	6.7	207	7.6	284	7.2	328	8.3	236	10.0	159	12.1	112	13.9	
Residence overcrowding																	
≤1 person per room	155	13.8	425	13.2	511	19.8	948	25.4	857	22.9	504	21.9	324	26.0	236	30.6	<0.001
1-2 person per room	543	48.3	1463	45.5	1170	45.2	1548	41.4	1572	41.9	1052	45.7	548	43.9	294	38.2	
> 2 person per room	427	38.0	1324	41.2	906	35.0	1241	33.2	1321	35.2	744	32.3	376	30.1	240	31.2	
General Health																	
History of medical conditions																	
History of hypertension	NA	NA	NA	NA	NA	NA	705	29.0	798	29.5	515	33.2	197	28.5	108	31.7	<0.001
History of diabetes	NA	NA	NA	NA	NA	NA	230	9.5	206	7.6	111	7.2	47	6.8	28	8.2	
Other diseases	NA	NA	NA	NA	NA	NA	1497	61.6	1701	62.9	923	59.6	447	64.7	205	60.1	
Past accident experience																	
Yes	77	2.7	400	4.5	563	7.0	628	6.1	606	5.6	312	4.8	155	5.1	110	6.3	<0.001
No	2758	97.3	8537	95.5	7461	93.0	9625	93.9	10248	94.4	6193	95.2	2901	94.9	1637	93.7	
Type of accident																	
Car accident	6	8.8	124	32.5	407	74.3	439	71.4	413	69.2	213	72.0	87	56.5	52	48.1	<0.001
Electric accident	2	2.9	8	2.1	9	1.6	15	2.4	21	3.5	6	2.0	3	1.9	1	0.9	
Fall	43	63.2	187	49.0	100	18.2	93	15.1	114	19.1	59	19.9	49	31.8	50	46.3	
Hot liquid burn	10	14.7	34	8.9	11	2.0	29	4.7	24	4.0	13	4.4	11	7.1	5	4.6	
Other	7	10.3	29	7.6	21	3.8	39	6.3	25	4.2	5	1.7	4	2.6	0	0.0	
History of physical disability																	
Yes	28	1.0	118	1.3	129	1.6	170	1.7	235	2.1	105	1.6	57	1.9	26	1.5	<0.001
No	2796	99.0	8826	98.7	7879	98.4	10131	98.3	10733	97.9	6397	98.4	3014	98.1	1695	98.5	
Type of disability																	

Table 5. Distal influences on oral health by age group, continued

	2-4		5-14		15-24		25-34		35-44		45-54		55-64		65+		
Variable	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	wN [a]	w% [b]	*p*
Movement disability	1	5.6	33	33.0	39	35.1	72	47.4	81	36.5	38	40.9	15	27.8	9	40.9	<0.001
Vision disturbance	6	33.3	34	34.0	48	43.2	63	41.4	62	27.9	51	54.8	28	51.9	9	40.9	
Hearing disturbance	0	0.0	9	9.0	13	11.7	10	6.6	55	24.8	1	1.1	6	11.1	2	9.1	
Speech disturbance	5	27.8	14	14.0	3	2.7	1	0.7	3	1.4	1	1.1	2	3.7	0	0.0	
Other	6	33.3	10	10.0	8	7.2	6	3.9	21	9.5	2	2.2	3	5.6	2	9.1	
Body mass index																	
Underweight = <18.5	1474	69.9	3046	43.1	204	2.9	276	3.1	348	3.7	151	2.6	82	3.1	42	2.7	<0.001
Normal weight = 18.5–24.9	377	17.9	2734	38.7	2664	38.4	3270	36.5	3286	35.0	2223	38.8	1019	38.4	616	40.0	
Overweight = 25–29.9	93	4.4	758	10.7	2549	36.8	3268	36.5	3407	36.3	2050	35.8	995	37.5	586	38.0	
Obesity = 30 or greater	164	7.8	529	7.5	1519	21.9	2137	23.9	2351	25.0	1306	22.8	559	21.1	297	19.3	
Oral health system & services																	
State of insurance																	
Yes	NA	NA	NA	NA	NA	NA	1616	41.0	1681	42.5	954	40.4	471	36.0	233	28.9	<0.001
No	NA	NA	NA	NA	NA	NA	2321	59.0	2276	57.5	1408	59.6	839	64.0	573	71.1	
Family state of insurance																	
Yes	366	34.6	924	31.0	732	29.1	1506	40.6	1548	41.6	909	41.3	436	34.4	227	29.1	<0.001
No	691	65.4	2055	69.0	1781	70.9	2204	59.4	2169	58.4	1294	58.7	832	65.6	553	70.9	
Regular source of dental care																	
PHC	55	58.5	2618	66.0	3277	63.4	3640	52.4	3483	48.6	2059	49.4	958	50.7	722	64.5	<0.001
Governmental hospital	6	6.4	408	10.3	515	10.0	829	11.9	809	11.3	579	13.9	193	10.2	130	11.6	
Private clinic	30	31.9	872	22.0	1249	24.2	2159	31.1	2456	34.2	1376	33.0	681	36.0	213	19.0	
Other	3	3.2	67	1.7	130	2.5	319	4.6	424	5.9	152	3.6	59	3.1	55	4.9	
Dental care availability when needed																	
Not available	277	10.7	1819	21.4	1805	23.5	2253	22.9	2409	23.2	1399	22.1	783	27.3	432	27.2	<0.001
Available	1965	76.0	5243	61.8	4660	60.7	5867	59.6	6109	58.8	3841	60.7	1499	52.4	790	49.7	
Do not remember	343	13.3	1427	16.8	1206	15.7	1722	17.5	1865	18.0	1086	17.2	581	20.3	368	23.1	

[a] Weighted frequency. [b] Weighted percent. Data were not complete for some variables (missing data from participants). NA= Non applicable.

Table 6. Proximal Influences on oral health by age group

	2-4		5-14		15-24		25-34		35-44		45-54		55-64		65+		
Variable	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	*p*
Oral health service usage																	
Dental visit frequency last year																	
Once	417	16.9	1884	23.2	1813	23.9	2306	23.7	2526	24.5	1616	26.1	681	23.4	406	24.7	<0.001
More than once	235	9.5	1666	20.5	2052	27.0	2518	25.9	2835	27.5	1519	24.5	755	26.0	410	24.9	
Did not visit a dentist in the past year	1147	46.5	3396	41.8	2714	35.7	3648	37.5	3538	34.3	2249	36.3	1054	36.3	607	36.9	
Never visited a dentist	583	23.6	724	8.9	581	7.6	688	7.1	838	8.1	499	8.1	262	9.0	132	8.0	
I do not know or do not remember	87	3.5	447	5.5	438	5.8	556	5.7	590	5.7	315	5.1	154	5.3	89	5.4	
Reasons for last dental visit																	
Pain or problem in your teeth or gums or mouth	472	56.2	2933	64.7	3340	69.1	4272	70.6	4790	72.0	2725	69.9	1243	67.2	703	68.8	<0.001
For treatment and follow up	102	12.1	681	15.0	641	13.3	832	13.7	901	13.5	532	13.7	295	15.9	155	15.2	
Routine examination and treatment	151	18.0	409	9.0	302	6.2	352	5.8	282	4.2	241	6.2	113	6.1	63	6.2	
I don’t know	107	12.7	430	9.5	460	9.5	495	8.2	589	8.9	350	9.0	174	9.4	84	8.2	
Other	8	1.0	80	1.8	93	1.9	102	1.7	89	1.3	48	1.2	25	1.4	17	1.7	
Dental health risk behavior																	
Tooth brushing frequency																	
I have never cleaned my teeth	413	17.8	866	10.7	830	11.1	1054	11.0	1235	12.0	744	12.2	343	12.2	171	10.5	<0.001
I clean my teeth some days but not daily	837	36.0	2544	31.5	1861	24.9	2358	24.5	2395	23.2	1630	26.8	703	24.9	390	24.0	
Once weekly	249	10.7	572	7.1	626	8.4	915	9.5	915	8.9	494	8.1	295	10.5	124	7.6	
Many times per week	241	10.4	1067	13.2	862	11.6	1040	10.8	1131	11.0	699	11.5	327	11.6	150	9.2	
Once daily	460	19.8	2045	25.3	2022	27.1	2637	27.4	2958	28.7	1512	24.8	703	24.9	501	30.9	
Twice or more daily	124	5.3	995	12.3	1260	16.9	1605	16.7	1686	16.3	1010	16.6	448	15.9	287	17.7	
Frequency of eating sweets																	
I don't eat at all	237	8.5	675	7.5	1556	19.4	2108	20.4	2338	21.4	1402	21.5	533	17.4	313	17.9	<0.001
Many times per month	1370	48.9	4807	53.6	4742	59.0	6017	58.4	6380	58.3	3724	57.0	2018	65.8	1066	60.8	
Many times per week	578	20.6	2165	24.1	1215	15.1	1498	14.5	1454	13.3	1012	15.5	356	11.6	263	15.0	

Table 6. Proximal Influences on oral health by age group, continued

	2-4		5-14		15-24		25-34		35-44		45-54		55-64		65+		
Variable	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	wN [a]	w%[b]	*p*
Once or more per day	616	22.0	1325	14.8	523	6.5	686	6.7	766	7.0	398	6.1	159	5.2	110	6.3	
Frequency of drinking soft drinks																	
I don't drink at all	1791	65.4	2807	31.5	2819	35.0	3812	36.8	4143	37.7	2548	38.9	1063	34.3	592	33.8	<0.001
Many times per month	725	26.5	4165	46.7	3765	46.8	4855	46.9	5013	45.6	2908	44.4	1540	49.7	817	46.6	
Many times per week	164	6.0	1457	16.3	1080	13.4	1215	11.7	1377	12.5	817	12.5	379	12.2	255	14.5	
Once or more per day	57	2.1	492	5.5	381	4.7	463	4.5	457	4.2	271	4.1	119	3.8	90	5.1	
Smoking status																	
Yes	NA	NA	NA	NA	NA	NA	810	7.7	729	6.5	452	6.9	196	6.2	144	8.1	<0.001
No	NA	NA	NA	NA	NA	NA	9695	92.3	10448	93.5	6097	93.1	2958	93.8	1637	91.9	
Secondhand smoker status																	
Yes	NA	NA	NA	NA	NA	NA	1228	20.7	1136	18.4	749	20.6	276	16.0	178	18.9	<0.001
No	NA	NA	NA	NA	NA	NA	4691	79.3	5046	81.6	2886	79.4	1444	84.0	763	81.1	

[a] Weighted frequency. [b] Weighted percent. Data were not complete for some variables (missing data from participants). NA= Non applicable.

Table 7. Distal Influences on oral health by geographic region

	North			South			East			West			Central			
Variable	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
Sociodemographic																
Age groups																
2-4	466	260	6.5	899	471	5.7	878	501	5.9	1599	901	5.0	832	830	5.0	<0.001
5-14	906	773	19.3	2398	1480	18.1	2044	1360	16.1	3824	3008	16.6	2481	2744	16.7	
15-24	956	690	17.2	1922	1404	17.1	1558	1250	14.8	3053	2689	14.8	2421	2403	14.6	
25-34	1052	752	18.8	1916	1593	19.4	2136	1808	21.4	3805	3365	18.5	2163	3375	20.5	
35-44	788	805	20.1	1305	1473	18.0	2047	1848	21.9	2685	3821	21.0	1670	3639	22.1	
45-54	444	405	10.1	790	890	10.9	1346	1036	12.3	1547	2416	13.3	939	2173	13.2	
55-64	209	189	4.7	524	493	6.0	682	439	5.2	792	1265	7.0	627	861	5.2	
65+	144	129	3.2	468	389	4.7	350	199	2.4	531	699	3.8	314	427	2.6	
Gender																
Male	2229	2229	55.7	4884	4463	54.5	5308	5122	60.7	8098	10293	56.7	5100	9742	59.2	<0.001
Female	2736	1773	44.3	5338	3730	45.5	5733	3319	39.3	9738	7873	43.3	6347	6710	40.8	
Citizenship																
Citizen	4826	3241	81.0	9809	6385	77.9	10602	5381	63.7	15399	9977	54.9	9519	9571	58.2	<0.001
Non-citizen	139	761	19.0	413	1808	22.1	439	3060	36.3	2437	8189	45.1	1928	6882	41.8	
Marital status																
Married	1567	1066	94.6	1629	1001	90.7	4841	3052	95.0	9028	7053	91.1	3720	5374	82.7	<0.001
Not-married	98	61	5.4	173	103	9.3	303	161	5.0	787	693	8.9	675	1121	17.3	
Socioeconomic																
Completed education level																
Primary school	705	577	20.5	1685	1341	25.0	1485	951	15.1	2230	2308	18.9	1528	2269	20.3	<0.001
Intermediate school	1420	1148	40.7	2367	2175	40.5	3064	2849	45.3	4120	4632	37.9	2677	4304	38.5	
High school	870	656	23.3	1413	1036	19.3	2193	1353	21.5	3384	3294	26.9	1744	2371	21.2	
Intermediate Diploma	168	100	3.5	280	230	4.3	312	207	3.3	389	329	2.7	359	561	5.0	
College or higher education	522	338	12.0	760	582	10.9	893	927	14.7	1974	1671	13.7	1356	1664	14.9	
Monthly household income																
(>38,200 Riyals)	3	12	0.7	12	8	0.2	28	15	0.4	70	47	0.4	59	84	0.9	<0.001
(22,901-38,200 Riyals)	73	83	4.8	58	35	1.0	130	60	1.6	276	440	4.2	239	374	3.9	
(7,700-22,900 Riyals)	1060	731	41.8	1532	1246	36.8	2836	1733	44.8	5220	4301	41.1	2223	3118	32.6	
(3,801-7,699 Riyals)	538	445	25.5	915	747	22.1	1406	1221	31.6	2995	2791	26.7	1400	2920	30.5	

Table 7. Distal Influences on oral health by geographic region, continued

	North			South			East			West			Central			
Variable	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
(3,800 Riyals or less)	567	476	27.2	1587	1346	39.8	1292	836	21.6	2580	2893	27.6	2060	3071	32.1	
Ownership of residence																
Own	1306	820	73.1	1540	921	83.2	2783	1522	48.1	6313	4716	61.2	2782	3180	50.6	<0.001
Rent	313	279	24.9	256	180	16.3	2168	1571	49.6	3378	2941	38.2	1491	3052	48.6	
Other	36	22	2.0	10	6	0.5	138	72	2.3	70	47	0.6	41	52	0.8	
Home Environment																
Type of residence																
Flat	414	329	29.3	883	542	49.0	3163	2053	64.6	5944	4870	62.9	1765	2917	46.8	<0.001
House	1217	780	69.4	895	548	49.5	1851	1063	33.4	3789	2812	36.3	2452	3216	51.6	
Other	27	15	1.3	28	16	1.4	105	63	2.0	79	62	0.8	41	96	1.5	
Residence condition																
New	504	357	31.8	863	501	45.3	2075	1270	40.0	3145	2191	28.3	1931	2434	37.7	<0.001
Old in good condition	976	651	57.9	824	530	47.9	2821	1704	53.7	5728	4825	62.4	2217	3507	54.3	
Old decaying	180	116	10.3	118	75	6.8	216	202	6.4	931	721	9.3	207	513	7.9	
Residence overcrowding																
≤1 person per room	332	235	21.1	371	233	21.1	830	458	15.0	1376	1088	14.5	1137	1946	32.6	<0.001
1-2 person per room	637	414	37.2	685	400	36.3	2779	1638	53.8	3951	3132	41.7	1920	2606	43.7	
> 2 person per room	669	463	41.6	743	469	42.6	1320	950	31.2	4131	3286	43.8	952	1411	23.7	
General Health																
History of medical conditions																
History of hypertension	80	65	14.0	271	197	15.1	715	606	33.9	457	586	18.7	751	1405	34.5	<0.001
History of diabetes	49	27	5.8	80	88	6.7	139	119	6.7	82	79	2.5	278	473	11.6	
Other diseases	432	373	80.2	1300	1019	78.1	1359	1064	59.5	2308	2477	78.8	1387	2197	53.9	
Past accident experience																
Yes	280	257	6.7	711	594	7.8	487	412	5.1	520	496	2.9	689	1092	7.0	<0.001
No	4513	3558	93.3	8976	6987	92.2	10173	7665	94.9	16264	16569	97.1	10088	14582	93.0	
Type of accident																
Car accident	158	111	44.2	404	365	64.0	272	252	63.0	302	288	59.5	394	726	68.2	<0.001
Electric accident	8	5	2.0	19	14	2.5	18	16	4.0	17	15	3.1	14	15	1.4	
Fall	53	92	36.7	193	147	25.8	114	84	21.0	119	114	23.6	209	257	24.2	
Hot liquid burn	21	11	4.4	35	28	4.9	19	21	5.3	25	38	7.9	35	40	3.8	
Other	29	32	12.7	25	16	2.8	40	27	6.8	42	29	6.0	20	26	2.4	

Table 7. Distal Influences on oral health by geographic region, continued

Variable	North N[a]	North wN[b]	North w%[c]	South N[a]	South wN[b]	South w%[c]	East N[a]	East wN[b]	East w%[c]	West N[a]	West wN[b]	West w%[c]	Central N[a]	Central wN[b]	Central w%[c]	*p*
History of physical disability																
Yes	31	21	0.6	178	136	98.2	287	244	3.0	120	122	0.7	207	344	2.2	<0.001
No	4459	3578	99.4	9625	7600	98.2	10343	7924	97.0	16682	17040	99.3	10663	15329	97.8	
Type of disability																
Movement disability	10	6	50.0	69	52	44.4	91	82	35.2	27	25	27.2	62	122	38.5	<0.001
Vision disturbance	4	2	16.7	48	44	37.6	118	90	38.6	39	40	43.5	81	125	39.4	
Hearing disturbance	2	1	8.3	12	8	6.8	17	27	11.6	8	10	10.9	22	50	15.8	
Speech disturbance	2	1	8.3	10	6	5.1	13	6	2.6	11	10	10.9	9	7	2.2	
Other	3	2	16.7	12	7	6.0	23	28	12.0	10	7	7.6	14	13	4.1	
Body mass index																
Underweight = <18.5	426	342	10.4	1693	1007	14.8	1508	984	14.4	2379	1672	11.6	1420	1618	12.4	<0.001
Normal weight = 18.5–24.9	1503	1213	37.0	2741	2235	32.8	4101	3102	45.5	5665	5425	37.7	3151	4214	32.2	
Overweight = 25–29.9	1458	1259	38.4	2726	2345	34.5	2015	1729	25.4	4046	4565	31.7	2483	3807	29.1	
Obesity = 30 or greater	607	466	14.2	1378	1217	17.9	1160	998	14.6	2363	2728	19.0	2053	3455	26.4	
Oral health system & services																
State of insurance																
Yes	68	44	3.9	479	298	27.0	995	776	24.3	896	899	11.6	3197	5091	79.0	<0.001
No	1593	1081	96.1	1322	804	73.0	4123	2422	75.7	8889	6826	88.4	1153	1355	21.0	
Family state of insurance																
Yes	57	37	3.7	472	285	27.4	932	724	27.6	736	710	9.7	3080	4891	78.4	<0.001
No	1490	955	96.3	1225	755	72.6	3166	1903	72.4	8479	6616	90.3	1031	1351	21.6	
Regular source of dental care																
PHC	2540	2101	80.8	4331	3650	75.3	4446	2934	62.7	5753	4630	51.5	2907	3499	37.1	<0.001
Governmental hospital	296	201	7.7	515	383	7.9	707	485	10.4	756	1216	13.5	951	1184	12.6	
Private clinic	339	278	10.7	893	699	14.4	1215	1172	25.1	1727	3053	34.0	2086	3835	40.7	
Other	32	19	0.7	168	116	2.4	147	85	1.8	88	86	1.0	344	903	9.6	
Dental care availability when needed																
Not available	1495	1059	28.6	2339	1756	23.6	2686	1751	22.6	4293	3739	23.9	2215	2873	18.9	<0.001
Available	2670	2222	60.1	5780	4630	62.3	5641	4575	58.9	8868	9078	58.0	6146	9468	62.3	
Do not remember	438	416	11.3	1334	1046	14.1	1949	1435	18.5	2334	2845	18.2	1981	2856	18.8	

[a] Non-weighted frequency. [b] Weighted frequency. [c] Weighted percent. Data were not complete for some variables (missing data from participants).

Table 8. Proximal influences on oral health by geographic region

Variable	North			South			East			West			Central			
	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
Oral health service usage																
Dental visit frequency last year																
Once	1185	1031	29.7	1999	1591	21.4	2374	1724	22.9	3600	3956	24.6	2301	3348	23.1	<0.001
More than once	790	684	19.7	2259	1839	24.8	2449	2009	26.7	3798	4277	26.6	2274	3181	22.0	
Did not visit a dentist in the past year	1780	1323	38.1	3569	2905	39.1	3801	2739	36.5	6138	6221	38.7	3726	5164	35.7	
Never visited a dentist	483	344	9.9	906	687	9.3	675	529	7.0	1602	1282	8.0	995	1464	10.1	
I do not know or do not remember	142	88	2.5	548	403	5.4	513	512	6.8	452	357	2.2	852	1316	9.1	
Reasons for last dental visit																
Pain or problem in your teeth or gums or mouth	1715	1521	74.5	3734	3048	69.5	4214	3315	66.4	6460	6962	72.0	3795	5632	65.5	<0.001
For treatment and follow up	293	248	12.2	698	569	13.0	784	731	14.7	1167	1428	14.8	877	1163	13.5	
Routine examination and treatment	142	120	5.9	331	301	6.9	473	319	6.4	641	591	6.1	442	580	6.7	
I don’t know	217	142	7.0	622	403	9.2	668	573	11.5	540	536	5.5	694	1035	12.0	
Other	11	10	0.5	80	62	1.4	80	51	1.0	168	151	1.6	121	189	2.2	
Dental health risk behavior																
Tooth brushing frequency																
I have never cleaned my teeth	664	486	13.8	1226	1004	13.7	1151	947	12.7	1696	1488	9.4	1108	1731	12.2	<0.001
I clean my teeth some days but not daily	1314	1193	34.0	2734	2004	27.4	3009	2292	30.6	3566	3674	23.3	2625	3556	25.0	
Once weekly	426	349	9.9	751	624	8.5	734	582	7.8	1309	1586	10.1	765	1050	7.4	<0.001
Many times per week	520	386	11.0	1297	1038	14.2	1216	924	12.3	1570	1472	9.3	1076	1698	11.9	
Once daily	1059	841	23.9	2035	1711	23.4	2609	1942	26.0	4331	4823	30.6	2443	3520	24.7	
Twice or more daily	364	258	7.3	1161	946	12.9	1025	796	10.6	2781	2734	17.3	1886	2683	18.8	
Frequency of eating sweets																
I don't eat at all	871	635	17.3	1837	1500	19.5	1634	1150	14.2	1795	1849	10.7	2323	4028	25.6	<0.001
Many times per month	2841	2360	64.2	5380	4447	57.7	6052	4765	59.0	9940	10376	60.2	5709	8174	52.0	
Many times per week	509	379	10.3	1673	1185	15.4	1785	1369	16.9	3430	3423	19.9	1751	2184	13.9	

Table 8. Proximal influences on oral health by geographic region, continued

	North			South			East			West			Central			
Variable	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	N[a]	wN[b]	w%[c]	*p*
Once or more per day	399	300	8.2	866	579	7.5	1073	798	9.9	1743	1583	9.2	1144	1325	8.4	
Frequency of drinking soft drinks																
I don't drink at all	1289	977	26.2	3261	2593	33.6	3180	2198	27.1	5942	5640	32.8	5128	8167	52.1	<0.001
Many times per month	2500	2131	57.1	4225	3414	44.2	5187	4116	50.7	8027	8628	50.2	4136	5498	35.0	
Many times per week	605	437	11.7	1738	1335	17.3	1524	1261	15.5	2085	2232	13.0	1157	1478	9.4	
Once or more per day	233	184	4.9	528	385	5.0	661	540	6.7	777	680	4.0	451	544	3.5	
Smoking status																
Yes	845	657	18.7	1334	1076	15.5	718	712	9.8	225	187	1.2	199	382	2.7	<0.001
No	3399	2857	81.3	6904	5849	84.5	8408	6541	90.2	14197	15416	98.8	9040	13542	97.3	
Secondhand smoker status																
Yes	882	695	37.4	1312	1125	29.1	1050	987	24.0	983	1098	12.8	457	874	11.4	<0.001
No	1501	1164	62.6	3249	2745	70.9	4128	3122	76.0	6747	7491	87.2	4713	6801	88.6	

[a] Non-weighted frequency. [b] Weighted frequency. [c] Weighted percent. Data were not complete for some variables (missing data from participants).

Table 9. Descriptive statistics of model variables for proximal and distal influences on oral pain and self-rated oral health status

Variable	5 -14 years			15 – 24 years			25+ years		
	N[a]	%[b]	Wt.%[c]	N[a]	%[b]	Wt.%[c]	N[a]	%[b]	Wt.%[c]
Gender									
Male	5813	49.9	50.9	4630	46.7	52.2	12802	43.7	61.2
Female	5840	50.1	49.1	5280	53.3	47.8	16472	56.3	38.8
Citizenship									
Citizen	10603	91.0	75.8	9064	91.5	79.6	26225	89.6	53.2
Non-citizen	1050	9.0	24.2	846	8.5	20.4	3049	10.4	46.8
Region									
East, West & Central	8349	71.6	75.9	7032	71.0	75.2	21634	73.9	79.3
North & South	3304	28.4	24.1	2878	29.0	24.8	7640	26.1	20.7
Marital status (25+ only)									
Married							11537	90.3	87.9
Not-married							1243	9.7	12.1
Education (25+ only)									
Primary school education							3167	14.2	14.8
Intermediate school education							7465	33.4	38.9
High school education							6364	28.4	24.8
Intermediate Diploma							1282	5.7	5.0
College or higher education							4092	18.3	16.5
Household monthly income									
3,800 Riyals or less	2134	37.8	40.4	1733	38.0	39.6	3599	21.6	25.3
3,801-7,699 Riyals	1258	22.3	21.9	1222	26.8	26.9	4190	25.1	29.7
7,700-22,900 Riyals	2188	38.7	36.5	1552	34.0	32.3	8084	48.5	39.6
22,901-38,200 Riyals	40	0.7	0.6	32	0.7	0.7	694	4.2	4.8
>38,200 Riyals	29	0.5	0.5	24	0.5	0.6	109	0.7	0.6
Household crowding (5-14 years only)									
≤1 person per room	528	12.4	13.2						
1-2 person per room	1967	46.1	45.5						
2-3 person per room	1153	27.0	26.6						
>3 person per room	622	14.6	14.6						
Accident									
No	10656	95.7	95.5	8826	93.4	93.0	26168	94.8	94.4

Table 9. Descriptive statistics of model variables for proximal and distal influences on oral pain and self-rated oral health status, continued

Variable	5 -14 years			15 – 24 years			25+ years		
	N[a]	%[b]	Wt.%[c]	N[a]	%[b]	Wt.%[c]	N[a]	%[b]	Wt.%[c]
Yes	483	4.3	4.5	624	6.6	7.0	1449	5.2	5.6
Disability									
No	11000	98.7	98.7	9237	98.4	98.4	27112	98.3	98.2
Yes	147	1.3	1.3	147	1.6	1.6	480	1.7	1.8
BMI									
Abnormal (<18.5 & >24.9)	5432	61.2	61.3	4940	60.4	61.6	14643	59.6	63.2
Normal (18.5-24.9)	3439	38.8	38.7	3233	39.6	38.4	9925	40.4	36.8
Health insurance									
No	3477	78.4	70.7	2643	76.0	70.8	9396	73.7	59.9
Yes	957	21.6	29.3	836	24.0	29.2	3346	26.3	40.1
Access									
Available/I don't know	8133	76.5	78.6	6725	74.9	76.5	18666	70.5	76.5
Not available	2498	23.5	21.4	2251	25.1	23.5	7808	29.5	23.5
Source of care									
Government clinic	4146	81.5	76.3	4737	77.1	73.3	14224	75.3	62.9
Privet or other clinic	941	18.5	23.7	1403	22.9	26.7	4663	24.7	37.1
Sweets consumption frequency									
I don't eat at all	813	7.3	7.5	1795	19.0	19.4	5467	19.7	20.5
Many times per month	4468	40.0	39.8	4217	44.7	44.4	12379	44.6	44.9
Once per week	1441	12.9	13.7	1340	14.2	14.6	3924	14.2	14.0
Many times per week	2723	24.4	24.1	1451	15.4	15.1	4059	14.6	14.1
Once per day	1173	10.5	10.2	437	4.6	4.7	1344	4.8	4.5
Many times per day	550	4.9	4.6	188	2.0	1.8	556	2.0	2.0
Soft drinks consumption									
I don't drink at all	3476	31.3	31.5	3180	33.7	35.0	9297	33.5	37.1
Many times per month	3897	35.1	34.9	3341	35.4	34.5	9948	35.9	34.6
Once per week	1313	11.8	11.8	1184	12.5	12.3	3239	11.7	11.7
Many times per week	1794	16.1	16.3	1275	13.5	13.4	3795	13.7	12.4
Once per day	538	4.8	4.8	366	3.9	3.8	1070	3.9	3.2
Many times per day	91	0.8	0.7	100	1.1	1.0	389	1.4	1.1

Table 9. Descriptive statistics of model variables for proximal and distal influences on oral pain and self-rated oral health status, continued

Variable	5 -14 years			15 – 24 years			25+ years		
	N[a]	%[b]	Wt.%[c]	N[a]	%[b]	Wt.%[c]	N[a]	%[b]	Wt.%[c]
Smoking (25+ only)									
No							25937	91.5	93.0
Yes							2404	8.5	7.0
Tooth brushing frequency									
Never	1097	10.8	10.7	1026	11.7	11.1	3047	11.8	11.6
I clean my teeth somedays but not daily	3234	31.7	31.5	2185	24.9	24.9	6482	25.1	24.5
Once weekly	718	7.0	7.1	716	8.2	8.4	2139	8.3	9.0
Many times per week	1385	13.6	13.2	1023	11.7	11.6	2902	11.2	11.0
Once daily	2558	25.1	25.3	2321	26.5	27.1	6909	26.8	27.3
Twice or more daily	1201	11.8	12.3	1495	17.1	16.9	4341	16.8	16.5
Dental visits frequency									
Never visited a dentist/ Don’t know or don’t remember	1434	14.0	5.5	1219	13.7	13.4	6562	5.0	13.4
Not visited a dentist in the past year	4068	39.8	8.9	3223	36.2	35.7	9900	8.2	36.0
Once	2489	24.4	41.8	2096	23.6	23.9	6206	37.8	24.5
More than once	2227	21.8	23.2	2356	26.5	27.0	6606	23.7	26.1
Type of visit									
For a complaint	5395	91.6	91.0	5233	93.8	93.8	15175	94.2	94.6
Routine examination and treatment	497	8.4	9.0	346	6.2	6.2	932	5.8	5.4
Oral pain									
Never felt	3825	37.8	39.8	2936	33.7	32.2	8779	34.0	32.5
Rarely	2145	21.2	21.2	1658	19.0	19.3	4971	19.3	20.4
Sometimes	2548	25.2	23.8	2275	26.1	26.9	6809	26.4	26.3
Many times	1603	15.8	15.2	1849	21.2	21.6	5260	20.4	20.8
Self-rated oral health status									
Bad	122	1.2	1.1	173	2.0	2.1	548	2.2	2.4
Acceptable	627	6.3	6.0	865	10.1	10.8	2372	9.4	10.5
Good	2756	27.7	27.6	2581	30.3	30.6	7624	30.2	32.8
Very good	3998	40.1	39.9	3278	38.4	38.3	9539	37.8	36.2
Excellent	2462	24.7	25.4	1635	19.2	18.2	5141	20.4	18.1

[a] Non-weighted frequency. [b] Non-weighted percent. [c] Weighted percent. Data were not complete for some variables (missing data from participants).

Table 10. Model fit indices values

Index	Values for the model of each age group		
	5 -14 years	15-24 years	25+ years
Robust Comparative Fit Index (RCFI)	0.966	0.971	0.958
Robust Tucker-Lewis Index (RTLI)	0.908	0.919	0.884
Robust Root Mean Square Error of Approximation (RRMSEA)	0.027	0.024	0.028
Robust Standardized Root Mean Square Residual (RSRMR)	0.031	0.020	0.028

Table 11. Direct effects for the distal and proximal influences on oral pain and self-rated oral health status in Saudi Arabia

	5-14 years					15-24 years					25+ years				
Pathway	β	SE	*p*-value	95% CI		β	SE	*p*-value	95% CI		β	SE	*p*-value	95% CI	
Oral pain <–															
Age	0.009	0.011	0.426	-0.013	0.030	0.006	0.010	0.538	-0.014	0.026	-0.010	0.010	0.325	-0.029	0.010
Gender	0.017	0.009	0.062	-0.001	0.035	0.003	0.011	0.764	-0.018	0.024	0.008	0.011	0.432	-0.012	0.029
Citizenship	-0.081	0.014	**<0.001**	-0.109	-0.053	-0.004	0.016	0.810	-0.035	0.027	-0.015	0.013	0.233	-0.040	0.010
Region	-0.006	0.009	0.465	-0.024	0.011	-0.018	0.010	0.074	-0.038	0.002	-0.046	0.013	**<0.001**	-0.071	-0.021
Marital status (25+ only)											0.022	0.015	0.128	-0.006	0.051
Education (25+ only)											-0.006	0.014	0.670	-0.033	0.021
Household monthly income	-0.030	0.013	**0.021**	-0.055	-0.004	0.010	0.015	0.488	-0.019	0.039	-0.021	0.015	0.158	-0.050	0.008
Household crowding (5-14 years only)	0.002	0.016	0.892	-0.029	0.033										
Health insurance	-0.036	0.017	**0.033**	-0.068	-0.003	0.051	0.018	**0.004**	0.016	0.085	0.042	0.015	**<0.001**	0.012	0.072
Access	0.195	0.010	**<0.001**	0.175	0.215	0.009	0.010	0.342	-0.010	0.029	0.015	0.010	0.108	-0.003	0.034
Source of care	0.053	0.016	**0.001**	0.022	0.083	0.012	0.014	0.411	-0.016	0.040	-0.001	0.016	0.937	-0.032	0.030
Accident	0.051	0.010	**<0.001**	0.032	0.070	0.028	0.009	**0.002**	0.010	0.046	0.007	0.013	0.600	-0.019	0.032
Disability	0.012	0.009	0.160	-0.005	0.030	0.008	0.009	0.375	-0.009	0.025	0.027	0.008	**0.001**	0.011	0.042
BMI	0.015	0.011	0.177	-0.007	0.038	-0.033	0.011	**0.003**	-0.055	-0.011	-0.013	0.011	0.269	-0.035	0.010
Sweets consumption frequency	0.007	0.010	0.516	-0.014	0.027	0.033	0.012	**0.007**	0.009	0.057	0.019	0.012	0.103	-0.004	0.041
Soft drinks consumption	0.021	0.011	0.058	-0.001	0.043	-0.034	0.012	**0.005**	-0.058	-0.01	-0.023	0.012	0.064	-0.047	0.001
Smoking (25+ only)											0.045	0.012	**<0.001**	0.021	0.069
Tooth brushing frequency	-0.038	0.010	**<0.001**	-0.057	-0.018	-0.098	0.01	**<0.001**	-0.118	-0.078	-0.079	0.011	**<0.001**	-0.101	-0.058
Dental visits frequency	0.510	0.012	**<0.001**	0.486	0.534	0.614	0.01	**<0.001**	0.594	0.633	0.577	0.012	**<0.001**	0.554	0.600
Type of visit	-0.064	0.014	**<0.001**	-0.090	-0.037	-0.063	0.015	**<0.001**	-0.092	-0.034	-0.088	0.016	**<0.001**	-0.120	-0.056
Self rated oral health status <–															
Age	-0.044	0.013	**0.001**	-0.069	-0.018	-0.033	0.013	**0.008**	-0.058	-0.009	0.013	0.011	0.218	-0.008	0.035
Gender	-0.030	0.011	**0.009**	-0.052	-0.007	0.023	0.013	0.085	-0.003	0.048	-0.020	0.012	0.107	-0.045	0.004
Citizenship	0.067	0.018	**<0.001**	0.032	0.102	0.013	0.020	0.526	-0.026	0.051	-0.050	0.015	**0.001**	-0.080	-0.020
Region	-0.080	0.012	**<0.001**	-0.103	-0.057	-0.014	0.013	0.257	-0.039	0.011	-0.008	0.014	0.551	-0.035	0.019
Marital status (25+ only)											-0.009	0.019	0.616	-0.046	0.027
Education (25+ only)											0.046	0.015	**0.003**	0.016	0.077
Household monthly income	0.073	0.016	**<0.001**	0.042	0.104	0.018	0.018	0.305	-0.017	0.053	-0.028	0.018	0.111	-0.063	0.006
Household crowding (5-14 years only)	-0.045	0.020	**0.022**	-0.084	-0.006										
Health insurance	-0.014	0.020	0.486	-0.053	0.025	-0.160	0.021	**<0.001**	-0.201	-0.119	-0.135	0.018	**<0.001**	-0.171	-0.099
Access	-0.096	0.013	**<0.001**	-0.122	-0.071	0.045	0.013	**0.001**	0.019	0.070	0.016	0.011	0.135	-0.005	0.038
Source of care	-0.136	0.018	**<0.001**	-0.172	-0.100	-0.001	0.017	0.956	-0.035	0.033	0.019	0.018	0.290	-0.017	0.055
Accident	-0.033	0.012	**0.007**	-0.057	-0.009	-0.011	0.014	0.435	-0.038	0.016	-0.043	0.011	**<0.001**	-0.065	-0.022
Disability	-0.016	0.010	0.120	-0.036	0.004	-0.078	0.018	**<0.001**	-0.112	-0.044	-0.049	0.018	**0.006**	-0.085	-0.014
BMI	0.051	0.013	**<0.001**	0.025	0.077	0.093	0.013	**<0.001**	0.067	0.118	0.067	0.013	**<0.001**	0.042	0.093
Sweets consumption frequency	-0.086	0.013	**<0.001**	-0.112	-0.061	-0.079	0.015	**<0.001**	-0.109	-0.05	-0.065	0.014	**<0.001**	-0.092	-0.039
Soft drinks consumption	0.022	0.013	0.100	-0.004	0.048	0.063	0.015	**<0.001**	0.035	0.092	0.068	0.014	**<0.001**	0.040	0.096
Smoking (25+ only)											-0.012	0.015	0.404	-0.042	0.017
Tooth brushing frequency	0.129	0.013	**<0.001**	0.104	0.154	0.162	0.014	**<0.001**	0.135	0.189	0.158	0.014	**<0.001**	0.131	0.186
Dental visits frequency	-0.130	0.014	**<0.001**	-0.157	-0.104	-0.143	0.014	**<0.001**	-0.17	-0.116	-0.132	0.015	**<0.001**	-0.161	-0.104
Type of visit	0.021	0.015	0.178	-0.010	0.051	0.046	0.015	**0.002**	0.017	0.075	0.047	0.015	**0.001**	0.018	0.075

Significant pathways in bold font; β = standardized regression weights SE = robust standard error; CI = confidence interval.

Table 12. Total indirect effects for the distal influences on oral pain and self-rated oral health status in Saudi Arabia

	5-14 years					15-24 years					25+ years				
Pathway	β	SE	*p*-value	95% CI		β	SE	*p*-value	95% CI		β	SE	*p*-value	95% CI	
Oral pain <–															
Age	0.062	0.007	**<0.001**	0.048	0.077	0.015	0.008	0.064	-0.001	0.030	-0.002	0.007	0.832	-0.016	0.013
Gender	0.000	0.006	0.971	-0.011	0.011	-0.003	0.009	0.732	-0.020	0.014	-0.016	0.008	**0.042**	-0.032	-0.001
Citizenship	-0.004	0.009	0.661	-0.022	0.014	0.026	0.014	0.057	-0.001	0.053	0.023	0.009	**0.016**	0.004	0.041
Region	0.027	0.006	**<0.001**	0.016	0.037	-0.014	0.009	0.113	-0.032	0.003	0.000	0.009	0.957	-0.017	0.018
Marital status (25+ only)											0.003	0.014	0.857	-0.025	0.030
Education (25+ only)											0.010	0.011	0.374	-0.012	0.031
Household monthly income	0.024	0.008	**0.003**	0.008	0.040	-0.006	0.012	0.597	-0.029	0.017	0.010	0.012	0.431	-0.014	0.033
Household crowding (5-14 years only)	-0.010	0.009	0.302	-0.028	0.009										
Health insurance	-0.023	0.010	**0.026**	-0.043	-0.003	-0.024	0.017	0.165	-0.058	0.010	-0.019	0.013	0.134	-0.043	0.006
Access	0.215	0.007	**<0.001**	0.202	0.227	-0.012	0.009	0.174	-0.028	0.005	-0.010	0.007	0.148	-0.023	0.003
Source of care	-0.014	0.010	0.167	-0.033	0.006	-0.016	0.012	0.195	-0.039	0.008	-0.018	0.012	0.139	-0.041	0.006
Accident	0.038	0.006	**<0.001**	0.026	0.050	0.014	0.009	0.100	-0.003	0.031	-0.016	0.009	0.061	-0.033	0.001
Disability	0.007	0.006	0.212	-0.004	0.019	-0.004	0.009	0.659	-0.023	0.014	0.004	0.010	0.675	-0.016	0.024
BMI	0.015	0.007	**0.034**	0.001	0.028	-0.014	0.009	0.122	-0.032	0.004	-0.020	0.008	**0.017**	-0.036	-0.004
Self rated oral health status <–															
Age	0.000	0.005	0.966	-0.009	0.009	-0.006	0.003	0.067	-0.012	0.000	0.001	0.003	0.617	-0.004	0.006
Gender	0.006	0.003	**0.041**	0.000	0.011	0.001	0.003	0.783	-0.005	0.007	0.006	0.003	**0.031**	0.001	0.012
Citizenship	0.005	0.004	0.196	-0.002	0.012	-0.004	0.005	0.421	-0.014	0.006	-0.005	0.004	0.198	-0.012	0.002
Region	-0.019	0.003	**<0.001**	-0.024	-0.014	0.003	0.004	0.360	-0.004	0.011	-0.003	0.005	0.533	-0.013	0.006
Marital status (25+ only)											-0.003	0.005	0.579	-0.013	0.007
Education (25+ only)											0.004	0.004	0.302	-0.004	0.012
Household monthly income	-0.003	0.003	0.415	-0.010	0.004	0.000	0.005	0.983	-0.009	0.009	0.000	0.005	0.966	-0.009	0.009
Household crowding (5-14 years only)	0.003	0.004	0.496	-0.005	0.010										
Health insurance	0.003	0.004	0.526	-0.006	0.011	0.007	0.007	0.282	-0.006	0.021	-0.012	0.006	**0.042**	-0.023	0.000
Access	-0.068	0.006	**<0.001**	-0.080	-0.056	0.005	0.003	0.143	-0.002	0.012	0.009	0.003	**0.002**	0.003	0.014
Source of care	0.012	0.005	**0.009**	0.003	0.021	0.006	0.005	0.183	-0.003	0.015	0.010	0.004	**0.028**	0.001	0.018
Accident	-0.007	0.002	**0.003**	-0.012	-0.003	-0.003	0.003	0.359	-0.010	0.004	0.008	0.003	**0.010**	0.002	0.014
Disability	-0.001	0.002	0.772	-0.005	0.004	0.001	0.003	0.739	-0.005	0.008	0.000	0.003	0.958	-0.006	0.006
BMI	-0.004	0.003	0.099	-0.010	0.001	0.006	0.003	0.089	-0.001	0.013	0.004	0.003	0.192	-0.002	0.010

Significant pathways in bold font; β = standardized regression weights SE = robust standard error; CI = confidence interval.

Table 13. Total effects for the distal influences on oral pain and self-rated oral health status in Saudi Arabia

	5-14 years					15-24 years					25+ years				
Pathway	β	SE	*p*-value	95% CI		β	SE	*p*-value	95% CI		β	SE	*p*-value	95% CI	
Oral pain <–															
Age	0.071	0.012	**<0.001**	0.047	0.095	0.021	0.013	0.095	-0.004	0.046	-0.011	0.011	0.306	-0.033	0.010
Gender	0.017	0.011	0.105	-0.004	0.038	0.000	0.013	0.984	-0.026	0.026	-0.008	0.012	0.517	-0.032	0.016
Citizenship	-0.085	0.017	**<0.001**	-0.119	-0.052	0.022	0.021	0.274	-0.018	0.063	0.008	0.015	0.610	-0.022	0.037
Region	0.020	0.011	0.060	-0.001	0.041	-0.033	0.013	**0.011**	-0.058	-0.008	-0.045	0.013	**<0.001**	-0.070	-0.021
Marital status (25+ only)											0.025	0.021	0.227	-0.015	0.065
Education (25+ only)											0.004	0.017	0.819	-0.029	0.036
Household monthly income	-0.006	0.016	0.715	-0.037	0.025	0.004	0.019	0.832	-0.032	0.040	-0.011	0.018	0.515	-0.046	0.023
Household crowding (5-14 years only)	-0.008	0.018	0.675	-0.043	0.028										
Health insurance	-0.058	0.020	**0.003**	-0.097	-0.020	0.027	0.024	0.258	-0.020	0.073	0.023	0.018	0.202	-0.013	0.059
Access	0.410	0.010	**<0.001**	0.390	0.430	-0.002	0.013	0.864	-0.028	0.023	0.006	0.011	0.607	-0.016	0.028
Source of care	0.039	0.018	**0.033**	0.003	0.074	-0.004	0.018	0.830	-0.039	0.032	-0.019	0.018	0.297	-0.055	0.017
Accident	0.089	0.012	**<0.001**	0.067	0.112	0.042	0.013	**0.001**	0.017	0.067	-0.009	0.014	0.513	-0.037	0.018
Disability	0.020	0.011	0.074	-0.002	0.042	0.004	0.012	0.768	-0.021	0.028	0.031	0.013	**0.021**	0.005	0.057
BMI	0.030	0.013	**0.024**	0.004	0.056	-0.047	0.014	**0.001**	-0.074	-0.020	-0.032	0.014	**0.018**	-0.059	-0.006
Self rated oral health status <–															
Age	-0.044	0.013	**0.001**	-0.069	-0.018	-0.039	0.013	**0.002**	-0.063	-0.014	0.015	0.011	0.189	-0.007	0.037
Gender	-0.024	0.012	**0.035**	-0.047	-0.002	0.023	0.013	0.080	-0.003	0.050	-0.014	0.013	0.285	-0.039	0.011
Citizenship	0.072	0.018	**<0.001**	0.037	0.107	0.008	0.020	0.670	-0.030	0.047	-0.055	0.016	**<0.001**	-0.085	-0.024
Region	-0.099	0.012	**<0.001**	-0.121	-0.076	-0.011	0.013	0.390	-0.036	0.014	-0.011	0.013	0.397	-0.037	0.015
Marital status (25+ only)											-0.012	0.019	0.526	-0.050	0.026
Education (25+ only)											0.050	0.016	**0.002**	0.019	0.082
Household monthly income	0.070	0.016	**<0.001**	0.038	0.101	0.018	0.018	0.313	-0.017	0.054	-0.028	0.019	0.136	-0.064	0.009
Household crowding (5-14 years only)	-0.043	0.020	**0.028**	-0.081	-0.005										
Health insurance	-0.011	0.020	0.577	-0.050	0.028	-0.152	0.022	**<0.001**	-0.195	-0.109	-0.146	0.018	**<0.001**	-0.182	-0.110
Access	-0.164	0.011	**<0.001**	-0.187	-0.142	0.050	0.013	**<0.001**	0.024	0.075	0.025	0.011	**0.026**	0.003	0.047
Source of care	-0.124	0.018	**<0.001**	-0.160	-0.088	0.005	0.018	0.772	-0.029	0.040	0.029	0.019	0.117	-0.007	0.065
Accident	-0.040	0.012	**0.001**	-0.064	-0.016	-0.014	0.013	0.291	-0.039	0.012	-0.036	0.012	**0.002**	-0.059	-0.013
Disability	-0.017	0.011	0.138	-0.039	0.005	-0.077	0.016	**<0.001**	-0.109	-0.045	-0.050	0.018	**0.005**	-0.085	-0.015
BMI	0.047	0.013	**<0.001**	0.021	0.073	0.099	0.013	**<0.001**	0.072	0.125	0.071	0.014	**<0.001**	0.045	0.098

Significant pathways in bold font; β = standardized regression weights SE = robust standard error; CI = confidence interval.

Table 14. Direct and Indirect Effects on Oral Pain and Self Rated Oral Health Status in Saudi Arabia for 5-14 years

	Pathway	β	SE	*p*-value	95% CI	
Age –>	Direct					
Dental visits frequency		0.104	0.012	<**0.001**	0.080	0.129
Type of visit		-0.116	0.018	<**0.001**	-0.151	-0.081
Tooth brushing frequency		0.001	0.013	0.930	-0.024	0.027
Sweets consumption frequency		-0.147	0.012	<**0.001**	-0.170	-0.123
Soft drinks consumption		0.135	0.012	<**0.001**	0.112	0.159
Age –> Oral Pain	Indirect via Dental visits frequency	0.053	0.006	<**0.001**	0.041	0.066
	Indirect via Type of visit	0.007	0.002	<**0.001**	0.004	0.011
	Indirect via Tooth brushing frequency	0.000	0.000	0.930	-0.001	0.001
	Indirect via Sweets consumption	-0.001	0.002	0.518	-0.004	0.002
	Indirect via Soft drinks consumption	0.003	0.002	0.060	0.000	0.006
Age –> Self rated oral health status	Indirect via Dental visits frequency	-0.014	0.002	<**0.001**	-0.018	-0.009
	Indirect via Type of visit	-0.002	0.002	0.196	-0.006	0.001
	Indirect via Tooth brushing frequency	0.000	0.002	0.930	-0.003	0.003
	Indirect via Sweets consumption	0.013	0.002	<**0.001**	0.008	0.017
	Indirect via Soft drinks consumption	0.003	0.002	0.103	-0.001	0.007
Gender –>	Direct					
Dental visits frequency		0.011	0.010	0.287	-0.009	0.031
Type of visit		0.015	0.017	0.361	-0.018	0.049
Tooth brushing frequency		0.073	0.012	<**0.001**	0.050	0.096
Sweets consumption		0.010	0.011	0.350	-0.011	0.032
Soft drinks consumption		-0.085	0.011	<**0.001**	-0.107	-0.063
Gender –> Oral Pain	Indirect via Dental visits frequency	0.006	0.005	0.287	-0.005	0.016
	Indirect via Type of visit	-0.001	0.001	0.371	-0.003	0.001
	Indirect via Tooth brushing frequency	-0.003	0.001	**0.001**	-0.004	-0.001
	Indirect via Sweets consumption	0.000	0.000	0.602	0.000	0.000
	Indirect via Soft drinks consumption	-0.002	0.001	0.069	-0.004	0.000

Table 14. Direct and Indirect Effects on Oral Pain and Self Rated Oral Health Status in Saudi Arabia for 5-14 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Gender –> Self rated oral health status	Indirect via Dental visits frequency	-0.001	0.001	0.288	-0.004	0.001
	Indirect via Type of visit	0.000	0.000	0.411	0.000	0.001
	Indirect via Tooth brushing frequency	0.009	0.002	<**0.001**	0.006	0.013
	Indirect via Sweets consumption	-0.001	0.001	0.355	-0.003	0.001
	Indirect via Soft drinks consumption	-0.002	0.001	0.107	-0.004	0.000
Citizenship –>	Direct	-0.004	0.017	0.805	-0.037	0.029
Dental visits frequency		0.009	0.028	0.757	-0.046	0.064
Type of visit		0.003	0.019	0.890	-0.035	0.041
Tooth brushing frequency		-0.054	0.018	**0.003**	-0.089	-0.018
Sweets consumption		-0.039	0.018	**0.031**	-0.075	-0.004
Soft drinks consumption						
Citizenship –> Oral Pain	Indirect via Dental visits frequency	-0.002	0.009	0.805	-0.019	0.015
	Indirect via Type of visit	-0.001	0.002	0.757	-0.004	0.003
	Indirect via Tooth brushing frequency	0.000	0.001	0.890	-0.002	0.001
	Indirect via Sweets consumption	0.000	0.001	0.524	-0.001	0.001
	Indirect via Soft drinks consumption	-0.001	0.001	0.142	-0.002	0.000
Citizenship –> Self rated oral health status	Indirect via Dental visits frequency	0.001	0.002	0.805	-0.004	0.005
	Indirect via Type of visit	0.000	0.001	0.755	-0.001	0.001
	Indirect via Tooth brushing frequency	0.000	0.003	0.890	-0.005	0.005
	Indirect via Sweets consumption	0.005	0.002	**0.008**	0.001	0.008
	Indirect via Soft drinks consumption	-0.001	0.001	0.202	-0.002	0.000
Region –>	Direct					
Dental visits frequency		0.039	0.010	<**0.001**	0.019	0.059
Type of visit		-0.034	0.012	**0.005**	-0.057	-0.010
Tooth brushing frequency		-0.065	0.011	<**0.001**	-0.088	-0.043
Sweets consumption		0.072	0.012	<**0.001**	0.048	0.096
Soft drinks consumption		0.082	0.012	<**0.001**	0.059	0.106

Table 14. Direct and Indirect Effects on Oral Pain and Self Rated Oral Health Status in Saudi Arabia for 5-14 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Region –> Oral Pain	Indirect via Dental visits frequency	0.020	0.005	<**0.001**	0.010	0.030
	Indirect via Type of visit	0.002	0.001	**0.011**	0.000	0.004
	Indirect via Tooth brushing frequency	0.002	0.001	**0.002**	0.001	0.004
	Indirect via Sweets consumption	0.000	0.001	0.520	-0.001	0.002
	Indirect via Soft drinks consumption	0.002	0.001	0.072	0.000	0.004
Region –> Self rated oral health status	Indirect via Dental visits frequency	-0.005	0.001	<**0.001**	-0.008	-0.002
	Indirect via Type of visit	-0.001	0.001	0.180	-0.002	0.000
	Indirect via Tooth brushing frequency	-0.008	0.002	<**0.001**	-0.012	-0.005
	Indirect via Sweets consumption	-0.006	0.001	<**0.001**	-0.009	-0.003
	Indirect via Soft drinks consumption	0.002	0.001	0.108	0.000	0.004
Income –>	Direct					
Dental visits frequency		0.047	0.015	**0.003**	0.016	0.077
Type of visit		-0.035	0.023	0.122	-0.079	0.009
Tooth brushing frequency		0.047	0.017	**0.006**	0.014	0.079
Sweets consumption		0.020	0.017	0.220	-0.012	0.053
Soft drinks consumption		-0.012	0.017	0.499	-0.045	0.022
Income –> Oral Pain	Indirect via Dental visits frequency	0.024	0.008	**0.003**	0.008	0.039
	Indirect via Type of visit	0.002	0.001	0.137	-0.001	0.005
	Indirect via Tooth brushing frequency	-0.002	0.001	**0.025**	-0.003	0.000
	Indirect via Sweets consumption	0.000	0.000	0.567	0.000	0.001
	Indirect via Soft drinks consumption	0.000	0.000	0.515	-0.001	0.000
Income –> Self rated oral health status	Indirect via Dental visits frequency	-0.006	0.002	**0.004**	-0.010	-0.002
	Indirect via Type of visit	-0.001	0.001	0.266	-0.002	0.001
	Indirect via Tooth brushing frequency	0.006	0.002	**0.007**	0.002	0.010
	Indirect via Sweets consumption	-0.002	0.001	0.227	-0.005	0.001
	Indirect via Soft drinks consumption	0.000	0.000	0.534	-0.001	0.001
Household crowding –>	Direct					

Table 14. Direct and Indirect Effects on Oral Pain and Self Rated Oral Health Status in Saudi Arabia for 5-14 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Dental visits frequency		-0.020	0.018	0.246	-0.055	0.014
Type of visit		-0.003	0.030	0.932	-0.060	0.055
Tooth brushing frequency		-0.019	0.019	0.329	-0.056	0.019
Sweets consumption		-0.026	0.019	0.160	-0.063	0.010
Soft drinks consumption		0.003	0.019	0.864	-0.034	0.041
Household crowding –>Oral Pain	Indirect via Dental visits frequency	-0.010	0.009	0.247	-0.028	0.007
	Indirect via Type of visit	0.000	0.002	0.932	-0.004	0.004
	Indirect via Tooth brushing frequency	0.001	0.001	0.347	-0.001	0.002
	Indirect via Sweets consumption	0.000	0.000	0.554	-0.001	0.000
	Indirect via Soft drinks consumption	0.000	0.000	0.865	-0.001	0.001
Household crowding –> Self rated oral health status	Indirect via Dental visits frequency	0.003	0.002	0.254	-0.002	0.007
	Indirect via Type of visit	0.000	0.001	0.931	-0.001	0.001
	Indirect via Tooth brushing frequency	-0.002	0.002	0.327	-0.007	0.002
	Indirect via Sweets consumption	0.002	0.002	0.177	-0.001	0.006
	Indirect via Soft drinks consumption	0.000	0.000	0.866	-0.001	0.001
Accident –>	Direct					
Dental visits frequency		0.076	0.012	**<0.001**	0.053	0.098
Type of visit		-0.007	0.012	0.550	-0.031	0.016
Tooth brushing frequency		0.022	0.012	0.059	-0.001	0.044
Accident –> Oral Pain	Indirect via Dental visits frequency	0.039	0.006	**<0.001**	0.027	0.050
	Indirect via Type of visit	0.000	0.001	0.552	-0.001	0.002
	Indirect via Tooth brushing frequency	-0.001	0.000	0.089	-0.002	0.000
Accident –> Self rated oral health status	Indirect via Dental visits frequency	-0.010	0.002	**<0.001**	-0.014	-0.006
	Indirect via Type of visit	0.000	0.000	0.585	-0.001	0.000
	Indirect via Tooth brushing frequency	0.003	0.002	0.063	0.000	0.006
Disability –>	Direct					

Table 14. Direct and Indirect Effects on Oral Pain and Self Rated Oral Health Status in Saudi Arabia for 5-14 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Dental visits frequency		0.014	0.011	0.211	-0.008	0.036
Type of visit		-0.010	0.010	0.331	-0.029	0.010
Tooth brushing frequency		0.011	0.011	0.348	-0.012	0.033
Disability –> Oral Pain	Indirect via Dental visits frequency	0.007	0.006	0.211	-0.004	0.019
	Indirect via Type of visit	0.001	0.001	0.342	-0.001	0.002
	Indirect via Tooth brushing frequency	0.000	0.000	0.366	-0.001	0.000
Disability –> Self rated oral health status	Indirect via Dental visits frequency	-0.002	0.001	0.212	-0.005	0.001
	Indirect via Type of visit	0.000	0.000	0.435	-0.001	0.000
	Indirect via Tooth brushing frequency	0.001	0.001	0.351	-0.002	0.004
BMI –>	Direct					
Dental visits frequency		0.028	0.013	**0.029**	0.003	0.053
Type of visit		0.000	0.019	0.986	-0.037	0.038
Tooth brushing frequency		-0.006	0.014	0.677	-0.033	0.021
BMI –> Oral Pain	Indirect via Dental visits frequency	0.014	0.007	**0.030**	0.001	0.027
	Indirect via Type of visit	0.000	0.001	0.986	-0.002	0.002
	Indirect via Tooth brushing frequency	0.000	0.001	0.681	-0.001	0.001
BMI –> Self rated oral health status	Indirect via Dental visits frequency	-0.004	0.002	**0.034**	-0.007	0.000
	Indirect via Type of visit	0.000	0.000	0.986	-0.001	0.001
	Indirect via Tooth brushing frequency	-0.001	0.002	0.677	-0.004	0.003
Insurance –>						
Dental visits frequency	Direct	-0.044	0.019	**0.019**	-0.081	-0.007
Type of visit		0.013	0.030	0.668	-0.046	0.072
Tooth brushing frequency		-0.053	0.021	**0.010**	-0.093	-0.013
Sweets consumption		-0.054	0.019	**0.004**	-0.091	-0.017
Soft drinks consumption		-0.050	0.020	**0.011**	-0.089	-0.011

Table 14. Direct and Indirect Effects on Oral Pain and Self Rated Oral Health Status in Saudi Arabia for 5-14 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Insurance –> Oral Pain	Indirect via Dental visits frequency	-0.022	0.010	**0.018**	-0.041	-0.004
	Indirect via Type of visit	-0.001	0.002	0.669	-0.005	0.003
	Indirect via Tooth brushing frequency	0.002	0.001	**0.041**	0.000	0.004
	Indirect via Sweets consumption	0.000	0.001	0.519	-0.001	0.001
	Indirect via Soft drinks consumption	-0.001	0.001	0.115	-0.002	0.000
Insurance –> Self rated oral health status	Indirect via Dental visits frequency	0.006	0.002	**0.021**	0.001	0.011
	Indirect via Type of visit	0.000	0.001	0.690	-0.001	0.002
	Indirect via Tooth brushing frequency	-0.007	0.003	**0.012**	-0.012	-0.001
	Indirect via Sweets consumption	0.005	0.002	**0.009**	0.001	0.008
	Indirect via Soft drinks consumption	-0.001	0.001	0.161	-0.003	0.000
Access –>						
Dental visits frequency	Direct	0.394	0.009	<**0.001**	0.375	0.412
Type of visit		-0.146	0.011	<**0.001**	-0.168	-0.123
Tooth brushing frequency		-0.123	0.010	<**0.001**	-0.143	-0.103
Sweets consumption		-0.018	0.011	0.124	-0.040	0.005
Soft drinks consumption		0.009	0.011	0.443	-0.014	0.031
Access –> Oral Pain	Indirect via Dental visits frequency	0.201	0.006	<**0.001**	0.188	0.213
	Indirect via Type of visit	0.009	0.002	<**0.001**	0.005	0.014
	Indirect via Tooth brushing frequency	0.005	0.001	<**0.001**	0.002	0.007
	Indirect via Sweets consumption	0.000	0.000	0.540	-0.001	0.000
	Indirect via Soft drinks consumption	0.000	0.000	0.477	0.000	0.001
Access –> Self rated oral health status	Indirect via Dental visits frequency	-0.051	0.006	<**0.001**	-0.062	-0.040
	Indirect via Type of visit	-0.003	0.002	0.175	-0.007	0.001
	Indirect via Tooth brushing frequency	-0.016	0.002	<**0.001**	-0.020	-0.012
	Indirect via Sweets consumption	0.002	0.001	0.132	0.000	0.003
	Indirect via Soft drinks consumption	0.000	0.000	0.499	0.000	0.001
Source of care –>						

Table 14. Direct and Indirect Effects on Oral Pain and Self Rated Oral Health Status in Saudi Arabia for 5-14 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Dental visits frequency	Direct	-0.011	0.019	0.547	-0.048	0.025
Type of visit		0.074	0.025	**0.004**	0.024	0.124
Tooth brushing frequency		0.129	0.021	<**0.001**	0.088	0.170
Sweets consumption		0.095	0.020	<**0.001**	0.055	0.135
Soft drinks consumption		0.036	0.020	0.073	-0.003	0.075
Source of care –> Oral Pain	Indirect via Dental visits frequency	-0.006	0.009	0.547	-0.024	0.013
	Indirect via Type of visit	-0.005	0.002	**0.017**	-0.009	-0.001
	Indirect via Tooth brushing frequency	-0.005	0.002	**0.003**	-0.008	-0.002
	Indirect via Sweets consumption	0.001	0.001	0.517	-0.001	0.003
	Indirect via Soft drinks consumption	0.001	0.001	0.183	0.000	0.002
Source of care –> Self rated oral health status	Indirect via Dental visits frequency	0.001	0.002	0.550	-0.003	0.006
	Indirect via Type of visit	0.002	0.001	0.232	-0.001	0.004
	Indirect via Tooth brushing frequency	0.017	0.003	<**0.001**	0.010	0.023
	Indirect via Sweets consumption	-0.008	0.002	<**0.001**	-0.012	-0.004
	Indirect via Soft drinks consumption	0.001	0.001	0.241	-0.001	0.002

Significant pathways in bold font; β = standardized regression weights SE = robust standard error; CI = confidence interval.

Table 15. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 15 - 24 years

	Pathway	β	SE	*p*-value	95% CI	
Age –>	Direct					
Dental visits frequency		0.019	0.012	0.124	-0.005	0.044
Type of visit		-0.032	0.016	**0.043**	-0.063	-0.001
Tooth brushing frequency		-0.011	0.013	0.405	-0.036	0.015
Sweets consumption frequency		-0.008	0.012	0.527	-0.032	0.016
Soft drinks consumption		-0.004	0.013	0.764	-0.029	0.022
Age –> Oral Pain	Indirect via Dental visits frequency	0.012	0.008	0.124	-0.003	0.027
	Indirect via Type of visit	0.002	0.001	**0.047**	0.000	0.004
	Indirect via Tooth brushing frequency	0.001	0.001	0.407	-0.001	0.004
	Indirect via Sweets consumption	0.000	0.000	0.541	-0.001	0.001
	Indirect via Soft drinks consumption	0.000	0.000	0.765	-0.001	0.001
Age –> Self rated oral health status	Indirect via Dental visits frequency	-0.003	0.002	0.128	-0.006	0.001
	Indirect via Type of visit	-0.001	0.001	0.111	-0.003	0.000
	Indirect via Tooth brushing frequency	-0.002	0.002	0.406	-0.006	0.002
	Indirect via Sweets consumption	0.001	0.001	0.528	-0.001	0.003
	Indirect via Soft drinks consumption	0.000	0.001	0.765	-0.002	0.001
Gender –>	Direct					
Dental visits frequency		-0.004	0.013	0.741	-0.03	0.022
Type of visit		0.006	0.019	0.768	-0.032	0.043
Tooth brushing frequency		0.003	0.013	0.837	-0.024	0.029
Sweets consumption		-0.017	0.013	0.165	-0.042	0.007
Soft drinks consumption		-0.029	0.013	**0.023**	-0.054	-0.004
Gender –> Oral Pain	Indirect via Dental visits frequency	-0.003	0.008	0.741	-0.019	0.013
	Indirect via Type of visit	0.000	0.001	0.767	-0.003	0.002
	Indirect via Tooth brushing frequency	0.000	0.001	0.837	-0.003	0.002
	Indirect via Sweets consumption	-0.001	0.000	0.210	-0.001	0.000
	Indirect via Soft drinks consumption	0.001	0.001	0.071	0.000	0.002

Table 15. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 15 - 24 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Age –>	Direct					
Gender –> Self rated oral health status	Indirect via Dental visits frequency	0.001	0.002	0.741	-0.003	0.004
	Indirect via Type of visit	0.000	0.001	0.767	-0.001	0.002
	Indirect via Tooth brushing frequency	0.000	0.002	0.837	-0.004	0.005
	Indirect via Sweets consumption	0.001	0.001	0.174	-0.001	0.003
	Indirect via Soft drinks consumption	-0.002	0.001	**0.049**	-0.004	0.000
Citizenship –>	Direct					
Dental visits frequency		0.043	0.021	**0.045**	0.001	0.084
Type of visit		-0.029	0.028	0.302	-0.085	0.026
Tooth brushing frequency		0.008	0.02	0.697	-0.032	0.048
Sweets consumption		-0.014	0.02	0.458	-0.053	0.024
Soft drinks consumption		0.013	0.021	0.542	-0.029	0.055
Citizenship –> Oral Pain	Indirect via Dental visits frequency	0.026	0.013	**0.045**	0.001	0.052
	Indirect via Type of visit	0.002	0.002	0.347	-0.002	0.006
	Indirect via Tooth brushing frequency	-0.001	0.002	0.697	-0.005	0.003
	Indirect via Sweets consumption	0.000	0.001	0.468	-0.002	0.001
	Indirect via Soft drinks consumption	0.000	0.001	0.550	-0.002	0.001
Citizenship –> Self rated oral health status	Indirect via Dental visits frequency	-0.006	0.003	0.050	-0.012	0.000
	Indirect via Type of visit	-0.001	0.001	0.350	-0.004	0.001
	Indirect via Tooth brushing frequency	0.001	0.003	0.698	-0.005	0.008
	Indirect via Sweets consumption	0.001	0.002	0.460	-0.002	0.004
	Indirect via Soft drinks consumption	0.001	0.001	0.552	-0.002	0.004
Region –>	Direct					
Dental visits frequency		-0.028	0.014	**0.039**	-0.055	-0.001
Type of visit		-0.02	0.021	0.345	-0.062	0.022
Tooth brushing frequency		-0.062	0.013	**<0.001**	-0.088	-0.037
Sweets consumption		-0.113	0.011	**<0.001**	-0.135	-0.091
Soft drinks consumption		0.023	0.012	**0.060**	-0.001	0.047

Table 15. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 15 - 24 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Region –> Oral Pain	Indirect via Dental visits frequency	-0.017	0.008	**0.039**	-0.034	-0.001
	Indirect via Type of visit	0.001	0.001	0.377	-0.002	0.004
	Indirect via Tooth brushing frequency	0.006	0.001	**<0.001**	0.003	0.009
	Indirect via Sweets consumption	-0.004	0.001	**0.010**	-0.007	-0.001
	Indirect via Soft drinks consumption	-0.001	0.001	0.124	-0.002	0.000
Region –> Self rated oral health status	Indirect via Dental visits frequency	0.004	0.002	0.050	0.000	0.008
	Indirect via Type of visit	-0.001	0.001	0.380	-0.003	0.001
	Indirect via Tooth brushing frequency	-0.010	0.002	**<0.001**	-0.014	-0.006
	Indirect via Sweets consumption	0.009	0.002	**<0.001**	0.005	0.013
	Indirect via Soft drinks consumption	0.001	0.001	0.087	0.000	0.003
Income –>	Direct					
Dental visits frequency		-0.014	0.018	0.449	-0.049	0.022
Type of visit		-0.026	0.025	0.295	-0.075	0.023
Tooth brushing frequency		-0.006	0.018	0.761	-0.041	0.03
Sweets consumption		-0.004	0.018	0.823	-0.04	0.031
Soft drinks consumption		-0.001	0.018	0.951	-0.037	0.035
Income –> Oral Pain	Indirect via Dental visits frequency	-0.008	0.011	0.450	-0.030	0.013
	Indirect via Type of visit	0.002	0.002	0.318	-0.002	0.005
	Indirect via Tooth brushing frequency	0.001	0.002	0.761	-0.003	0.004
	Indirect via Sweets consumption	0.000	0.001	0.824	-0.001	0.001
	Indirect via Soft drinks consumption	0.000	0.001	0.951	-0.001	0.001
Income –> Self rated oral health status	Indirect via Dental visits frequency	0.002	0.003	0.451	-0.003	0.007
	Indirect via Type of visit	-0.001	0.001	0.333	-0.004	0.001
	Indirect via Tooth brushing frequency	-0.001	0.003	0.761	-0.007	0.005
	Indirect via Sweets consumption	0.000	0.001	0.823	-0.003	0.003
	Indirect via Soft drinks consumption	0.000	0.001	0.951	-0.002	0.002

Table 15. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 15 - 24 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Accident –>	Direct					
Dental visits frequency		0.022	0.013	0.090	-0.003	0.048
Type of visit		-0.019	0.013	0.149	-0.044	0.007
Tooth brushing frequency		0.006	0.013	0.662	-0.02	0.032
Accident –> Oral Pain	Indirect via Dental visits frequency	0.014	0.008	0.090	-0.002	0.029
	Indirect via Type of visit	0.001	0.001	0.171	-0.001	0.003
	Indirect via Tooth brushing frequency	-0.001	0.001	0.662	-0.003	0.002
Accident –> Self rated oral health status	Indirect via Dental visits frequency	-0.003	0.002	0.091	-0.007	0.001
	Indirect via Type of visit	-0.001	0.001	0.194	-0.002	0.000
	Indirect via Tooth brushing frequency	0.001	0.002	0.663	-0.003	0.005
Disability –>	Direct					
Dental visits frequency		-0.003	0.013	0.846	-0.029	0.024
Type of visit		0.059	0.044	0.177	-0.027	0.145
Tooth brushing frequency		-0.012	0.013	0.349	-0.038	0.013
Disability –> Oral Pain	Indirect via Dental visits frequency	-0.002	0.008	0.846	-0.018	0.014
	Indirect via Type of visit	-0.004	0.003	0.206	-0.010	0.002
	Indirect via Tooth brushing frequency	0.001	0.001	0.351	-0.001	0.004
Disability –> Self rated oral health status	Indirect via Dental visits frequency	0.000	0.002	0.846	-0.003	0.004
	Indirect via Type of visit	0.003	0.002	0.171	-0.001	0.007
	Indirect via Tooth brushing frequency	-0.002	0.002	0.351	-0.006	0.002
BMI –>	Direct					
Dental visits frequency		-0.02	0.014	0.149	-0.048	0.007
Type of visit		-0.003	0.018	0.854	-0.039	0.033
Tooth brushing frequency		0.019	0.014	0.156	-0.007	0.046
BMI –> Oral Pain	Indirect via Dental visits frequency	-0.013	0.009	0.150	-0.030	0.005

Table 15. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 15 - 24 years, continued

	Pathway	β	SE	*p*-value	95% CI	
	Indirect via Type of visit	0.000	0.001	0.855	-0.002	0.003
	Indirect via Tooth brushing frequency	-0.002	0.001	0.162	-0.005	0.001
BMI –> Self rated oral health status	Indirect via Dental visits frequency	0.003	0.002	0.157	-0.001	0.007
	Indirect via Type of visit	0.000	0.001	0.854	-0.002	0.001
	Indirect via Tooth brushing frequency	0.003	0.002	0.158	-0.001	0.007
Insurance–>	Direct					
Dental visits frequency		-0.037	0.026	0.149	-0.087	0.013
Type of visit		0.022	0.035	0.521	-0.046	0.090
Tooth brushing frequency		0.010	0.023	0.654	-0.034	0.055
Sweets consumption		-0.092	0.022	**<0.001**	-0.134	-0.049
Soft drinks consumption		-0.124	0.021	**<0.001**	-0.165	-0.083
Insurance –> Oral Pain	Indirect via Dental visits frequency	-0.023	0.016	0.150	-0.054	0.008
	Indirect via Type of visit	-0.001	0.002	0.521	-0.006	0.003
	Indirect via Tooth brushing frequency	-0.001	0.002	0.656	-0.005	0.003
	Indirect via Sweets consumption	-0.003	0.001	**0.027**	-0.006	0.000
	Indirect via Soft drinks consumption	0.004	0.002	**0.011**	0.001	0.008
Insurance –> Self rated oral health status	Indirect via Dental visits frequency	0.005	0.004	0.161	-0.002	0.013
	Indirect via Type of visit	0.001	0.002	0.531	-0.002	0.004
	Indirect via Tooth brushing frequency	0.002	0.004	0.656	-0.006	0.009
	Indirect via Sweets consumption	0.007	0.002	**0.002**	0.003	0.012
	Indirect via Soft drinks consumption	-0.008	0.002	**<0.001**	-0.012	-0.004
Access –>	Direct					
Dental visits frequency		-0.016	0.013	0.218	-0.042	0.010
Type of visit		-0.011	0.015	0.469	-0.040	0.018
Tooth brushing frequency		0.023	0.013	0.085	-0.003	0.049
Sweets consumption		0.038	0.012	**0.002**	0.014	0.062
Soft drinks consumption		0.039	0.013	**0.003**	0.013	0.064

Table 15. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 15 - 24 years, continued

	Pathway	β	SE	*p*-value	95% CI	
Access –> Oral Pain	Indirect via Dental visits frequency	-0.010	0.008	0.218	-0.026	0.006
	Indirect via Type of visit	0.001	0.001	0.470	-0.001	0.003
	Indirect via Tooth brushing frequency	-0.002	0.001	0.087	-0.005	0.000
	Indirect via Sweets consumption	0.001	0.001	**0.039**	0.000	0.002
	Indirect via Soft drinks consumption	-0.001	0.001	**0.045**	-0.003	0.000
Access - Self rated oral health status	Indirect via Dental visits frequency	0.002	0.002	0.222	-0.001	0.006
	Indirect via Type of visit	0.000	0.001	0.495	-0.002	0.001
	Indirect via Tooth brushing frequency	0.004	0.002	0.094	-0.001	0.008
	Indirect via Sweets consumption	-0.003	0.001	**0.008**	-0.005	-0.001
	Indirect via Soft drinks consumption	0.002	0.001	**0.015**	0.000	0.004
Source of care –>	Direct					
Dental visits frequency		-0.021	0.018	0.258	-0.057	0.015
Type of visit		0.021	0.026	0.427	-0.031	0.072
Tooth brushing frequency		0.019	0.018	0.287	-0.016	0.054
Sweets consumption		0.020	0.017	0.227	-0.013	0.054
Soft drinks consumption		0.010	0.018	0.559	-0.024	0.045
Source of care –> Oral Pain	Indirect via Dental visits frequency	-0.013	0.011	0.258	-0.035	0.009
	Indirect via Type of visit	-0.001	0.002	0.455	-0.005	0.002
	Indirect via Tooth brushing frequency	-0.002	0.002	0.291	-0.005	0.002
	Indirect via Sweets consumption	0.001	0.001	0.271	-0.001	0.002
	Indirect via Soft drinks consumption	0.000	0.001	0.566	-0.002	0.001
Source of care –> Self rated oral health status	Indirect via Dental visits frequency	0.003	0.003	0.259	-0.002	0.008
	Indirect via Type of visit	0.001	0.001	0.456	-0.002	0.003
	Indirect via Tooth brushing frequency	0.003	0.003	0.287	-0.003	0.009
	Indirect via Sweets consumption	-0.002	0.001	0.237	-0.004	0.001
	Indirect via Soft drinks consumption	0.001	0.001	0.563	-0.002	0.003

Significant pathways in bold font; β = standardized regression weights SE = robust standard error; CI = confidence interval.

Table 16. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 25+ years

	Pathway	β	SE	*p*-value	95% CI	
Age –>	Direct					
Dental visits frequency		0.000	0.012	0.982	-0.023	0.023
Type of visit		0.009	0.015	0.553	-0.020	0.037
Tooth brushing frequency		0.004	0.011	0.683	-0.017	0.026
Smoking		-0.004	0.010	0.652	-0.023	0.015
Sweets consumption		0.007	0.010	0.478	-0.013	0.027
Soft drinks consumption		0.008	0.010	0.427	-0.012	0.029
Age –> Oral Pain	Indirect via Dental visits frequency	0.000	0.007	0.982	-0.013	0.013
	Indirect via Type of visit	-0.001	0.001	0.564	-0.003	0.002
	Indirect via Tooth brushing frequency	0.000	0.001	0.684	-0.002	0.001
	Indirect via Smoking	0.000	0.000	0.653	-0.001	0.001
	Indirect via Sweets consumption	0.000	0.000	0.511	0.000	0.001
	Indirect via Soft drinks consumption	0.000	0.000	0.480	-0.001	0.000
Age –> Self rated oral health status	Indirect via Dental visits frequency	0.000	0.002	0.982	-0.003	0.003
	Indirect via Type of visit	0.000	0.001	0.569	-0.001	0.002
	Indirect via Tooth brushing frequency	0.001	0.002	0.683	-0.003	0.004
	Indirect via Smoking	0.000	0.000	0.683	0.000	0.000
	Indirect via Sweets consumption	0.000	0.001	0.478	-0.002	0.001
	Indirect via Soft drinks consumption	0.001	0.001	0.430	-0.001	0.002
Gender –>	Direct					
Dental visits frequency		-0.027	0.013	**0.037**	-0.052	-0.002
Type of visit		-0.017	0.015	0.262	-0.047	0.013
Tooth brushing frequency		0.026	0.012	**0.035**	0.002	0.050
Smoking		-0.010	0.011	0.348	-0.032	0.011
Sweets consumption		0.002	0.012	0.844	-0.021	0.026
Soft drinks consumption		-0.005	0.012	0.695	-0.027	0.018

Table 16. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 25+ years, continued

	Pathway	β	SE	*p*-value	95% CI	
Gender –> Oral Pain	Indirect via Dental visits frequency	-0.015	0.007	**0.039**	-0.030	-0.001
	Indirect via Type of visit	0.002	0.001	0.259	-0.001	0.004
	Indirect via Tooth brushing frequency	-0.002	0.001	**0.044**	-0.004	0.000
	Indirect via Smoking	0.000	0.001	0.374	-0.001	0.001
	Indirect via Sweets consumption	0.000	0.000	0.845	0.000	0.000
	Indirect via Soft drinks consumption	0.000	0.000	0.700	0.000	0.001
Gender –> Self rated oral health status	Indirect via Dental visits frequency	0.004	0.002	**0.049**	0.000	0.007
	Indirect via Type of visit	-0.001	0.001	0.256	-0.002	0.001
	Indirect via Tooth brushing frequency	0.004	0.002	**0.038**	0.000	0.008
	Indirect via Smoking	0.000	0.000	0.531	0.000	0.001
	Indirect via Sweets consumption	0.000	0.001	0.844	-0.002	0.001
	Indirect via Soft drinks consumption	0.000	0.001	0.695	-0.002	0.001
Citizenship –>	Direct					
Dental visits frequency		0.039	0.015	**0.011**	0.009	0.069
Type of visit		-0.025	0.019	0.176	-0.062	0.011
Tooth brushing frequency		0.011	0.015	0.459	-0.019	0.041
Smoking		-0.022	0.014	0.112	-0.050	0.005
Sweets consumption		0.023	0.015	0.128	-0.007	0.052
Soft drinks consumption		0.014	0.015	0.348	-0.015	0.043
Citizenship –> Oral Pain	Indirect via Dental visits frequency	0.022	0.009	**0.012**	0.005	0.040
	Indirect via Type of visit	0.002	0.002	0.189	-0.001	0.006
	Indirect via Tooth brushing frequency	-0.001	0.001	0.463	-0.003	0.002
	Indirect via Smoking	-0.001	0.001	0.122	-0.002	0.000
	Indirect via Sweets consumption	0.000	0.000	0.277	0.000	0.001
	Indirect via Soft drinks consumption	0.000	0.000	0.413	-0.001	0.000
Citizenship –> Self rated oral health status	Indirect via Dental visits frequency	-0.005	0.002	**0.021**	-0.009	-0.001
	Indirect via Type of visit	-0.001	0.001	0.211	-0.003	0.001
	Indirect via Tooth brushing frequency	0.002	0.002	0.458	-0.003	0.007

Table 16. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 25+ years, continued

	Pathway	β	SE	*p*-value	95% CI	
	Indirect via Smoking	0.000	0.000	0.461	0.000	0.001
	Indirect via Sweets consumption	-0.001	0.001	0.158	-0.004	0.001
	Indirect via Soft drinks consumption	0.001	0.001	0.352	-0.001	0.003
Region –>	Direct					
Dental visits frequency		-0.022	0.013	0.099	-0.048	0.004
Type of visit		0.012	0.018	0.501	-0.023	0.047
Tooth brushing frequency		-0.078	0.013	**<0.001**	-0.103	-0.054
Smoking		0.236	0.013	**<0.001**	0.210	0.262
Sweets consumption		-0.125	0.010	**<0.001**	-0.145	-0.104
Soft drinks consumption		0.011	0.011	0.334	-0.011	0.032
Region –> Oral Pain	Indirect via Dental visits frequency	-0.013	0.008	0.098	-0.028	0.002
	Indirect via Type of visit	-0.001	0.002	0.496	-0.004	0.002
	Indirect via Tooth brushing frequency	0.006	0.001	**<0.001**	0.004	0.009
	Indirect via Smoking	0.011	0.003	**<0.001**	0.005	0.016
	Indirect via Sweets consumption	-0.002	0.001	0.107	-0.005	0.001
	Indirect via Soft drinks consumption	0.000	0.000	0.403	-0.001	0.000
Region –> Self rated oral health status	Indirect via Dental visits frequency	0.003	0.002	0.091	0.000	0.006
	Indirect via Type of visit	0.001	0.001	0.499	-0.001	0.002
	Indirect via Tooth brushing frequency	-0.012	0.002	**<0.001**	-0.017	-0.008
	Indirect via Smoking	-0.003	0.004	0.403	-0.010	0.004
	Indirect via Sweets consumption	0.008	0.002	**<0.001**	0.004	0.012
	Indirect via Soft drinks consumption	0.001	0.001	0.346	-0.001	0.002
Marital status –>	Direct					
Dental visits frequency		0.003	0.021	0.888	-0.039	0.045
Type of visit		0.043	0.027	0.109	-0.010	0.097
Tooth brushing frequency		-0.036	0.019	0.056	-0.072	0.001
Smoking		0.053	0.023	**0.023**	0.007	0.098
Sweets consumption		-0.007	0.018	0.683	-0.043	0.028
Soft drinks consumption		0.019	0.017	0.251	-0.014	0.053

Table 16. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 25+ years, continued

	Pathway	β	SE	*p*-value	95% CI	
Marital status –> Oral Pain	Indirect via Dental visits frequency	0.002	0.012	0.888	-0.023	0.026
	Indirect via Type of visit	-0.004	0.003	0.132	-0.009	0.001
	Indirect via Tooth brushing frequency	0.003	0.002	0.065	0.000	0.006
	Indirect via Smoking	0.002	0.001	0.059	0.000	0.005
	Indirect via Sweets consumption	0.000	0.000	0.688	-0.001	0.001
	Indirect via Soft drinks consumption	0.000	0.000	0.309	-0.001	0.000
Marital status –> Self rated oral health status	Indirect via Dental visits frequency	0.000	0.003	0.888	-0.006	0.005
	Indirect via Type of visit	0.002	0.001	0.151	-0.001	0.005
	Indirect via Tooth brushing frequency	-0.006	0.003	0.061	-0.012	0.000
	Indirect via Smoking	-0.001	0.001	0.434	-0.002	0.001
	Indirect via Sweets consumption	0.000	0.001	0.685	-0.002	0.003
	Indirect via Soft drinks consumption	0.001	0.001	0.268	-0.001	0.004
Education –>	Direct					
Dental visits frequency		0.024	0.018	0.190	-0.012	0.059
Type of visit		0.008	0.018	0.672	-0.028	0.044
Tooth brushing frequency		0.053	0.016	**0.001**	0.023	0.084
Smoking		0.016	0.015	0.275	-0.013	0.045
Sweets consumption		0.024	0.015	0.106	-0.005	0.052
Soft drinks consumption		0.003	0.015	0.831	-0.025	0.032
Education –> Oral Pain	Indirect via Dental visits frequency	0.014	0.010	0.190	-0.007	0.034
	Indirect via Type of visit	-0.001	0.002	0.670	-0.004	0.002
	Indirect via Tooth brushing frequency	-0.004	0.001	**0.002**	-0.007	-0.002
	Indirect via Smoking	0.001	0.001	0.304	-0.001	0.002
	Indirect via Sweets consumption	0.000	0.000	0.253	0.000	0.001
	Indirect via Soft drinks consumption	0.000	0.000	0.832	-0.001	0.001
Education –> Self rated oral health status	Indirect via Dental visits frequency	-0.003	0.002	0.187	-0.008	0.002
	Indirect via Type of visit	0.000	0.001	0.670	-0.001	0.002
	Indirect via Tooth brushing frequency	0.008	0.003	**0.001**	0.003	0.014

Table 16. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 25+ years, continued

	Pathway	β	SE	*p*-value	95% CI	
	Indirect via Smoking	0.000	0.000	0.498	-0.001	0.000
	Indirect via Sweets consumption	-0.002	0.001	0.123	-0.004	0.000
	Indirect via Soft drinks consumption	0.000	0.001	0.832	-0.002	0.002
Income –>	Direct					
Dental visits frequency		0.017	0.019	0.387	-0.021	0.054
Type of visit		-0.017	0.024	0.477	-0.065	0.031
Tooth brushing frequency		0.013	0.018	0.466	-0.022	0.048
Smoking		-0.004	0.014	0.770	-0.032	0.024
Sweets consumption		-0.002	0.017	0.911	-0.035	0.031
Soft drinks consumption		0.014	0.016	0.378	-0.018	0.046
Income –> Oral Pain	Indirect via Dental visits frequency	0.010	0.011	0.385	-0.012	0.031
	Indirect via Type of visit	0.002	0.002	0.475	-0.003	0.006
	Indirect via Tooth brushing frequency	-0.001	0.001	0.469	-0.004	0.002
	Indirect via Smoking	0.000	0.001	0.771	-0.001	0.001
	Indirect via Sweets consumption	0.000	0.000	0.911	-0.001	0.001
	Indirect via Soft drinks consumption	0.000	0.000	0.428	-0.001	0.000
Income –> Self rated oral health status	Indirect via Dental visits frequency	-0.002	0.002	0.382	-0.007	0.003
	Indirect via Type of visit	-0.001	0.001	0.466	-0.003	0.001
	Indirect via Tooth brushing frequency	0.002	0.003	0.466	-0.003	0.008
	Indirect via Smoking	0.000	0.000	0.788	0.000	0.000
	Indirect via Sweets consumption	0.000	0.001	0.911	-0.002	0.002
	Indirect via Soft drinks consumption	0.001	0.001	0.387	-0.001	0.003
Accident –>	Direct					
Dental visits frequency		-0.024	0.015	0.102	-0.053	0.005
Type of visit		0.000	0.019	0.998	-0.037	0.037
Tooth brushing frequency		0.028	0.012	0.021	0.004	0.053
Accident –> Oral Pain	Indirect via Dental visits frequency	-0.014	0.008	0.102	-0.030	0.003
	Indirect via Type of visit	0.000	0.002	0.998	-0.003	0.003

Table 16. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 25+ years, continued

	Pathway	β	SE	*p*-value	95% CI	
	Indirect via Tooth brushing frequency	-0.002	0.001	**0.028**	-0.004	0.000
Accident –> Self rated oral health status	Indirect via Dental visits frequency	0.003	0.002	0.112	-0.001	0.007
	Indirect via Type of visit	0.000	0.001	0.998	-0.002	0.002
	Indirect via Tooth brushing frequency	0.005	0.002	**0.024**	0.001	0.008
Disability –>	Direct					
Dental visits frequency		0.010	0.018	0.586	-0.025	0.044
Type of visit		0.011	0.013	0.420	-0.015	0.036
Tooth brushing frequency		0.004	0.013	0.771	-0.022	0.030
Disability –> Oral Pain	Indirect via Dental visits frequency	0.006	0.010	0.586	-0.014	0.025
	Indirect via Type of visit	-0.001	0.001	0.428	-0.003	0.001
	Indirect via Tooth brushing frequency	0.000	0.001	0.772	-0.002	0.002
Disability –> Self rated oral health status	Indirect via Dental visits frequency	-0.001	0.002	0.587	-0.006	0.003
	Indirect via Type of visit	0.000	0.001	0.443	-0.001	0.002
	Indirect via Tooth brushing frequency	0.001	0.002	0.771	-0.004	0.005
BMI –>	Direct					
Dental visits frequency		-0.028	0.013	**0.033**	-0.055	-0.002
Type of visit		0.047	0.018	**0.007**	0.013	0.082
Tooth brushing frequency		-0.011	0.013	0.385	-0.037	0.014
BMI –> Oral Pain	Indirect via Dental visits frequency	-0.016	0.008	**0.033**	-0.032	-0.001
	Indirect via Type of visit	-0.004	0.002	**0.011**	-0.007	-0.001
	Indirect via Tooth brushing frequency	0.001	0.001	0.389	-0.001	0.003
BMI –> Self rated oral health status	Indirect via Dental visits frequency	0.004	0.002	**0.039**	0.000	0.007
	Indirect via Type of visit	0.002	0.001	**0.030**	0.000	0.004
	Indirect via Tooth brushing frequency	-0.002	0.002	0.386	-0.006	0.002
Insurance –>	Direct					

Table 16. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 25+ years, continued

	Pathway	β	SE	*p*-value	95% CI	
Dental visits frequency		-0.049	0.019	**0.011**	-0.087	-0.011
Type of visit		-0.009	0.020	0.670	-0.048	0.031
Tooth brushing frequency		-0.086	0.018	<**0.001**	-0.122	-0.050
Smoking		0.003	0.017	0.881	-0.031	0.036
Sweets consumption		-0.172	0.018	<**0.001**	-0.207	-0.138
Soft drinks consumption		-0.227	0.017	<**0.001**	-0.260	-0.193
Insurance –> Oral Pain	Indirect via Dental visits frequency	-0.028	0.011	**0.011**	-0.050	-0.007
	Indirect via Type of visit	0.001	0.002	0.671	-0.003	0.004
	Indirect via Tooth brushing frequency	0.007	0.002	<**0.001**	0.003	0.010
	Indirect via Smoking	0.000	0.001	0.881	-0.001	0.002
	Indirect via Sweets consumption	-0.003	0.002	0.111	-0.007	0.001
	Indirect via Soft drinks consumption	0.005	0.003	0.065	0.000	0.011
Insurance –> Self rated oral health status	Indirect via Dental visits frequency	0.006	0.003	**0.013**	0.001	0.012
	Indirect via Type of visit	0.000	0.001	0.671	-0.002	0.001
	Indirect via Tooth brushing frequency	-0.014	0.003	<**0.001**	-0.020	-0.008
	Indirect via Smoking	0.000	0.000	0.882	0.000	0.000
	Indirect via Sweets consumption	0.011	0.003	<**0.001**	0.006	0.017
	Indirect via Soft drinks consumption	-0.015	0.003	<**0.001**	-0.022	-0.009
Access –>						
Dental visits frequency	Direct	-0.009	0.011	0.391	-0.030	0.012
Type of visit		0.011	0.017	0.515	-0.022	0.045
Tooth brushing frequency		0.044	0.011	<**0.001**	0.022	0.067
Smoking		0.004	0.011	0.713	-0.018	0.026
Sweets consumption		0.049	0.012	<**0.001**	0.026	0.071
Soft drinks consumption		0.046	0.011	<**0.001**	0.024	0.068
Access –> Oral Pain	Indirect via Dental visits frequency	-0.005	0.006	0.392	-0.017	0.007
	Indirect via Type of visit	-0.001	0.001	0.505	-0.004	0.002
	Indirect via Tooth brushing frequency	-0.004	0.001	<**0.001**	-0.006	-0.002
	Indirect via Smoking	0.000	0.001	0.717	-0.001	0.001

Table 16. Direct and indirect effects on oral pain and self-rated oral health status in Saudi Arabia for 25+ years, continued

	Pathway	β	SE	*p*-value	95% CI	
	Indirect via Sweets consumption	0.001	0.001	0.126	0.000	0.002
	Indirect via Soft drinks consumption	-0.001	0.001	0.097	-0.002	0.000
Access –> Self rated oral health status	Indirect via Dental visits frequency	0.001	0.001	0.394	-0.002	0.004
	Indirect via Type of visit	0.001	0.001	0.509	-0.001	0.002
	Indirect via Tooth brushing frequency	0.007	0.002	**<0.001**	0.003	0.011
	Indirect via Smoking	0.000	0.000	0.758	0.000	0.000
	Indirect via Sweets consumption	-0.003	0.001	**0.001**	-0.005	-0.001
	Indirect via Soft drinks consumption	0.003	0.001	**0.001**	0.001	0.005
Source of care –>	Direct					
Dental visits frequency		-0.029	0.020	0.138	-0.068	0.009
Type of visit		-0.012	0.019	0.517	-0.048	0.024
Tooth brushing frequency		0.026	0.018	0.154	-0.010	0.062
Smoking		0.020	0.014	0.168	-0.008	0.048
Sweets consumption		0.009	0.018	0.622	-0.026	0.043
Soft drinks consumption		0.046	0.017	**0.006**	0.013	0.079
Source of care –> Oral Pain	Indirect via Dental visits frequency	-0.017	0.011	0.140	-0.039	0.006
	Indirect via Type of visit	0.001	0.002	0.508	-0.002	0.004
	Indirect via Tooth brushing frequency	-0.002	0.001	0.158	-0.005	0.001
	Indirect via Smoking	0.001	0.001	0.194	0.000	0.002
	Indirect via Sweets consumption	0.000	0.000	0.637	-0.001	0.001
	Indirect via Soft drinks consumption	-0.001	0.001	0.115	-0.002	0.000
Source of care –> Self rated oral health status	Indirect via Dental visits frequency	0.004	0.003	0.154	-0.001	0.009
	Indirect via Type of visit	-0.001	0.001	0.513	-0.002	0.001
	Indirect via Tooth brushing frequency	0.004	0.003	0.159	-0.002	0.010
	Indirect via Smoking	0.000	0.000	0.478	-0.001	0.000
	Indirect via Sweets consumption	-0.001	0.001	0.625	-0.003	0.002
	Indirect via Soft drinks consumption	0.003	0.001	**0.018**	0.001	0.006

Significant pathways in bold font; β = standardized regression weights SE = robust standard error; CI = confidence interval.

FIGURES

Figure 1. A framework for distal and proximal influences on oral health

Distal influences on oral health

Sociodemographic
Age
Gender
Citizenship
Region
Marital status

Socioeconomic
Completed education level
Monthly income
Ownership of residence

Home environment
Type of residence
Residence condition
Residence overcrowding

General health
Relevant medical conditions
Accident
Physical disability
Obesity

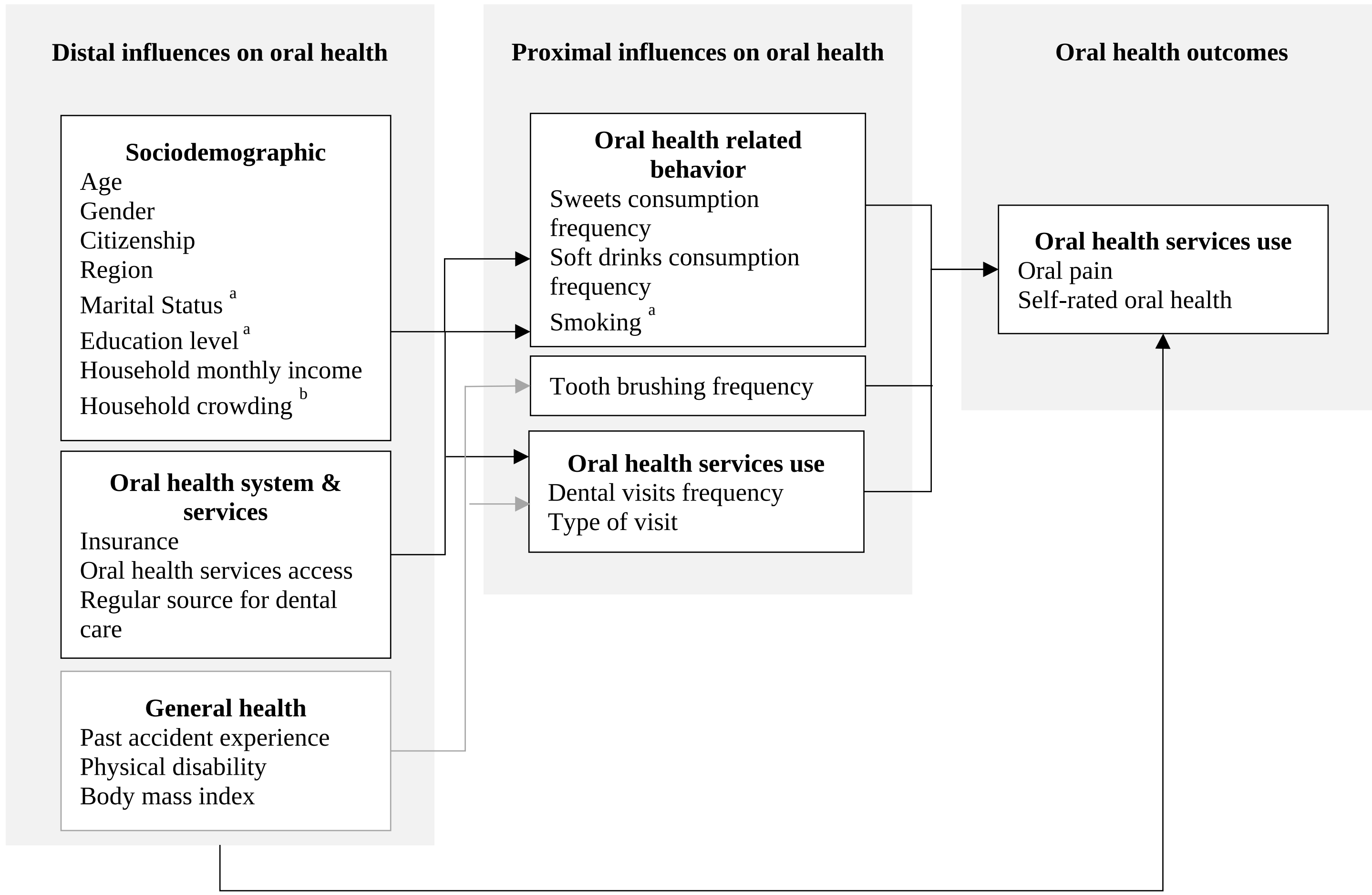
Oral health system & services
State of insurance
Regular source of dental care
Dental health care availability

Proximal influences on oral health

Oral health services usage
Dental visits frequency
Reasons for visit

Ora health risk behavior
Oral hygiene
Sugary food consumption
Smoking & tobacco use

Figure 2: Conceptual framework for distal and proximal influences on self-reported oral pain and oral health status



[a] In adults 25 years and older group. [b] In children 5 to 14 years group.

Figure 3. The structural model for the hypothesized direct and indirect pathways of influences on self-reported oral pain and self-rated oral health status in Saudi Arabia for 5-14 years old

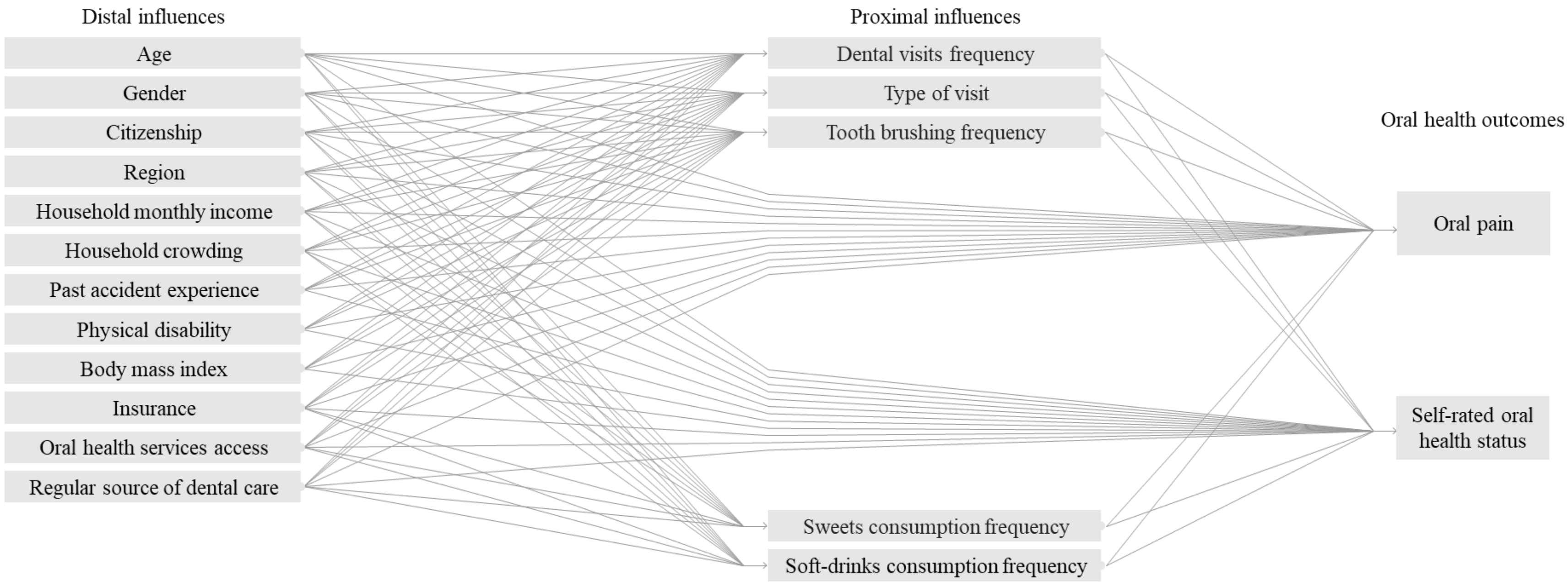


Figure 4. The structural model for the hypothesized direct and indirect pathways of influences on self-reported oral pain and self-rated oral health status in Saudi Arabia for 15-24 years old

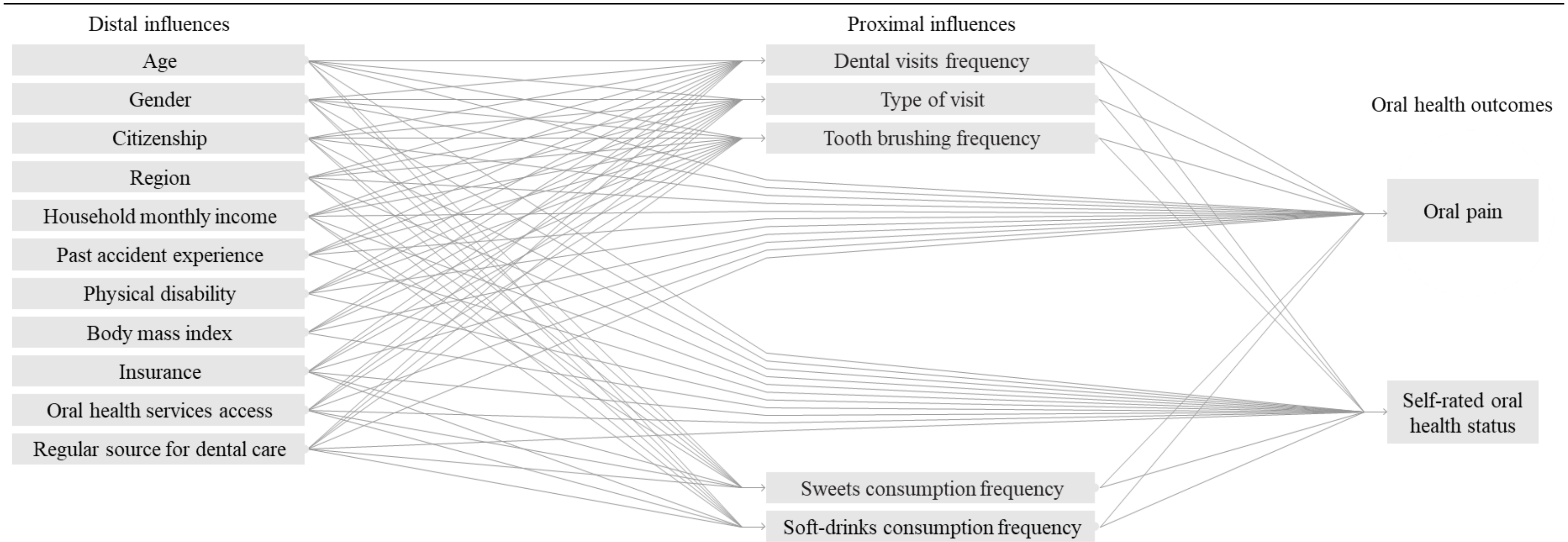
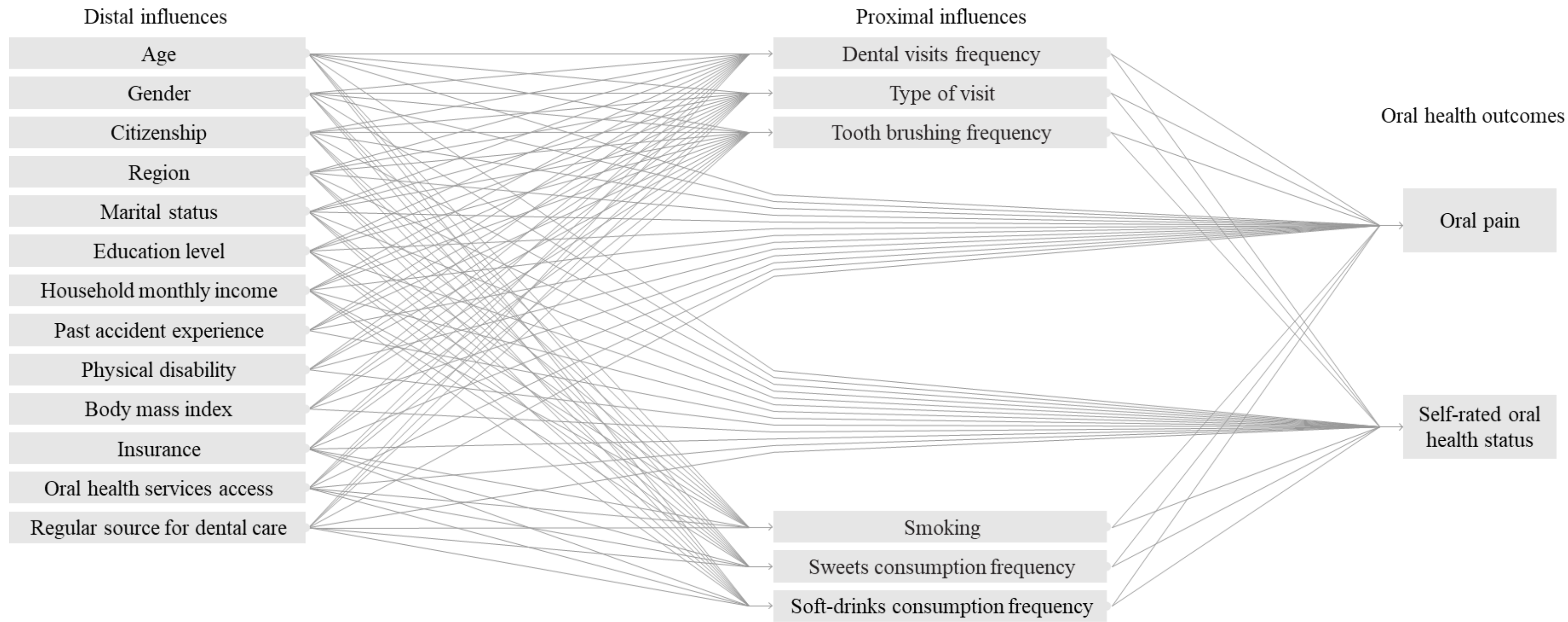


Figure 5. The structural model for the hypothesized direct and indirect pathways of influences on self-reported oral pain and self-rated oral health status in Saudi Arabia for 25 years and older



REFERENCES

1. Kassebaum N, Bernabé E, Dahiya M, Bhandari B, Murray C, Marcenes W. Global burden of severe periodontitis in 1990-2010: a systematic review and meta-regression. J Dent Res. 2014;93(11):1045-53.
2. Kassebaum NJ, Smith AG, Bernabé E, Fleming TD, Reynolds AE, Vos T, et al. Global, regional, and national prevalence, incidence, and disability-adjusted life years for oral conditions for 195 countries, 1990–2015: a systematic analysis for the global burden of diseases, injuries, and risk factors. J Dent Res. 2017;96(4):380-7.
3. Petersen PE. Sociobehavioural risk factors in dental caries–international perspectives. Community Dent Oral Epidemiol. 2005;33(4):274-9.
4. Al Agili DE. A systematic review of population-based dental caries studies among children in Saudi Arabia. The Saudi dental journal. 2013;25(1):3-11.
5. Almas K, Al-Malik TM, Al-Shehri MA, Skaug N. The knowledge and practices of oral hygiene methods and attendance pattern among school teachers in Riyadh, Saudi Arabia. Saudi Med J. 2003;24(10):1087-91.
6. Amin T, Al-Abad B. Oral hygiene practices, dental knowledge, dietary habits and their relation to caries among male primary school children in Al Hassa, Saudi Arabia. Int J Dent Hyg. 2008;6(4):361-70.
7. Morgano S, Doumit M, Shammari KA, Al-Suwayed A, Al-Suwaidi A, Debaybo D, et al. Burden of oral disease in the Middle East: Opportunities for dental public health. Int Dent J. 2010;60(3S1):197-9.

8. Al Hamdan E, Fahmy M. Socioeconomic factors and complete edentulism for female patients at King Saud University, Riyadh, Saudi Arabia. Tanta Dental Journal. 2014;11(3):169-73.

9. Alhabdan YA, Albeshr AG, Yenugadhati N, Jradi H. Prevalence of dental caries and associated factors among primary school children: a population-based cross-sectional study in Riyadh, Saudi Arabia. Environ Health Prev Med. 2018;23(1):1-14.

10. El Bcheraoui C, Tuffaha M, Daoud F, Kravitz H, AlMazroa MA, Al Saeedi M, et al. Use of dental clinics and oral hygiene practices in the Kingdom of Saudi Arabia, 2013. Int Dent J. 2016;66(2):99-104.

11. Watt RG, Daly B, Allison P, Macpherson LM, Venturelli R, Listl S, et al. Ending the neglect of global oral health: time for radical action. The Lancet. 2019;394(10194):261-72.

12. Salam AA. Population and household census, Kingdom of Saudi Arabia 2010: facts and figures. International Journal of Humanities and Social Science. 2013;3(16):258-63.

13. General Authority of Statisitcs. The General Population and Housing Census 2010. Available from: https://www.stats.gov.sa/en/73.

14. World Health Organization. Oral health surveys: basic methods: World Health Organization; 2013.

15. Pihlstrom BL, Michalowicz BS, Johnson NW. Periodontal diseases. The lancet. 2005;366(9499):1809-20.

16. U.S. Agency for International Development. DHS Methodology 2020. Available from: https://dhsprogram.com/What-We-Do/Survey-Types/DHS-Methodology.cfm.

17. Dixon J, Singleton R, Straits B. Sampling, Steps in Probability Sampling. In: Dixon J, Singleton R, Straits B, editors. The process of social research. New York: Oxford University Press; 2016. p. 148-60.

18. United Nations Department of Economic and Social Affairs. World Population Prospects 2019 2019. Available from: https://population.un.org/wpp/Publications/Files/WPP2019_Volume-I_Comprehensive-Tables.pdf.

19. López R, Smith PC, Göstemeyer G, Schwendicke F. Ageing, dental caries and periodontal diseases. J Clin Periodontol. 2017;44:S145-S52.

20. Schwendicke F, Dörfer C, Schlattmann P, Page LF, Thomson W, Paris S. Socioeconomic inequality and caries: a systematic review and meta-analysis. J Dent Res. 2015;94(1):10-8.

21. Singh A, Peres M, Watt R. The relationship between income and oral health: a critical review. J Dent Res. 2019;98(8):853-60.

22. Hamasha AA-H, Aldosari MN, Alturki AM, Aljohani SA, Aljabali IF, Alotibi RF. Barrier to access and dental care utilization behavior with related independent variables in the elderly population of Saudi Arabia. Journal of International Society of Preventive & Community Dentistry. 2019;9(4):349.

23. Quadri FA, Jafari FA, Albeshri AT, Zailai AM. Factors influencing patients' utilization of dental health services in Jazan, Kingdom of Saudi Arabia. International journal of clinical pediatric dentistry. 2018;11(1):29.

24. Almutlaqah MA, Baseer MA, Ingle NA, Assery MK, Al Khadhari MA. Factors affecting access to oral health care among adults in Abha City, Saudi Arabia. Journal of International Society of Preventive & Community Dentistry. 2018;8(5):431.

25. Farsi J. Dental visit patterns and periodontal treatment needs among Saudi students. EMHJ-Eastern Mediterranean Health Journal, 16 (7), 801-806, 2010. 2010.

26. Gowdar IM, Alqahtani AM, Asiri AM, Aldossary SF, Alkhurayef IA, Alheneshi DI. Oral health myths among general population at Riyadh Region, Saudi Arabia. J Pharm Bioallied Sci. 2021;13(Suppl 1):S241.

27. Andersen RM. National health surveys and the behavioral model of health services use. Med Care. 2008:647-53.

28. Khaliq AA. The Saudi health care system: a view from the minaret. World health & population. 2012;13(3):52-64.

29. Al-Mazrou Y, Al-Ghaith T, Yazbeck AS, Rabie TS. How labor laws can transform health systems: the case of Saudi Arabia. Health Systems & Reform. 2017;3(1):26-33.

30. Almalki M, FitzGerald G, Clark M. Health care system in Saudi Arabia: an overview. EMHJ-Eastern Mediterranean Health Journal, 17 (10), 784-793, 2011. 2011.

31. Moradi-Lakeh M, El Bcheraoui C, Tuffaha M, Daoud F, Al Saeedi M, Basulaiman M, et al. Tobacco consumption in the Kingdom of Saudi Arabia, 2013: findings from a national survey. BMC Public Health. 2015;15(1):1-10.

32. Collaborators GOD, Bernabe E, Marcenes W, Hernandez C, Bailey J, Abreu L, et al. Global, regional, and national levels and trends in burden of oral conditions from 1990 to 2017: a systematic analysis for the global burden of disease 2017 study. J Dent Res. 2020;99(4):362-73.

33. Petersen PE, Bourgeois D, Ogawa H, Estupinan-Day S, Ndiaye C. The global burden of oral diseases and risks to oral health. Bull World Health Organ. 2005;83(9):661-9. Epub 2005/10/08. doi: /S0042-96862005000900011. PubMed PMID: 16211157; PubMed Central PMCID: PMCPMC2626328.

34. Marmot M, Bell R. Social determinants and dental health. Advances in dental research. 2011;23(2):201-6.

35. Wu B, Plassman BL, Liang J, Remle RC, Bai L, Crout RJ. Differences in self-reported oral health among community-dwelling black, Hispanic, and white elders. Journal of aging and health. 2011;23(2):267-88.

36. Souza EHAd, Barbosa MBCB, Oliveira PAPd, Espíndola J, Gonçalves KJ. Impact of oral health in the daily life of institutionalized and non institutionalized elder in the city of Recife (PE, Brazil). Ciencia & saude coletiva. 2010;15(6):2955-64.

37. Meng X, Gilbert GH, Duncan RP, Heft MW. Satisfaction with dental appearance among diverse groups of dentate adults. Journal of aging and health. 2007;19(5):778-91.

38. Joaquim A, Wyatt CC, Aleksejūnienė J, Greghi SL, Pegoraro LF, Kiyak HA. A comparison of the dental health of Brazilian and Canadian independently living elderly. Gerodontology. 2010;27(4):258-65.

39. Daly B, Newton T, Batchelor P, Jones K. Oral health care needs and oral health-related quality of life (OHIP-14) in homeless people. Community dentistry and oral epidemiology. 2010;38(2):136-44.

40. Lawrence HP, Thomson WM, Broadbent JM, Poulton R. Oral health-related quality of life in a birth cohort of 32-year olds. Community dentistry and oral epidemiology. 2008;36(4):305-16.

41. Gilbert GH, Duncan RP, Heft MW, Dolan TA, Vogel WB. Multidimensionality of oral health in dentate adults. Medical care. 1998:988-1001.

42. Goes PS, Watt RG, Hardy R, Sheiham A. Impacts of dental pain on daily activities of adolescents aged 14–15 years and their families. Acta Odontologica Scandinavica. 2008;66(1):7-12.

43. Cohen LA, Bonito AJ, Eicheldinger C, Manski RJ, Macek MD, Edwards RR, et al. Behavioral and socioeconomic correlates of dental problem experience and patterns of health care-seeking. The Journal of the American Dental Association. 2011;142(2):137-49.

44. Locker D, Grushka M. The impact of dental and facial pain. Journal of dental Research. 1987;66(9):1414-7.

45. Gift HC, Reisine ST, Larach DC. The social impact of dental problems and visits. American journal of public health. 1992;82(12):1663-8.

46. Ratnayake N, Ekanayake L. Prevalence and impact of oral pain in 8-year-old children in Sri Lanka. International journal of paediatric dentistry. 2005;15(2):105-12.

47. Shepherd M, Nadanovsky P, Sheiham A. Dental public health: The prevalence and impact of dental pain in 8-year-old school children in Harrow, England. British dental journal. 1999;187(1):38.

48. Quinonez C, Figueiredo R, Locker D. Disability days in Canada associated with dental problems: a pilot study. International journal of dental hygiene. 2011;9(2):132-5.

49. Vargas CM, Macek MD, Marcus SE. Sociodemographic correlates of tooth pain among adults: United States, 1989. Pain. 2000;85(1-2):87-92.

50. Pau A, Croucher R, Marcenes W. Demographic and socio-economic correlates of dental pain among adults in the United Kingdom, 1998. British dental journal. 2007;202(9):E21.

51. Brondani MA, MacEntee MI. Thirty years of portraying oral health through models: what have we accomplished in oral health-related quality of life research? Qual Life Res. 2014;23(4):1087-96. Epub 2013/10/08. doi: 10.1007/s11136-013-0541-3. PubMed PMID: 24097081.

52. Steele JG, Sanders AE, Slade GD, Allen PF, Lahti S, Nuttall N, et al. How do age and tooth loss affect oral health impacts and quality of life? A study comparing two national samples. Community dentistry and oral epidemiology. 2004;32(2):107-14.

53. Petersen PE, Yamamoto T. Improving the oral health of older people: the approach of the WHO Global Oral Health Programme. Community dentistry and oral epidemiology. 2005;33(2):81-92.

54. MacEntee MI, Stolar E, Glick N. Influence of age and gender on oral health and related behaviour in an independent elderly population. Community dentistry and oral epidemiology. 1993;21(4):234-9.

55. Mc CG, Bedi R. Gender variations in the social impact of oral health. Journal of the Irish Dental Association. 2000;46(3):87-91.

56. Vargas CM, Crall JJ, Schneider DA. Sociodemographic distribution of pediatric dental caries: NHANES III, 1988–1994. The Journal of the American Dental Association. 1998;129(9):1229-38.

57. Nicolau B, Marcenes W, Allison P, Sheiham A. The life course approach: explaining the association between height and dental caries in Brazilian adolescents. Community dentistry and oral epidemiology. 2005;33(2):93-8.

58. Edelstein BL. Disparities in oral health and access to care: findings of national surveys. Ambulatory pediatrics. 2002;2(2):141-7.

59. Van De Mheen H, Stronks K, Van Den Bos J, Mackenbach JP. The contribution of childhood environment to the explanation of socio-economic inequalities in health in adult life: a retrospective study. Social Science & Medicine. 1997;44(1):13-24.

60. Litt MD, Reisine S, Tinanoff N. Multidimensional causal model of dental caries development in low-income preschool children. Public health reports. 1995;110(5):607.

61. Petersen P. Effectiveness of oral health care--some Danish experiences. Proceedings of the Finnish Dental Society Suomen Hammaslaakariseuran toimituksia. 1992;88(1-2):13-23.

62. Lave JR, Keane C, Lin C, Ricci E. The impact of dental benefits on the utilization of dental services by low-income children in western Pennsylvania. Pediatr Dent. 2002;24(3):234-40.

63. Valachovic RW. Dental workforce trends and children. Ambulatory Pediatrics. 2002;2(2):154-61.

64. Control CfD, Prevention. US Department of Health and Human Services Physical activity guidelines for Americans 2008. Washington, DC. 2008.

65. Mouradian WE, Wehr E, Crall JJ. Disparities in children's oral health and access to dental care. Jama. 2000;284(20):2625-31.

66. Nishida C, Uauy R, Kumanyika S, Shetty P. The joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases: process, product and policy implications. Public health nutrition. 2004;7(1a):245-50.

67. Reisine S, Litt M, Tinanoff N. A biopsychosocial model to predict caries in preschool children. Pediatric dentistry. 1994;16:413-.

68. Reisine S, Douglass JM. Psychosocial and behavioral issues in early childhood caries. Community dentistry and oral epidemiology. 1998;26(S1):32-44.

69. Oliveira ER, Narendran S, Williamson D. Oral health knowledge, attitudes and preventive practices of third grade school children. Pediatric dentistry. 2000;22(5):395-400.

70. WHO J, Consultation FE. Diet, nutrition and the prevention of chronic diseases. 2003.

71. Allam E, Zhang W, Zheng C, Gregory RL, Windsor LJ. Smoking and oral health. Cigarette Smoke Toxicity: Linking Individual Chemicals to Human Diseases. 2011:257-80.

72. Wolfe MD, Carlos JP. Oral health effects of smokeless tobacco use in Navajo Indian adolescents. Community Dentistry and Oral Epidemiology. 1987;15(4):230-5.

73. Arminger G, Schoenberg RJ. Pseudo maximum likelihood estimation and a test for misspecification in mean and covariance structure models. Psychometrika. 1989;54(3):409-25.

74. Savalei V. On the computation of the RMSEA and CFI from the mean-and-variance corrected test statistic with nonnormal data in SEM. Multivariate behavioral research. 2018;53(3):419-29.

75. Santos PS, Barasuol JC, Moccelini BS, Magno MB, Bolan M, Martins-Junior PA, et al. Prevalence of toothache and associated factors in children and adolescents: a systematic review and meta-analysis. Clin Oral Investig. 2021:1-15.

76. Aldosari M, Mendes SdR, Aldosari A, Aldosari A, de Abreu MHNG. Factors associated with oral pain and oral health-related productivity loss in the USA, National Health and Nutrition Examination Surveys (NHANES), 2015–2018. PLoS One. 2021;16(10):e0258268.

77. Alsubaie ASR. Oral health-related behaviors and dental pain among children in Saudi Arabia. Journal of International Oral Health. 2019;11(1):1.

78. Abdullah M, Ali MH, Rahiman S. Knowledge, practice and awareness of oral hygiene among three different age populations of same ethnic group–a community based study. Brazilian Journal of Oral Sciences. 2010;9(4):481-7.

79. Ahmad MS, Bhayat A, Al-Samadani KH, Abuong Z. Oral health knowledge and practice among administrative staff at Taibah university, Madina, KSA. European Journal of General Dentistry. 2013;2(03):308-11.

80. Peer E, Gamliel E. Too reliable to be true? Response bias as a potential source of inflation in paper-and-pencil questionnaire reliability. Practical Assessment, Research, and Evaluation. 2011;16(1):9.

81. Fisher RJ, Katz JE. Social-desirability bias and the validity of self-reported values. Psychology & marketing. 2000;17(2):105-20.

82. Tahmassebi J, Duggal M, Malik-Kotru G, Curzon M. Soft drinks and dental health: a review of the current literature. J Dent. 2006;34(1):2-11.

83. Maida CA, Marcus M, Spolsky VW, Wang Y, Liu H. Socio-behavioral predictors of self-reported oral health-related quality of life. Qual Life Res. 2013;22(3):559-66.

84. Dey AN, Lucas JW. Physical and mental health characteristics of US-and foreign-born adults: United States, 1998–2003. Adv Data. 2006;369:1-19.

85. Liu Y. Differentiation of self-rated oral health between American non-citizens and citizens. Int Dent J. 2016;66(6):350-5.

86. Pattussi MP, Olinto MTA, Hardy R, Sheiham A. Clinical, social and psychosocial factors associated with self-rated oral health in Brazilian adolescents. Community Dent Oral Epidemiol. 2007;35(5):377-86.

87. Blizniuk A, Ueno M, Zaitsu T, Kawaguchi Y. Association between self-reported and clinical oral health status in Belarusian adults. J Investig Clin Dent. 2017;8(2):e12206.

88. Mejia G, Armfield JM, Jamieson L. Self-rated oral health and oral health-related factors: the role of social inequality. Aust Dent J. 2014;59(2):226-33.

89. Fisher-Owens SA, Gansky SA, Platt LJ, Weintraub JA, Soobader M-J, Bramlett MD, et al. Influences on children's oral health: a conceptual model. Pediatrics. 2007;120(3):e510-e20.

CURRICULUM VITAE

Naif Nabel F. Abogazalah

Education

2022	PhD in Dental Sciences, Indiana University. Indianapolis, Indiana, USA.
2016	Master of Science in Dentistry. Joint Operative and Preventive Dentistry Graduate program. Indiana University School of Dentistry. Indianapolis, Indiana, USA.
2011	Bachelor degree in Dental Surgery. King Khalid University College of Dentistry. Abha, Kingdom of Saudi Arabia.

Certificates

2019	Certificate of Postgraduate Study in Public Health. Richard M. Fairbanks School of Public Health, Indiana University – Purdue University. Indianapolis, Indiana, USA.
2016	Certificate of Postgraduate Study in Operative Dentistry. Indiana University School of Dentistry. Indianapolis, Indiana, USA.
2012	Professional Accreditation Certificate. Accordance to the Saudi Commission for Health Specialties. Kingdom of Saudi Arabia.
2011	Internship completion certificate. King Khalid University College of Dentistry. Abha, Kingdom of Saudi Arabia.

Honors and awards

2018	Saudi Ministry of Health award in recognition of participation and implementation of the National Demographic and Health Survey of Kingdom of Saudi Arabia in 2017.
2018	Indiana University-Purdue University Indianapolis Chancellor's appreciation award in recognition for collaborative work between Indiana University and Saudi Ministry of Health regarding the National Demographic and Health Survey of Kingdom of Saudi Arabia in 2017.

2018	Founding Dean Paul K. Halverson, Fairbanks School of Public Health, award in recognition of Public Health Services in the Saudi National and Demographic Health Survey in 2017.
2016	Delta Dental Foundation Award for Master Thesis research project in form of project funding. Delta Dental Foundation. Okemos, Michigan, USA.
2011	Second Honor Degree awarded by King Khalid University.
2011	Third Rank Achievement awarded by King Khalid University.

Professional Experience

2015 – 2022	Bench instructor. Indiana University School of Dentistry. Indianapolis, Indiana, USA.
2013 – 2016	Resident, Operative Dentistry program. Indiana University School of Dentistry. Indianapolis, Indiana, USA.
2011 – 2013	General dentist. King Khalid University College of Dentistry. Abha, Kingdom of Saudi Arabia.
2011 – 2013	Teaching assistant. King Khalid University, College of Dentistry. Abha, Kingdom of Saudi Arabia.
Jul - Aug 2011	Al Faraa Primary Health Care Center. Al Faraa, Kingdom of Saudi Arabia.
Feb - Jun 2011	King Khalid University Dental Clinics. Abha, Kingdom of Saudi Arabia.
Dec 2010 - Jan 2011	Riyadh Armed Forces Hospital. Riyadh, Kingdom of Saudi Arabia.
Oct - Nov 2010	King Khalid University Hospital at King Saud University. Riyadh, Kingdom of Saudi Arabia.
Aug - Sep 2010	King Fahad Armed Forces Hospital at King Faisal Military City. Khamis Mushait, Kingdom of Saudi Arabia.

Conference Presentations

May 2011	Prevalence of Incisor Crowding among 13-16-year-old school boys in Abha City, Saudi Arabia. The Second Scientific Research Day. King Khalid University College of Dentistry. Abha, Saudi Arabia.
March 2013	Adhesive performance of contemporary esthetic restoratives to cervical tooth dentin. IADR/AADR/CADR 91st General Session and Exhibition. Seattle, WA, USA.
Feb 2015	Table Clinic. Conservative Esthetic Approach for Crown Fracture with Pulp Exposure. Annual Scientific Meeting of the Academy of Operative Dentistry. Chicago, IL, USA.
April 2015	Conservative Esthetic Approach for Crown Fracture with Pulp Exposure. 23rd Indiana University School of Dentistry Research Day. Indianapolis, IN, USA.
April 2016	Near-infrared Digital Imaging Transillumination for Approximal Non-cavitated Caries Detection. 24rd Indiana University School of Dentistry Research Day. Indianapolis, IN, USA.
July 2016	Caries Activity Assessment: Which is More Dominant, Visual or Tactile Examination? Near-infrared Digital Imaging Transillumination for Approximal Non-cavitated Caries Detection. 63rd ORCA Congress. Athens, Greece.
March 2017	Non-cavitated Approximal Caries Detection with Near-Infrared Digital Imaging Transillumination. IADR/AADR 95th General Session and Exhibition. San Francisco, CA, USA.
March 2017	Imaging Geometry on Detecting Non-cavitated Approximal Caries Using Fiber-Optic Trans-Illumination. IADR/AADR 95th General Session and Exhibition. San Francisco, CA, USA.
April 2017	Binding of Streptococcus mutans to Collagen in Presence of Nicotine. 25th Indiana University School of Dentistry Research Day. Indianapolis, IN, USA.
April 2017	Comparison between Visual and Tactile Parameters for Caries Activity Assessment. 25th Indiana University School of Dentistry Research Day. Indianapolis, IN, USA.
April 2017	Binding of Streptococcus mutans to Collagen in Presence of Nicotine. 47th Annual Meeting of the AADR and the 42nd Annual Meeting of the CADR. Fort Lauderdale, FL, USA.

April 2020	Sociodemographic and Behavioral Influences on Oral Health in Saudi Arabia. 28th Indiana University School of Dentistry Research Day. Indianapolis, IN, USA.
April 2021	Oral Health Influences in Saudi Arabia, 2017 National Survey. 29th Indiana University School of Dentistry Research Day. Indianapolis, IN, USA.
July 2021	Oral Health Influences in Saudi Arabia, 2017 National Survey. 99th IADR General Session and Exhibition, 50th AADR Annual Meeting, and 45th CADR Annual Meeting. Virtual Meeting.

Publications

Abogazalah, Naif; Constantin Yiannoutsos; Esperanza Angeles Martinez Mier; Muhammad Tantawy; Juan Fernando Yepes Oral Health Influences in Saudi Arabia Reported in the 2017 Nationwide Demographic and Health Survey. Saudi Dental Journal. Submitted on March, 2022.

Abogazalah, Naif; Eckert, George J; Ando, Masatoshi. In vitro visual and visible light transillumination methods for detection of natural non-cavitated approximal caries. Clinical Oral Investigations. 2018. doi: 10.1007/s00784-018-2546-3.

Abogazalah, Naif; Eckert, George J; Ando, Masatoshi. In vitro performance of near infrared light transillumination at 780-nm and digital radiography for detection of non-cavitated approximal caries. J Dent.2017. 63: 44-50.

Abogazalah, Naif; Ando, Masatoshi. Alternative methods to visual and radiographic examinations for approximal caries detection. 2017. J Oral Sci. doi: 10.1016/j.jdent.2017.05.018.

Abdelaziz, Khalid; **Abogazalah, Naif**; El-Malky, Wael. Microleakage in Contemporary Esthetic Restorations Following Cyclic Wet-Dry Storage, Saudi Journal for Dental Research. 2016. 7:81-90.

Abdelaziz, Khalid; **Abogazalah, Naif**; Saleh, Ahmed. Adhesive performance of contemporary esthetic restoratives to cervical tooth dentin. 2013. J Dent Res, Vol 92, Spec Iss A: abstract number 174054. 2013.

Togoo, Rafi; V., Shaheen; AbdulWahab, Mohammad; **Abogazalah, Naif**. Prevalence of Incisor Crowding among 13-16-

year-old school boys in Abha City, Saudi Arabia. Int J Cont Dent. 2011. Vol 2, No 6.