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MALOCCLUSION, ORTHODONTIC TREATMENT NEED AND ORAL HEALTH-RELATED QUALITY OF LIFE IN ADOLESCENTS: A COMPARISON BETWEEN PUBLIC AND PRIVATE SCHOOLS IN BEIRUT

by
SUZANNA ADNAN AL MA'ALI

A thesis
submitted in partial fulfillment of the requirements
for the degree of Master of Science in Epidemiology
to the Department of Epidemiology and Population Health
of the Faculty of Health Sciences
at the American University of Beirut

Beirut, Lebanon
April, 2015

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Approved by:

Dr. Monique Chaaya, Professor and Chair Epidemiology and Population Health	Advisor
Dr. Joseph G. Ghafari, Professor and Head Orthodontics and Dentofacial Orthopedics	Member of Committee
Dr. Miran Jaffa, Assistant Professor Epidemiology and Population Health	Member of Committee
Ms. Mayada Kanj, Instructor Health Promotion and Community Health	Member of Committee

Date of thesis defense: April 21, 2015

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ACKNOWLEDGMENTS

No one can whistle a symphony.
It takes a whole orchestra to play it.
Halford Edward Luccock

This thesis is a reflection of an enormous amount of teamwork and cooperation. I would therefore like to take this opportunity to express my utmost appreciation to all the individuals who have contributed to this journey.

I am sincerely grateful to

Dr. Monique Chaaya, for teaching me everything I know about epidemiology and then showing me – through this research – how to apply it in the real world;

Dr. Joseph Ghafari, for providing me the opportunity to incorporate Public Health and research into my training as an orthodontist, for giving me scientific perspective and for providing the needed "push" when I needed it;

Dr. Miran Jaffa, for introducing me to the vast world of biostatistics and for her guidance when biostatistics got too vast and too complicated for me;

Ms. Mayada Kanj, for giving me perspective on the amount of work, effort and resources that are needed to make changes, and for highlighting the importance of giving contextual recommendations;

Mrs. Sonia El Khoury, for her assistance in obtaining the official approval for this work and for her support of research on the oral health of children in Lebanon;

Dr. Naji Shallita, for his support of this work and his indispensable assistance in recruiting a substantial portion of the adolescents in our sample;

The directors, teachers and nurses in all private and public schools involved in this research, for their cooperation and for their appreciation of research and of the importance of oral health among youth;

Antoine Hanna and *Celine Moukarzel*, for setting an example with previous research and for providing guidance and assistance at every possible opportunity;

Ms. Asma Shihab, for her constant assistance from "behind-the-scenes";

and last but not least, to *Katy* and *Mohannad*, for sharing all phases of this journey with me. The only thing better than a good team, is a team of good friends.

AN ABSTRACT OF THE THESIS OF

Suzanna Adnan Al Ma'ali for Master of Science
Major: Epidemiology

Title: Malocclusion, orthodontic treatment need and oral health-related quality of life in adolescents: a comparison between public and private schools in Beirut

Introduction:

Adolescence is a vulnerable period in molding occlusion and is when disparities in malocclusion are aggravated by social inequalities. The aim of this study was to assess how social inequalities contribute to the burden from malocclusion in adolescents.

Design:

A comparative cross-sectional study of secondary school adolescents aged 11-18 years attending public and private schools in Beirut-Lebanon.

Methods:

A sample of 656 adolescents aged 11-18 years attending 7 public and 9 private schools were screened by a calibrated examiner. Crowding and sagittal, vertical and transverse indicators of malocclusion were recorded. Parents answered a questionnaire on child- and family-related demographic, socio-economic (SE) and behavioral factors. Adolescents answered the Child Perceptions Questionnaire on oral health-related quality of life (OHRQoL). The modified index for orthodontic treatment need (IOTN) was computed. Multiple logistic and linear regressions were performed to explore the determinants of sagittal malocclusion (overjet), crowding and IOTN and to associate IOTN with OHRQoL.

Results:

One in seven adolescents is in need for orthodontic treatment. Malocclusion and treatment need (IOTN) were comparable between private and public schools. After adjusting for appropriate variables, income was the strongest predictor of overjet and IOTN. Economically disadvantaged children had strikingly elevated odds of being in need for orthodontic treatment (OR=23). Age and childhood feeding mode significantly predicted overjet. Mouth breathing showed a positive association with crowding and IOTN. Bottle feeding duration was negatively associated with crowding severity. Adolescents in definite need for treatment reported significantly lower OHRQoL.

Conclusion:

The burden from unmet orthodontic treatment need is unequally distributed along the social spectrum. The implications for inequities in quality of life are contrary to the concepts of social justice and the fundamentality of oral health as a universal right. Our findings highlight the importance of promoting timely interceptive orthodontic treatment through structural changes toward an integrated system of timely screening, referral and provision of treatment, with specific emphasis on targeting the SE disadvantaged.

CONTENTS

ILLUSTRATIONS

TABLES

ABBREVIATIONS

IOTN	Index Of Orthodontic Treatment Need
DHC	Dental Health Component
AC	Aesthetic Component
QOL	Quality of Life
OHRQoL	Oral Health-Related Quality of Life
TDI	Traumatic Dental Injury
CPQ	Child Perceptions Questionnaire
SE(S)	Socio Economic (Status)
MCPD	Maximum Contact Point Displacement
PBS	Public School Sample
PVS	Private School Sample
DMFT	Decayed, Missing and Filled Teeth
CI	Confidence Interval
ICC	Intra Class Correlation
GEE	Generalized Estimated Equations
GLM	Generalized Linear Models
NHANES	National Health and Nutrition Examination Survey
ICS	International Collaborative Study
WHO	World Health Organization
ADA	American Dental Association
GDP	General Dental Practitioner
US	United States
UK	United Kingdom
UAE	United Arab Emirates

for

MY FAMILY

the family I was *born* into
and the family I *chose* for myself.

CHAPTER I

INTRODUCTION

The term malocclusion is defined as "any deviation from the normal or ideal relationship of the upper and lower teeth, as they are brought into functional contact" (Wang, Zeng, Zhang, & Yang, 2012). It encompasses irregularities in the alignment of individual teeth and/or a mal-relationship of the dental arches or jaws, in any of the three planes of space (Proffit, Fields Jr, & Sarver, 2006; Thilander & Rönning, 1995).

The World Health Organization (WHO) acknowledges both the potential disfigurement and the impairment of function resulting from malocclusion, and, as such, recognizes the need for orthodontic treatment if there is an impediment to either one's physical or emotional well-being (World Health Organization, 1987). Individuals with extreme malocclusions seek treatment for reasons of poor oral function and, often more importantly, as a result of the social discrimination resulting from their disfiguring malocclusions (Proffit, Phillips, & Dann, 1990). However, in malocclusions that are less functionally debilitating, the improvement of esthetics is likely to be the overriding, if not the only, motive for seeking treatment.

In as much as dentistry has shifted towards prevention (as opposed to treatment) in the control of tooth decay (Ramos-Gomez, Crystal, Domejean, & Featherstone, 2012; Watt, 2005), orthodontics has geared towards interception and early intervention (J. L. Ackerman, 1974; Philip, 2011). The American Association of Orthodontists (AAO) currently recommends that a child's first visit to an orthodontist be no later than at the age of 7 years

(American Association of Orthodontists, 2013). This enables the detection of early signs of developing problems and the provision of relatively simple and inexpensive treatments at the optimal time (American Association of Orthodontists, 2013; Philip, 2011). Timely interceptive orthodontic procedures can prevent the development of certain occlusal problems and/or reduce the complexity of future malocclusions, often either obviating the need for later conventional "braces" or producing results such that further treatment may be considered elective (King & Brudvik, 2010; Philip, 2011).

The period of transition between childhood and adolescence is a particularly vulnerable period in molding and establishing malocclusion (Proffit, Fields, & Moray, 1998) and the age of 12, in particular, has been assigned by the WHO as the "global indicator age" for international comparisons of oral disease trends (World Health Organization, 2013). It has been demonstrated that crowding/incisor irregularity, which is a major driving force for orthodontic treatment, worsens as the individual grows into adolescence and loses all primary teeth (Proffit et al., 1998). Therefore, a child passing the age of 12 without having had an orthodontic consultation often represents a lost opportunity, especially in light of the existing evidence on the benefits of interceptive orthodontics in resolving incisor irregularity (Brennan & Gianelly, 2000).

Orthodontic treatment, similar to dental treatment in general, is not equally obtained by all individuals requiring it. Two factors may contribute to this equation: perceived need for orthodontic treatment (driven by functional and/or esthetic disharmonies) and access to treatment when the need is acknowledged. The elevated costs of orthodontic treatment create an inequality in the access to orthodontic care, with various

contributing socio-economic factors (Abu Alhaija, Al-Khateeb, & Al-Nimri, 2005; Frazao & Narvai, 2006; Germa, Kaminski, & Nabet, 2010).

The twenty-first century's boom in interest in esthetics has resulted in an increased awareness of both facial and dental attractiveness and a concomitant increase in the pursuit of esthetic dental treatments, including orthodontics. A discrepancy nevertheless exists between acceptance of and need for orthodontic treatment, with individuals having both heightened perceived need for and privileged access to orthodontic services benefiting the most from treatment. Socio-economic indicators have further been implicated in both the development of malocclusion and the severity of its manifestation, with children attending public schools being in greater need for orthodontic treatment than those attending private schools (Frazao & Narvai, 2006). Hanna et al. (2015) recently reported similar findings in Beirut, where some malocclusion indices in children aged 6-11 were more severe in children attending public schools. He further demonstrated that, compared to American children of the same age, the average Lebanese child had a greater unmet need for orthodontic treatment. As a result of these disparities, some children with borderline need benefit from orthodontic treatment whereas others with high need do not, because of disparities in socio-economic (SE) backgrounds (Proffit et al., 1998).

Evidence on the prevalence of malocclusion in adolescents in Lebanon is more than a decade outdated (Doumit & Doughan, 2002; Saleh, 1999), but the vulnerability of this transitional age would suggest an increase in certain aspects of malocclusion compared to that demonstrated by Hanna et al. (2015) in younger children. The health inequalities highlighted in the younger age group may translate into the inequitable development of

malocclusions in SE disadvantaged children that may otherwise be preventable through timely interceptive orthodontics.

The weight imposed by the social inequalities present in Lebanon, coupled with the vulnerability of the adolescent age in terms of malocclusion establishment, dictates the pursuit of an investigation into the disparities in malocclusion between adolescents of different socio-economic backgrounds. Our research was carried out to assess malocclusion and orthodontic treatment need in adolescents from different SE backgrounds in Beirut. Does the development of malocclusion in this age group depend on social status? Do the determinants of malocclusion differ, and is the need for orthodontic treatment dependent on the social inequalities existing in the population? Therefore, the research question that this study attempted to answer was:

"How do social inequalities contribute to the burden of malocclusion in adolescents in Beirut?"

CHAPTER II

LITERATURE REVIEW

Definitions and concepts vital to the understanding of this subject will gradually be introduced throughout this review. The epidemiology of malocclusion will be reviewed in terms of its prevalence and its determinants. Research illustrating the burden of malocclusion on affected individuals will also be discussed. Finally, relevant concepts related to the treatment of malocclusion from a public health perspective will be described. The role and significance of inequalities in oral health and access to treatment will be emphasized throughout the different sections. The review will conclude with the aims and the hypotheses of the current investigation, in addition to a brief description of the significance of such research for the improvement of dental public health in Lebanon.

A. Malocclusion

1. Definitions and Concepts

The term "occlusion" refers to the contact between the maxillary and mandibular teeth at rest and during function, and reflects an integrated system of functional units involving the teeth, the temporomandibular (jaw) joints and the muscles of the head and the neck (Nelson, 2009). The sophistication of the units involved in occlusion naturally results in a complexity of malocclusion, which in turn may manifest as disturbances in dental development (discrepancies in the arrangement of the teeth) and/or in skeletal development (those that affect the structure of the upper and/or lower jaws) (Proffit et al., 2006;

Thilander & Rönning, 1995). As such, numerous indicators and classifications for malocclusion have been proposed over the roughly 250 years since interest in this field began (J. L. Ackerman & Proffit, 1969; Miguel-Neto et al., 2010). By far the most commonly used of these indices is the Angle classification of malocclusion. In 1989, Edward H. Angle (1899) developed a malocclusion classification based on the antero-posterior relationship between the upper and lower permanent first molars (6-year-old molars). The ideal relationship between these first molars was classified as a class I Angle occlusion, with deviations termed as either Angle class II or class III malocclusion, depending on the direction of deviation. Another antero-posterior indicator of malocclusion that has gained particular attention is the distance between the upper front teeth and the lower front teeth, *overjet*; which may be considered a reflection of the degree of protrusion of the upper front teeth. Given its association with trauma to the front teeth and to quality of life and facial esthetics (Nguyen, Bezemer, Habets, & Prahl-Andersen, 1999; Seehra, Fleming, Newton, & DiBiase, 2011), overjet has become a feature of malocclusion integral to classification and diagnosis. Crowding is another feature of malocclusion that warrants mentioning due to its appreciation by individuals seeking treatment. Although the layperson rarely discerns that he/she has a class II Angle occlusion, he/she is often conscious of the degree of crowding, overlap or irregularity in alignment of his/her front teeth.

The abovementioned indicators reflect only a fraction of the indicators that may be used to describe any one malocclusion. Angle's classification, in particular, despite its popularity, has received much criticism for its inability to accurately depict and differentiate between different malocclusions (Graber, 1972; Rinchuse & Rinchuse, 1989). Numerous attempts have ensued in order to modify/improve on the Angle classification

method, replace it with a more sensitive indicator or devise methods founded on *several* indicators of malocclusion rather than relying solely on the molar relationship (J. L. Ackerman & Proffit, 1969; Bjork, Krebs, & Solow, 1964; British Standard Institute, 1983; Dewey, 1915; A. C. Williams & Stephens, 1992). Nevertheless, owing to its simplicity, Angle's method of classification remains to be a widespread tool for the classification of malocclusion (Du, Rinchuse, Zullo, & Rinchuse, 1998; Rinchuse & Rinchuse, 1989).

2. Adolescence and Malocclusion

Paralleling the acknowledgement of the importance of oral health and occlusion, governments, organizations and researchers have increasingly recognized the need for accurate representations of the prevalence of malocclusion in the general population. One of the greatest challenges in carrying out such prevalence studies is the retrieval of a sample that adequately reflects the population being studied in an efficient and cost-effective manner. As such, the vast majority of these studies have been carried out on school children, given their accessibility in adequate and representative numbers.

However, from a public health perspective, the utilization of school children transcends merely convenience and accessibility. The period between the end of childhood and early adolescence holds particular significance in the specialty of orthodontics, being crucial to the diagnosis of malocclusion and the planning of its treatment. Although some aspects of malocclusion self-improve during the transition from the primary to the permanent dentition, others become permanent and may even deteriorate without timely interception (Gois et al., 2012; Jolley et al., 2010; Thilander, Pena, Infante, Parada, & de Mayorga, 2001). Consequently, the age of 12 is a popular age for examining school

children for malocclusion in epidemiological studies (Burden & Holmes, 1994; Chestnutt et al., 2006; Josefsson, Bjerklin, & Lindsten, 2007; Mandall et al., 2005; Manzanera, Montiel-Company, Almerich-Silla, & Gandia, 2009; Perillo, Masucci, Ferro, Apicella, & Baccetti, 2010). Measuring malocclusion at this age is an indicator of the prevalence in the recently established permanent dentition and, if left untreated, is unlikely to change significantly during adolescence and early adulthood (Helm & Petersen, 1989). Moreover, the estimation of malocclusion during adolescence has implications regarding access to appropriate and timely orthodontic treatment, and is essential in evaluating dental health systems and allocating resources (al Nimri & Richardson, 2000; King & Brudvik, 2010; Vakiparta, Kerosuo, Nystrom, & Heikinheimo, 2005).

3. Prevalence

Various epidemiologic studies have been carried out to estimate the prevalence of malocclusion, unfortunately resulting in disparate conclusions. Although different prevalence rates for different populations are conceivable, the variations are often substantial even within studied populations, suggesting that they are likely to be the result of more than differences inherent to the studied populations (Evensen & Ogaard, 2007; Thilander et al., 2001). The employment of inconsistent registration methods of malocclusion (ranging from Angle's molar classification to the registration of any type of malocclusion), coupled with the disparities in sample sizes, sampling techniques, and the ages and races of populations studied has resulted in a wide range of estimates (Borzabadi-Farahani, Borzabadi-Farahani, & Eslamipour, 2009a; Evensen & Ogaard, 2007; Thilander et al., 2001).

a. Global and International Estimates

Estimates of the prevalence of malocclusion in various populations range from 40 to 93% (Evensen & Ogaard, 2007; Thilander et al., 2001). Separate reports range from as low as 38.9% (Dhar, Jain, Van Dyke, & Kohli, 2007) to as high as 97.6% (Rwakatema, Nganga, & Kemoli, 2006).

Table 2.1 presents a summary of prevalence rates of malocclusion reported by studies investigating adolescents. The widest variability in reported rates involves the Caucasian race, with estimates ranging between 38.9% in Finland and 93% in Italy (Ciuffolo et al., 2005; Myllarniemi, 1970). However, it must be noted that the lowest estimate (38.9%) was reported on a Finnish sample aged 3 to 19 years (Myllarniemi, 1970). Given that malocclusion is less common in younger ages, the reported value is likely to be an underestimate of the prevalence of malocclusion in Finnish adolescents.

Reports on the prevalence among African populations also show considerable variability, with rates ranging between 45% and 97.6% (Kerosuo, Laine, Kerosuo, Ngassapa, & Honkala, 1988; Rwakatema et al., 2006). For the Hispanic and Asian races, however, reported rates are relatively less variable: 88-93% for the former and 61-92.9% for the latter.

b. Regional and Local Estimates

Studies on the prevalence of malocclusion conducted in the region are few compared to the international pool of literature. Reported prevalence rates of malocclusion range between 55 and 92% and are based on studies carried out in Jordan, Lebanon, Kuwait, Saudi Arabia, Turkey and Iran (Abu Alhaija et al., 2005; al-Emran, Wisth, & Boe, 1990; Behbehani,

Artun, Al-Jame, & Kerosuo, 2005; Borzabadi-Farahani et al., 2009a; Doumit & Doughan, 2002; Gelgor, Karaman, & Ercan, 2007; Murshid et al., 2010). However, the general trend across the most recent of these studies is similar. In a sample of 1,024 randomly selected adolescents aged 13-14 in Saudi Arabia, only 9% were judged to have normal occlusion (Murshid et al., 2010). Gelgor and coworkers (2007) similarly examined 2329 Turkish adolescents of the age 12-17 years and judged 10.1% to be free of malocclusion. Correspondingly, of the 1,299 Kuwaiti 8th graders recruited by stratified cluster sampling, 14% were found not to have a malocclusion (Behbehani et al., 2005). In Iranian adolescents, however, a slightly lower prevalence of malocclusion was reported, with 22.9% of 11-14 year olds considered to have a normal occlusion (Borzabadi-Farahani et al., 2009a). As mentioned earlier in this section, in addition to differences in the populations studied, the different age groups examined and variations in the recording of malocclusion, including inter-examiner inconsistencies in recording the same traits, are likely to have contributed to the variations in reported prevalence of malocclusion.

The lowest prevalence rate for malocclusion in adolescents in the region has been reported in Lebanon. However, data on Lebanese adolescents have not been updated for more than a decade. Doumit and Doughan (2002) screened 1,257 Lebanese adolescents from six administrative regions in Lebanon and concluded that 55% of 12 and 15 year olds had a malocclusion. However, the criteria used to register the presence of malocclusion were not described, with malocclusions described as present or absent. Surveying 851 Lebanese students aged 9-15; Saleh (1999) concluded that the prevalence of malocclusion was 59.7%. This conclusion, however, was based primarily on the presence or absence of a class I Angle molar relationship. Given the vast array of malocclusion features in the

Table 2.1: Prevalence of malocclusion from retrieved epidemiological studies

Author (Publication Year)	Country/ Population	N	Age	Prevalence
Ciuffolo et al. (2005)	Italy	810	11-14	93%
Gabris et al. (2006)	Hungary	483	16-18	70.4%
Massler, Frankel (1951)	American Caucasians	2,758	14-18	78.9%
Mills (1966)	American Caucasians	1,455	8-17	82.5%
Foster, Day (1974)	UK	1,000	11-12	59.9%
Thilander, Myrberg (1973)	Sweden	5,459	13	73.8%
Kerosuo et al. (1991)	Finland	458	12-18	88%
Helm (1968)	Denmark	1,700	9-18	78.5%
Myllarniemi (1970)	Finland	1,531	3-19	38.9%
Ingervall, Hedegard (1975)	Finland	200	8-16	76.5%
Dhar et al. (2007)	India	812	11-14	38.9%
Al Emran et al. (1990)	Saudi Arabia	500	14	62.4%
Abu alhaija et al. (2005)	Jordan	1,003	13-15	92%
Behbehani et al. (2005)	Kuwait	1,299	13-14	86%
Murshid et al. (2010)	Saudi Arabia	1,024	13-14	91%
Saleh (1999)	Lebanon	851	9-15	59.7%
Doumit, Doughan (2002)	Lebanon	1,257	12, 15	55%
Gelgor et al. (2007)	Turkey	2,329	12-17	89.9%
Kerusuo et al. (1988)	Tanzania	642	11-18	45%
Ng'ang'a et al. (1996)	Kenya	919	13-15	72%
Mugonzibwa et al. (2004)	Tanzania	869	3.5-16	Up to 51%
Onyeaso (2004)	Nigeria	636	12-17	76%
Rwakatema et al. (2006)	Tanzania	289	12-15	97.6%
Altemus (1959)	African Americans	3,289	12-16	83.5%
Garner, Butt (1985)	African Americans	445	13-15	73%
	Kenyans	505		83.2%
Mtaya et al. (2009)	Tanzania	1,601	12-14	63.8%
Silva, Kang. (2001)	Latin Americans	507	12-18	93%
Thilander et al. (2001)	Colombia	4,724	13-17	88%
Lew et al. (1993)	China	1,050	12-14	92.9%
Wood (1971)	Eskimo	100	11-20	82%
Harrison, Davis (1996)	Native Canadian	1,438	7-15	61%
Grewe et al. (1968)	American Indians	651	9-14	65.4%

vertical or transverse planes or in the alignment of teeth that may accompany a class I molar relationship, this estimate is likely to underrate the prevalence of malocclusion.

Several other studies on malocclusion have been carried out in Egypt, Lebanon, Syria and Iran. However, these have either investigated the condition in an orthodontic population (individuals seeking orthodontic treatment) (Kassis, Serhal, & Bassil-Nassif, 2010) or, similar to the work of Saleh in Lebanon, have only registered malocclusion in terms of Angle's molar relationship (Alkilzy, Shaaban, Altinawi, & Splieth, 2007; El-Mangoury & Mostafa, 1990). Given these limitations, the results of these studies are inadequate to make conclusions about the overall prevalence of malocclusion.

4. Determinants of Malocclusion

The etiology of malocclusion is neither simple nor has it been entirely uncovered. Although early investigations into this area of study placed emphasis on the role that genes play in the establishment of malocclusion (Davenport, 1917; Stein, Kelley, & Wood, 1956; Stoddard, 1947), modern research is increasingly revealing the complex and multifactorial nature of malocclusion and the interdependent relationship between two major groups of determinants in its development: genetic and non-genetic factors (Hartsfield, Morford, Otero, & Fardo, 2013; Moss, 1997; Thilander & Rönning, 1995).

Although the term "environmental" determinants of malocclusion is often employed to collectively delineate all non-genetic factors associated with the development of malocclusion, "functional factors" merit a separate discussion and perhaps even to be considered as a third, separate group of etiological factors (Huh et al., 2013). For the

purposes of this discussion, non-genetic determinants will be divided into two separate categories: environmental and functional factors.

In recent years, research on the determinants of oral health has begun to diverge from the traditional biomedical model; embracing the social causes of oral health as an important cause for disparities. Especially in the context of community dentistry and dental public health, oral health is increasingly being viewed through a multidimensional, multilevel approach that acknowledges the contribution of political, economic, social and environmental determinants (Fisher-Owens et al., 2007; Watt, 2012; D. M. Williams, 2011).

The ensuing discussion in no way attempts to isolate the major etiological groups in their contribution to malocclusion but merely aims to illustrate the role each plays, albeit with an assumed interrelationship between them. Following the discussion of each separately, a brief illustration of the inter-relationship between the various determinants within a conceptual framework is presented.

a. Genetic Determinants

The shape and size of the skeleton of the head, face, jaws and teeth are considered to be, to a large extent, genetically determined (Harris, 2008; Thesleff, 2006; Townsend, Hughes, & Richards, 2006). Early interest in the association between genetics and occlusion attributed the development of malocclusion to incompatibilities in the *sizes* of the teeth and the jaws, as a result of "race mixture" (Davenport, 1917). It has been stipulated that the genetic diversity resulting from the mixing of different ethnic groups would result in disproportion between the sizes of the jaws and the teeth, and between the sizes of the

jaws themselves, relative to each other (P. Brown, 1987; Petrovic, Vukic-Culafic, Ivic, Djuric, & Milekic, 2013). This reasoning has not been supported by ensuing advances in genetics and molecular biology. Most occlusal variation is now largely believed to be the result of a more complicated control of numerous genes and their interactions with epigenetic environmental influences (Hartsfield et al., 2013; Mossey, 1999; Smith & Bailit, 1977).

A detailed discussion of the genetic contribution to malocclusion is beyond the scope of this thesis. Worth noting, however, is that across numerous studies examining the contribution of genetic variation to malocclusion (Hartsfield et al., 2013) variations in skeletal (jaw) relationships appear to be more closely associated to genetic variability than variations in dental occlusal traits (Harris, 2008; Hartsfield et al., 2013; Townsend et al., 2006). Various genetic studies have identified gene control in determining the dimensions of the lower jaw and a recent review by Hartsfield and coworkers (2013) identified 13 possible locations on 9 chromosomes that have been implicated.

The understanding of "genetic" control is complicated by the sophistication of genetic regulation itself. Concepts such as penetrance, variable expressivity and epigenetics challenge the traditional understanding of genetic regulation and emphasize the capacity for non-genetic factors such as diet, respiratory factors, pollution, muscular function and drugs to result in modifications in gene expression (Hartsfield et al., 2013).

b. Non-Genetic Determinants

As a result of research failing to ascribe full control to genetics in the development of most malocclusions, the paradigm has shifted towards a multifactorial hypothesis

including both genetic and environmental factors, with suggestions of predominance of environmental factors for at least some aspects of malocclusion (Corruccini, Townsend, Richards, & Brown, 1990; Proffit, Fields Jr, & Sarver, 2012). Some of the non-genetic factors that have been linked to the development of malocclusion include diet, early loss of primary teeth, disturbances in normal breathing, and sucking habits (Corruccini et al., 1990; Proffit et al., 2012; Thilander & Rönning, 1995).

i. Environmental Factors

Modernized or industrialized populations have continually been shown to present more malocclusion than both ancestral populations and concurrent "un-modernized" populations living in conditions more resembling of our ancestral environment (Begg, 1954; Corruccini, Potter, & Dahlberg, 1983; Kaifu, Kasai, Townsend, & Richards, 2003). Consequently, malocclusion has been described as a disease of civilization or westernization similar to congestive heart disease and hypertension. The transition from predominant occlusal harmony to predominant malocclusion, described as an occlusal "epidemiologic transition", has been shown to occur within as little as one to two generations (Corruccini & Lee, 1984; Corruccini et al., 1990). This has primarily been associated with the changes in dietary habits accompanying industrialization; specifically the transition to soft and processed foods.

However, it must be emphasized that, although modernization has been linked to the development of malocclusion through the evolutionary changes associated with soft diet, urbanization is linked to several other local and generalized environmental factors that are increasingly believed to play pivotal roles in malocclusion; including caries, premature

loss of primary teeth and breathing-related factors (Corruccini & Lee, 1984; Corruccini et al., 1990; Kaifu et al., 2003). Although some authors have questioned the associations with local factors, dental caries and premature loss of primary teeth have been linked to disturbances in occlusion and space that translate into malocclusion in the mixed and permanent dentitions (Mtaya, Brudvik, & Astrom, 2009; Proffit et al., 2012; Schopf, 1981). Other local factors involved include disturbances in individual teeth, including ankyloses (when a tooth fuses to the surrounding bone), over-retained primary teeth (delayed loss), disturbances in the eruption of permanent teeth (tooth impaction in bone), significant variations in the sizes of individual teeth, the presence of supernumerary (extra) teeth and missing teeth (Proffit et al., 2012; Thilander & Rönning, 1995).

ii. Functional Factors

According to the "Functional Matrix Theory" described by Moss and his colleagues, the shapes of the bones in the head and the face evolve as a response to relevant functions; including the growth of the brain, breathing, and the activity of muscles (Moss, 1997; Moss & Salentijn, 1969). In accordance with this theory, increasing research illustrates the association between oral functional factors and the development of malocclusion, with emphasis on the roles played by mouth breathing, sucking habits and abnormal swallowing (Proffit et al., 2012; Thilander & Rönning, 1995)

It has been postulated that disturbances in the "normal" mode of nasal breathing, replaced by breathing through the mouth, lead to an imbalance in the functions of certain oral and facial muscles (Rubin, 1980). Mouth breathing in growing children has been associated with a narrow upper jaw and resultant transverse discrepancies in occlusion

(Allen, Rebellato, Sheats, & Ceron, 2003; Gois et al., 2008; Linder-Aronson, 1970; Ovsenik, 2009), increased overjet (Malhotra, Gupta, Pandey, Singh, & Nagar, 2013), anterior open bites (Berjis, Sonbolestan, Jabbarifar, & Farokh, 2005) and changes in facial features (Lessa et al., 2005; Rubin, 1980; Souki et al., 2012). In a nested case-control of 300 Brazilian preschool children (as part of a larger cross-sectional sample of 745 children), Gois and co-workers (Gois et al., 2008) conclude that the odds for having a malocclusion for children who are mouth breathers are 10.9 times those for children who breathe normally (adjusted 95% CI: 5.5-21.4).

It is not surprising, however, that some authors have questioned these associations, especially in view of the difficulty in accurately assessing mouth breathing (Melink, Vagner, Hocevar-Boltezar, & Ovsenik, 2010; Souki et al., 2009). Whereas some authors have attempted to quantitatively measure the amount of air flow through the nose using specially-designed instruments (Ovsenik, 2009), others resorted to the assessment of variables that are likely to result in mouth breathing (Melink et al., 2010; Souki et al., 2009); such as enlarged adenoids or tonsils and nasal obstruction or rhinitis (either through clinical examinations or radiographs (x-rays), introducing even more variability). Variations in the age of the growing child at the time of initiation of mouth breathing, the duration of this altered function, and the varying individual susceptibility to its effects further complicate the assessment of the association between mouth-breathing and malocclusion (Mossey, 1999).

Similar associations have been reported for sucking habits and malocclusion (Bishara, Warren, Broffitt, & Levy, 2006; Melink et al., 2010; Ovsenik, 2009). Sucking habits may be classified into nutritive and non-nutritive habits, with the former including

breastfeeding and bottle feeding, and the latter including finger/thumb and pacifier sucking. Similar to mouth breathing, non-nutritive sucking habits have been most strongly associated with the development of transverse occlusal discrepancies, namely posterior cross-bite (Andrade Ada, Gameiro, Derossi, & Gaviao, 2009; Bishara et al., 2006; Gois et al., 2008; Melink et al., 2010; Ovsenik, 2009). Associations have also been identified with the development of an anterior open bite and increased overjet (daCosta & Orenuga, 2002; Farsi & Salama, 1997). Similar to mouth breathing, the effect of non-nutritive sucking on the development of malocclusion greatly depends on the duration, intensity and frequency of the habit, but recent research supports that the threshold for developing a transverse malocclusion is breached after close to 2 to 3 years of duration; resulting in definite malocclusion (Gois et al., 2008; Melink et al., 2010)

Nutritive sucking habits have recently begun to receive interest in the literature. Breastfeeding is believed to play a protective role against the development of malocclusion by several authors (Kobayashi, Scavone, Ferreira, & Garib, 2010; Peres, Barros, Peres, & Victora, 2007; Thomaz, Cangussu, & Assis, 2012). Although some ascribe this to the direct effects of breastfeeding in stimulating facial muscles and enhancing the growth of both jaws, others believe it acts indirectly by reducing the duration of harmful sucking habits (Agarwal et al., 2014; Luz, Garib, & Arouca, 2006; Montaldo, Montaldo, Cuccaro, Caramico, & Minervini, 2011). Shorter breastfeeding and longer bottle feeding durations have been associated with increased uptake of non-nutritive sucking habits and their persistence beyond the first year of life. Other authors, however, have refuted the relationship between breastfeeding and malocclusion altogether (Legovic & Ostric, 1991; Viggiano, Fasano, Monaco, & Strohmenger, 2004; Warren & Bishara, 2002).

iii. Social Factors

Oral health has been shown to be subject to a social gradient, with individuals' health status being directly reflective of their position along the socioeconomic (SE) hierarchy (Watt & Sheiham, 2012). Socially disadvantaged groups are consistently ascribed with poorer oral health compared to their more SE privileged counterparts (Christensen, Twetman, & Sundby, 2010; Larson, Russ, Crall, & Halfon, 2008; Polk, Weyant, & Manz, 2010) This position along the SE spectrum is reflective of a complex integration of factors including occupational status, income level, educational attainment and social class, and is linked to an individual's degree of power and access to resources (Watt & Sheiham, 2012). These SE factors may be reflected through proxy indicators including ethnicity (for example being part of an ethnic minority), family size (number of children), presence of dental insurance and accessibility to treatment (Christensen et al., 2010; Larson et al., 2008; Polk et al., 2010). It is therefore not surprising that various authors attempting to investigate separate, specific SE factors have sometimes failed to detect an association with the development of malocclusion. Baskaradoss, Geevarghese, Roger, and Thaliath (2013) and investigated the relationship between income and other economic indicators and found no relationship with malocclusion. Nalcaci and coworkers (2012) examined the relationship between malocclusion and maternal and paternal education and monthly income (each separately) and reached similar conclusions. In a comparable recent study, De Sousa and coworkers found no differences in malocclusion between children attending private schools as compared to those attending public schools, and they also found no association with maternal schooling or with household income (Sousa, Pinto-Monteiro, Martins, Granville-Garcia, & Paiva, 2014).

Interestingly, the studies that have found an association between SE status (SES) and malocclusion appear to have utilized composite or aggregate indicators that are reflective of a more general notion of SE position. Using a proxy measure for SES based on zip code and area of residence, Tickle and coworkers (1999) found that among the 5918 examined 14 year old children, significantly more severe malocclusions were present among the more SE deprived children. Similarly, Mtaya and coworkers (2009) found significant differences in the occurrence of open-bites between Tanzanian adolescents residing in two SE different districts. Frazao and Narvai (2006) published data on a randomly selected probabilistic sample of 13,801 children from public and private schools in 131 cities in the state of São Paulo, Brazil. In their multivariate model, the SE factors that remained significantly associated with more severe malocclusion were: type of school, an index reflective of access to dental treatment, in addition to an interaction term between school type and ethnicity (Frazao & Narvai, 2006). Again, all these factors seem to suggest a wider set of underlying SE variables reflective of the influence of a broader social context. Another trend across these studies compared to the work of authors who refute the association of SE factors with malocclusion is that they examine a slightly older age group in which access to orthodontic treatment may be believed to play a role in inequalities in the presence of malocclusion. The works of Basskarados et al, Nalcaci et al and De Sousa et al were carried out on the ages of 3-5, 11-14 and 11-15, respectively, compared to the ages of 14, 12-14 and 12 to 18 in the works of Tickle et al., Mtaya et al. and Frazao and Narvai, respectively.

c. A Conceptual Framework for Oral Health

In recent years, oral health has become envisioned under a conceptual framework that acknowledges 5 key groups of determinants of oral health in children and adolescents: genetic and biologic predisposition, social factors, environmental factors, oral health behavior and dental health care (Fisher-Owens et al., 2007; D. M. Williams, 2011). These determinants interact on more than one level: the individual, family and community levels (**Figure 1**) (Fisher-Owens et al., 2007). Watt and Sheiham (2012), in a supplementary dissection of this multidimensionality, illustrate an even broader scope of influences that they term "structural determinants". These macro determinants, including macroeconomic policies, macro-politics and educational and health systems, mediate how other intermediary social determinants, including SES, affect oral health by modulating social circumstances and psychological and behavioral factors (**Figure 2.1**).

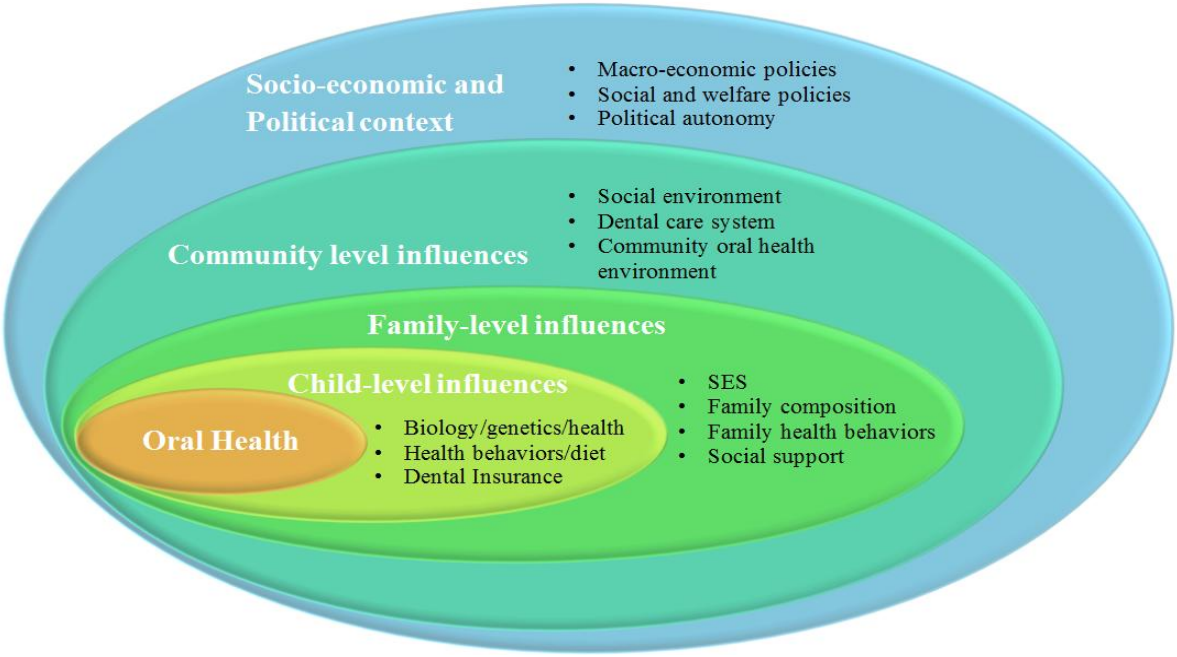


Figure 2.1: A conceptual framework for oral health (Adapted from Fisher-Owens et al., 2007; Watt and Sheiham, 2012).

Critical to the multidimensionality of such models is the understanding that no single influence acts in isolation, but rather through complex interactions between dimensions and at different levels. These inter-connections are complicated further by the effects of time and its relation to the progression of oral disease and malocclusion, and by variations in the vulnerability and resilience of each individual child (Fisher-Owens et al., 2007).

5. The Burden of Malocclusion on the Individual

Malocclusion has been linked to negative consequences on oral health, oral function, physical trauma, psychosocial well-being and quality of life (QOL).

a. Oral Health and Function

Consequences of malocclusion include functional disturbances of mastication, swallowing and speech (Magalhaes, Pereira, Marques, & Gameiro, 2010; Proffit et al., 2012). Malocclusion, specifically crowding of teeth, has also been linked to impediment of oral hygiene measures, dental plaque accumulation, progression of carious dental lesions and periodontal diseases (Baskaradoss et al., 2013; Bollen, 2008; Gaikwad et al., 2014; Nalcaci et al., 2012). However, the relationship between malocclusion and oral health remains a very controversial one. Attempts at establishing associations between the average malocclusion and oral health indicators, via both independent research and systematic reviews, have often either failed or given contradictory results. However, it appears that severe forms of malocclusion certainly have adverse effects on function, including speech, chewing performance and normal function of the jaw joint (Andrade Ada et al., 2009; Laine, 1992; Magalhaes et al., 2010). Furthermore, although evidence suggests that

willingness and motivation to maintain oral hygiene have a greater impact on oral health than does tooth alignment, at least in the individual with "average" implementation of oral hygiene measures, crowding may predispose to poorer oral health (M. Ackerman, 2004; Bollen, 2008).

b. Traumatic Dental Injury (TDI)

The association between malocclusion and dental trauma is one aspect where it seems there is no controversy. Evidently, the determinants of traumatic dental injusry (TDI) encompass various individual, lifestyle and environmental factors, with a significant portion of trauma to the face relating to sports, road accidents, violence and unsafe play areas (Petti, 2015). Nonetheless, the risk of injury or harm to the teeth themselves (specifically the maxillary incisors) has been shown to be directly associated with the amount of overjet. The results of two systematic reviews demonstrate that children with an overjet of more than 3mm are twice as much at risk of injury to their anterior teeth compared to their counterparts with less overjet (Nguyen et al., 1999; Petti, 2015). Nguyen and coworkers (1999) aimed to achieve the greatest possible internal validity and reliability of results, and therefore only included 11 studies in their meta-analysis. The more recent meta-analysis, however, aimed at combining the majority of the available literature in order to achieve a degree of external validity sufficient enough to allow generalization at the global level (54 studies included). The similarity between their findings indicates that the association between an overjet greater than 3mm and trauma is both internally and externally valid.

It has been estimated that, depending on the extent of the injury, TDI treatment requires anywhere between 2 and 9 dental visits to complete and accounts for 2–5 million USD expenditure per one million inhabitants per year (Andersson, 2013). The continuing rise in the prevalence of TDIs reported in various industrialized countries emphasizes the public health importance of acknowledging its association with malocclusion. In fact, it is estimated that over two hundred million injuries to anterior teeth globally are attributable to a large overjet (Petti, 2015).

c. Psychosocial Well-Being and Oral Health-Related Quality of Life (OHRQoL)

The concept has long been introduced that individuals with malocclusion often feel self-conscious about their facial and dental appearance, and that physical attractiveness impacts the social well-being of individuals (Baldwin, 1980; Shaw, 1981). Dental esthetics and/or malocclusion have been associated with greater "self-concept" or self-esteem (Badran, 2010; Mandall, McCord, Blinkhorn, Worthington, & O'Brien, 2000). Moreover, in a study on 1,017 healthy, young Japanese adults aged 18-19, it was noted that even mild to moderate malocclusions contributed to psychological stress, particularly interpersonal sensitivity and depression (Ekuni et al., 2011).

Despite the lack of concrete evidence on the relationship between malocclusion and psychosocial well-being, this relationship deserves particular attention in children and adolescents. Adolescence is characterized by rapid physiological, social, and cognitive changes, and is reportedly accompanied by increased self-awareness and self-reflection – particularly in relation to body and appearance (Meland, Haugland, & Breidablik, 2007). In an investigation of an adolescent group of British children aged 10-14, bullying was

significantly associated with malocclusions where teeth "stick out" (Seehra et al., 2011). In the same study, the bullied adolescents had lower levels of physical appearance- related self-esteem and lower OHRQoL.

OHRQoL is a multidimensional construct that has been developed as a tool to evaluate the extent of the adverse impacts imparted by oral conditions on social life (Sischo & Broder, 2011). As opposed to attempts to investigate the effect of oral conditions on isolated outcomes, such as self-esteem or stress, the multidimensional OHRQoL construct supports a "biopsychosocial model of health into which symptoms, physical functioning, and emotional and social well-being are incorporated" (Kleinman, 1988). Numerous instruments have been developed to assess self-reported OHRQoL in adolescents for use in epidemiologic studies (Sischo & Broder, 2011). Notable examples include the Child Perceptions Questionnaire (CPQ_{11-14})(Jokovic et al., 2002), the child's version of Oral Health Impacts on Daily Performances (Gherunpong, Tsakos, & Sheiham, 2004), and the Child Oral Health Impact Profile (Broder, McGrath, & Cisneros, 2007).

The results of two systematic reviews suggest the presence of a significant correlation between malocclusion and lower OHRQoL scores, irrespective of how both variables are assessed (Andiappan, Gao, Bernabe, Kandala, & Donaldson, 2014; Liu, McGrath, & Hagg, 2009). Nevertheless, these correlations have been labeled as "moderate, at best" ((Liu et al., 2009)).

Irrespective of the average strength of association between malocclusion and OHRQoL reported in epidemiological studies, the introduction of such concepts into dentistry and orthodontics reflects a welcome shift of paradigm that has the potential to

incorporate individual social, emotional and physical burdens in defining appropriate, patient-centered goals for the treatment of malocclusion (Sischo & Broder, 2011).

B. The Need for Orthodontic Treatment

1. Introduction and Relevant Concepts

The controversies highlighted in the preceding section discussing the consequences of malocclusion on affected individuals emphasize the presence of a *spectrum* of severity. Although it must be recognized that, in their extreme forms, malocclusions have the potential to induce substantial physical and psycho-social burdens, many individuals with less severe forms often live completely normal lives, oblivious to the presence of their malocclusions (Livas & Delli, 2013; Zamzuri, Razak, & Esa, 2014). Therefore, not every individual with malocclusion requires and/or desires treatment.

Although inaccessibility to dental treatment may not be implicated in the direct pathway of development of malocclusion, it has already been discussed how failure to receive timely orthodontic interventions may allow otherwise preventable malocclusions to manifest, and other malocclusions to progress to more severe forms that are more difficult and more complicated to treat later in life (Gois et al., 2012; Jolley et al., 2010; Thilander et al., 2001). In the earlier discussion of the conceptual framework for oral health, access to oral health services was illustrated as having an important role on the individual, family and community levels. In populations inflicted by SE inequalities, health disparities are widened by the increased uptake of orthodontic treatment by socially advantaged individuals (in some cases for the correction of minor malocclusions) whereas their disadvantaged counterparts may be unable to obtain treatment for more severe

malocclusions (Proffit et al., 1998). Such inequalities in the accessibility to treatment have driven the development of methods to estimate the burden of malocclusion on individuals, and not merely its presence. This resulted in the development of indices attempting to capture and quantify the need for orthodontic treatment to correct an existing malocclusion in an objective and standardized manner. Such measures are crucial in determining needs and priorities in public health settings where funds for orthodontic treatment are limited (Borzabadi-Farahani, 2011).

2. Objective Assessments of Orthodontic Treatment Need

Indices for orthodontic treatment need allocate scores to an overall malocclusion based on the contribution of several individual elements, their severity, and/or the conceivable destruction to oral health or to well-being (Borzabadi-Farahani, 2011). These scores are reflective of a spectrum of need for orthodontic treatment, ranging from no/minimal to severe need. Several indices have been developed over the years – a review of which is beyond the scope of this thesis; but notable examples include the Treatment Priority Index (Grainger, 1967), the Dental Aesthetic Index (Cons, Jenny, & Kohout, 1986), the Index of Orthodontic Treatment Need (IOTN) (Brook & Shaw, 1989), and the Index of Complexity Outcome and Need (Brook & Shaw, 1989). At a population level, such indices are crucial to prioritize treatment allocation based on both the severity of malocclusion and the conceivable detrimental effects it may have on oral health, particularly when services are publicly funded or are limited (Borzabadi-Farahani, 2011; Proffit et al., 2006). Owing to the more meaningful information they provide regarding *unmet* public health need for

orthodontics, these indices have generally replaced the assessment of individual features of malocclusion in epidemiological surveys.

3. Epidemiological Surveys Using Indices for Orthodontic Treatment Need

Between the late 1960's and 1970's, interest in assessing unmet orthodontic treatment need at national levels was initiated through the work of two major organizations: the National Center for Health Statistics in the United States through the National Health and Nutrition Examination Surveys (NHANES) and the WHO through the International Collaborative Studies (ICS) of oral health outcomes. **Table 2.2** below displays selected results regarding orthodontic treatment need recorded during the most recent of these surveys: the ICS II (1988-1992) (Chen, Andersen, Barmes, Leclerq, & Lyttle, 1997) and the NHANES III (1989-1994) (Proffit et al., 1998), carried out almost in parallel to each other.

Despite the differences in the age groups examined and in the indices used the proportions of adolescents in definite need for orthodontic treatment lie in the range between 11 and 22% (**Table 2.2**). Proportions outside this range may be noted for New Zealand (31%), Lakota Indians (34%) and Navajo Indians (60%), and may be attributed, at least in part, to differences in the populations being studied.

The IOTN, used in the NHANES III study, has been established as an objective method for the assessment of orthodontic treatment need and has become one of the most validated and widely implemented indices in epidemiological surveys (Al-Azemi & Artun, 2010; Borzabadi-Farahani, 2011). The remaining review of the more recent literature will be limited to epidemiological studies utilizing the IOTN.

Table 2.2: Proportion of adolescents in definite need for orthodontic treatment as recorded in ICS II and NHANES III (Reproduced from: Chen et al, 1997; Proffit et al, 1998)

	Country/ population	Age (years)	Index used	Percentage
ICS II conducted by the WHO (1988 – 1992)	Erfurt, Germany	12-13	Dental Aesthetic Index (DAI)*	16
	Yamanashi, Japan			21
	New Zealand			31
	Latvia			16
	Lodz, Poland			17
	San Antonio, USA			20
	Baltimore, USA			22
	Baltimore, USA, Lakota Indians (*Indian Health Service)*			34
	Baltimore, USA, Navajo Indians (*Indian Health Service)*			60
NHANES III conducted by NCHS (1989 – 1994)	Whites (Caucasian), USA	12-17	Index of Orthodontic treatment need (IOTN)**	13.5
	Blacks (African-American), USA			21.5
	Mexican-American, USA			11.9

*DAI: definite need considered in individuals with DAI scores falling in the "severe malocclusion" and "handicapping malocclusion" categories

**IOTN; definite need considered in individuals with IOTN scores of 4 and 5

Globally, reports on the prevalence of definite orthodontic treatment need range from as low as 12.6% in Nigeria (O. Otuyemi, 1994) to 59.5% in Italy (Nobile, Pavia, Fortunato, & Angelillo, 2007) (**Table 2.3**). Despite the utilization of the same index to report on treatment need, differences in sample size, sampling techniques, age of examined children, inter-examiner reliability in scoring IOTN between studies and other methodological issues account for the differences reported even within similar populations. In two Italian populations, Perillo and coworkers (2010) recorded a 27.3% need for orthodontic treatment, compared to 59.5% recorded by Nobile and coworkers (2007). In addition to differences in the samples in terms of age and city of residence, Nobile and

coworkers included children undergoing orthodontic treatment in their analysis, all of whom belonged to the group in need for treatment. Although this is unlikely to explain all the difference, it did have the result of inflating the proportion of individuals in need for orthodontic treatment compared to usual reports on exclusively untreated samples. Similar but less drastic differences may be noted for children in the UK (15 – 35%) (Alkhatib, Bedi, Foster, Jopanputra, & Allan, 2005; Burden & Holmes, 1994; Mandall et al., 2000; Tickle et al., 1999).Interestingly, out of the 4 epidemiological studies identified in Iran, the two with larger samples sizes report a similarly lower prevalence of definite need (18.4% and 20.3%); (Hedayati, Fattahi, & Jahromi, 2007; Safavi et al., 2009) in comparison to the two studies with smaller sample sizes (Borzabadi-Farahani, Borzabadi-Farahani, & Eslamipour, 2009b; Fariba & Sirous, 2013).

Only 4 studies have been conducted on orthodontic treatment need in adolescents in the Middle East, with relatively consistent and similar results in the two countries studied (Jordan and Kuwait; 28-34%) (Abu Alhaija et al., 2005; Al-Azemi & Artun, 2010; Hamdan, 2001; Kerosuo, Al Enezi, Kerosuo, & Abdulkarim, 2004).

In a recent large scale study, the first of its kind in the region, school-aged students from 66 public and private schools in Dubai, United Arab Emirates (UAE) were screened (Al Jeshi, Al-Mulla, & Ferguson, 2014). Among 17,614 untreated subjects from 9 Arab (Egypt, UAE, Yemen, Syria, Iran, Jordan, Iraq, Palestine, and Lebanon) and 4 South Asian countries from South Asia (India, Pakistan, Philippines, and Bangladesh), 14.4% were in definite need for orthodontic treatment.

Table 2.3: Proportion of adolescents in need for orthodontic treatment from selected epidemiological studies using the IOTN

Authors (publication year)	Country (City/region)	N	Age (years)	Definite need (IOTN 4-5)
Nobile et al. (2007)	Italy (Catanzaro)	546	11-15	59.5%
Perillo et al. (2010)	Italy (Naples)	703	12	27.3%
Alkhatib et al. (2005)	UK (Northwest London)	2,788	12-14	15%
Mandall et al. (2000)	UK (Manchester)	434	14-15	18%
Tickle et al. (1999)	UK (Northwest)	6,067	14	26.2%
Chestnutt et al. (2006)	UK	2,595 2,142	12 15	35% 21%
Burden, Holmes (1994)	UK (Manchester & Sheffield)	1,829	11-12	32.8%
De Olivera, Sheiham (2003)	Brazil (Bauru, Sao Paolo)	1,060	15-16	22%
Manzanera et al. (2009)	Spain (Valencia)	655	12 15-16	21.8% 17.10%
Josefsson et al. (2007)	Sweden (Jönköping & Motala)	493	12-13	37%
Abdullah, Rock (2001)	Malaysia	5,112	12-13	47.9%
Otuyemi et al. (1997)	Nigeria (Rural North and South)	704	12-18	12.60%
Kolawole et al. (2008)	Nigeria (Ile-Ife)	250	11-14	14%
Ngom et al.(2006)	Senegal	665	12-13	42.5%
Puertes-Fernández et al. (2010)	(Western Saharan Refugees) Algeria (Toulouf)	248	12	18.10%
Mugonzibwa et al. (2004)	Tanzania (Dar-es-Salaam)	180 95	9-11 15-16	22.2% 35.8%
Borzabadi-Farahani et al. (2009)	Iran (Isfahan)	502	11-14	36.1%
Hedayati (2007)	Iran (Shiraz)	2,000	11-14	18.4%
Safavi et al. (2009)	Iran (Tehran)	5,200	14-16	20.3%
Fariba, Sirous (2013)	Iran (Zahedan)	395	11-14	36.5%
Uçüncü, Ertugay (2001)	Turkey (Ankara)	250	11-14	38.8%
Hamdan (2001)	Jordan (Amman)	320	14-17	28%
Abu Alhaija et al. (2004)	Jordan (Irbid)	1,002	12-14	34%
Kerosuo et al. (2004)	Kuwait	139	14-18	28%
Al-Azemi, Artun (2010)	Kuwait	1,481	13-14	31.1%
Al Jeshi et al (2014)	UAE	17,614	9-24	14.4%

However, the ages of the examined students are reported to range between 9.08 and 24.4 years, limiting direct comparisons to other results on adolescents. Given that malocclusion is less frequent in younger ages, and more likely to be treated in older ages, the lower proportion of these UAE students in need for orthodontic treatment compared to studies on adolescents in the region is not surprising. The authors also report on differences in the proportion in need for treatment comparing Arab to South Asian students, with 17.9% of South Asians in definite need compared to only 9.1% from Arab countries. Similarly, among the students from Arab countries, those from Syria, Yemen and Iran were in a significantly less need for orthodontic treatment than UAE nationals.

In order to understand the apparent inequalities in orthodontic treatment need reported between studies, and between different populations within the same studies (Al Jeshi et al., 2014; Chen et al., 1997; Proffit et al., 1998), one methodological feature of the majority of these epidemiological studies must be emphasized. Given their intention to measure *unmet* need for treatment, these data are limited to individuals without any history of orthodontic treatment (with the exception of the work of Nobile and coworkers in 2007). For example, the increased rate of uptake of orthodontic treatment reported among American whites in the NHANES III study and among the German, Polish and Baltimore samples in the ICS II in comparison to the rest of the studied groups is likely to have resulted in the under-representation of more severe malocclusions and in consequent reductions in average scores of objective treatment need (Chen et al., 1997; Proffit et al., 1998). Therefore, although racial genetic differences in the development of malocclusion are conceivable, the majority of the variations between populations are likely to be the direct result of different levels of treatment uptake, which reflect a multitude of underlying

determinants including dental health policies, accessibility to treatment and the presence of dental insurance (Chen et al., 1997; Okunseri, Bajorunaite, Matthew, & Iacopino, 2007; Proffit et al., 1998). Similarly, in the multinational setting studied by Al Jeshi and coworkers (2014), access to orthodontic treatment may be a function of many factors, including individual SES, health services in the country of origin, health services in the expatriate country and their accessibility specifically to foreigners, and years of residence in the country.

C. Significance

Data on malocclusion in Lebanese adolescents is more than a decade outdated. Furthermore, there has been no investigation on the need for orthodontic treatment need in adolescents in Lebanon. Existing evidence on pre-adolescent Lebanese children suggests the presence of social inequalities in malocclusion (Hanna et al., 2015), but the statistics on this age group cannot be used to make assumptions on adolescents. Given the tendency for malocclusion to increase as children grow into adolescence and the role social determinants play in access to orthodontic treatment, inequalities may persist or even increase in older children and adolescents.

D. Research Objectives

School type (private versus public) was selected to reflect the two ends of the social spectrum. The research aimed to investigate inequalities by pursuing the following objectives:

- Compare the prevalence of malocclusion and orthodontic treatment need between adolescents attending private and public schools in Beirut
- Assess various determinants of malocclusion
- Associate orthodontic treatment need with oral-health related quality of life

E. Hypotheses

Lebanese youth aged 12-17 are expected to be in greater need for orthodontic treatment when compared to international data.

Hypothesis I: The prevalence of malocclusion is greater in youth attending public schools than those attending private schools.

Hypothesis II: The proportion of students with an unmet orthodontic treatment need is higher in public schools than in private schools.

Hypothesis III: There is an association between orthodontic treatment need and poor oral health related quality of life.

Differences in the proportion of youth who have undergone/are undergoing orthodontic treatment comparing private to public schools are expected to support inequalities in the access to orthodontic treatment.

F. Significance to Public Health in Lebanon

This research is foreseen to contribute to the fields of Community Dentistry and Oral Public Health in Lebanon by means of the identification and verification of determinants to malocclusion and the documentation and quantification of socio-economic

inequalities both in the development of malocclusion and in the access to orthodontic treatment in Lebanese adolescents. The data resulting from this research is envisioned to form the basis for collaborations with the Ministries of Public Health and of Education and other stakeholders to push forward public health actions targeting the equitable intervention and treatment of malocclusion in adolescents, including, but not limited to, measures towards increasing public awareness on the role of malocclusion in the general well-being of adolescents, the installment of more rigorous screening of adolescents for malocclusion in schools and the establishment of dental insurance programs.

CHAPTER III

METHODS

Details of the recruitment process, measures utilized, data collection procedures, ethical considerations and statistical analysis methods are described in this chapter.

A. Research Design

In this comparative cross-sectional study, data were collected by means of a dental examination and two self-administered questionnaires, one for the participant adolescent and the second for his/her parent or legal guardian.

B. Participants

1. Target Population

The target population was set as adolescents attending grades 6-12 in private and public schools in Beirut. The age group of 12-17 was selected to represent adolescent age and was considered most useful for the purpose of providing information lacking in Lebanon and for comparisons with international data, particularly US public health data stratified within the same age brackets.

2. Exclusion Criteria

Given that orthodontic treatment is often carried out in early to mid adolescence, students who were undergoing orthodontic treatment at the time of the study and those who

had received it in the past could not be included in the assessment of occlusion-related variables. However, adolescents with history of orthodontics were not excluded because two adjunct parts of this study were concomitantly carried out on the same population relating to oral health and to the utilization of dental services. These domains are the subjects of two other theses.

3. Sample Selection and Recruitment

The absence of a recent sampling frame for private schools in Beirut necessitated the utilization of non-probability sampling methods. More importantly, however, previous research experience with schools in Beirut indicated very low interest and acceptance to participate, particularly with private schools (Hanna et al., 2015).

a. Private Schools:

Based on previous reports of a higher rate of rejection to participate by private schools and by parents of adolescents in these schools (Hanna et al., 2015), which we also experienced in the first few months of the current study, private schools were oversampled until the population projected though power analysis was reached.

Private schools were initially contacted by phone and the aim of the ongoing study was briefly explained to the appropriate person in charge (usually the director of the secondary school). Depending on each school's protocol, initial contact was followed either by the direct scheduling of a personal meeting with the principal of the school to present the details of the study or by sending an email describing the study, it's aims and the stages involved.

Out of 21 approached schools, 10 refused to schedule a meeting – either during the initial phone call or after having received the email. Reported reasons for the decline included the existence of yearly dental examinations at the schools and the perceived burden on the school and curriculum by engaging the students in another round of examinations, given their busy academic programs. Of the 11 schools where the principal accepted to meet with the researchers 2 failed to eventually participate: one because their students had already been screened and thus it would be inappropriate towards the dentist to have the students re-examined. The other school, following initial consent and acceptance of the package of questionnaires to be distributed, informed the researchers that the supplied package was lost and that the school was no longer interested in participating.

The total number of private schools participating was 9, with a total of 2,377 adolescents and parents targeted for participation **(Figure 3.1**). However, 3 of these 9 schools refused the participation of older classes (grades 10-12). This resulted in the oversampling of 12-14 year old adolescents in the private school sample (PVS).

b. Public Schools:

The involvement of students attending public schools in this research, a domain under the jurisdiction of the Ministry of Education and Higher Education, necessitated approval from the Directorate of Pedagogic and Scholar Orientation. This approval was obtained in the form of a written letter that was presented to the principal of each participating public school. An approach similar to that with private schools was followed. All 7 public schools agreed to participate without restrictions on the grades approached. Therefore, a total of 1,306 adolescents and their parents were targeted (**Figure 3.1**).

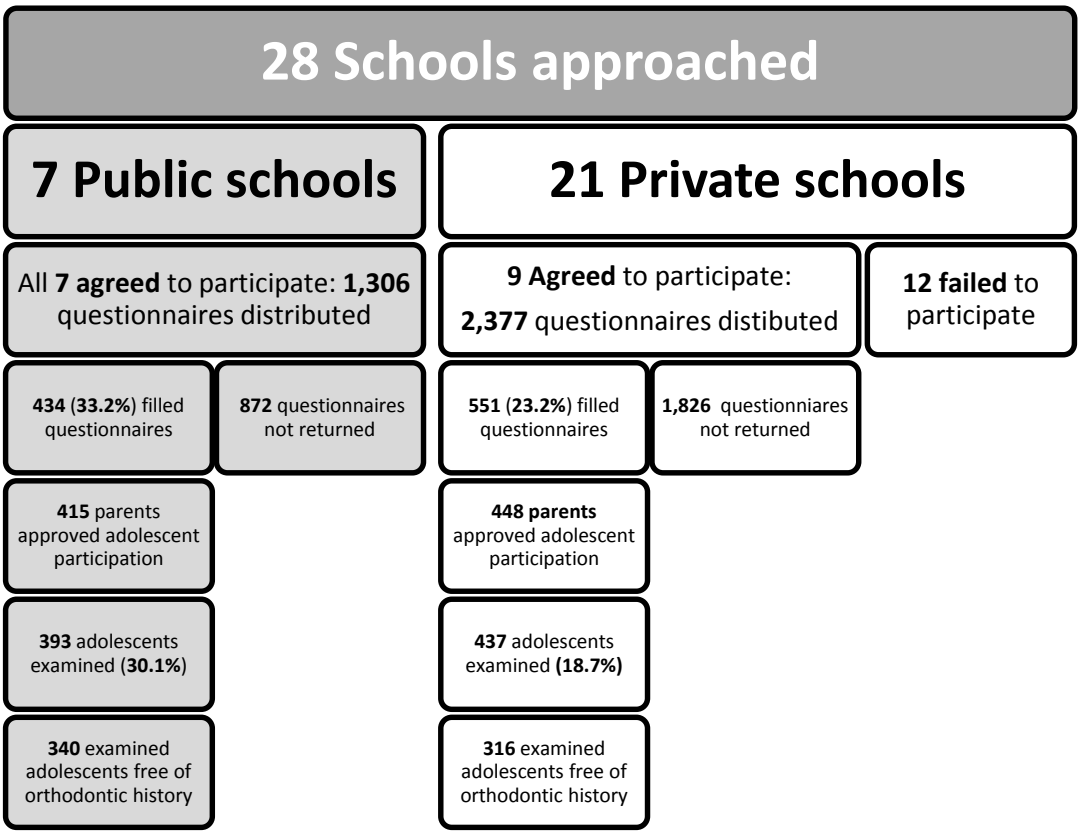


Figure 3.1: Flow diagram illustrating the recruitment process of schools and students

4. Sample Size:

Out of 3,683 eligible adolescents and parents/guardians, 948 of guardians agreed to participate by filling out the questionnaire (pooled response rate of 25.7%). Of those who filled out the questionnaire, 863 consented to have their son/daughter participate (91.03% of questionnaires filled by parents; 23.4% of total approached). However, 30 potential participants failed to be examined either because they were absent from school on the days of examination or because they, themselves, refused to participate when assent was sought. When adolescents refused to participate despite their parent's approval, the most common reason was fear or discomfort at the idea of their teeth being check by a dentist, followed by

apparent peer pressure from their classmates (i.e. when one adolescent refused participation, his/her group of friends were also more likely to refuse).

The final sample of adolescents examined consisted of 437 students attending 9 private schools and 393 adolescents attending 7 public schools (**Figure 3.1**), adding up to a total of 831 subjects (22.6% of total approached sample). Of the total examined sample, 174 were undergoing or had previously received orthodontic treatment. Therefore, the subset of adolescents without any history of orthodontic treatment included 340 public school students and 316 private school students, totaling 656 adolescents (**Figure 3.1)**.

C. Measures

The indices and instruments used in this study were selected to assess the three main projected outcomes: malocclusion, orthodontic treatment need, and oral health-related quality of life (OHRQoL). As described in the literature review, malocclusion and orthodontic treatment need are closely related concepts that provide different contexts for the appreciation of malocclusion. While orthodontic treatment need is a reflection of malocclusion, it gauges severity of malocclusion and impacts treatment cost and coverage.

1. Occlusal Indices:

The literature review highlights how different aspects of malocclusion have been related to an extensive pool of determinants, with certain factors associated with very specific occlusal manifestations. Therefore, malocclusion was assessed by recording disaggregated measures of the main characteristics of occlusion in the three planes of space: sagittal, vertical and transverse. The measured indices were based on the method

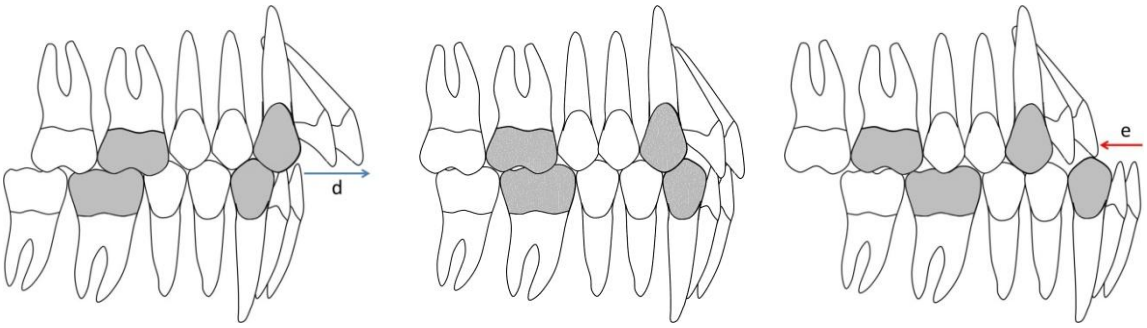
used by the NHANES III to assess malocclusion, where measures were made of anterior crowding in the upper and lower arches, midline diastema, posterior cross-bite, overjet, overbite and molar relationship. Additionally, canine relationship and the presence of an impinging bite were also evaluated, as proposed by Hanna and coworkers (2015).

a. Sagittal Occlusal Measures

i. Molar and Canine Occlusion

The occlusion was assessed on both molars and canines. It was classified based on the position of the upper first molar relative to the lower first molar as proposed by Angle (1899) and similarly on the relationship between the upper and lower canines (**Figure 3.2**). Illustrated in this figure is the progression from a full class II molar and canine occlusion through the class I occlusion to reach the class III occlusion, as the lower teeth are progressively positioned more forward relative to the upper teeth (**Figure 3.2, (a), (b)** and **(c)**; molars and canines highlighted in grey). Deviations from the class I halfway towards the class II or the class III malocclusion were designated as half cusp class II and half cusp class III occlusions. Accordingly, 5 possible ordinal categorizations of molar and canine occlusion were possible on each side (right and left).

When the first molars were not present, the occlusion on the premolars was measured and the missing teeth were noted. When the canine was not erupted, the occlusion was not recorded on the affected side unless the primary canine was still present.



a. Class II b. Class I c. Class III

Figure 3.2: Illustrations of antero-posterior occlusal measures. **(a)** Full class II: upper dentition more forward relative to the lower arch. **(b)** Class I: correct relationship between upper and lower arches. **(c)** Full Class III: lower dentition more forward relative to upper. **(d)** Blue arrow represents an increased overjet, with upper incisors protruding in front of lower incisors. **(e)** Red arrow represents a negative overjet, also termed an anterior cross-bite on all anterior teeth, with lower incisors protruding in front of upper incisors.

ii. Overjet

A periodontal probe was used to measure the distance, in millimeters, between the outer surface of the most protrusive maxillary central incisor and the outer surface of the corresponding lower central incisor, yielding either a positive measurement for a positive overjet (**Figure 3.2, (d)**), zero for an edge to edge relationship (**Figure 3.3, (c)**), or a negative value for a reverse or negative overjet (**Figure 3.2, (e)**).

Although overjet (OJ) was recorded as a continuous variable, it was grouped into 4 categories representing increasing severity and functional and esthetic burden, as proposed by Brook and Shaw (1989). This categorization of OJ is illustrated below:

a) Normal: $0 \text{ mm} < OJ \leq 3.5 \text{ mm}$

b) Moderate: $3.5 \text{ mm} < OJ \leq 6 \text{ mm}$

c) Severe: $6 \text{ mm} < OJ \leq 9 \text{ mm}$

d) Extreme: $9 \text{ mm} < OJ$

iii. Anterior Crossbite

Anterior cross-bite was evaluated as a separate measure from overjet. Although a negative overjet implies that the upper front teeth (incisors) occlude behind the lower 4 incisors (**Figure 3.2, (e)**), an anterior cross-bite may involve less than all four upper front teeth, i.e. only one or two teeth.

The number of teeth involved in anterior cross-bite and the maximum millimeter measurement using a periodontal probe were noted. All subjects who had a cross-bite on all four of their incisors were considered to have an anterior cross-bite.

b. Vertical Occlusal Measures

i. Overbite

Similar to overjet, a periodontal probe was used to measure the vertical overlap between the maxillary incisors and was given a positive score in cases of positive overlap of teeth (**Figure 3.3, (a)** and **(b)**) or was labelled as zero in case teeth were edge to edge (**Figure 3.3, (c)**). The maximum millimeter measurement on either right or left central incisors was noted (**Figure 3.3, (e)** and **(f)).**

Overbite (OB) was also grouped according to the criteria proposed by Brook and Shaw (1989) to represent varying degrees of severity. This categorization is illustrated below:

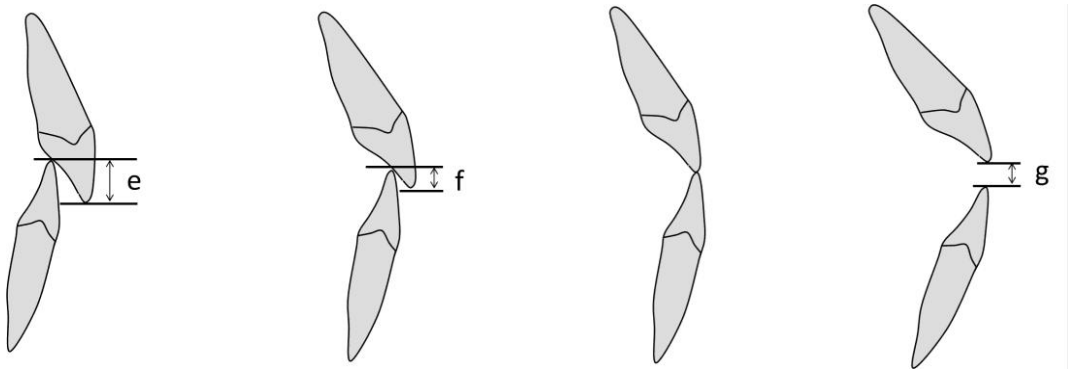
a) Normal: 0 mm < OB < 3.5 mm

b) Increased: 3.5 mm ≤ OB , without impingement on the palate

c) Severe: 3.5 mm ≤ OB , with impingement on the palate

ii. Open Bite

In the absence of overlap between the incisors beyond an edge to edge relationship, an anterior open bite was noted (**Figure 3.3, (d)**)**.** The number of teeth involved in open bite was counted and the maximum amount of open bite was measured in millimeters using a periodontal probe (**Figure 3.3, (g)**). All individuals with an anterior open bite on all 4 front teeth were considered to have an anterior open bite.



a. Deep bite b. Average overbite c. Edge to edge (overjet and overbite) d. Anterior open bite

Figure 3.3: Illustrations of vertical occlusal measures. Two variants of positive overbite illustrated in **(a)** and **(b)**. **(e)** Millimeter measurement of deep bite. **(f)** Millimeter measurement of an average overbite. **(c)** Edge to edge relationship with zero horizontal and vertical overlap between incisors. **(d)** Negative overbite. **(g)** Millimeter measurement of anterior open bite.

c. Transverse Occlusal Measures

i. Posterior Crossbite

The presence or absence of a posterior cross-bite was assessed by having the subject occlude his/her teeth and then counting the number of teeth displaced towards the tongue from the normal transverse relationship (**Figure 3.4, (a)**). Although all teeth in

cross-bite were noted, the subject was categorized as having a posterior cross-bite only if 2 or more posterior teeth were involved (premolars and molars).

Figure 3.4: An illustration of posterior cross-bite. **(a)** Posterior cross-bite: lower posterior teeth are positioned more towards the cheek compared to upper posterior teeth which are occluding more towards the tongue. **(b)** Normal transverse posterior occlusion: upper teeth are positioned closer to the cheeks relative to the lower teeth.

ii. Midline Diastema

Using a periodontal probe, the millimeter distance of the space between the two maxillary central incisors was measured at the level of the incisal edges. Individuals with a space between their incisors equal to 2mm or greater were considered to have a midline diastema (**Figure 3.5**).

Figure 3.5: Measurement of midline diastema

d. Other Occlusal Measures

i. Irregularity Index

The irregularity index was used as an indicator of the mal-alignment of anterior teeth (incisors) in the upper and lower arches. Using a periodontal probe, the millimeter displacement of the contact points between each two adjacent teeth was measured and rounded down to the nearest whole millimeter (**Figure 3.6**). Contact point displacements less than 1mm were noted down as zero. When teeth where missing or not yet fully erupted, the measurement for that particular contact point was denoted "Y" but the remaining displacements were measured normally. The final irregularity score for each arch was calculated by summing all individual contact point displacements in each arch.

Figure 3.6: Measurement of contact point displacements and irregularity score

The maximum contact point displacement (MCPD) between any two teeth in any of the two arches was also noted as a separate finding. This was recorded as a continuous variable but was also categorized into 3 categories of severity (Brook & Shaw, 1989):

a) Normal: 0 mm < MCPD ≤ 1 mm

b) Moderate: 2 mm ≤ MCPD ≤ 4 mm

c) Severe: 4 mm < MCPD

ii. Additional Occlusal Findings

Any other apparent occlusal finding or anomaly requiring orthodontic attention was noted. Examples include disturbances in the eruption of teeth and in their shape and number. Special attention was given to noting down two particular occurrences: congenitally missing maxillary lateral incisors and un-erupted maxillary canines. Given that maxillary lateral incisors erupt at around the age of 8-9 years (American Dental Association, 2006), clinical assessment of their absence in our sample of 12 to 17 year olds was sufficiently accurate to assess the prevalence of congenitally missing lateral incisors without the need to radiographic confirmation. Similarly, un-erupted canines were noted when on one side the permanent canine had completely erupted whereas on the other side there were no signs of eruption (with or without the presence of the primary canine). In cases where both canines were un-erupted, if the examined subject was younger than 15 years it was assumed that he/she was delayed in dental eruption (Bishara, 1992; Konda, Ahmed, Ali, & Konda, 2011).

In a different part of the research carried out on the same population of students, a different examiner recorded the DMFT (decayed, missing and filled teeth) for each adolescent, as a measure of caries burden.

2. Need for Orthodontic Treatment

The Index of Orthodontic Treatment Need (IOTN) was used to assess each examined subject's need for orthodontic treatment. In their original publication, Brook and Shaw (1989) describe two components of the IOTN: a dental health component (DHC) and an aesthetic component (AC). They advocate the use of both simultaneously and assigning

an individual a score for treatment need based on the higher score among the two. In our study, however, only the DHC was used. The DHC has been reported to be a more objective measure than the AC since it assigns a precise grade to specific measureable traits of malocclusion with clear cut-offs between grades (Al-Azemi & Artun, 2010; Borzabadi-Farahani, 2011). The AC, on the other hand, is based on a subjective assessment of a range of photographs and their comparison with the examined individual's esthetic dental appearance (Borzabadi-Farahani, 2011; Brook & Shaw, 1989).

The DHC of the IOTN is one of the most widely used indices in epidemiological studies of malocclusion (Liu et al., 2009) and was selected as the measure of choice because of its simplicity, reported objectivity and utility for comparisons between populations (Al-Azemi & Artun, 2010; Cooper, Mandall, DiBiase, & Shaw, 2000). It was calculated based on the original criteria proposed by the authors in 1989 (**Table 3.1**). The separate measures of malocclusion recorded in all 3 planes of space, along with the labeled "other occlusal measures", were used to assign each examined adolescent an IOTN score. Depending on the worst single occlusal trait, each adolescent was given a score ranging from 1 to 5, with a score of 1 indicating no need for orthodontic treatment and a score of 5 indicating a "very great" need.

For the purposes of data analysis, the grades were re-categorized according to the Modified IOTN scoring system proposed by Burden and coworkers (2001):

a) No definite need for orthodontic treatment: $1 <$ IOTN score ≤ 3

b) Definite need for orthodontic treatment: IOTN > 3 (grades 4 and 5)

Table 3.1: Details of the IOTN scoring system (adapted from Brook and Shaw, 1989)

Grade 5 (*Very great*)	**Grade 3 (*Moderate*)**
i. Defects of cleft lip and/or palate ii. Increased overjet > 9 mm iii. Reverse overjet > 3.5 mm with reported masticatory or speech difficulties iv. Impeded eruption of teeth (except of third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any other pathological cause v. Extensive hypodontia (missing teeth) with restorative implications (more than one tooth missing in any quadrant) requiring pre-restorative orthodontics	i. Increased overjet > 3.5 mm but ≤ 6 mm with incompetent lips at rest ii. Reverse overjet > 1 mm but ≤ 3.5 mm iii. Increased and complete overbite with gingival contact but without indentations or signs of trauma iv. Anterior or posterior cross-bite with ≤ 2 mm but > 1 mm displacement between retruded contact position and inter-cuspal position v. Moderate lateral or anterior open bite > 2 mm but ≤ to 4 mm vi. Moderate displacement of teeth > 2 mm but ≤ 4 mm.
Grade 4 (*Great*)	**Grade 2 (*Little*)**
i. Increased overjet > 6 mm but ≤ 9 mm ii. Reverse overjet > 3.5 mm with no reported masticatory or speech difficulties iii. Reverse overjet > 1 mm but ≤ 3.5 mm with reported masticatory or speech difficulties iv. Anterior or posterior cross-bites with > 2 mm displacement between retruded contact position and inter-cuspal position v. Posterior lingual cross-bites with no occlusal contact in one or both buccal segments vi. Severe displacement of teeth > 4 mm vii. Extreme lateral/anterior open bite > 4 mm viii. Increased and complete overbite causing notable indentations on the palate or labial gingivae ix. Patient referred by colleague for collaborative care e.g. periodontal, restorative or TMJ considerations x. Less extensive hypodontia (missing teeth) requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis (not more than 1 tooth missing in any quadrant)	i. Increased overjet > 3.5 mm ≤ 6 mm with lips competent at rest ii. Reverse overjet > 0 mm but ≤ 1 mm. iii. Increased overbite > 3.5 mm with no gingival contact iv. Anterior or posterior cross-bite with ≤ 1 mm displacement between retruded contact position and inter-cuspal v. position vi. Small lateral or anterior open bites > 1 mm but ≤ 2 mm. vii. Pre-normal or post-normal occlusions with no other anomalies viii. Mild displacement of teeth > 1 mm but ≤ 2 mm.
	Grade 1 (*None*)
	Other variations in occlusion including displacement less than or equal to 1 mm.

The modified IOTN score reportedly improves the reliability and validity of the IOTN (Burden, Pine, & Burnside, 2001). Even when the original IOTN is used, it has become common for studies to report on the group of individuals with IOTN scores of 4 and 5 combined as a measure of unmet orthodontic treatment need. The extensive use of this modification to the IOTN in epidemiological studies therefore encouraged its use in our study in order to allow meaningful comparisons regionally and internationally.

3. Oral Health-Related Quality of Life (OHRQoL):

The Child Perceptions Questionnaire for ages 11-14 (CPQ_{11-14}) was used (Jokovic et al., 2002) to measure adolescent oral health-related quality of life (OHRQoL). In a literature review assessing the impact of malocclusion/orthodontic treatment need on QOL, the CPQ was found to be the most commonly utilized (Liu et al., 2009). The CPQ_{11-14} is a 37-item questionnaire that is specifically designed to address the impact of oral diseases and disorders on the well-being of children aged 11 to 14. The questions cover four domains: oral symptoms, functional limitations, emotional well-being and social well-being. All questions inquire about the frequency of various events related to the orofacial region in the preceding 3 months and are specifically tailored for the age group of early to mid-adolescence (different versions of the CPQ for younger ages have also been developed). Each question is given a score of 0 to 4 depending on the respondent's answer ("Never" = 0; "Once/twice" = 1; "Sometimes" = 2; "Often" = 3; and "Every day/almost every day" = 4). The sum of scores for all questions represents the final score and higher final scores indicate greater impairment of OHRQoL. Although shortened forms of the CPQ_{11-14} have been developed (Jokovic, Locker, & Guyatt, 2006), the original 37-item

questionnaire remains the most widely used and has been validated in several languages including the Arabic language (Barbosa, Tureli, & Gaviao, 2009; A. Brown & Al-Khayal, 2006; Olivieri, Ferro, Benacchio, Besostri, & Stellini, 2013).

Age-specific questionnaires have been recommended when assessing OHRQoL in children and adolescents (Cunningham & O'Brien, 2007; Sischo & Broder, 2011), and it may be argued that the use of the CPQ_{11-14} beyond the age of 14 has not been validated. However, this questionnaire was chosen as the measure of choice for our 11-18 sample because it has been shown to be valid and reliable in an orthodontic population (Cunningham & O'Brien, 2007) and because of the presence of a validated Arabic version. Although its validity applies to the younger part of our sample (11-14 years), the older adolescents were not expected to have difficulties in answering it, at least in terms of cognitive ability.

D. Calibration

Prior to the start of the data collection phase, the principal examiner was calibrated against an experienced orthodontist (RH) to ensure the reliability of the measurements of the occlusal indices. Both the examiner and the experienced orthodontist performed and recorded all the measures of occlusion separately on 10 orthodontic study models displaying a various range of malocclusion features. Two-way mixed intra-class correlations (ICC) were computed to test for the consistency in ratio measures (all millimeter measurements; as proposed by Hallgren (2012)) yielding ICC coefficient values >0.92 for all single measurements. Similarly, ICCs for ordinal variables (canine and molar occlusion) were 0.94 and 0.95, respectively. For binary outcomes, percent agreement

measures were computed (presence of posterior cross-bite, presence of anterior cross-bite, presence of anterior open-bite, presence of midline diastema). These yielded Kappa values of 1.00 for all measures except for the assessment of the presence of a posterior cross-bite (Kappa statistic = 0.80). The Kappa statistic for posterior cross-bite was lower than for the remaining variables because the two calibrators differed on only one out of ten observations, but indicated substantial agreement nevertheless (Hallgren, 2012).

E. Procedures

Data collection extended over a period of 7 months, starting in May, 2014 and ending in February, 2015. The data collection procedures were carried out in two stages. In each participating school, the initial stage was to distribute the questionnaires directed at the parents/guardians with attached consent form, to all eligible students (**Appendices I and II**). The adolescents whose parents' filled the questionnaires (parent consent and questionnaire) returned them to the school with their son/daughter, where a designated individual, usually the school nurse, was responsible for safe keeping. Once enough time had elapsed to allow for return of the questionnaires, usually one week, dates were coordinated for the second stage of data collection (oral examination and adolescent questionnaire).

1. Stage One: Structured Questionnaire Directed at Parent/Legal Guardian

The questionnaire sent to the parents/guardians was in the Arabic language and investigated factors associated with malocclusion (**Appendix II**). Attached to the questionnaire as the cover page was the assent form including information on assistance in

case of inquiries or illiteracy of parents/guardians, along with the researchers' contact information. The questions covered the following domains:

- Socio-demographic and economic indicators: age, gender, family income, parent or guardian educational level
- Medical status of the adolescent: general health and breathing mode (nasal or mouth breather)
- Non-nutritive sucking habits: history of thumb/finger sucking or pacifier use (age at start, aged stopped, duration and intensity)
- Nutritive sucking habits: feeding mode during the first 6 months of life, breast and bottle feeding durations
- History of adolescents' encounter with orthodontist: whether the adolescent had ever been evaluated by an orthodontist and the age at first consultation

Additionally, the questionnaire covered domains related to the two other parts of this study.

2. Stage Two: Adolescent Participation

On the day assigned for examination, the researchers were led to a designated area set aside by the school for the research procedures. In most instances, this was the infirmary and, when available, an adjacent classroom or library. After the room was set up for the research procedures, all questionnaires were screened for parental approval of adolescent participation. When parents did not approve of their son/daughter's participation, the

questionnaire was set aside in a separate box and the concerned adolescent was not considered eligible to participate.

The adolescents with parental approval were called in to the infirmary in groups of three. Briefly, one member of the research team explained the purpose of the study and what it entails, while another distributed assent forms. The adolescents were given a chance to read the information in the assent form and were then asked if they would like to participate in the study by undergoing a dental examination and answering a questionnaire. The adolescents were asked to sign or write their names if they approved. Following attainment of assent, one investigator began the dental examination procedures for one participant while another member of the research team distributed the questionnaires to the remaining 2 participants and was available for questions. When the examination procedures were completed on the first participant, he/she moved to the section where the adolescents were answering the questionnaire and another participant was screened. This sequence was repeated until all students in the group were screened and had filled out the questionnaire, and then another group of adolescents was summoned.

a. Dental Examination

Dental examinations were carried out in well-lit rooms, on a plastic chair near a window for a source of natural light while at the same time avoiding direct sunlight. This was usually performed either in a separate room from where participants were filling out questionnaires (when provided by the school), or in a secluded corner of the same room to allow sufficient privacy. All examination procedures were carried out using non-invasive dental instruments that included a dental mouth mirror, a probe and a periodontal probe.

The dental mirror and probe were sterilized and came in sealed and disposable examination kits. An adequate number of periodontal probes were sterilized and single-packed before each daily round of examination. Additionally, disposable latex gloves and facial masks were used by all research members carrying out examination procedures. Hand hygiene norms were applied between examinations.

Two examiners carried out two different parts of the examination. The study principal investigator (SM) collected data on occlusal measures on all participants while another member of the research team filled out the examination charts. On the same adolescent, the principal investigator in the study on oral health and hygiene (KB) examined decay (DMFT) and oral hygiene indicators while another member filled out the charts. Each participant was examined within 5 minutes by both researchers combined. On average, 30 adolescents were examined per day, depending on response rate, school preference, school cooperation and individual variations in adolescent cooperation.

b. Structured Questionnaire Directed at Adolescent

The bulk of the adolescent questionnaire, consisting of the Arabic validated version of the CPQ_{11-14} (**Appendix III**), covered four major oral health related quality of life domains (A. Brown & Al-Khayal, 2006):

- Oral symptoms: including pain, bleeding gums and bad breath
- Functional limitations: including difficulty eating and food impaction between teeth
- Emotional well-being: including appearance related anxiety and reduced self-esteem

- Social well-being: including avoidance of smiling/laughing in the presence of peers and teasing/bullying by peers

Additionally, the adolescents were asked whether they had ever been evaluated for orthodontic treatment, their age at first consultation, and whether they had received orthodontic treatment. The questionnaire also included sections relating to the parallel research investigating factors associated with oral health and hygiene.

F. Ethical Considerations

All regulations and rules of confidentiality were followed according to the American University of Beirut Institutional Review Board's (IRB) protocols. IRB approval was obtained prior to the initiation of data collection procedures.

1. Respect for Persons

Respect for autonomy was ensured by obtaining informed consent from the parent/guardian for participation in the study. The cover page of the questionnaire sent to the parents explained fully the details of the study and required the parent/guardian's signed consent on both the use of the information in the questionnaire and the participation of the adolescent in the study. It was clearly explained that each part required a separate signature, and that the parents were able to agree to any one or more part(s) of the study, or to none. Illiterate or visually impaired legal guardians had the possibility of consenting and giving the information orally. A statement in large and bolded font stated this clearly at the top of

the first page of the consent form, along with the provision of the contact information of the research members (**Appendix I**).

Another integral process to ensure respect for persons was the attainment of active assent of every adolescent before enrollment in the study. The details of the study were explained both orally and through a written assent form to all adolescents whose parents consented to their participation (**Appendix IV**). All adolescents signed or wrote their name and date on the assent form before initiation of the examination procedures.

To ensure confidentiality and protect privacy, all questionnaires and examination sheets were coded using serial numbers for each examined participant and parent. In 4 private schools, the school administration requested that the name of the adolescent not even be requested in all questionnaires. The questionnaires were therefore assigned serial numbers in the space assigned for the participant name before being sent to the parents. Similarly, the participating adolescents were requested to write their serial numbers on their questionnaires, and these same numbers were noted on the examination sheets. However, even for the questionnaires and sheets that contained the name of the adolescent, names were used only to ensure the correct linking of each parent questionnaire to the adolescent's questionnaire and examination form following data entry. All names were dropped from the final datasets used for analyses.

2. Beneficence and Non-Maleficence

All examination procedures performed were non-invasive and did not produce any significant discomfort to the adolescent. All examination instruments were sterile and were used on only one subject. The disposable examination kits were discarded following each

single use. Given the hazard of injury from the sharp disposable probe, it was not disposed of in the school as were the remaining non-hazardous elements from the disposable examination kits. All used disposable probes were stored in a separate sealed container and were collected at the end of each examination session and disposed of in designated sharps containers in the division of Orthodontics and Dentofacial Orthopedics at the American University of Beirut Medical Center. The used periodontal probes were also safely stored following each single use and were cleaned and sterilized following institutional standards at the end of each day in preparation for the next examination session.

Each examined adolescent received information on the health of his/her mouth and the need for orthodontic treatment. This information was provided orally and in the form of a short communication letter sent to the parents/legal guardians. These letters summarized whether the adolescent was in need to visit a dentist urgently, within 3 months, or for a check-up, and whether the subject was in need for orthodontic treatment or in need for a more detailed consultation in an orthodontic clinic setting. In these same letters, recommendations on where dental and orthodontic treatment could be received at reasonable prices were detailed. Every attempt was made to answer the subjects' questions relative to their oral health and malocclusion, but when an answer required a more accurate diagnosis, the adolescent was advised verbally and in the referral paper to see the appropriate specialist.

All examination sessions were scheduled in coordination with the schools' academic agendas, avoiding examination periods and important school activities. To minimize each participant's absence from class, adolescents were called in for participation

in groups of three. On average, within 15-20 minutes, all three adolescents had filled out the questionnaire, had been screened and had returned to class.

3. Justice

The extension of data collection over a period of around 7 months resulted in variations in the time of the academic year during which the students were screened. As a result, some 6th graders had not turned 12 yet when examined and some 12th graders had already turned 18. Similarly, owing to the nature of public schools in Beirut, school grade often did not correspond with concomitant age, resulting in a good proportion of 12 graders and even some 11 graders having already turned 18.

Given the breach of social justice anticipated at allowing some members of a class to participate and preventing others to do so (in the attempt to limit the sample to those aged 12-17), all students within the same classroom agreeing to participate were screened. This resulted in the screening of 14 adolescents aged between 11 and 12 years, in addition 13 participants who had already turned 18. The restriction to grades 7 to 11 in private schools, and grades 7 to 10 in public schools, would theoretically have limited the ages of the recruited sample to 12-17. However, the slow recruitment rate, particularly in private schools, necessitated all attempts to capture as large a sample as possible and prevented the implementation of such measures.

In private schools in particular, a possible unintentional breach of justice might be perceived from the high number of schools refusing to participate. Not all adolescents attending private and public schools in Beirut ended up with the same probability of inclusion in the study. However, given the fact that schools rejecting participation provided

yearly dental screenings for their students, we may assume that those adolescents who were not eligible to participate in the study were in less need because of prior screening.

G. Data Management

For each subject enrolled in the study, one unique serial number was assigned. Depending on the extent of participation, each serial number corresponded to a minimum of 1 form (parent questionnaire) to a maximum of 3 forms (parent and adolescent questionnaires, examination sheet). The EpiData™ program version 3.1 was used to create 3 data structures, one for each questionnaire/form to be entered. Appropriate checks and skips were assigned to minimize data entry mistakes. Once all data was entered, the three resulting datasets were merged into the final dataset.

Data cleaning was first performed by ensuring the correct linking of each adolescent questionnaire and examination form to their corresponding parent questionnaire, according to the serial number and, if present, the participant's name. Following the confirmation of serial number entries and correct linking, data was de-identified by dropping all names and keeping only serial numbers. Additionally, all identifiers, including age, gender, school number, and school type were compared across the duplicate variables from the 3 datasets and any inconsistencies were investigated and corrected. Frequency distributions were finally generated for all variables to assess data distribution and the presence of outliers. Decisions on the need to regroup variables were taken when needed.

H. Statistical Analyses

A comparative analysis of demographic and socio-economic characteristics was performed to compare the adolescents who were examined with those whose parents filled the questionnaires but refused their son/daughters' participation. Similarly, within the examined sample, adolescents free of the history of orthodontic treatment were compared to those who had received treatment.

Subsequently, three main levels of analysis were conducted on the subsample of untreated examined adolescents: descriptive, bivariate and multivariate analyses (n=656). Descriptive univariate analyses were conducted by type of school for all child- and family-level influences on oral health. This was similarly conducted for all malocclusion outcomes and for the need for orthodontic treatment. Finally, bivariate and multivariate analyses were employed to explore the effects of potential covariates on selected outcomes.

To allow for the adjustment of standard errors and significance tests in consideration of the clustering effect introduced by the sample design, linear and logistic regressions were used to estimate test scores and p-values at all levels of analysis, including the descriptive, bivariate and multivariate analyses.

In the descriptive analyses, linear regressions adjusted for school cluster were used to compare continuous variables across comparative groups (examined versus non-examined, treated versus non-treated and private versus public school) and were utilized for age and millimeter measurements of overjet, overbite, maxillary and mandibular irregularity and maximum contact displacement. For all remaining variables, logistic regressions adjusting for school cluster, including binary, ordinal and multinomial logistic regressions, were used as indicated. Only parental education with examination status

(comparing adolescents who were examined to those who were not; **Table 4.1**) and family income with school type (**Table 4.4**) necessitated the use of multinomial regressions instead of ordinal regressions since the proportional odds assumptions did not hold. Given that the aim at this stage of analysis was only to test for association, the multinomial logistic regression was opted for instead of other more advanced methods for the analysis of ordinal data.

Three outcomes were targeted for bivariate and multivariate analyses owing to their close association with patient discomfort, esthetic satisfaction and treatment seeking: overjet, maximum contact point displacement (MCPD) and orthodontic treatment need. MCPD was chosen, rather than maxillary or mandibular irregularity, to represent crowding not limited to any specific jaw. The need for orthodontic treatment was selected in order to explore the determinants of living with an unmet orthodontic treatment need among social groups, reflective of social inequalities.

For the bivariate and multivariate analyses exploring overjet and MCPD as continuous outcomes, coefficients of association (β) and p-values were estimated using simple and multiple linear regressions adjusted for school cluster. Simple and multiple logistic regressions were similarly used to model the need for orthodontic treatment, generating odds ratios and p-values. All covariates associated with the outcomes at p-value<0.2 at the bivariate level were included in the multivariate analyses. For all variables included in the final multivariate models, adjusted coefficients of association (β) or odds ratios (OR), two-sided p-values and 95% confidence intervals (CI) were reported. The significance threshold was set at p-value <0.5. Stata/SE ™ data analysis and statistical software, version 11.1 for windows ®, was used to perform all statistical analyses.

CHAPTER IV

RESULTS

A. Introduction

This chapter contains the results of the cluster-adjusted univariate, bivariate and multivariate analyses of the information retrieved from parent and adolescent questionnaires and dental examinations of adolescents attending public and private schools in Beirut.

In the univariate analysis, selected socio-demographic and socio-economic variables are first compared between the examined sample and the sample whose parents filled out the questionnaire but refused the participation of their children (n=948; **Table 4.1**). Similarly, selected socio-demographic and socio-economic variables are then compared between the examined adolescents without any history of orthodontics and those who had received orthodontic treatment (n=830; **Table 4.2**).

The remaining analyses are carried out on the sample of adolescents free of any orthodontic history (n=656; **Tables 4.3-4.17**). This includes comparative analyses of all variables of interest by type of school (**Tables 4.3-4.4**), followed by comparative analyses of occlusal outcomes, orthodontic treatment need and history of adolescent orthodontic encounter by school type (**Tables 4.5-4.9**). To conclude, bivariate and multivariate analyses to explore the determinants of selected occlusal outcomes of interest are displayed (**Tables 4.10-4.20)**.

Finally, a brief exploration of the association between orthodontic treatment need and OHRQoL on the entire examined sample (n=830) is discussed (**Table 4.21**).

B. Characteristics of the Examined and Non-Examined Adolescents

Socio-demographic characteristics of the examined and non-examined adolescents were similar. There were no differences in age, gender, grade or school type (**Table 4.1**). However, the examined sample differed significantly from the non-examined sample with respect to socio-economic profile. In the examined group, there was a significantly greater proportion of adolescents living in families with lower incomes and a lower proportion of born to parents with higher education. Similarly, a significantly greater proportion of the non-examined adolescents had received orthodontic treatment and that was double that present in the non-examined sample (43.5% compared to 21.3%; p-value 0.000).

C. Characteristics of the Examined Adolescents by Orthodontic Treatment Status

Despite not reaching statistical significance, the untreated sample was younger in age than the sample of children who had received orthodontic treatment (14.6 years compared to 15 years; p-value 0.058; **Table 4.2**). More than twice as many treated adolescents attended private schools compared to public schools (69.5% attending private schools), whereas in the untreated sample a slight majority attended public schools (51.8%; p-value 0.000). Correspondingly, the majority of the treated adolescents had parents with higher education (58.2%) and belonged to families in the 2 highest income categories (40% plus 38.7%). In comparison, the majority of the untreated sample belonged to middle categories in both parent educational level and family income (p-values 0.000 for both variables).

D. Characteristics of the Untreated Adolescents by School Type

For a more meaningful and relevant conceptualization, all variables were explored in context of the conceptual framework for the determinants of oral health (Fisher-Owens et al., 2007). Variables were categorized into child-related oral health determinants or family-related oral health determinants.

1. Child-Related Determinants of Oral Health

Child-related determinants of oral health were categorized into socio-demographic variables, factors related to health and development of the adolescent and behavioral factors. Behavioral factors were those that have been hypothesized in the literature to affect the growth and function of the jaws and included history of thumb or pacifier sucking (non-nutritive sucking habits) and feeding mode during infancy (nutritive sucking habits).

a. Socio-Demographic Factors

In the public school sample (PBS), both age and grade (middle school vs. high school) were significantly higher than in the private school sample (PVS) (**Table 4.3(a)**; **Figure 4.1**). Although this may be reflective of a possible inherent difference in age proportions between adolescents attending private schools and adolescents attending public schools in Beirut, it is also the direct result of the greater restrictions faced in targeting older classes in private schools. As a result, the average age of the PVS was more than 1 year less than that of the PBS (13.9 years compared to 15.3 years; p-value 0.008). On the other hand, despite an apparent disproportion of males relative to females between the two samples, statistical comparison adjusting for school cluster gave a non-significant p-value

(0.442). Although the difference in gender proportion in the samples is acknowledged and accounted for in later multivariate analyses, it cannot be used to infer greater participation by females than males in public schools. It seems rather to be a reflection of a difference in the overall sizes of the male versus the female public high schools enrolled in our study (i.e. the recruited female public high schools had a larger total number of students enrolled than the male public highschools).

b. General Health and Development

There were no differences with respect to general health status, childhood breathing mode and maternal narghile smoking between adolescents in the PVS and the PBS as reported by their parents (**Table 4.3(a)**). However, a greater proportion of mothers in the PBS reported having smoked cigarettes while pregnant with the participant adolescent (16.9% compared to 6.5%; p-value 0.007). The reported prevalence of narghile smoking during pregnancy was low in both samples (4.4%; 2.6%) and was dropped from consequent analyses.

c. Behavioral Factors

The two samples were similar in parent-reported history of sucking habits of the adolescent during childhood (**Table 4.3(b)**). On average, there were no significant differences in reported presence of these habits and the total duration of these sucking habits between the PVS and in the PBS. However, feeding habits during infancy differed significantly between the two groups. A greater proportion of adolescents in the PBS were exclusively breastfed during the first 6 months of life. To complement this, a greater

proportion in the PVS received both breast and bottle milk during the first 6 months, but a similar proportion was fed only bottle milk compared to the PBS. In terms of total duration of both breast and bottle feeding, adolscents attending public schools were on the average breastfed longer whereas those attending private schools were on the average bottle fed longer. Both relationships were statistically significant.

2. Family-Related Determinants of Oral Health

The average socio-economic profile of the parents of adolescents in the PBS and PVS is presented in **Table 4.4**. On average, the adolescents attending public schools had parents who were less educated and belonged to families with lower incomes when compared to those attending private schools (p-values all <0.05). A striking majority of the parents of the PVS had obtained higher post-high school education (61.4%) and was more than three times the proportion in the PBS (16.3%; p-value 0.001). Income was significantly different between the two groups both in terms of actual monetary amount and in terms of its reported perceived sufficiency for the coverage of basic family needs. Worth noting is that only 1.7% of the PBS had family incomes greater than 3,000,000 L.L compared to 31.3% in the PVS.

There were no differences in the coverage of dental insurance between families of children in the PVS compared to those in the PBS (**Table 4.4)**. This is likely to be a reflection of the provision of partial dental coverage by two public sectors to its employees: the Lebanese army and internal security forces (data collected for a different part of this study; not shown). Therefore, dental health coverage in our sample was apparently not related to socio-economic ability to obtain it.

E. Parent Report of Adolescent Encounter with Orthodontist

In the examined sample, there were statistically significant differences between private and public school adolescents in the rate of receiving orthodontic treatment. Compared to 27.7% in the PVS, only 13.5% of the PBS either had or were undergoing orthodontic treatment (p-value 0.000; data not shown).

Of 910 parents who responded to the question of whether their child was ever evaluated by an orthodontist, less than half (46.6%) responded affirmatively (data not shown). In the PVS, the percent of adolescents ever having an orthodontic consultation was just above half (53.7%). However, only 37.8% of the PBS ever received an orthodontic consultation, and this was significantly different than the case in private schools (p-value 0.036; data not shown). Although the mean age of first orthodontic consult was less in the PVS (11.3 ± 2.2 years compared to 12.2 ± 2.4 years in public schools), the difference did not reach statistical significance (p-value 0.064; data not shown). Among those ever having an orthodontic consult in the complete sample, the mean age of the first evaluation was at 11.66 ± 2.33 years.

F. Occlusal Characteristics of Untreated Adolescents by School Type

The explored occlusal characteristics are displayed as sagittal measures (**Table 4.5**), vertical measures (**Table 4.6**), transverse measures (**Table 4.7**) and measures of contact point displacement (**Table 4.8**).

1. Sagittal Occlusal Measures

In the comparison between adolescents in private schools and those in public schools, there were no differences in any of the sagittal measures of occlusion. Two thirds of the whole sample had a class I occlusion, with insignificant differences between the two types of school (p-value 0.231; **Table 4.5** presents proportions of occlusion reflective of an average of right and left, molar and canine occlusions. For detailed disaggregated proportions and respective p-values, refer to **Appendix V**). Although a slightly greater proportion had a class I occlusion in the PBS (70.8% compared to 62.7%), this is likely to be a reflection of the older average age of the sample. The mean overjet of the sample of untreated adolescents was 3.2 ± 1.7mm. However, slightly less than one third of the combined sample had an overjet greater than 3.5mm and were thus at increased risk for trauma of their upper front teeth (30.1%). Very few of the children had an anterior cross-bite, concomitant with the low proportion with class III malocclusion. Furthermore, of those with an anterior cross-bite, the majority had a mild anterior cross-bite of -1mm or less, with only 3 adolescents having more severe cross-bites of -2 to -3mm (data not shown).

2. Vertical Occlusal Measures

On the average, the overbite for the complete sample was 3.2 ± 1.7mm (**Table 4.6**). The amount of positive overlap in millimeters and the proportion of adolescents with deep bites greater than 3.5mm were comparable between the PVS and PBS (p-value 0.234 and 0.176, respectively). However, despite not having achieved statistical significance, the

proportion of children with a complete overbite impinging on the palate in the PBS was double that present in the PVS (4.3% compared to 1.9%).

3. Transverse Occlusal Measures

The presence of transverse malocclusions was low in the participant sample. Overall, the prevalence of a posterior cross-bite involving more than one tooth was 13.7%, with private and public school children similarly affected (14.4% compared to 13.0%, p-value of 0.595; **Table 4.7**). Analogously, only 4.0% of the total sample had a midline diastema of at least 2mm, and this was very similar across both samples.

4. Other Occlusal Measures

a. Incisor Irregularity

The total maxillary irregularity score was on the average 3.7 ± 3.5 in the complete sample, reflecting an overall mild irregularity (**Table 4.8**). There were no differences between adolescents attending private schools compared to those attending public schools (p-value 0.454). Similarly, when only the maximum displacement between any two teeth in either the maxilla or mandible was noted, the PBS was similar to the PVS. In both samples, the majority had a moderate maximum contact point displacement (MCPD) of 2-4mm (70.9% in public schools, 63.0% in private schools, p-value 0.294). The total mandibular irregularity score, however, showed differences between the two samples, with greater mean mandibular irregularity scores in the PBS (3.9 ± 3.2 compared to 3.3 ± 3.2, p-value 0.046). However, despite statistical significance, the difference is unlikely to be clinically significant.

b. Additional Occlusal Findings

Of the total sample of 830 examined, 2.9% (n=24) had at least one missing tooth. The prevalence of missing maxillary lateral incisors was slightly less than 2% (n=15; 1.9% of total sample). Furthermore, 1.6% of the sample had more than one congenitally missing tooth. Of particular worth noting is that 15 adolescents aged 12.5 years or over (1.8%) had un-erupted canines on one side while the canine on the contralateral side had been fully erupted, suggestive of impacted canines. Of these, 11 (1.3%) were over 13.5 and may be considered to have almost definite impactions.

C. The Need for Orthodontic Treatment

The proportion of adolescents in need for orthodontic treatment among the PVS and the PBS did not differ significantly, both when using the classical IOTN scores (ranging 1 to 5; p-value 0.890; data not shown) and when using the modified IOTN to categorize into the presence or absence of definite need (**Table 4.9**, p-value 0.955). Overall, 16.0% of the total sample had a definite orthodontic treatment need that they had not received. In the PVS, this unmet need was present in 16.1% of the sample whereas in the PBS it was present in 15.9%. Among 12-17 year-old adolescents, the original age bracket targeted to allow for comparisons with NHANES data, 16.4% had a definite need for orthodontic treatment.

To take into account the different age distributions between our PVS and our PBS (**Figure 4.1**), an age standardized proportion was estimated for orthodontic treatment need. Age standardized prevalence rates suggest that prevalence of unmet need was in fact

slightly greater in the PBS compared to the PVS, but still not statistically significant (12.9% compared to 11.8%, p-value 0.632).

Age-stratification of orthodontic treatment need highlighted differences in the proportion in definite need between adolescents of varying ages (**Figure 4.2**). The prevalence of definite need for orthodontic treatment was least among 11 and 18 year-old adolescents (0%). Need for treatment gradually increased with age and peaked at age 15 (21.6%) before dropping to around pre-peak levels (14.3% at age 17 years).

D. Bivariate Analyses

To explore the determinants of selected outcomes, bivariate explorations were conducted to test associations with various child- and family-related potential explanatory variables. For covariates with more than 2 categories, p-values shown correspond to the significance of the association of the overall variable with the respective outcome. Where associations with the outcome exist for only one sub-category of the covariate, in-text references are made when relevant.

Three outcome variables were selected based on perceived significance for public and community oral health and/or their contribution to the burden on individuals from malocclusion: overjet, maximum contact point displacement (MCPD) and need for orthodontic treatment.

1. Overjet

Overjet was chosen as a significant outcome for exploration given its close association with increased risk for trauma of the upper front teeth and its relative

importance for individuals seeking treatment (complaining from teeth sticking out). To examine possible determinants of overjet in our sample, bivariate associations between the recorded child- and family-related determinants of oral health were associated with overjet as a continuous outcome measured in millimeters (**Tables 4.10-4.12**).

Adjusting for the effect of school cluster, only 2 variables were associated with overjet at the bivariate level: one child-related and one family-related (**Table 4.10(b); Table 4.12**). Although feeding method during first 6 months of life was significantly associated with the amount of overjet (p-value 0.013; **Table 4.10(b**), only adolescents who were fed both breast and bottle milk had a significantly larger average overjet compared to those fed only breast milk (3.4mm compared to 3.0mm; p-value 0.004; data not shown). Adolescents who were only bottle-fed did not differ from those who were only breastfed during the first 6 months of life (p-value 0.391; data not shown).

Among the family-related determinants of oral health, only family income was significantly associated with overjet severity at the bivariate level (p-value 0.002, **Table 4.11(a)**). Compared to adolescents living in families with incomes <500,000 L.L., adolescents living in families with all higher categories of income had reduced amounts of average overjet (β= -1.163, p-value 0.003; β= -1.057, p-value 0.019; β= -1.271, p-value 0.005, for each level of increase in family income, respectively; data not shown).

2. Maximum Contact Point Displacement (MCPD)

Given the close association between crowding with treatment seeking, MCPD was chosen as a proxy for the presence of any irregularity (maxillary or mandibular). To examine possible determinants of MCPD in our sample, bivariate associations between the

recorded child- and family-related determinants of oral health were associated with MCPD as a continuous outcome measured in millimeters (**Tables 4.13-4.15**).

Adjusting for the effect of school cluster, 3 variables were associated with MCPD at the bivariate level. The Decayed, Missing and Filled Teeth (DMFT) score was the only associated health-related variable and showed a mild positive association with MCPD severity (β=0.04; data not shown; p-value 0.039; **Table 4.14**). Although the mode of feeding during the first 6 months of infancy was not associated with MCPD, the association with the duration of bottle feeding was found to be significant (p-value 0.008; **Table 4.13(b)**). However, only adolescents who had been bottle fed for a period of 6 months to 2 years presented with reduced MCPD severity compared to those who were bottle fed for less than 6 months (β= -0.280; p-value 0.003; data not shown).

One family-related determinant was associated with MCPD severity: family income (p-value 0.012; **Table 4.15**). Of the various income categories, only adolescents born into families with incomes >3,000,000 L.L. had significantly less severe MCPD compared to those born into families with incomes <500,000 L.L. (β= -0.540; p-value 0.014; data not shown).

3. The Need for Orthodontic Treatment (Modified IOTN Score)

Instead of using the classical IOTN scoring system that ranges from 1 to 5, the modified IOTN score was used as the outcome of interest. It was believed that the categorization of adolescents into those with a definite need (IOTN 4 and 5) and those without a definite need (IOTN 1, 2 and 3) would be of greater public health significance than assigning 5 different grades of varying severity. As such, bivariate associations

between the recorded child- and family-related determinants of oral health were associated with the need for orthodontic treatment as a binary outcome (**Tables 4.16-4.17**).

Adjusting for the effect of school cluster, only 2 variables were associated with the need for orthodontic treatment at the bivariate level. One of these covariates was a child-level health related determinant: childhood breathing (p-value 0.020; **Table 4.16(a)**). Both the adolescents who were reported to breathe through their mouth and nose and those reported to breath only through their mouth were more likely to be in need for orthodontic treatment compared to those reported to breathe through the nose only (p-value 0.025 and 0.03 respectively, data not shown).

Similar to both overjet and MCPD, income was again associated with the need for orthodontic treatment (p-value 0.000; **Table 4.17**). This association was only significant for two income categories compared with the lowest category (data not shown). Adolescents born into families with the highest income category were less likely to be in need for treatment compared to those born into families with incomes less than 500,000 L.L. (**Figure 4.3**). In fact, only 2.33% of adolescents in the highest income category were in definite need for treatment compared to 32.43% of those born into families in the lowest income category (**Table 4.17**). Although the proportion of adolescents in need for treatment born into families with income between 500,000 L.L and 999,999 L.L. was significantly less than that in the lowest income category (p-value 0.014; data not shown), the difference in need between the 1,000,000-3,000,000 income category and the lowest one did not reach statistical significance (p-value 0.135; data not shown). Nevertheless, the trend with increasing income was significant at p-value 0.004 (data not shown).

E. Multivariate Analyses

Multinomial regression models were used to explore all potential risk factors for the three selected outcomes of interest (overjet (mm), **Table 4.18**; MCPD (mm), **Table 4.19**) and need for orthodontic treatment (**Table 4.20**).

Given the absence of significant associations between school type and our selected outcomes at the bivariate level (p-values > 0.2; **Tables 4.5, 4.8** and **4.9**), school type was dropped from all multivariate analyses. Since, in our data, school type was not a sensitive proxy for social inequalities in overjet, MCPD and treatment need; every attempt was made to adjust for education and income in our final models (as indicators of SES).

When closely related variables were associated with the outcome at the bivariate level, efforts to include them all in the final model were made (e.g. the presence of a sucking habit and sucking duration, feeding method and the duration of bottle feeding or duration of breast feeding). However, when the inclusion of these variables together lead to poor models or other problems such as collinearity and/or the absence of goodness of fit, decisions were made to keep the variable that was biologically more significant and/or contributed more to the model. Further elaborations are made below in each specific context.

All regression models were adjusted for the effect of school clustering. In cases where running the models without the adjustment for school cluster resulted in different interpretations, in-text references are made in context.

1. Overjet

Seven variables explained 10.14% of the variability in overjet in our sample (p-value 0.000; **Table 4.18**). Three variables were statistically significantly associated with overjet in the final model: age, feeding method during the first 6 months of life and income. Gender, the history of a sucking habit, childhood breathing mode and parent education were not statistically significantly associated with overjet severity, despite contribution to the variability in overjet in the final model.

Adjusting for all covariates, age was negatively correlated with overjet (adjusted β: -0.158; 95% CI: -0.281; -0.034; p-value 0.016). Adolescents who had been both breast and bottle fed during their first 6 months of life were more likely to have greater overjet than those exclusively breastfed, adjusting for all remaining variables (adjusted β: 0.696; 95% CI: 0.328; 1.065; p-value 0.001). In the same model, however, those adolescents who had only been bottle fed did not differ significantly from those who were exclusively breastfed (p-value 0.438). Finally, greater family income was significantly associated with reduced overjet and this relationship was apparent when all levels of higher income were compared to the baseline income of <500,000 L.L.

Despite the fact that at the bivariate level in addition to feeding type both breastfeeding and bottle feeding durations were significantly associated with overjet, these two variables could not be included in the final model because of collinearity with education. However, given the biological plausibility of the association between feeding method and overjet being confounded by either breastfeeding or bottle feeding time, it was necessary to exclude this possibility. As such, one of the explored multivariate regressions to explain overjet included the same variables as in **Table 4.18** except education, with the

addition of both breastfeeding and bottle-feeding time (data not shown). In this model, neither breast nor bottle feeding times were significant, but feeding method remained to be statistically significant. However, this model only explained 8.55% of the variability in overjet. Given the verification that it was indeed feeding method and not the duration of either type of feeding that was associated with overjet, these two variables were dropped. The incorporation of education into this model increased the percent variability of overjet explained 10.14%, and the model was thus chosen to be the most parsimonious model achievable.

Worth noting is the fact that 50% of the variability explained by the final model are contributions of the two socio-economic variables family income and parent education. The removal of these two variables alone reduces the percent variability explained to only 5.12 % (data not shown).

Finally, when the model was run without taking clustering into account, the results obtained were very similar. The same three variables remained to be the only significant predictors, with slightly more inflated p-values (data not shown).

2. Maximum Contact Point Displacement (MCPD)

Eight variables explained 5.05% of the variability in MCPD in our sample (p-value 0.000; **Table 4.19**). Only two variables significantly predicted MCPD in the final model: childhood breathing and bottle feeding duration. Age, gender, DMFT score, the duration of sucking habits and the mode of feeding during the first 6 months of life contributed to the final model but were not statistically significantly associated with the severity of MCPD.

Adolescents who, according to their parents, used to breathe through only their mouth during their childhood were at significantly greater risk of having greater MCPD, adjusting for all other covariates (adjusted β: 0.353; 95% CI: 0.046; 0.660; p-value: 0.027). On the other hand, adolescents who were bottle fed between 6 months and 2 years had significantly reduced overjet severity compared to those bottle fed for less than 6 months (adjusted β: -0.328; 95% CI: -0.602; -0.055; p-value: 0.022). This relationship did not show for adolescents who were bottle fed for more than 2 years.

Despite the insignificance of the association between feeding type and MCPD in the final model, it was maintained to adjust for possible the possible confounding effect with bottle feeding duration. The duration of breastfeeding was also deemed worthy of exploration as a confounder, but it was not possible to incorporate it in the final model. Therefore, in one of the exploratory models, the three variables (feeding type, duration of bottle feeding and duration of breastfeeding) were all included and income was dropped (data not shown). This model confirmed that adjusting for all the same variables as in the final model chosen except income, it was bottle feeding duration and not breastfeeding duration or feeding method that significantly explained some of the MCPD. This model, however, only explained 3.98% of the variability in MCPD. In order to incorporate income into the regression, bottle feeding was therefore dropped and replaced with income, leading to the final model explaining 5.05% of the variability in MCPD.

Noteworthy is the fact that, out of the three regression models explaining the selected outcome variables, MCPD is the only outcome where the final model did not include education as an explanatory variable. Because of collinearity, it was not possible to incorporate it into the model containing both bottle-feeding duration and feeding type

during the first 6 months of life. Various trials of model building revealed that feeding type contributed more to the percent variability of MCPD than education, and it therefore received priority over education in the final model. However, when the final model was run without adjustment for school cluster, the results differed significantly from the cluster-adjusted model. Adjusting for the same covariates, only DMFT score was associated with MCPD severity with a very modest association (adjusted β: 0.043; 95% CI: 0.0001; 0.084; p-value: 0.043).

3. The Need for Orthodontic Treatment

Five variables were incorporated into the final model predicting the need for orthodontic treatment (**Table 4.20**). Age, gender and parental educational level were not associated with the need for orthodontic treatment.

Adjusting for all covariates, only two variables were significantly associated with the need for orthodontic treatment: breathing mode during childhood and income. However, only those adolescents who reportedly used to breathe through both their nose and their mouth were more likely to be in need for orthodontic treatment compared to those reported to breathe only through their nose (adjusted OR: 1.790; 95 % CI: 1.035; 3.096; p-value 0.037). Despite an OR for treatment need even greater for those reportedly breathing through only their mouth compared to those breathing through their nose (OR: 1.958), this association did not reach statistical significance (95% CI: 0.857; 4.473; p-value 0.111). Similar to breathing mode, education also showed a significant association at only one level of exposure. Only those adolescents born into families with incomes greater than 3,000,000 L.L. were at significantly lower odds of being in need for treatment compared to those born

into families with income less than 500,000 L.L., adjusting for all other covariates (adjusted OR: 0.042; 95% CI: 0.002; 0.767; p-value 0.032).

When the effect of school cluster was ignored, some changes were evident despite an overall similarity in the two models (data not shown). Income remained to be significantly associated with the need for treatment only at the highest level, and more significantly that in the cluster-adjusted model (p-value 0.009). However, reported history of breathing method lost its significance in the association with treatment need, showing p-values and confidence intervals of borderline significance (95% CI: 0.958; 3.253; p-value 0.056; data not shown).

F. Oral Health-Related Quality of Life

To explore the impact of substantial malocclusion on OHRQoL, Child Perceptions Questionnaire (CPQ) scores (total and domain specific) were compared between individuals in definite need for orthodontic treatment and those who were not (**Table 4.21).** Adjusting for school type, age, gender and orthodontic history, adolescents with definite need for orthodontic treatment had higher average total CPQ scores and therefore lower OHRQoL. They also had higher scores for the domains of functional limitations and emotional and social well-being (p-values all <0.05). Worth noting is the fact that receiving orthodontic treatment was significantly associated only with the functional limitations domain (p-value 0.048, data not shown), whereas females were more likely to have worse (higher) scores for both emotional and social well-being and thus also worse total CPQ scores (p-values 0.001, 0.005, 0.016 respectively; data not shown).

CHAPTER V

DISCUSSION

A. Introduction

Previous studies have set the groundwork in estimating the prevalence of malocclusion in selected adolescent ages in Lebanon (Doumit & Doughan, 2002; Saleh, 1999). However, what distinguishes our study from already published research on adolescents is the assessment of possible determinants of malocclusion and the quantification of orthodontic treatment need. Notably, this study is the first in Lebanon to assess how social inequalities relate to malocclusion and the need for orthodontic treatment in adolescents. Although our sample was recruited through non-probability sampling techniques, the large sample size and the inclusion of different private and public schools enables the researchers to reflect on the malocclusion among adolescents enrolled in schools in Beirut.

To answer our research question on the presence of inequalities and how they reflect on malocclusion and orthodontic treatment need, our study was designed as a comparative cross-sectional study of adolescents attending private and public schools in Beirut. Although this dichotomization did not represent the two extremes of the socio economic (SE) spectrum in our sample, our results still support the presence of substantial social inequalities in both malocclusion and orthodontic treatment need.

B. Discussion of Major Findings

1. Occlusal Characteristics

Our findings illustrate that adolescents attending public schools and those attending private schools, on the average, have similar malocclusions. The one major contributor to malocclusion in Lebanese adolescents is incisor irregularity, with at least some form of crowding present in three quarters of adolescents. Sagittal discrepancies in occlusion are also common. Notably, slightly less than one third of the adolescents have an overjet that is greater than 3.5mm, and therefore an even greater proportion are above the 3mm threshold. The importance of this lies in the fact that an overjet of 3mm has been implicated as a major culprit in the risk for trauma to the upper front teeth (Nguyen et al., 1999; Petti, 2015).

a. <u>Incisor Irregularity:</u>

The widespread presence of crowding in our sample of adolescents is in concordance with the majority of international and regional studies conducted in various countries across different parts of the world (Borzabadi-Farahani et al., 2009a; Gelgor et al., 2007; Proffit et al., 1998; Rwakatema et al., 2006; Sanchez-Perez et al., 2013; Thilander et al., 2001). Reported prevalence rates range from 50 to 81.4%, and support our finding that most adolescents do have some form of incisor irregularity.

In the comparison to results from the region, our data are in line with several studies assessing incisor irregularity among adolescents in Saudi Arabia and Kuwait (al-Emran et al., 1990; Al Hummayani, 2005; Behbehani et al., 2005; Togoo, V S, Wahab, & Abogazalah, 2012). Furthermore, our data suggests that mandibular irregularity scores are

substantially larger in adolescents than in 6-11 year old school children (Hanna, 2012). This is consistent with reports of crowding increasing from childhood to adolescence by various authors (Gois et al., 2012; Jolley et al., 2010; Thilander et al., 2001).

Our exploration of the determinants of MCPD highlights mouth breathing and bottle feeding during childhood as significant predictors of anterior crowding. Previous studies have also related mouth breathing to crowding, particularly in the upper arch (Betts, Vanarsdall, Barber, Higgins-Barber, & Fonseca, 1995; Huynh, Morton, Rompre, Papadakis, & Remise, 2011; Lopatiene & Babarskas, 2002). Abnormal breathing has been associated with altered development of the jaws leading to narrow arches and therefore less space for tooth eruption (Huynh et al., 2011). Additionally, it has been associated with increased lower incisor irregularity as a result of changes in the direction of jaw growth that lead to soft tissue stretching and increased pressure on the lower incisors from adjacent muscles (Solow & Sonnesen, 1998). In the study conducted on 6-11 year old school children in Lebanon, mouth breathing was also associated with mandibular irregularity, adjusting for other covariates (Hanna et al., 2015).

Surprisingly, increased bottle feeding duration is protective against MCPD severity in our sample of adolescents. To our knowledge, bottle feeding has not been directly related to crowding in previous studies, but the general trend is to associate its presence with shorter breastfeeding times, increased uptake of harmful sucking habits and therefore higher risk of malocclusion (Agarwal et al., 2014; Luz et al., 2006; Melink et al., 2010; Montaldo et al., 2011). The absence of a biological explanation for the opposite association found in our study suggests that bottle feeding duration may be a proxy to some other factor. Given that our sample is restricted to adolescents who have never received

orthodontic treatment, this factor may be socio-economic and may be a reflection of the degree of uptake of orthodontic treatment. One possible explanation is that adolescents who were bottle fed for 6 months to 2 years are more likely to have employed mothers, who may have social capital that is more conducive towards having their child treated with orthodontics. These families may be positioned higher along the social gradient described by Watt and Sheiham and coworkers (2012), and bottle feeding may be a proxy for the interaction between a multitude of underlying factors, including occupational status, education, income and social class. Although the respondent parent was asked about family income in our study, two factors may have decreased the accuracy of its assessment. On the one hand, some parents did not respond to this question, and it is likely that non-response was more common among those with family incomes at the extremes (either the lowest category or the highest category). Additionally, to encourage respondents to answer the question, family income was categorized into rather broad and limited categories. It is highly likely that among those who reported incomes greater than 3,000,000 L.L. there is large variability. Therefore, it may be speculated that bottle feeding duration could be simply an indicator of greater income and higher social empowerment towards receiving treatment, especially given the association between family income and parental education with adolescent orthodontic treatment that is illustrated in our sample.

The association between bottle feeding and reduced MCPD must be interpreted with caution. The assessment of bottle feeding in our study used a very soft measure, with only 3 broad categories defined. Although this was the case to reduce the burden on the respondent and to take into account difficulties in remembering exact durations, this resulted in somewhat indistinctive categories. In fact, most of the respondents reported that

their adolescent was bottle fed between 6 months and 2 years. The discussion above highlights possible explanations to the association with bottle feeding but only the validation of this result in future studies that measure feeding practices and duration more precisely will allow for more accurate conclusions. Qualitative research methods may be necessary to understand other factors relating to bottle feed and any associations with SE indicators.

It is worth noting that, despite the significance of the association with mouth breathing and bottle feeding duration, the two variables explain a very small portion of the variability observed in MCPD. The presence of other factors, uncaptured by our study, is highly likely. It may be possible that certain factors, including sucking habits and their duration, affect the upper and lower jaws differently and were therefore not apparent in the association with MCPD in general. Another possible explanation is the presence of underlying, non-modifiable determinants such as genetics, evolutionary diet-related changes, and widespread environmental phenomena that affect populations at large. This is supported by the lower prevalence rates of crowding (12.9% and 19%) reported in African populations by several authors (Isiekwe, 1983; Ng'ang'a, Ohito, Ogaard, & Valderhaug, 1996). This observation is reinforced by the analysis of Buschang and Shulman (2003) of incisor irregularity in the NHANES III sample. Based on multivariate analysis of the data from 9059 individuals aged 15-50, the authors conclude that race is the most significant predictor of incisor irregularity.

b. Overjet:

Slightly less than one third of our sample of Lebanese adolescents have an increased overjet, comparable to the trend across various international and regional studies assessing overjet in adolescents (Behbehani et al., 2005; Borzabadi-Farahani et al., 2009a; Gelgor et al., 2007; Proffit et al., 1998; Thilander et al., 2001).

Only three variables significantly predict overjet in our sample of adolescents: age, feeding mode during the first 6 months of life, and income. The inverse relationship between age and overjet is compatible with sagittal mandibular growth which experiences a peak during the adolescent growth spurt and continues at a slow rate till around the age of 17 in females and 19 in males (Lewis, Roche, & Wagner, 1985; Nahhas, Valiathan, & Sherwood, 2014; Woodside, 1968). Comparing our findings to those of Hanna and coworkers (2015), the data indicate a slightly less, but not clinically significant, overjet in our older sample.

The positive association between bottle feeding and increased overjet in our model is also supported by the literature that illustrates the protective effects of breastfeeding on jaw growth (Kobayashi et al., 2010; Peres et al., 2007; Thomaz et al., 2012). However, in our sample, only adolescents who were fed both breast and bottle milk during the first 6 months of life show greater overjet than those exclusively breastfed although biologically one would assume this relationship to show for those exclusively bottle fed as well. Interestingly, the durations of bottle feeding and breastfeeding do not seem to be significant predictors of overjet in our sample. These inconsistencies may be the result of information bias related to the categorization of our measures in the parental questionnaire and/or to the difficulty for parents to recall exact durations of bottle or breast feeding.

The final significant variable in our model explaining overjet is income, indicating a significant social disadvantage for the most economically underprivileged adolescents. A biological explanation for this association between income and overjet is unlikely, and it is probably rather a reflection of inequalities in receiving treatment as a result of the exclusion of adolescents with orthodontic history from our analyses.

2. Need for Orthodontic Treatment

The results of our study suggest that around one in 7 untreated adolescents attending private and public schools in Beirut is in a definite need for orthodontic treatment, based on IOTN scores. Compared to American adolescents of similar ages examined in the NHANES III, the prevalence of definite need for treatment among adolescents in Beirut lies in between the two rates reported for American whites and Black-Americans (Proffit et al., 1998). The NHANES adolescent population best corresponds to the subset of our research population aged 12-17 years attending both private and public schools. Proffit et al. (1998) report separate proportions for American Caucasians, Mexicans and Africans (13.5%, 21.5% and 11.7% respectively). The comparison with our sample is most pertinent with the white adolescents, as the participants in our study may be considered Caucasians. Accordingly, the computed need (16.4% for the age bracket 12-17 years) among Beirut school youth is nearly 3% higher than the NHANES white population (**Figure 5.1**). The combination of both public and private school adolescents is also valid because no differentiation was made in the NHANES study between school types. The closeness of proportions with the NHANES study is significant in the context of global definitions of malocclusion among racial and ethnic groups (in this instance the

commonality of the Caucasian definition) and environmental (mostly dietary habits) etiologic components of malocclusion.

The multitude of the more recent studies conducted internationally and regionally, however, report very wide ranges for the proportion of adolescents in need for treatment (14% to 47.9%); (Abdullah & Rock, 2001; O. D. Otuyemi, Ugboko, Adekoya-Sofowora, & Ndukwe, 1997). These variations are likely to partly reflect differences in the development of malocclusion inherent to the studied populations. For instance, the lowest rate is reported in a Nigerian sample and is concomitant with reports of lower prevalence of crowding and overjet in African populations, both of which are major contributors to assigning treatment need (O. D. Otuyemi et al., 1997).

Much of the variability, however, is likely to be the result of differences in age between the examined adolescents in the different studies and in orthodontic treatment uptake in different areas. Inherent to assessing unmet orthodontic treatment need is the fact that examined individuals have not received prior treatment. By default, areas with greater uptake of orthodontic treatment result in a greater number of exclusions of adolescents because of orthodontic history. Although several factors influence treatment seeking, individuals with the most severe malocclusions are more likely to seek and receive treatment. As a result, in areas were orthodontic treatment is common, cross-sectional epidemiological studies tend to over-represent individuals with less severe malocclusions. This must be kept in mind when interpreting the rates of orthodontic treatment need that are reported on adolescent ages when orthodontic treatment is usually acquired.

In this context, it is interesting to compare our results with a recent study carried out in the region on a very large population of school-aged students from 66 private and

public schools in the UAE (Al Jeshi et al., 2014). Their reported proportion of untreated adolescents in need for orthodontic treatment (14.4%) is strikingly similar to our findings. More interestingly, however, is that among the subset from Arab countries only 9.1% were in need for treatment – considerably lower than in our population of adolescents. This illustrates social inequalities both within the sample examined by Al Jeshi and coworkers, and perhaps even within Arab populations. Although direct comparisons may be limited, the reported need for orthodontic treatment among Arab adolescents residing in their countries is considerably greater than 9% (compared to 16% in our Lebanese sample and compared to various regional reports presented in **Table 2.3)**. This may be the result of Arab populations residing in the UAE belonging to different positions along the SE spectrum and having greater access to orthodontic treatment.

Such inequalities are supported by our multivariate analysis, where family income and childhood breathing mode are the only significant predictors of the need for orthodontic treatment. Specifically, family income appears to be most significant in explaining orthodontic treatment need, with adolescents belonging to the most economically advantaged families having exceptionally minimal odds of being in need for treatment, adjusting for other covariates. Although SE factors have been implicated in disparities in orthodontic treatment need among adolescents by several authors (Dhanni, Saify, Goutham, & Kulkarni, 2008; Frazao & Narvai, 2006; Mtaya et al., 2009; Tickle et al., 1999), our study is to our knowledge the first to show a direct relationship with family income as a distinct entity.

Given that abnormal breathing affects the manifestation of certain malocclusion traits, it is reasonable for it to be associated with IOTN scoring. Earlier in this chapter we

discussed the association between mouth breathing and MCPD. In addition to greater MCPD directly leading to greater scores for the need for treatment, mouth breathing has been implicated in narrow maxillary arches. Reduced transverse maxillary dimensions have been associated with greater incidence of maxillary impaction, which is a definite indication for treatment in the IOTN grading system and is another possible explanation for the association between mouth breathing and orthodontic treatment need (Bishara, 1992; Ngan, Hornbrook, & Weaver, 2005; Shapira & Kuftinec, 1998). It is worth noting that, although the effect size of definite need for treatment for strict mouth breathers is even greater than that for those reporting mixed breathing (mouth and nose), the association was significant only for those with mixed breathing. It is possible that the lack of significance is the result of insufficient power to achieve significance because of a small subset of adolescents who reportedly breathed only through their mouths.

It is interesting to note that, in the comparison with the available data on younger Lebanese children, the proportion in need for orthodontic treatment is less in our older sample (Hanna, 2012). As discussed earlier, certain aspects of malocclusion, including crowding, tend to worsen with age. However, other aspects, like overjet, improve. It appears that this improvement, coupled with the uptake of orthodontic treatment in early adolescence, results in a reduction in the orthodontic treatment need in adolescents compared to children. Although research on this topic is scarce, other authors have also reported similar trends (Baubiniene, Sidlauskas, & Miseviciene, 2009; Chi, Harkness, & Crowther, 2000).

3. Social Inequalities

In the preceding discussion, income has been underscored as a determinant of sagittal malocclusion (overjet) and orthodontic treatment need. This highlights significant health disparities among adolescents that relate to the social inequalities present in the Lebanese population.

Specific elements relating to the process of recruiting our sample are conducive towards a broader conceptualization of social inequalities in malocclusion than captured by our study. Acknowledging the difficulties in assessing SES directly because of the multi-dimensionality of the construct of the social gradient (Watt & Sheiham, 2012) and because of the frequency of under-reporting and missing values in questionnaires when it comes to SE indicators, we approached private and public schools as proxy indicators for SES. From the out start, private schools catering to adolescents in higher SES families and providing yearly dental screening refused to participate. To better understand the SE category of the participating private schools compared to the overall pool of private schools in Beirut, we examined each school's yearly tuition fees. Although all participating private schools are categorized as "non-free private schools", two schools have annual fees between 3 - 4.5 million L.L., 4 schools between 4.5 - 6 million L.L. and 2 schools have fees of 7 - 7.5 million L.L. In contrast, high SES schools request fees that may reach 15 - 20 million L.L. for the highest grades.

Moreover, parents who refused the participation of their child were more educated, had higher family incomes and their children were more likely to have received orthodontic treatment. Among the examined adolescents, those who had received orthodontic treatment were excluded from our analyses. The excluded adolescents were more likely to attend a

private school and have more educated parents with higher incomes. The biases inherent to the recruitment of our PVS suggest that it under-represented adolescents attending high SES private schools, who are examined at least yearly by a dentist, and who belong to families with greater incomes, more educated parents, and who are more likely to have had orthodontic treatment. It is worth emphasizing that, despite the tendency for the outlined biases to mask the presence of social disparities, the association with income remains significant. The authors are therefore confident that among adolescents in Beirut, social inequalities are a significant determinant of disparities in malocclusion and of the need for orthodontic treatment.

One final note regarding the need for orthodontic treatment is not amenable to statistical illustration. However, it is worth noting in the discussion on disparities, not in the need for orthodontic per se, but in unmet treatment need. When social inequalities are related to unmet need for treatment, it is inherent that, first, the child or adolescent has a malocclusion that requires treatment. However, it is also implied that he/she has surpassed the optimal age for the initiation of orthodontic treatment without receiving it, and that this is related to an underlying social factor. Unless a child's malocclusion requires a form of early, interceptive orthodontic treatment, conventional fixed orthodontic treatment with braces is often delayed until the child is in a fully permanent dentition, or just before. It is difficult to assign a cut-off age for the distinction between a need and an "unmet need", because the timing of orthodontic treatment may be the result of many factors that are beyond the scope of this thesis. However, the presence of an orthodontic treatment need in older adolescents can be considered to be "more" unmet than in younger adolescents who have just entered their permanent dentition stage. This is pertinent to our sample because

the mean age of the adolescents in our final PBS is significanltly greater than that in our PVS. Although not documented, a good proportion of the younger untreated adolescents attending private schools in our sample mentioned that they had already seen an orthodontist and were planned to have braces in the near future – as soon as "all their baby teeth fall out". Therefore, although it must be acknowledged that our results do not show inequalities in orthodontic treatment need between adolescents in public schools and those in average SES private schools, they do not prove equality in unmet needs either. Future research with better distinctions between need and unmet need may prove useful for a more accurate investigation of inequalities in orthodontic treatment need.

4. Oral Health-Related Quality of Llife

Our results support the growing body of research in favor of a negative correlation between malocclusion and OHRQoL (Dawoodbhoy, Delgado-Angulo, & Bernabe, 2013; Sardenberg et al., 2013; Scapini, Feldens, Ardenghi, & Kramer, 2013) and support the conclusions of the two most recent systematic reviews published on the topic (Dimberg, Arnrup, & Bondemark, 2014; Liu et al., 2009). In our adolescent sample, the association between being in need for orthodontic treatment and poor OHRQoL assessed using the CPQ_{11-14} remains significant after adjusting for age, gender, school type and history of receiving orthodontic treatment. In light of the social inequalities illustrated in our sample, this association warrants envisioning the disparities in orthodontic treatment need in context of the effects on the social and emotional well-being of adolescents and their quality of life.

C. Strengths and Limitations

Several of the strengths and limitations of the study carried out have been illustrated in their relevant contexts throughout this chapter. Therefore, this section will serve as a concise summary.

1. Limitations

The selection bias resulting from the reduced response rates and uptake at the levels of private school recruitment, parent approval of adolescent participation and adolescent exclusion from analysis due to orthodontic history all limit the generalizability of our private schools to the complete spectrum of private schools located in Beirut. Our data are also a poor indication of the malocclusion status of adolescents not attending schools, who may have worse oral health.

Other limitations include all those inherent to using a self-administered questionnaire. Some degree of information bias in the form of poor recall, inaccurate reporting, under-reporting and misinterpretation of questions, is inevitable. Additionally, certain variables were gauged through "soft" measures. For questions on income, broad categories were selected to encourage response and discourage under-reporting. For other questions, including the duration of bottle feeding, broad categories were chosen because it was thought that parents of adolescents would have difficulty in remembering accurately events that occurred between 10 and 17 years ago. Nevertheless, the reduced accuracy of these measures must be acknowledged.

Finally, in the assessment of orthodontic treatment need, only the dental health component (DHC) was used. However, in their original publication, the authors of the

IOTN describe the DHC and an aesthetic component (AC), advocating the use of both simultaneously and assigning the higher score among the two to indicate any individual's need for treatment (Brook & Shaw, 1989). Although an informed decision was made to use only the DHC based on reports of better objectivity, it must be acknowledged that for some of the adolescents the use of both components would have resulted in a higher score for the need for treatment, based on esthetic impairment. Therefore, in the reporting of orthodontic treatment need, one must keep in mind that the proportion of adolescents in definite need for treatment in our sample is at least that which we report, and possibly greater if esthetic burden is taken into consideration.

2. *Strengths*

This study fills a gap of more than one decade since Saleh (1999) and Doumit and Doughan (2002) assessed malocclusion in adolescents in Lebanon. Not only does this study serve as an update, it also provides a more extensive account of various malocclusion measures in different planes of space. Such details were understandably absent in previous studies, since they were, to our knowledge, the first to be carried out on Lebanese adolescents. Given the presence of an existing foundation on the prevalence of malocclusion in general, our work serves as a natural progression in the direction of a more detailed exploration of specific malocclusion traits.

Additionally, our study is the first in Lebanon to assess orthodontic treatment need in adolescents. Preceded by a similar study on younger children attending private and public schools in Beirut (Hanna et al., 2015), the data collected through this research allows for comparisons crucial in the assessment of the progression of malocclusion and

orthodontic treatment need among Lebanese children as they grow into adolescence. In the absence of long-term cohorts, such comparisons will allow for insight on the status of treatment need with implications regarding timely interceptive and conventional orthodontic treatment. Similarly, ours is the first study to depart form merely description of malocclusion in the Lebanese population to the assessment of its determinants and how it is affected by social inequalities.

Notwithstanding the already mentioned biases and obstacles in sample recruitment, the examined adolescents are similar to the non-examined children with respect to age and gender. Similarly, neither of the two demographic variables differs significantly between the subset of adolescents subjected to our data analyses and those who were excluded because of history of orthodontic treatment. Furthermore, the availability of data on SES at the various levels of filtering allows for the revision of the inferences made from our results to be limited to adolescents attending middle SES private schools in Beirut. Finally, although this selection bias resulted in our selected proxy of school type to be a poor reflection of SES, it did not prevent the illustration of social inequalities with different family income levels.

The available knowledge on the adolescents that did not participate suggests that any inaccuracies in our reporting of social inequalities resulting from selection bias are likely to be more conservative than the truly existing differences.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Our findings have illustrated the presence of social disparities in malocclusion among adolescents in Beirut. The burden from orthodontic treatment need is unequally distributed along the social spectrum and has implications for inequities in the quality of life of Lebanese adolescents that are contrary to the concepts of social justice and the fundamentality of oral health as a universal right. Although the selective nature of our sample restricts our conclusions to adolescents of middle SES, the availability of data on those excluded from our study allows for tentative inferences beyond our direct sample, until confirmed by future research. Our failure to represent the most SE advantaged segment of the population suggests even greater inequalities than our study was able to capture.

In our assessment of various modifiable determinants of malocclusion we were able to confirm associations already described in the literature, in addition to highlighting possible associations with childhood feeding mode that remain to be confirmed by future research. More importantly, however, our data suggest the presence of socially determined missed opportunities in the implementation of timely orthodontic screening and intervention, with important implications for community dentistry and dental public health.

B. Recommendations

Although dentistry has geared towards primary prevention in the control of oral diseases, the low modifiability of malocclusion through currently established determinants, confirmed by our multivariate analyses, highlights the significance of secondary prevention in the control of malocclusion progression. Jolley et al. (2010) have illustrated how 80% of children who received timely intervention were no longer categorized as needing treatment 2 years later, compared to only 6% of controls. King and Brudvik (2010) similarly illustrated the benefits of a systematic approach to interceptive orthodontics.

1. Short-Term Recommendations

Schools are an important access point to monitoring the development of malocclusion. Although yearly dental screening for children in grade 9 and below is enforced by the Ministry of Education, this requirement does not include orthodontic screening and does not apply to private schools. Our data, on the other hand, suggest that the needs of adolescents attending lower SES private schools are not less than those in public schools. We propose that orthodontic screening should be obligatory for all private and public school children age 7-14 years. This may be planned yearly between ages 7-10 to maximize benefit from the possibility of interceptive orthodontics, and then every other year (ages 12 and 14). Until more permanent solutions are available, such services may be provided through volunteer work by practicing orthodontists who may be recruited through the Lebanese Dental Association (LDA). Orthodontic residents in the 4 programs available in the country may also be involved, as part of community dental service.

General dental practitioners (GDPs), general physicians and pediatricians present additional access points along the pathway of promoting timely orthodontic consultation. Efforts within the LDA and the Lebanese Order of Physicians are necessary to educate these practitioners on the importance of encouraging parents to receive timely orthodontic consultations for their children and on acquiring the skills (for GDPs and even pediatricians) for early identification of potential occlusal problems requiring urgent referral. Such efforts may be in the form of compulsory lectures and workshops integrated into the process of joining and maintaining membership in the respective order/association.

It is crucial that alternatives for affordable orthodontic services be provided in parallel with screening procedures, with specific emphasis on interceptive orthodontic services. Unfortunately, primary dental health care centers in Lebanon, which provide reduced-cost dental services for many disadvantage families, do not provide any orthodontic services. Collaborations between the Ministry of Public Health, the LDA and University-based orthodontic residency programs in the country need to consider the inclusion of limited interceptive orthodontics to be performed by orthodontists and/or specifically trained GDPs. These practitioners may be recruited as part of volunteer work (for example one day a month for each practitioner) or as community service incorporated into orthodontic residency programs.

Despite the low potential for the primary prevention of malocclusion, established risk factors such as mouth breathing and thumb sucking, in addition to potential risk factors such as reduced breastfeeding, do merit attention. Efforts to increase parental awareness on the harm resulting from these functional risk factors may be disseminated through schools (parent-teacher meetings, school activities involving parents, referral letters following

yearly medical exam) and during pediatricians' visits. It is worth noting that such measures will only be useful if combined with structural changes that will allow parents to seek appropriate care.

2. Long-Term Recommendations

In an attempt to promote changes in oral health that are permanent, the same principles behind the short-term interventions suggested above should be directed towards more distal components of each targeted access point of change and should lead to structural changes in policy. Otherwise, interventions carry the risk of increasing health disparities because the greatest benefit is gained by individuals with more resources (Schou & Wight, 1994; Watt, 2012).

Government budget in a country like Lebanon limits the ability to target the underlying drivers of social stratification. However, local policies may be directed at intermediary determinants by targeting local settings such as schools and health care providers (Watt & Sheiham, 2012). Such policies should ultimately lead to the sustainability of yearly orthodontic screenings and clear referrals to specific dental health care centers for all children of specified ages attending private and public schools in Lebanon. The provision of a permanent orthodontist providing interceptive orthodontic treatment in at least one primary dental health care center in each geographical area should be the ultimate goal. Clear and legislative procedures supported by the Ministries of Public Health and of Education would be necessary. For example, a freshly graduated orthodontist may need to undergo an internship of one year in a primary health care center providing

interceptive orthodontic treatment, before becoming eligible for registration in the LDA and obtaining a work permit.

Ultimately, these structural changes should result in an integrated system of timely screening, referral and provision of simple and affordable interceptive orthodontic interventions. Failure of implementation at any of these levels may end up targeting family-level determinants of oral health instead. Consequently, various obstacles including parental awareness and accessibility to treatment may limit the benefit of children positioned along the bottom of the social gradient.

C. Directions for Future Research

We believe that our study was an important step in illustrating the presence of inequalities. However, limited national resources necessitate the identification of the most socio-economically disadvantaged populations so that they are targeted by interventions aiming to reduce disparities. The fact that even within private schools there are social inequalities in treatment need highlights the need for a national, random, stratified, population-based study to quantitatively assess the prevalence of orthodontic treatment need in public and private schools across different geographical areas of the country. Based on the experience amassed at the various levels of our research, we advance a number of suggestions for future endeavors:

- The direct encouragement by the Ministry of Education, in concert with the Ministry of Public Health, for the participation of private and public to avoid potential selection biases resulting from the refusal to particpate.

- Collecting research data during the annual dental examinations when scheduled at the schools. Screening would target adolescents without restriction, including those who have received orthodontic treatment, and would categorize their malocclusion into no definite need, definite need and met need. The distinction between need and unmet need is also advised, using age cutoffs and/or asking about futureplans to receive treatment. Planning with schools should be performed at least one semester in advance and screening is advisably timed at the beginning of the school year and in coordination with the school dentist, if present.
- In case schools do not have yearly dental screening, it is advisable to prepare the field prior to the intiation of data collection, in order to increase parental participation. This goal could be achieved through informing and educating parents about the research during school activities that they attend, including parent-teacher meetings, school "open days" and sports activities.
- Collaboration among university-based residency programs to provide several calibrated examiners for time-effective screenings. In private schools, training and calibration of existing dentists is another possibility. At a more national level, the pertinent governmental agencies and/or the national dental association may introduce programs similar to the NHANES that would provide researchers with a solid ongoing registry from which they may set various projects to answer specific research questions and test hypotheses.

TABLES

Table 4.1: Percent distribution of adolescents whose parents answered questionnaire (11-18 years) by selected background characteristics and status of examination, adjusted for school cluster (n=948)

Selected Background Characteristics	Examination Status			p-value
	Not examined (n=118) N (%)	Examined (n=830) N (%)	Total (n=948) N (%)	
Age (years)				
Mean ± S.D.	14.6 ± 1.7	14.7 ± 1.7	14.7 ± 1.7	0.751
Grade				
Middle school	70 (59.3%)	454 (54.7%)	524 (55.3%)	0.676
High school	48 (40.7%)	376 (45.3%)	424 (44.7%)	
Gender ɳ				
Males	51 (43.6%)	355 (42.8%)	406 (42.9%)	0.905
Females	66 (56.4%)	475 (57.2%)	541 (57.1%)	
School type				
Private	77 (62.3%)	437 (52.7%)	514 (54.2%)	0.377
Public	41 (34.7%)	393 (47.3%)	434 (45.8%)	
****Education of parent/legal guardian** ɳ				
Low	8 (7.0%)	59 (7.4%)	67 (7.4%)	0.001*$^{\overline{\top}}$
Middle	32 (28.1%)	400 (50.4%)	432 (47.6%)	
High	74 (64.9%)	335 (42.2%)	409 (45.0%)	
Family income (LL) ɳ				
<500,000	2 (2.0%)	43 (6.1%)	45 (5.6%)	0.003*$^{\overline{\top}}$
500,000-999,999	18 (18.4%)	222 (31.3%)	240 (29.7%)	
1,000,000-3,000,000	32 (32.7%)	297 (41.8%)	329 (40.7%)	
>3,000,000	46 (46.9%)	148 (20.8%)	194 (24.0%)	
History of orthodontics ɳ				
Untreated	61 (56.5%)	653 (78.7%)	714 (76.1%)	< 0.001*
Treated (current/past)	47 (43.5%)	177 (21.3%)	224 (23.9%)	

* p–value <0.05; $^{\overline{\top}}$ p-value for test of trend <0.05

** Levels of education grouped into: **low** - illiterate, read-write, primary school; **middle** - middle or secondary school; **high** - college or university

ɳ Numbers in cells do not add up to total N column-wise because of missing values

Table 4.2: Percent distribution of examined adolescents (11-18 years) by selected background characteristics and orthodontic treatment status, adjusted for school cluster (n=830)

Selected Background Characteristics	Orthodontic Treatment Status		p-value
	Not treated (n=656) N (%)	Treated (n=174) N (%)	
Age (years)			
Mean ± S.D.	14.6 ± 1.7	15.0 ± 1.8	0.058
Grade			
Middle school	375 (57.2%)	79 (45.4%)	0.163
High school	281 (42.8%)	95 (54.6%)	
Gender			
Males	293 (44.7%)	62 (35.6%)	0.172
Females	363 (55.3%)	112 (64.4%)	
School type			
Private	316 (48.2%)	121 (69.5%)	< 0.001*
Public	340 (51.8%)	53 (30.5%)	
****Education of parent/legal guardian ɳ**			
Low	50 (8.0%)	9 (5.3%)	< 0.001*$^{\mp}$
Middle	338 (54.2%)	62 (36.5%)	
High	236 (37.8%)	99 (58.2%)	
Family income (LL) ɳ			
<500,000	37 (6.7%)	6 (3.9%)	< 0.001*$^{\mp}$
500,000-999,999	195 (35.1%)	27 (17.4%)	
1,000,000-3,000,000	237 (42.7%)	60 (38.7%)	
>3,000,000*	86 (15.5%)	62 (40.0%)	

* p–value <0.05

$^{\mp}$ p-value for test of trend <0.05

** Levels of education grouped into: **low** - illiterate, read-write, primary school; **middle** - middle or secondary school; **high** - college or university

ɳ Numbers in cells do not add up to total N column-wise because of missing values

Table 4.3(a): Percent distribution of untreated adolescents (11-18 years) by child-level influences on oral health and type of school, adjusted for school cluster (n=656)

Child-level Influences on Oral Health	School type			P-value
	Public (n=340) N (%)	Private (n=316) N (%)	Total (n=656) N (%)	
Demographic variables				
Age (years)				
Mean ± S.D.	15.3 ± 1.6	13.9 ± 1.5	14.6 ± 1.7	0.008*
Grade				
Middle school	121 (35.6%)	254 (80.4%)	375 (57.2%)	0.002*
High school	219 (64.4%)	62 (19.6%)	281 (42.8%)	
Gender				
Males	128 (37.7%)	165 (52.2%)	293 (44.7%)	0.442
Females	212 (62.3%)	151 (47.8%)	363 (55.3%)	
Health and Development				
Chronic diseases ɳ				
Yes	24 (7.4%)	20 (6.7%)	44 (7.1%)	0.784
No	299 (92.6%)	277 (93.3%)	576 (92.9%)	
Childhood breathing mode ɳ[1]				
Nose	104 (41.6%)	115 (46.4%)	219 (44.0%)	0.264
Nose and mouth	118 (47.2%)	110 (44.3%)	228 (45.8%)	
Mouth	28 (11.2%)	23 (9.3%)	51 (10.2%)	
Maternal smoking during pregnancy ɳ				
Cigarettes (yes)	53 (16.9%)	19 (6.5%)	72 (11.8%)	0.007*
Narghile (yes)	12 (4.4%)	6 (2.60%)	18 (3.5%)	0.360

* p–value <0.05

ɳ Numbers in cells do not add up to total N column-wise because of missing values

ɳ[1] In addition to missing values, some parents answered "I do not know" (n=97, 16.3%). Legal guardians of adolescents in public schools were more likely not to know their child's mode of breathing (p-value =0.047; data not shown)

Table 4.3(b): Percent distribution of untreated adolescents (11-18 years) by child-level influences on oral health and type of school, adjusted for school cluster (n=656) (*Continued*)

Child-level Influences on Oral Health	School type			P-value
	Public (n=340) N (%)	Private (n=416) N (%)	Total (n=656) N (%)	
Behavioral Factors				
Non-nutritive sucking habits ɳ				
Yes	72 (22.4%)	75 (24.9%)	147 (23.6%)	0.492
No	249 (77.6%)	226 (75.1%)	475 (76.4%)	
Duration of sucking habits (years)				
Mean ± S.D.	0.5 ± 1.6	0.5 ± 1.5	0.5 ± 1.6	0.936
Nutritive sucking habits in first 6 months ɳ				
Breastfeeding	152 (47.7%)	89 (29.9%)	241 (39.1%)	< 0.001*$^{\overline{T}}$
Bottle and breast	95 (29.8%)	131 (44.0%)	226 (36.6%)	
Bottle feeding	72 (22.5%)	78 (26.1%)	150 (24.3%)	
Breastfeeding duration ɳ^{1}				
6 months or less	163 (53.6%)	221 (74.4%)	384 (62.9%)	0.009*$^{\overline{T}}$
7 months – 1 year	84 (17.8%)	46 (15.5%)	100 (16.6%)	
More than 1 year	87 (28.6%)	30 (10.1%)	117 (19.5%)	
Bottle feeding duration ɳ^{2}				
Less than 6 months	85 (30.7%)	45 (16.0%)	130 (23.3%)	0.001*$^{\overline{T}}$
6 months – 2 years	124 (44.8%)	168 (59.8%)	292 (52.3%)	
More than 2 years	68 (24.5%)	68 (24.2%)	136 (24.4%)	

* p–value <0.05

$^{\overline{T}}$ p-value for test of trend <0.05

ɳ Numbers in cells do not add up to total N column-wise because of missing values

ɳ^{1} In addition to missing values, some parents answered "I do not know" (n=13, 2.1%). Legal guardians of adolescents in public schools were more likely not to know the duration of breastfeeding (p-value =0.041; data not shown)

ɳ^{2} In addition to missing values, some parents answered "I do not know" (n=39, 6.5%). Legal guardians of adolescents in public schools were more likely not to know the duration of bottle feeding but did not reach statistical significance (p-value =0.062; data not shown)

Table 4.4: Percent distribution of untreated adolescents (11-18 years) by family-level influences on oral health and type of school, adjusted for school cluster (n=656)

Family-level Influences on Oral Health	School type			P-value
	Public (n=340) N (%)	Private (n=316) N (%)	Total (n=656) N (%)	
Socioeconomic Profile				
[**]Education of parent/legal guardian [ɳ]				
Low	46 (14.1%)	4 (1.3%)	50 (8.0%)	0.001*[Ŧ]
Middle	227 (69.6%)	111 (37.3%)	338 (54.2%)	
High	53 (16.3%)	183 (61.4%)	236 (37.8%)	
Family Income (LL) [ɳ]				
<500,000	30 (10.1%)	7 (2.7%)	37 (6.7%)	< 0.001*[Ŧ]
500,000-999,999	155 (52.4%)	40 (15.4%)	195 (35.1%)	
1,000,000-3,000,000	106 (35.8%)	131 (50.6%)	237 (42.7%)	
>3,000,000	5 (1.7%)	81 (31.3%)	86 (15.5%)	
Perceived income sufficiency [ɳ]				
Insufficient	88 (27.5%)	36 (12.9%)	124 (20.7%)	< 0.001*[Ŧ]
Barely sufficient	139 (43.4%)	118 (42.4%)	257 (43.0%)	
Sufficient	82 (25.6%)	103 (37.1%)	185 (30.9%)	
More than sufficient	11 (3.4%)	21 (7.6%)	32 (5.4%)	
Family dental Insurance [ɳ]				
Yes	32 (10.7%)	29 (11.3%)	61 (14.9%)	0.858

* p–value <0.05

[Ŧ] p-value for test of trend <0.05

[**] Levels of education grouped into: **low** - illiterate, read-write, primary school; **middle** - middle or secondary school; **high** - college or university

[ɳ] Numbers in cells do not add up to total N column-wise because of missing values

Table 4.5: Percent distribution of untreated adolescents (11-18 years) by sagittal measures of occlusion and type of school, adjusted for school cluster (n=656)

Sagittal measures of occlusion	School type			P-Value
	Public (n=340) N (%)	Private (n=316) N (%)	Total (n=656) N (%)	
****Occlusion ɳ**				
Class II	22 (6.5%)	25 (7.9%)	47 (7.2%)	0.231
Half-cusp II	65 (19.1%)	75 (23.8%)	140 (21.4%)	
Class I	240 (70.6%)	198 (62.9%)	438 (66.9%)	
Half-cusp III	11 (3.2%)	16 (5.1%)	27 (4.1%)	
Class III	2 (0.6%)	1 (0.3%)	3 (0.5%)	
Overjet (mm) ɳ1				
0<OJ≤3.5 (normal)	229 (69.6%)	217 (70.2%)	446 (69.9%)	0.728
3.5<OJ≤6 (moderate)	83 (25.2%)	77 (24.9%)	160 (25.1%)	
6<OJ≤9 (severe)	14 (4.3%)	14 (4.5%)	28 (4.4%)	
9<OJ (extreme)	3 (0.9%)	1 (0.3%)	4 (0.6%)	
Mean ± S.D.	3.2 ± 1.7	3.2 ± 1.6	3.2 ± 1.7	0.688
Anterior cross-bite ɳ1				
Yes	11 (3.2%)	7 (2.2%)	18 (2.7%)	0.288

* p–value <0.05

** Percent distribution of occlusion presented as average proportions of right and left molar occlusion, unadjusted for school cluster. Separate distributions for each (right molar, left molar, right canine and left canine occlusions) did not show significant differences between private and public schools, adjusting for school cluster, and are presented in **Appendix V**

ɳ Numbers in cells do not add up to total N column-wise because of inability to assess canine occlusion in 1 adolescent in the private school sample (unerupted)

ɳ1 Numbers in cells do not add up to total N column-wise because overjet and anterior cross-bite are mutually exclusive. Hence, 638 (n for overjet) + 18 (n for anterior crossbite) = 656 (total sample)

Table 4.6: Percent distribution of untreated adolescents (11-18 years) by vertical measures of occlusion and type of school, adjusted for school cluster (n=656)

Vertical measures of occlusion	School type			P-Value
	Public (n=340) N (%)	Private (n=316) N (%)	Total (n=656) N (%)	
Anterior open bite ɳ				
Yes	15 (4.4%)	4 (1.3%)	19 (2.9%)	0.004*
Overbite (mm) ɳ				
Overbite < 3.5	184 (56.6%)	160 (51.3%)	344 (54.0%)	0.234
Overbite ≥ 3.5 without impingement	127 (39.1%)	146 (46.8%)	273 (42.9%)	
Overbite ≥ 3.5 with impingement	14 (4.3%)	6 (1.9%)	20 (3.1%)	
Mean overbite (mean ± S.D.)	3.1 ± 1.6	3.3 ± 1.7	3.2 ± 1.7	0.185

* p–value <0.05

ɳ Numbers in cells do not add up to total N column-wise because anterior open bite and overbite are mutually exclusive. Hence, 19 (n for anterior open bite) + 637 (n for overbite) = 656 (total sample)

Table 4.7: Percent distribution of untreated adolescents (11-18 years) by transverse measures of occlusion and type of school, adjusted for school cluster (n=656)

Transverse measures of occlusion	School type			P-Value
	Public (n=340) N (%)	Private (n=316) N (%)	Total (n=830) N (%)	
Posterior cross-bite				
Present (>1tooth)	49 (14.4%)	41 (13.0%)	90 (13.7%)	0.595
Midline diastema				
Present (≥2 mm)	15 (4.4%)	11 (3.5%)	26 (4.0%)	0.653

* p–value <0.05

Table 4.8: Percent distribution of adolescents (11-18 years) by intra-arch contact point displacement and type of school, adjusted for school cluster (n=656)

Contact point displacement	School type			P-Value
	Public (n=340) N (%)	Private (n=316) N (%)	Total (n=656) N (%)	
Maxillary irregularity (mm)				
Mean ± S.D.	3.8 ± 3.5	3.5 ± 3.4	3.7 ± 3.5	0.454
Mandibular irregularity (mm)				
Mean ± S.D.	3.9 ± 3.2	3.3 ± 3.2	3.6 ± 3.2	0.046*
****Maximum contact point displacement (MCPD)**				
Ideal/mild	74 (21.8%)	91 (28.8%)	165 (25.1%)	
Moderate	241 (70.9%)	199 (63.0%)	440 (67.1%)	0.294
Severe	25 (7.3%)	26 (8.2%)	51 (7.8%)	
Mean ± S.D.	2.57 ± 1.33	2.48 ± 1.48	2.53 ± 1.40	0.649

* p–value <0.05

** Maximum contact point displacement grouped into: **Ideal to mild** – 0 to 1mm; **moderate** – 2 to 4mm; **severe** – more than 4mm

Table 4.9: Percent distribution of untreated adolescents (11-18 years) by need for orthodontic treatment and type of school, adjusted for school cluster (n=656)

**Need for orthodontic treatment	School type			p-value
	Public (n=340) N (%)	Private (n=316) N (%)	Total (n=656) N (%)	
No definite need	286 (84.4%)	265 (83.9%)	551 (84.0%)	0.955
Definite need	53 (15.6%)	51 (16.1%)	105 (16.0%)	
Definite need (Age standardized)	12.9%	11.8%	12.4%	0.632

* p–value <0.05

** Need for orthodontic treatment according to modified IOTN**: no definite need** – IOTN ≤ 3; **definite need** – IOTN > 3

Table 4.10(a): Bivariate associations between categorical child level influences on oral health and overjet, adjusted for school cluster (n=656)

Child-level Influences on Oral Health	Overjet			p-value
	N	Mean (mm)	S.D.	
Demographic Variables				
Gender				
Male	288	3.3	1.8	0.066ǂ
Female	361	3.1	1.6	
Health and Development				
Chronic disease				
Yes	43	3.3	2.5	0.744
No	571	3.2	1.6	
Childhood Breathing				
Nose	217	3.0	1.5	0.065ǂ‾
Mixed nose and mouth	227	3.2	1.7	
Mouth	50	3.9	2.3	
Maternal cigarettes during pregnancy				
Yes	72	3.1	1.7	0.642
No	531	3.2	1.7	

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05
‾ p-value for test of trend < 0.05

Table 4.10(b): Bivariate associations between categorical child level influences on oral health and overjet, adjusted for school cluster (n=656) (*Continued*)

Child-level Influences on Oral Health	Overjet			p-value
	N	Mean (mm)	S.D.	
Behavioral Factors				
Non-nutritive sucking habits				
Yes	146	3.3	1.8	0.515
No	470	3.2	1.6	
Feeding method				
Breast	239	3.0	1.5	0.013ǂ*
Breast and bottle	223	3.4	1.8	
Bottle	150	3.2	1.8	
Breastfeeding duration				
6 months or less	381	3.3	1.8	0.163ǂ
7 months – 2 years	99	3.2	1.6	
More than 2 years	116	3.0	1.5	
Bottle feeding duration				
Less than 6 months	129	3.0	1.5	0.096ǂ
6 months – 2 years	291	3.2	1.7	
More than 2 years	135	3.2	1.7	

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05

Table 4.11: Bivariate associations between continuous child level influences on oral health and overjet, adjusted for school cluster (n=656)

Child-level Influences on Oral Health	Overjet			p-value
	Unadjusted ß	Robust S.E.	95% CI	
Demographics				
Age (years)	-0.071	0.037	[-0.150; 0.009]	0.077ǂ
Health and Development				
DMFT	-0.011	0.013	[-0.039; 0.018]	0.440
Behavioral Factors				
Duration of sucking habits (years)	0.060	0.038	[-0.021; 0.142]	0.135ǂ

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05

Table 4.12: Bivariate associations between family-level influences on oral health and overjet, adjusted for school cluster (n=656)

Family-level Influences on Oral Health	Overjet			p-value
	N	Mean (mm)	S.D.	
Socio-economic Profile				
****Education of informant**				
Low	49	3.3	1.6	0.583
Middle	334	3.3	1.7	
High	235	3.1	1.5	
Family income				
<500,000	35	4.3	2.2	0.002ǂ*
500,000-999,999	194	3.1	1.7	
1,000,000-3,000,000	235	3.2	1.6	
>3,000,000	86	3.0	1.2	
Perceived income sufficiency				
Insufficient	123	3.3	1.8	0.587
Barely sufficient	225	3.3	1.8	
Sufficient	183	3.2	1.5	
More than sufficient	32	2.9	1.4	
Family dental Insurance				
Yes	61	3.1	1.6	0.999
No	489	3.2	1.7	

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05
** Levels of education grouped into: **low** - illiterate, read-write, primary school; **middle** - middle or secondary school; **high** - college or university

Table 4.13(a): Bivariate association between categorical child level influences on oral health and maximum contact point displacement (MCPD), adjusted for school cluster (n=656)

Child-level Influences on Oral Health	MCPD			P-Value
	N	Mean (mm)	S.D.	
Demographics				
Gender				
Male	293	2.6	1.5	0.484
Female	363	2.5	1.3	
Health and Development				
Chronic disease				
Yes	44	2.7	1.4	0.499
No	576	2.5	1.4	
Childhood Breathing				
Nose	219	2.5	1.3	0.195ǂ
Mixed nose and mouth	228	2.5	1.4	
Mouth	51	2.7	1.5	
Cigarettes during pregnancy				
Yes	72	2.5	1.5	0.958
No	537	2.5	1.4	

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05

Table 4.13(b): Bivariate association between categorical child level influences on oral health and maximum contact point displacement (MCPD), adjusted for school cluster (n=656) (*Continued*)

Child-level Influences on Oral Health	MCPD			P-Value
	N	Mean (mm)	S.D.	
Behavioral factors				
Non-nutritive Sucking habits				
Yes	157	2.3	1.5	0.191ǂ
No	475	2.6	1.3	
Feeding method				
Breast	241	2.5	1.3	0.982
Breast and bottle	226	2.5	1.4	
Bottle	150	2.5	1.6	
Breastfeeding duration				
6 months or less	384	2.5	1.5	0.343
7 months – 2 years	100	2.5	1.2	
More than 2 years	117	2.7	1.4	
Bottle feeding duration				
Less than 6 months	130	2.7	1.3	0.008ǂ*
6 months – 2 years	292	2.4	1.3	
More than 2 years	136	2.6	1.6	

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05

Table 4.14: Bivariate associations between continuous child level influences on oral health and maximum contact point displacement (MCPD), adjusted for school cluster (n=656)

Child-level Influences on Oral Health	MCPD			p-value
	Unadjusted ß	Robust S.E.	95% CI	
Demographics				
Age (years)	0.036	0.038	[-0.045; 0.117]	0.355
Health and Development				
DMFT	0.042	0.019	[0.002; 0.082]	0.039ǂ*
Behavioral Factors				
Duration of sucking habits (years)	-0.050	0.026	[-0.105; 0.006]	0.076ǂ

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05

Table 4.15: Bivariate associations between family-level influences on oral health and maximum contact point displacement (MCPD), adjusted for school cluster (n=656)

Family-level Influences on Oral Health	MCPD			
	N	Mean (mm)	S.D.	p-value
Socio-economic Profile				
[**]Education of informant				
Low	20	2.4	1.2	0.102ǂ[Ŧ]
Middle	197	2.8	1.6	
High	407	2.4	1.3	
Family income				
<500,000	37	2.7	1.4	0.012ǂ*[Ŧ]
500,000-999,999	195	2.6	1.4	
1,000,000-3,000,000	237	2.6	1.4	
>3,000,000	86	2.2	1.1	
Perceived income sufficiency				
Insufficient	124	2.6	1.6	0.087ǂ[Ŧ]
Barely sufficient	257	2.7	1.4	
Sufficient	185	2.5	1.3	
More than sufficient	32	2.1	1.1	
Family dental Insurance				
Yes	61	2.5	1.2	0.713

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05
Ŧ p-value for test of trend <0.05
[**] Levels of education grouped into: **low** - illiterate, read-write, primary school; **middle** - middle or secondary school; **high** - college or university

Table 4.16(a): Bivariate association between child level influences on oral and the need for orthodontic treatment, adjusted for school cluster (n=656)

Child-level Influences on Oral Health	**Need for orthodontic treatment		P-Value
	No definite need N (%)	Definite need N (%)	
Demographic variables			
Age (years; mean ± S.D.)	14.6 ± 1.7	14.6 ± 1.5	0.945
Gender			
Male	246 (84.0%)	47 (16.0%)	0.987
Female	305 (84.0%)	58 (16.0%)	
Health and Development			
Chronic disease			
Yes	34 (77.3%)	10 (22.7%)	0.399
No	486 (84.4%)	90 (15.6%)	
Childhood Breathing			
Nose	196 (89.5%)	23 (10.5%)	0.020ǂ*∓
Mixed nose and mouth	189 (82.9%)	39 (17.1%)	
Mouth	40 (78.4%)	11 (21.6%)	
Cigarettes during pregnancy			
Yes	62 (16.2%)	10 (13.4)	0.701
No	450 (83.8%)	87 (86.1%)	
DMFT (mean ± S.D.)	4.8 ± 3.5	5.4 ± 3.6	0.229

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05
∓ p-value for test of trend <0.05
** Need for orthodontic treatment according to modified IOTN**: no definite need** – IOTN ≤ 3; **definite need** – IOTN > 3

Table 4.16(b): Bivariate association between child level influences on oral and the need for orthodontic treatment, adjusted for school cluster (n=656) (*Continued*)

Child-level Influences on Oral Health	**Need for orthodontic treatment		P-Value
	No definite need N (%)	Definite need N (%)	
Behavioral Factors			
Non-nutritive Sucking habits			
Yes	121 (82.3%)	26 (17.7%)	0.419
No	401 (84.4%)	74 (15.6%)	
Duration of sucking habits (years**;** mean ± S.D.)	0.5 ± 1.5	0.6 ± 1.9	0.483
Feeding method			
Breast	207 (85.9%)	34 (14.1%)	0.665
Breast and bottle	189 (83.6%)	37 (16.4%)	
Bottle	124 (82.7%)	26 (17.3%)	
Breastfeeding duration			
6 months or less	318 (82.8%)	66 (17.2%)	0.405
7 months – 2 years	88 (88.0%)	12 (12.0%)	
More than 2 years	97 (82.9%)	20 (17.1%)	
Bottle feeding duration			
Less than 6 months	197 (82.3%)	23 (17.7%)	0.511
6 months – 2 years	252 (86.3%)	40 (13.7%)	
More than 2 years	115 (84.6%)	21 (15.4%)	

ǂ p-value < 0.2 and included in multivariate analysis
***** p-value < 0.05
** Need for orthodontic treatment according to modified IOTN**: no definite need** – IOTN ≤ 3; **definite need** – IOTN > 3

Table 4.17: Bivariate associations between family-level influences on oral health and the need for orthodontic treatment, adjusted for school cluster (n=656)

Family-level Influences on Oral Health	***Need for orthodontic treatment		P-Value
	No definite need N (%)	Definite need N (%)	
Socio-economic indicators			
Education of informant **			
Low	40 (80.0%)	10 (20.0%)	0.365
Middle	278 (82.3%)	60 (17.7%)	
High	207 (87.7%)	29 (12.3%)	
Family income			
<500,000	25 (67.6%)	12 (32.4%)	< 0.001ǂ*∓
500,000-999,999	164 (84.1%)	31 (15.9%)	
1,000,000-3,000,000	192 (81.0%)	45 (19.0%)	
>3,000,000	84 (97.7%)	2 (2.3%)	
Perceived income sufficiency			
Insufficient	98 (79.0%)	26 (21.0%)	0.717∓
Barely sufficient	213 (82.9%)	44 (17.1%)	
Sufficient	161 (87.0%)	24 (13.0%)	
More than sufficient	28 (87.5%)	4 (12.5%)	
Family dental Insurance			
Yes	53 (86.9%)	8 (13.1%)	0.549
No	412 (83.6%)	81 (16.4%)	

ǂ p-value < 0.2 and included in multivariate analysis
* p-value < 0.05
∓ p-value for test of trend < 0.05
** Levels of education grouped into: **low** - illiterate, read-write, primary school; **middle** - middle or secondary school; **high** - college or university
** *Need for orthodontic treatment according to modified IOTN**: no definite need** – IOTN ≤ 3; **definite need** – IOTN > 3

Table 4.18: Multivariate analysis showing associations between overjet (mm) and other variables, adjusting for school cluster (n=656)

Associated variables	Adjusted ß	Robust S.E.	95% CI	p-value
	Overjet (mm) ǂ			
Age (years)	-0.158	0.058	[-0.281; -0.034]	0.016*
Gender (Male)	-0.131	0.155	[-0.469; 0.202]	0.413
Childhood Breathing (Nose)				
Mixed	0.277	0.173	[-0.094; 0.647]	0.132
Mouth	0.429	0.457	[-0.552; 1.410]	0.364
Presence of sucking habit (No)	0.022	0.230	[-0.469; 0.513]	0.924
Feeding method (Breast)				
Breast and bottle	0.696	0.172	[0.328; 1.065]	0.001*
Bottle	0.161	0.201	[-0.271; 0.592]	0.438
Educational level (Low)				
Average	0.252	0.295	[-0.379; 0.884]	0.406
High	-0.251	0.466	[-1.251; 0.749]	0.599
Family income (<500,000)				
500,000-999,999	-1.327	0.403	[-2.190; -0.463]	0.005*
1,000,000-3,000,000	-1.220	0.467	[-2.217; 0.224]	0.020*
>3,000,000	-1.269	0.581	[-2.514; -0.023]	0.046*

( ) Base outcome

* Adjusted p-value < 0.05

ǂ Percent of overjet explained by variables combined: 10.14%; model significant at Prob > F = 0.000

Table 4.19: Multivariate analysis showing associations between maximum contact point displacement (MCPD; mm) and other variables, adjusting for school cluster (n=656)

Associated variables	Adjusted ß	Robust S.E.	95% CI	p-value
	MCPD (mm) ǂ			
Age (years)	0.039	0.051	[-0.069; 0.148]	0.450
Gender (Male)	0.044	0.126	[-0.227; 0.315]	0.732
Childhood Breathing (Nose)				
Mixed	0.175	0.124	[-0.091; 0.440]	0.180
Mouth	0.353	0.143	[0.046; 0.660]	0.027*
DMFT	0.043	0.025	[-0.012; 0.097]	0.115
Duration of sucking habit (years)	-0.032	0.036	[-0.110; 0.046]	0.396
Feeding method (Breast)				
Breast and bottle	0.083	0.134	[-0.205; 0.371]	0.547
Bottle	-0.114	0.138	[-0.411; 0.182]	0.423
Bottle feeding duration (< 6 months)				
6 months – 2 years	-0.328	0.127	[-0.602; -0.055]	0.022*
More than 2 years	-0.160	0.146	[-0.473; 0.154]	0.094
Family income (<500,000)				
500,000-999,999	0.237	0.373	[-0.564; 1.037]	0.536
1,000,000-3,000,000	0.204	0.247	[-0.325; 0.734]	0.422
>3,000,000	-0.001	0.283	[-0.607; 0.605]	0.997

( ) Base outcome
* Adjusted p-value < 0.05
ǂ Percent of MCPD explained by variables combined: 5.05%; model significant at Prob > F = 0.000

Table 4.20: Multivariate analysis showing associations between the need for orthodontic treatment (IOTN >3; binary) and other variables, adjusting for school cluster (n=656)

Associated variables	Adjusted OR	Robust S.E.	95% CI	p-value
	Need for Orthodontic treatment (Present) ǂ			
Age (years)	0.939	0.115	[0.735; 1.191]	0.590
Gender (Male)	0.953	0.242	[0.580; 1.566]	0.851
Childhood Breathing (Nose)				
Mixed	1.790	0.500	[1.035; 3.096]	0.037*
Mouth	1.958	0.825	[0.857; 4.473]	0.111
Educational level (Low)				
Average	1.296	0.521	[0.589; 2.851]	0.520
High	1.326	0.546	[0.592; 2.970]	0.492
Family income (<500,000)				
500,000-999,999	0.683	0.361	[0.242; 1.924]	0.471
1,000,000-3,000,000	0.489	0.489	[0.208; 2.692]	0.658
>3,000,000	0.042	0.063	[0.002; 0.767]	0.032*

( ) Base outcome

* Adjusted p-value < 0.05

ǂ Pseudo r^2 for total model: 0.0687; model significant at Prob > Chi^2 = 0.000

Table 4.21: Percent distribution of examined adolescents (11-18 years) by mean Child Perceptions Questionnaire (CPQ) scores and type of school, adjusted for school cluster (n=830)

CPQ scores	**Need for orthodontic treatment		p-value	Adjusted p-value‡
	No definite need (Mean ± S.D.)	Definite need (Mean ± S.D.)		
Oral symptoms	4.2 ± 3.0	4.6 ± 2.2	0.230	0.243
Functional limitations	4.3 ± 4.2	5.2 ± 4.1	0.046*	0.038*
Emotional well-being	5.2 ± 5.8	6.5 ± 6.0	0.019*	0.019*
Social well-being	3.9 ± 5.0	4.9 ± 4.7	0.050	0.020*
Total CPQ	17.6 ± 13.6	21.3 ± 13.9	0.025*	0.017*

* p-value < 0.05

‡ p-value adjusted for age, gender, school type and history of orthodontic treatment

** Need for orthodontic treatment according to modified IOTN**: no definite need** – IOTN ≤ 3; **definite need** – IOTN > 3

FIGURES

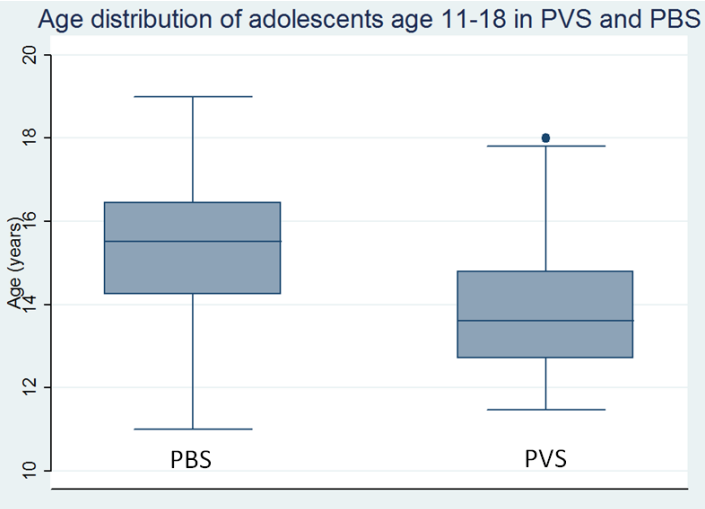


Figure 4.1: Age distribution among examined, untreated adolescents in the public school sample (PBS) and in the private school sample (PVS)

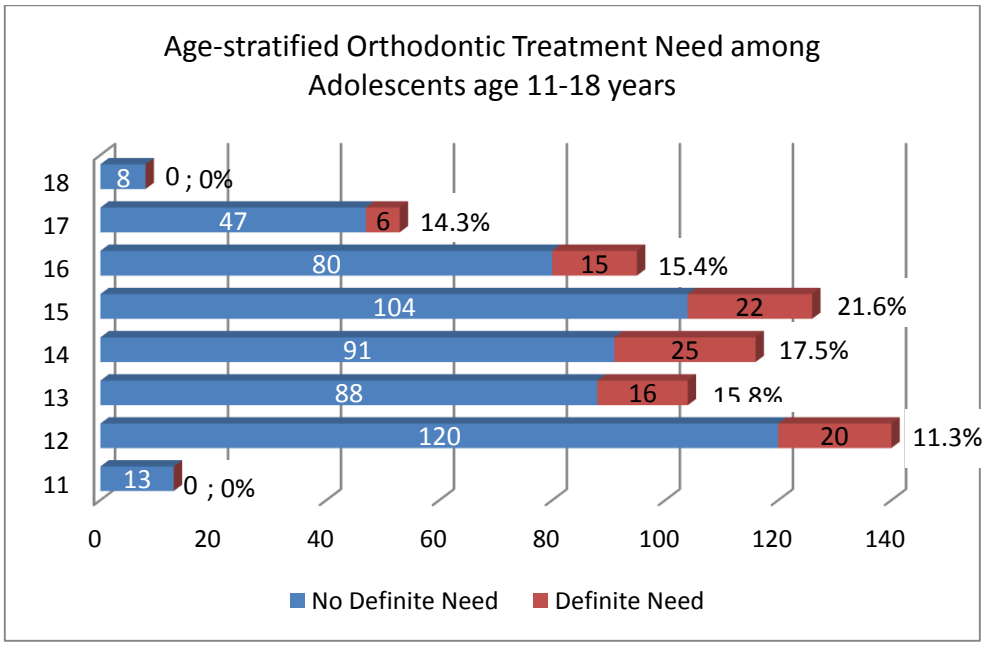


Figure 4.2: Orthodontic treatment need among adolescents age 11-18 attending private and public schools in Beirut, stratified by age

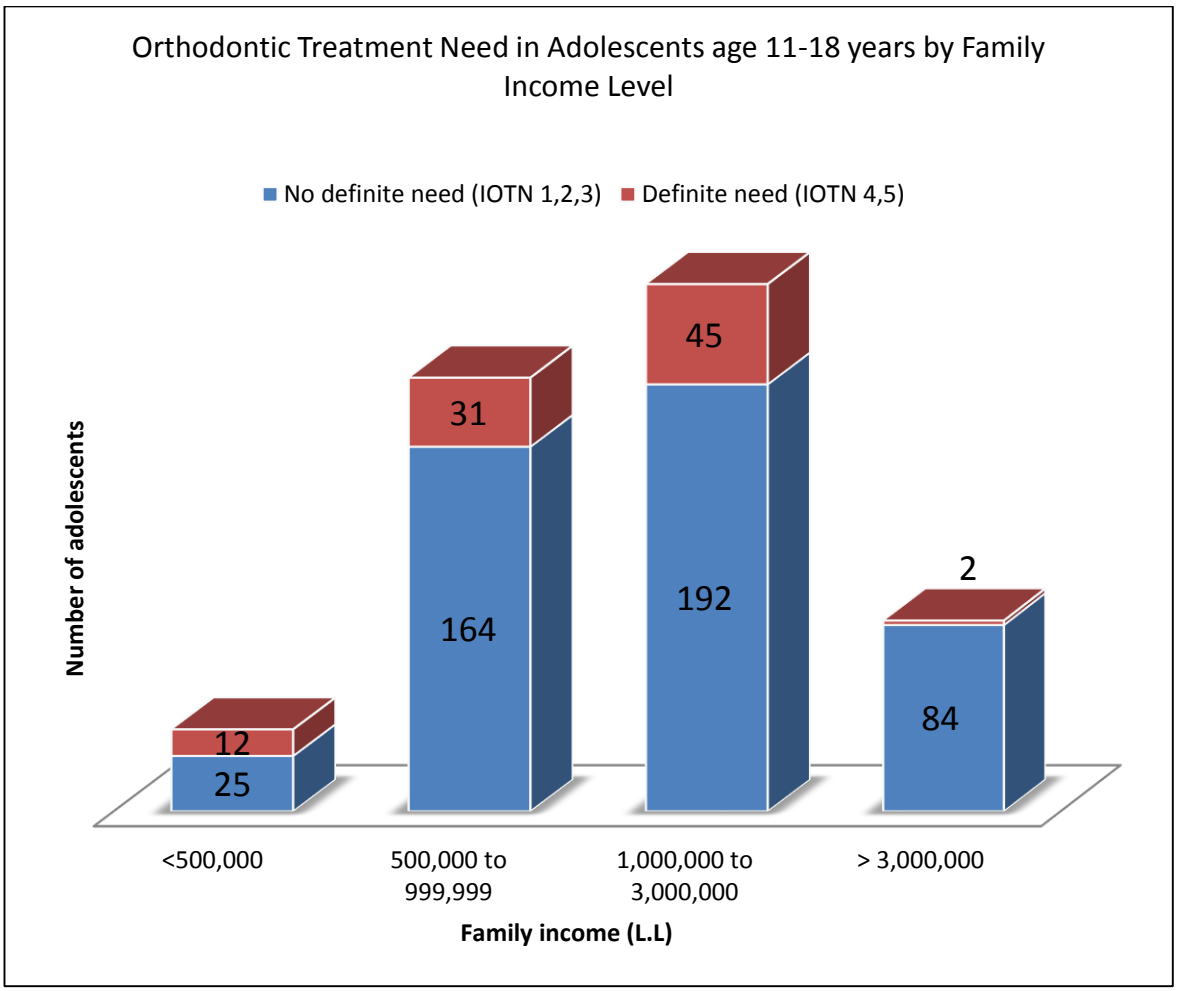


Figure 4.3: Orthodontic treatment need among adolescents age 11-18 attending private and public schools in Beirut, by income category

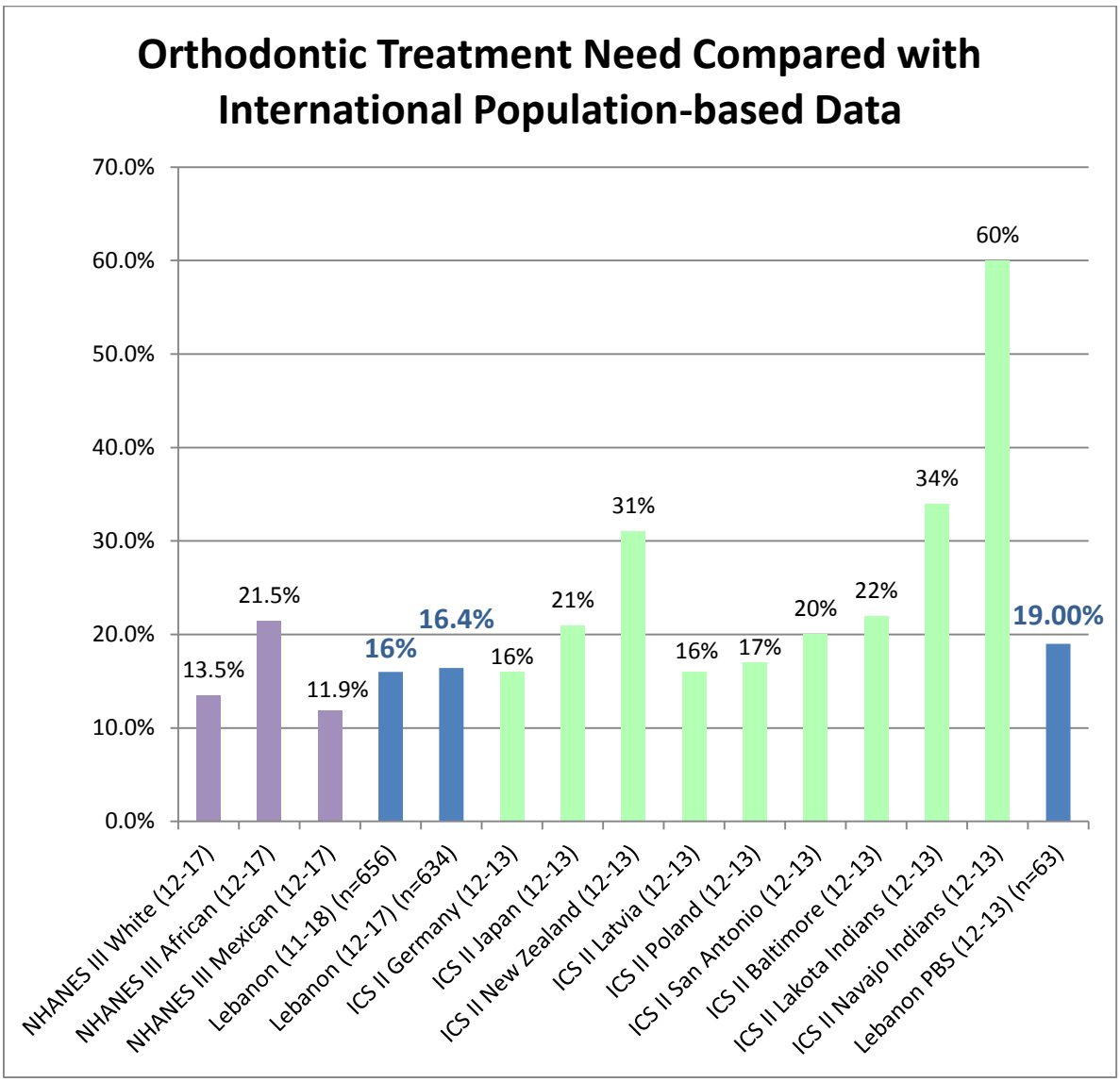


Figure 5.1: Orthodontic treatment need among Beirut school adolescents compared to data from international population-based studies (NHANES III and ICS II)

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Appendix I

الرقم المتسلسل :I__I__I__I__I__I

القسم الاوّل: التعريف

اسم الولد_____
اسم المدرسة_____
الصفّ_____
عمر الولد في آخر عيد ميلاد _____
جنس الولد:
1. ذكر
2. أنثى

I1. علاقتك بالولد:
1. الوالدة
2. الاب
3. الجدّ\الجدّة
4. أخ\أخت
5. عمّ\عمّة
6. علاقة اخرى، حدد: _____

القسم الثاني: معلومات ديموغرافيّة\اجتماعيّة

SD1. عمر حضرتكم في آخرعيد ميلاد: [_____] سنة

SD2. جنس حضرتكم:
1. ذكر
2. انثى

SD3. الوضع العائليّ:
1. متأهل\متأهلة
2. مُطلّق\مُطلّقة
3. أرمل\أرملة

SD4. أعلى مستوى علميّ:
1. أُمّيّ
2. كتابة\قراءة
3. ابتدائيّ
4. متوسّط
5. ثانويّ
6. كلّيّة\جامعة

SD5.عدد الاولاد في العائلة:

1) ١
2) ٢
3) ٣
4) ٤
5) اكثر من ٤ اولاد

SD6. ترتيب ولادة الولد المعني في هذه الاستمارة؟

1. البكر
2. الاخير\الاصغر
3. آخر (حدّد).....

SD7. الدخل الاجماليّ الشهري للعائلة :

1. ما دون ال 500,000 ل.ل
2. بين 500,000 و 999,999 ل.ل
3. بين 1000,000 و 3000,000 ل.ل
4. ما فوق ال 3000,000 ل.ل

SD8. هل تعمل حاليًا؟

1) نعم، دوام كامل
2) نعم، دوام جزئي
3) ابحث عن عمل
4) لا اعمل حاليًا
5) متقاعد
6) ربة منزل

SD9. في حال كنتم تعملون ، هل تؤمن لكم وظيفتكم دخلاً ثابتاً؟

1) نعم
2) لا

SD10. هل يكفي دخل العائلة لسد احتياجاتكم الأساسية من مأكل، مشرب أو طبابة؟

1) لا يكفي
2) بالكاد يكفي
3) يكفي
4) يكفي و يزيد

SD11. هل لدى العائلة أي ضمان صحي؟

1) نعم
2) لا (إذا كانت الإجابة لا، انتقل إلى القسم الثالث)

SD12. في حال كانت الاجابة "نعم"، الرجاء إختيار الاحتمال المناسب:

1) صندوق الضمان الوطني الاجتماعي
2) تعاونية موظفي الدولة

3) ضمان الجيش
4) ضمان قوى الامن الداخلي
5) ضمان وزارة الصحة
6) ضمان خاص

SD13. هل يغطي الضمان الصحي علاج الاسنان؟
1) نعم
2) كلا

القسم الثالث: الوضع الصحّيّ للولد

H1. هل الولد المعني بهذه الأستمارة عانى أو لا يزال يعاني من أي مرض مزمن ؟
1. نعم
2. كلاً *(انتقل الى السؤال H3)*

H2. إذا كانت الإجابة بنعم، من أي الأمراض المزمنة التالية عانى أو يعاني منها ؟
1. مرض السكري
2. أمراض القلب
3. مشاكل رئوية
4. أمراض الجهاز الهضمي
5. سرطان
6. آخر(حدّد)_____

H3. هل يتنفس الولد المعني بهذه الأستمارة في الوقت الحالي من:
1. الأنف
2. الفم
3. من الأنف والفم
4. لا اعرف

H4. في طفولته، هل كان يتنفس في الغالب من:
1. الأنف *(انتقل الى السؤال H7)*
2. الفم
3. من الأنف والفم
4. لا اعرف *(انتقل الى السؤال H7)*

H5.إذا كان طفلك يتنفس من فمه، هل خضع للعلاج ؟
1. نعم
2. كلاً *(انتقل الى السؤال H7)*

H6.إذا كانت الإجابة بنعم في أي عمرتم علاج ذلك؟ [_____] سنة

H7. هل كانت الوالدة تُدخّن السجائر خلال فترة حملها بالولد المعني في هذه الاستمارة ؟

1. نعم
2. كلاّ *(انتقل الى السؤال H10)*
3. لا اعرف *(انتقل الى السؤال H10)*

H8. خلال ايّ فصل من الحمل كانت تدخن؟

1. الاوّل
2. الثانيّ
3. الثالث
4. كلّ فترة الحمل
5. لا اعرف

H9. تقريبا كم عدد السجائر يوميّا كانت تدخن الأم خلال فترة الحمل؟

1. 1-10
2. 11-20
3. أكثر من 20 سيجارة
4. لا اعرف

H10. هل كانت الوالدة تُدخّن الارغيله خلال فترة حملها بالولد المعني في هذه الاستمارة ؟

1. نعم
2. كلا
3. لا اعرف

القسم الرابع: عادات معيّنة لدى الولد

S1.هل كان الولد المعني بهذه الأستمارة يمصّ اصبعه، شفّته، او ايّ شيء آخر خلال فترة الرضاعة أو الطفولة؟

1. نعم
2. كلا *(انتقل الى القسم الخامس)*
3. لا اعرف *(انتقل الى القسم الخامس)*

S2. إذا نعم، ماذا كان يمصّ ؟

1. ابهام\اصبع
2. الشفّة
3. اللهاية الخاصة بالأطفال
4. آخر، حدّد: _____

S3. في ايّ عمر بدأ\بدأت هذه العادة ؟ [____] سنة

S4. في ايّ عمر، اوقف\اوقفت هذه العادة؟

1. [____] سنة
2. لم تتوقف هذه العادة بعد

S5. كم كانت مدّة\فترة ممارسة هذه العادة يوميا/ في اليوم الواحد؟

1. ساعة او اقلّ
2. أكثر من ساعة وأقل من 3 ساعات
3. أكثر 3 ساعات وأقل من 6 ساعات
4. ست ساعات وما فوق
5. لا أذكر

القسم الخامس: عادات إطعام الولد في الطفولة

F1. كيف تمّ اطعام الولد المعني في هذه الإستمارة خلال اوّل ستة اشهر من طفولته؟

1. رضاعة
2. القنّينة *(انتقل الى السؤال F3)*
3. كلاهما
4. لا اعرف *(انتقل ال القسم السادس)*

F2. كم شهراً إستمرت فترة الرضاعة من الثدي ؟

1. أقل من شهرين
2. 2-4 اشهر
3. 5-6 أشهر
4. 7-12 شهر
5. 1-2 سنة
6. اكثر من سنتين
7. لا اتذكّر

F3. كم كانت مدّة ارضاعه من القنيّنة؟

1. 1-5 اشهر
2. ما بين 6 أشهر و سنتين
3. اكثر من سنتين
4. لا اتذكّر

القسم السادس: نمط الاهتمام بصحّة الفم\الاسنان

OH1. كيف تقيم صحة الأ سنان مقارنةً مع غيرها من المشاكل الصحية؟

1) نفس الأهمية
2) أقل أهمية
3) أكثر أهمية

OH2. ما هي الاسباب التي قد تدفعك لاصطحاب أولادكم لزيارة طبيب الأسنان؟

1) فحص الاسنان	نعم	كلا
2) تنظيف الاسنان	نعم	كلا
3) تسوس الاسنان	نعم	كلا
4) ألم حاد في الأسنان	نعم	كلا

5) مظهر الأسنان نعم كلا
6) حالات أخرى: _____

OH3. هل تعتقد ان حالة فم الولد المعني هي؟

1. ممتازة
2. جيّدة
3. عاديّة
4. سيّئة
5. سيّئة جدا

OH4 .هل تعرّضت اسنان الولد لمادة الفلوريد من غير معجون الأسنان؟

1. نعم
2. كلا *(انتقل لى القسم السابع)*

OH5. إذا نعم، كيف تمّ اخذ الفلوريد ؟

(يمكنكم اختيار أكثر من خيار)

1. بواسطة الماء
2. غسول الفمّ
3. إضافات غذائيّة\حبوب
4. خلال زيارات طبيب الاسنان

القسم السابع:الخدمات الصحية لطب الأسنان

DS1. هل سبق أن عاين طبيب اسنان الولد المعني في هذه الاستمارة ؟

1. نعم
2. كلا *(انتقل الى سؤال DS5)*

DS2. في حال كانت الإجابة "نعم"، متى كانت آخر مرّة أخذتم ولدكم لزيارة طبيب الأسنان؟

1. أقل من 3 اشهر
2. 4 الى 6 اشهر
3. 7 الى 12 شهر
4. أكثر من 12 شهر
5. لا أذكر

DS3. آخر مرة عاين طبيب اسنان الولد كانت لأيّ سبب من الاسباب التالية؟

1. كشف روتينيّ نعم كلا
2. تنظيف نعم كلا
3. تسوّس نعم كلا
4. الم حاد نعم كلا
5. شكل الاسنان نعم كلا
6. آخر, حدد: _____

DS4. الرجاء إختيار الخدمات التي قدمت لولدكم في <u>زيارته الأخيرة</u> لطبيب الأسنان وتحديد مبلغ المال الذي قمتم بدفعه مقابل هذه الخدمات

	نعم	لا	المبلغ
1) **فحص روتيني (فحص عادي)**			_____ ل.ل
2) **رعاية وقائية:** * ساد الشقوق sealant ،حافظ المسافة، تطبيق الفلورايد			_____ ل.ل
3) **معالجة سناً واحداً:** قلع ضرس، حشوة، حشوة قناة او قطع عصب، تلبيسة			_____ ل.ل
4) **تقويم الأسنان**			_____ ل.ل

* ساد الشقوق (sealant): هي مادة بلاستيكية تلصق من قبل طبيب أسنان الأطفال على الأسنان لمنع تجمع بقايا الطعام وبالتالي الوقاية من التسوس.
*تطبيق الفلورايد: يقوم طبيب الاسنان بتطبيق مادة تحتوي على الفليور على اسنان الطفل للوقاية من التسوس.
* حافظ المساحة: يقوم طبيب الأسنان بوضع جهاز داخل فم الولد للمحافظة على مساحة سنٍ مقلوع أو مفقود

DS5. في حال عدم إصطحاب الولد المعني لزيارة طبيب الأسنان في الأشهر ال-١٢ الأخيرة، ما هي الأسباب؟ يمكنكم إختيار أكثر من إحتمال واحد:

1. لم يكن بحاجة إلى طبيب أسنان — نعم كلا
2. غلاء تكاليف علاج الأسنان — نعم كلا
3. عدم معرفتكم بوجود عيادة أو مركز أسنان في منطقة سكنكم — نعم كلا
4. صعوبة وصولكم إلى عيادة أو مركز أسنان — نعم كلا
5. أسباب أخرى_____

DS6. هل سبق أن عاين أخصائي تقويم أسنان الولد المعني في هذه الاستمارة ؟

1. نعم ، في عمر: _____سنة (أول معاينة)
2. كلا

DS7. هل تعتقد ان الولد المعني في هذه الاستمارة بحاجة الى تقويم اسنان <u>في الوقت الحالي</u>؟

1. نعم، إنه بحاجة الآن الى تقويم أسنان *(انتقل ال سؤال DS8)*
2. كلا، هو حصل على علاج تقويم أسنان وبالتالي ليس بحاجة له *(انتقل ال سؤال DS9)*
3. كلا، هو ليس بحاجة الى علاج تقويم أسنان ولم يحصل عليه سابقا *(انتقل ال سؤال DS10)*
4. لا اعرف *(انتقل ال سؤال DS10)*

DS8. لأيّة اسباب تعتقد أنه بحاجة لتقويم الأسنان ؟

1. أسنان متراكمة فوق بعضها البعض أو غير منتظمة
2. أسنان ناتئة (بارزة الي الخارج)
3. وضع غير طبيعيّ لأيّ من الفكّين
4. آخر ، حدّد: _____

(إنتقل الي السؤال DS10)

DS9. لأيّة اسباب حصل ابنك على علاج تقويم الأسنان ؟

1. اسنان متراكمة فوق بعضها البعض أو غير منتظمة
2. اسنان ناتئة (بارزة الي الخارج)
3. وضع غير طبيعيّ لأيّ من الفكّين
4. آخر ، حدّد: _____

DS10. هل تعلم أن هناك مراكز/عيادات أسنان تقدم خدمات أقل كلفة من عيادات الأسنان الخاصة؟

1. نعم
2. كلا *(انتقل الى القسم الثامن)*

DS11. إذا كانت الإجابة نعم، حدد أسماء المراكز التى تعرفها: ----------

DS12. في حال كانت الإجابة نعم، كيف علمتم بوجود هذه المراكز؟

1. الإعلام
2. حملات توعية قامت بها وزارة الصحة
3. حملات توعية قامت بها المراكز نفسها
4. مدرسة أولادكم
5. صديق أو قريب
6. غيره: _____

DS13. في حال كنتم على علم بهذه المراكز، هل تأخذون أولادكم لمعالجة أسنانهم فيها؟

1. نعم *(انتقل إلى السؤال **DS15**)*
2. كلا

DS14. إذا كنتم على علم بوجود هذه المراكز، لكنكم لا تأخذون أولادكم لمعالجة أسنانهم فيها، ما هي الأسباب التي تمنعكم؟

1.	تكاليف العلاج مرتفعة (لا استطيع تحمل الكلفة)	نعم	كلا
2.	عدم تصنيف صحة الفم كأولوية	نعم	كلا
3.	لا تؤمن هذه المراكز نوعية علاج جيد	نعم	كلا
4.	بعد مسافة هذه المراكز عن منزلكم	نعم	كلا
5.	أسباب أخرى: _____		

(انتقل الى القسم الثامن)

DS15. إذا كنتم تأخذون أولادكم لمعالجة أسنانهم في هذه المراكز، منذ متى تفعلون ذلك؟

1. اقل من سنة
2. اكثر من سنة

DS16. هل كنتم تتلقون من هذه المراكز إتصالاً للمراجعة؟

1. نعم
2. كلا

القسم الثامن: تكاليف علاج الأسنان

DI1. إذا كان لديكم الخيار لأخذ أولادكم إلى احدى الإحتمالات الثلاث التالية، التي تؤمن الخدمات نفسها لمعالجة الأسنان ولكن بتكاليف مختلفة، أي إحتمال تختارون؟ (الرجاء رسم إشارة ✓ في الخانة الفارغة تحت الاحتمال الذي يناسبكم لكل من العلاجات الآتية)

1) معاينة واحدة

مستوصف – مجانا	مركز علاج جامعي - ٥،٠٠٠ ل.ل	عيادات خاصة - ٣٠،٠٠٠ ل.ل

2) جلسة تنظيف أسنان واحدة

مستوصف - ١٠،٠٠٠ ل.ل	مركز علاج جامعي - ١٠،٠٠٠ ل.ل	عيادات خاصة - ٦٥،٠٠٠ ل.ل

3) حشوة مركبة واحدة

مستوصف - ١٠،٠٠٠ ل.ل	مركز علاج جامعي - ١٥،٠٠٠ ل.ل	عيادات خاصة - ٦٠،٠٠٠ ل.ل

4) قلع سن واحد

مستوصف - ٧،٠٠٠ ل.ل	مركز علاج جامعي - ١٥،٠٠٠ ل.ل	عيادات خاصة - ٤٥,٠٠٠ل.ل

5) معالجة قناة الجذر الواحدة (قطع عصب)

مستوصف - ١٥،٠٠٠ ل.ل	مركز علاج جامعي - ٢٥،٠٠٠ ل.ل	عيادات خاصة - ٧٥،٠٠٠ ل.ل

6) ساد شقوق على ضرس واحد* (Sealant)

مركز علاج جامعي - ١٢،٠٠٠ ل.ل	عيادات خاصة - ٣٠،٠٠٠ ل.ل

7) جلسة تطبيق فلورايد واحدة*

مركز علاج جامعي - ١٠،٠٠٠ ل.ل	عيادات خاصة - ٤٥,٠٠٠ل.ل

8) حافظ المساحة *

مركز علاج جامعي - ١٥٠،٠٠٠ ل.ل	عيادات خاصة - ٢٢٥,٠٠٠ل.ل

9) علاج تقويم الأسنان*

مركز علاج جامعي - ٢،٢٥٠،٠٠٠ ل.ل	عيادات خاصة - ٣,٣٧٥,٠٠٠ ل.ل

* الخدمات التالية هي خدمات غير متوفرة في المستوصفات: تطبيق ساد شقوق، تطبيق الفلورايد، حافظ المساحة، علاج تقويم الأسنان

DI2. علما ان ارتفاع أقساط ضمان الأسنان يوفر تغطية إضافية لإجراءات طب الأسنان، أي قسط من الأقساط السنوية التالية (الرسم السنوي المدفوع لشركة الضمان) هو ضمن امكانياتكم ؟

1) ١٠٠$
2) ٢٠٠$
3) ٣٠٠$
4) ٤٠٠$
5) ٥٠٠$
6) اكثر من ٥٠٠$
7) لا استطيع تحمل أي قسط من الأقساط السابقة

DI3. في ما يلي، مشاريع مختلفة وضعتها شركة ضمان صحي لتغطية علاج أسنان ولدكم. الرجاء إختيار المشروع الذي يناسبكم وذلك بوضع علامة ✓ في المربّع الفارغ.

☐ **المشروع رقم ١: التغطية الشاملة - مبلغ لا يقل عن ٥٠٠$ سنويا**

- تغطية ١٠٠٪ لجميع إجراءات طب الأسنان (الوقائية والإصلاحية)
- تقويم الاسنان: تقوم شركة الضمان بدفع مبلغ يتراوح بين ١٠٠٠$ و ١٥٠٠$(وذلك لمرة واحدة فحسب)

☐ **المشروع رقم ٢: تغطية الاقساط - مبلغ لا يقل عن ٣٠٠$ سنويا**

- تغطية ١٠٠٪ للإجراءات الأسنان الوقائية
- المشاركة في دفع تكاليف الإجراءات الإصلاحية للأسنان*
- تقويم الاسنان: تقوم شركة الضمان بدفع مبلغ يتراوح بين ٥٠٠$ و ١٠٠٠$(وذلك لمرة واحدة فحسب)

☐ **المشروع رقم ٣: تغطية التكاليف الاساسية - مبلغ لا يقل عن ١٥٠$ سنويا**

- تغطية ١٠٠٪ للإجراءات الوقائية للأسنان
- المشاركة في دفع تكاليف الإجراءات الإصلاحية للأسنان*

*المشاركة في الدفع يعني ان شركة التأمين لا تغطي ١٠٠% لتكاليف بعض الاجراءات ويتوجب عليكم دفع الفرق إلى طبيب الأسنان

☐ **لا استطيع تحمل تكلفة أي من المشاريع السابقة**

DI4. في حال كان لديكم ضمان يغطي تكاليف طب الاسنان، هل لديكم مشكلة في اختيار طبيب أسنان من قائمة أطباء الأسنان المتعاقدين مع شركة التأمين، والتي قد لا تشمل طبيب اسنانكم؟

1. نعم
2. كلا

جزيل الشكر لمشاركتكم

Appendix II

الرقم المتسلسل :I__I__I__I__I__I

تقييم صحة الفم في المدارس التكميلية والثانوية في لبنان: مقارنة بين المدارس العامة والخاصة
الجامعة الامريكيّة في بيروت
موافقة الأهل المستنيرة

<u>للأهالي الذين يواجهون صعوبة في تعبئة الاستمارة الرجاء الاستعانة بفريق البحث (معلومات الإتصال تتبع على الصفحة التالية) أو بشاهد عمره فوق 18 سنة بوجود توقيع الوالد/الوالدة أو كتابته إسمه/إسمها</u>

تقوم كلّيّة العلوم الصحيّة وبالتعاون مع قسم تقويم الاسنان في الجامعة الامريكيّة في بيروت باستطلاع يتعلّق بصحّة الفم (الاسنان) لسبعمئة وعشرين - 720– طالب تتراوح أعمارهم بين 12 و 17 سنة منتسبين الى المدارس الخاصة والعامة. ان مشاركتم طوعيّة. في حال قررتم المشاركة، تعاونكم المشكور سيمكننا من جمع المعلومات المتعلّقة بحالة وسلامة أسنان أولادكم. هذه المعلومات سوف تستخدم ضمن دراسة تقوم ببحث العلاقة بين صحة الفم وعوامل تتعلّق بسلوكيات وعادات الاولاد والاهل معا، بما فيها استخدام خدمات طب الأسنان الصحية. سوف يقوم هذا البحث أيضا بدراسة الاختلافات في صحة الفم بين طلاب المدارس العامة والخاصة.

كل الأسماء والأجوبة سوف تكون مجهولة المصدر، ولن تنشر مُطلقا. سيحدد رقم تسلسل لكل استطلاع وسيستخدم هذا الرقم في الدراسة عوضا عن اسم الطالب. جميع الاستطلاعات سوف تخزن في خزائن مقفولة لا صلاحية لفتحها إلا للباحث الرئيسي.

نرجو ان تأخذوا وقتكم بقراءة هذه المعلومات بدقّة ورويّة، قبل قرار المشاركة في الاستطلاع او عدمه:

- تتكون الدراسة من 3 أجزاء طوعية :
  1. إجابة حضرتكم الطوعية عن الأسئلة في الاستمارة الملحقة بهذه الرسالة
  2. الكشف على أسنان أبنائكم، بموافقتكم وموافقة أبنائكم، من قبل أطبّاء اسنان متخصّصين (كيتي بيطار وسوزانا المعالي) بهدف تدوين المعلومات عن صحة فمهم وأسنانهم. لن تتم أي إجراءات علاجية ولن يشعر ابنكم/ابنتكم بأي ألم خلال الفحص ولن يتعرض لأي مخاطر.
  3. إجابة أبناءكم الطوعية عن استمارة خاصة بهم تستفسر عن صحة فمهم وأسنانهم بما يتعلق بالعناية بنظافتها، بالإضافة الى الاستفار عن عاداتهم الغذائية ومعتقداتهم بما يخص أسنانهم.

- لن يأخذ الاستطلاع من وقتكم اكثر من 15 دقيقة ولستم مجبرين مجبرين بالإجابة عن جميع الأسئلة، حتى بعد توقيع القبول بالمشاركة.
- سوف يتم استدعاء إبنكم/إبنتكم من الصف من أجل إجراء الكشف على الأسنان. سوف يتم التنسيق مع إدارة المدرسة والمعلمين لتحديد الوقت المناسب لذلك، على أن لا يتعارَض الفحص مع وقت الإمتحانات أو الحصص الدراسية الأساسية. إذا كان الولد بحاجة الى علاج معيّن لأسنانه (علاج لتسوس الأسنان أو تقويم الأسنان) سوف يتمّ إبلاغ الأهل عبر رسالة خطيّة تُرسل مع ولدهم.
- من إيجابيات مشاركة ابنكم/ابنتكم في هذه الدراسة إمكانية الإكتشاف المبكر لمشاكل صحة الفم بما فيها تسوس الأسنان وسوء الإطباق، ما يمكن المعالجة المبكرة.
- إن مشاركتكم طوعية. اختياركم عدم المشاركة لن ينتج عنه أي ضرر أو عقاب على ابنكم/ابنتكم، ولن يتم التعرض لأي من حقوق أو امتيازات ابنكم/ابنتكم كما ولن تتأثر علاقتكم بالمدرسة أو بالجامعة الأميركية في بيروت.

بعد قراءة وفهم تفاصيل الدراسة، نرجو منكم وضع علامة (صح) في المربع والتوقيع أدناه عند الجزء أو الأجزاء الذي/التي توافقون المشاركة به/بها. نذكركم بأن كل جزء بحاجة الى توقيع منفصل، وأنه بإمكانكم الموافقة على جزء واحد أو اثنين أو جميع الأجزاء.

☐ **أوافق على تعبئة الاستمارة** الملحقة بهذه الرسالة وبالتالي على استخدام المعلومات التي سوف اشارك بها في الدراسة

....
اسم الوالد/الوالدة أو الشاهد التوقيع التاريخ

☐ **أوافق على أن يتم الكشف على أسنان إبني/ إبنتي** _____ من قبل أطباء الأسنان المذكورين أعلاه وذلك داخل الحرم المدرسي وبالتنسيق مع المدرسة

....
اسم الوالد/الوالدة أو الشاهد التوقيع التاريخ

☐ **أوافق على أن يجيب/ تجيب إبني/ إبنتي** _____ على الاستمارة الخاصة بالطلاب والتي سوف تتوفر في المدرسة أثناء وجود أطباء الأسنان المختصين

....
اسم الوالد/الوالدة أو الشاهد التوقيع التاريخ

شكرا سلفا لمساهمتكم

فريق البحث، يستطيع المساعدة في حال تعذّر عليكم تعبئة الاستمارة.
الرجاء الاتصال عند الحاجة ب:

- *البروفيسور مونيك شعيا، قسم الوبائيات، كلية العلوم الصحية، الجامعة الاميركيّة في بيروت، خلوي: 03-458143، بريد الكترونيّ: mchaaya@aub.edu.lb*
- *الدكتور كيتي بيطار، قسم تقويم الاسنان، الجامعة الاميركيّة في بيروت، خلوي: 03-414082، بريد الكترونيّ: kb30@aub.edu.lb*
- *الدكتور سوزانا المعالي، قسم تقويم الاسنان في الجامعة الاميركيّة في بيروت، خلوي: 71-520428، بريد الكترونيّ: sa152@aub.edu.lb*

للاتصال بفريق مستقل عن فريق البحث لأي استفسارات، مخاوف، شكاوى على البحث، استفسارات عن حقوقك وحقوق ابنك/ابنتك، للمزيد من المعلومات أو لمشاركة تجربتكم ، الرجاء الإتصال بلجنة الأخلاقيات:

Institutional Review Board (IRB)
Tel: +961-1-3500000 Ext: 5445 or Ext: 5454; Email: irb@aub.edu.lb

Appendix III

الرقم المتسلسل :I__I__I__I__I__I

تقييم صحة الفم في المدارس التكميلية والثانوية في لبنان: مقارنة بين المدارس العامة والخاصة

الجامعة الامريكيّة في بيروت

الاسئلة الخاصة بالطالب المشارك

القسم الاوّل: التعريف

الاسم _____
اسم المدرسة _____
الصفّ_____

SD1. العمر في آخر عيد ميلاد [__I__] سنة

SD2. الجنس

3. ذكر
4. انثى

القسم الثاني: نمط الاهتمام بصحّة الفم و الاسنان

1. كم مرة تنظف أسنانك في اليوم؟

1. مرّة يوميّا
2. 2- 3 مرّات يوميّا
3. اقلّ من مرّة
4. نادراً
5. ابدا

2. ما هي المواد المستعملة لتنظيف الاسنان؟
(يمكنك اختيار أكثر من خيار)

1. معجون اسنان
2. الخيط
3. غسول فم
4. لا شيء
5. آخر، حدّد:_____.

3. هل سبق أن فحصك اي طبيب اسنان ؟

3. نعم
4. كلا (انتقل الى القسم الثالث)

4. متى كانت آخر مرّة؟

1. شهر أو أقل
2. 1 الى 3 اشهر
3. 4 الى 6 اشهر
4. اكثر من 6 اشهر

5. آخر مرة عاينك طبيب اسنان كانت لأيّ سبب من الاسباب التالية؟

1. كشف روتينيّ	نعم	كلا
2. تنظيف	نعم	كلا
3. تسوّس	نعم	كلا
4. الم حاد	نعم	كلا
5. مشكلة في شكل الاسنان	نعم	كلا
6. آخر, حدد:_____		

القسم الثالث: صحة الفم والحياة العامة

1. هل تعتقد ان حالة فمك الصحيّة هي .....؟

6. ممتازة
7. جيّدة
8. عاديّة
9. سيّئة
10. سيّئة جدا

2. خلال <u>الأشهر الثلاثة الماضية</u> .... هل عانيت من أي من الأعراض الآتية <u>بسبب أسنانك/ فمك</u>:

	(0) أبداً	(1) مرة أو مرتين	(2) بعض الأحيان	(3) غالباً/ كثيراً	(4) كل يوم/ أو تقريباً كل يوم
1. ألم في أسنانك، أو شفتيك، أو فكيك، أو فمك؟					
2. نزيف باللثة؟					
3. تقرحات في فمك؟ (حمو أو تقرح مؤلم يظهر في الفم وذلك في الشفتين واللسان وعلى جدار الخدين من الداخل، وأحياناً سقف الحلق واللثة)					
4. رائحة نفس غير مستحبة (كريهة)؟					

	(0) أبداً	(1) مرة أو مرتين	(2) بعض الأحيان	(3) غالباً/ كثيراً	(4) كل يوم/ أو تقريباً كل يوم
5. طعام عالق داخل أسنانك أو بينها؟					
6. طعام عالق بأعلى فمك؟					
7. تنفست من خلال فمك؟					
8. استغرقت وقتا أطول من اللآخرين لتناول وجبتك؟					
9. واجهت صعوبات في النوم؟					
10. صعوبة في عض أو مضغ أطعمة مثل التفاح، عرنوس الذرة، أو قطع اللحم؟					
11. صعوبة في فتح الفم على سعته؟					
12. صعوبة في نطق أي كلمة؟					
13. صعوبة في تناول الأطعمة التي تحبها؟					
14. صعوبة في الشرب بواسطة المصاصة (Chalumeau)؟					
15. صعوبة شرب أو تناول الأطعمة الساخنة أو الباردة؟					
16. سرعة الانفعال أو الإحباط؟					
17. عدم الثقة في النفس؟					
18. الخجل أو الإحراج؟					
19. القلق من رأي الآخرين حيال أسنانك؟					
20. القلق بأنك لست جيد المظهر أو مقبول الشكل كالآخرين؟					
21. الإنزعاج؟					
22. التوتر أو الخوف؟					
23. القلق بأنك لست بصحة جيدة كالآخرين؟					
24. القلق بأنك مختلف عن كالآخرين؟					

	(0) أبداً	(1) مرة أو مرتين	(2) بعض الأحيان	(3) غالباً/ كثيراً	(4) كل يوم/ أو تقريباً كل يوم
25. التغيب عن المدرسة بسبب ألم، أو موعد، أو عملية جراحية؟					
26. أي صعوبة في الانتباه في المدرسة؟					
27. أي صعوبة في أداء الواجبات المنزلية؟					
28. عدم الرغبة في الكلام أو القراءة بصوت عال في الصف؟					
29. تجنبت المشاركة في أنشطة مثل الرياضة، أو النوادي، أو التمثيل، أو الموسيقى، أو الرحلات المدرسية؟					
30. واجهت صعوبة في اللعب على آلة نفخ موسيقية؟					
31. تجنبت التحدث مع الطلاب الآخرين؟					
32. تجنبت الإبتسام أو الضحك عندما كنت بصحبة غيرك من الطلاب؟					
33. تجنبت قضاء الوقت مع الطلاب الآخرين؟					
34. تخاصمت مع الطلاب الآخرين أو مع عائلتك؟					
35. أغاظك أو سخر منك الطلاب الآخرون، أو نادوك بألقاب غير محببة؟					
36. أشعرك طلاب آخرون بالانعزال أو الوحدة؟					
37. وجه إليك طلاب آخرون أسئلة عن أسنانك، أو شفتيك، أو فكيك، أو فمك؟					

القسم الرابع: تقويم الأسنان

الأسئلة التالية سوف تستفسر عن تقويم الأسنان. ما نعنيه بتقويم الأسنان أي جهاز ثابت أو متحرك يستخدم من قبل أخصائي تقويم الأسنان من أجل صف أسنانك

1. هل سبق أن فحصك أخصائي تقويم أسنان؟

1. نعم
2. كلا (انتقل الى السؤال 8)

2. إذا كانت الإجابة نعم، في أي عمر تقريبا عاينك أخصائي تقويم أسنان <u>لأول مرة</u> ؟ [_____] سنة

.

3. هل سبق أن حصلت على علاج تقويم لأسنانك؟

1. نعم (انتقل ال سؤال 8)
2. لا

4. هل انت حاليا تحت متابعة أخصائي تقويم أسنان؟

1. نعم
2. لا

5. من كان صاحب فكرة أن تحصل على علا ج التقويم؟

1. انا (انتقل الى سؤال 6)
2. أهلي (أمي أو أبي) (انتقل الى سؤال 7)
3. أصدقائي (انتقل ال سؤال 7)
4. طبيب الأسنان (انتقل الى سؤال 7)
5. أخصائى التقويم (انتقل الى سؤال 7)
6. آخر، حدد: _____.

6. لماذا كنت تظن أنك بحاجة لتقويم اسنانك؟

1. صعوبة في نطق بعض الأحرف والكلمات
2. صعوبة في المضغ والأكل
3. أوجاع في الفك أو الاسنان
4. لتحسين منظر أسناني/ابتسامتي
5. معظم أصدقائي/ زملائي حصلوا على علاج تقويم

6. آخر، حدد: _____.

7. هل تعتقد أن قرار حصولك على علاج التقويم كان الاختيار الصحيح؟

1. نعم، السبب: _____. (انتقل ال القسم الخامس)
2. لا، السبب: _____. (انتقل الى القسم الخامس)
3. لا أعرف (انتقل الى القسم الخامس)

8. هل تعتقد انك بحاجة لعلاج التقويم؟

1. نعم
2. لا (انتقل الى القسم الخامس)
3. لا أعرف (انتقل الى القسم الخامس)

97. لماذا تعتقد انك بحاجة لعلاج التقويم؟

1. صعوبة في نطق بعض الأحرف والكلمات
2. صعوبة في المضغ والأكل
3. وضع غير طبيعيّ لأيّ من الفكّين
4. اسنان متراكمة فوق بعضها البعض
5. اسنان ناتئة
6. لتحسين منظر أسناني/ابتسامتي
7. معظم أصدقائي/ زملائي حصلوا على علاج تقويم
8. أهلي (أمي أو أبي) ينصحوني بذلك
9. طبيب الأسنان / أخصائى التقويم ينصحني بذلك
10. آخر، حدد: _____.

10. لماذا لم تحصل على علاج التقويم على الرغم من أنك تعتقد انك بحاجة له؟

1. ليس لدي الوقت لذلك بسبب متطلبات المدرسة
2. أهلي لا يعتقدون أنني بحاجة الى علاج
3. طبيب الأسنان / أخصائى التقويم لا يعتقد أنني بحاجة الى علاج
4. لا أحبذ فكرة وجود أجهزة ظاهرة على أسناني يستطيع أصدقائي/ زملائي رؤيتها
5. علاج تقويم الأسنان مكلف جدا

القسم الخامس: العادات و الخصائص الغذائية

1. **أي من الأنماط الغذائية التالية تتطابق مع عاداتك اليومية في تناول الطعام؟**

1. أتناول ثلاث وجبات رئيسية في اليوم فقط (الفطور، الغداء، العشاء)
2. بالإضافة الى الفطور، الغداء والعشاء، أتناول وجبة أو وجبتين خفيفتين
3. أتناول بالعادة أقل من 3 وجبات رئيسية في اليوم. حدد الوجبة (أو الوجبات) التي لا تتناولها بالعادة
   a. _____
   b. _____
   c. _____

2. **كم مرة تتناول الوجبات السريعة عادةً؟**

1. يوميّا
2. من مرة الى 3 مرات اسبوعيّا
3. من 4 الى 6 مرات اسبوعيّا
4. في المناسبات
5. ابدا

3. كم مرة تستهلك مادة الصودا عادةً ؟ بيبسي، كوكاكولا وغيرها؟

1. اكثر من مرّة يوميّا
2. مرّة\يوم
3. اقلّ من المعدّل اليوميّ. عدّة مرات اسبوعيّا
4. في المناسبات
5. ابدا

4. **كم مرة تستهلك الحلويات (كالشوكولا و السكاكر) ؟**

1. اكثر من مرّة يوميّا
2. مرّة\يوم
3. اقلّ من المعدّل اليوميّ. عدّة مرات اسبوعيّا
4. في المناسبات
5. ابدا

5. هل جربت التدخين, لو مرة في حياتك؟

1. نعم (سجائر فقط)
2. نعم (النرجيلة فقط)
3. نعم (سجائر و نرجيلة)
4. كلا (انتقل الى السؤال 8)

6 . كم كان عمرك حين دخنت أول مرة؟

1. حدد العمر: سنة [_____]
2. لا أعرف/ لا أتذكر

7. خلال الشهر الماضي، ما هو عدد السجائر التي دخنتها؟

1. اقل من 5
2. 10-5
3. 25-10
4. أكثر من 25
5. أبدا"
6. لا أعرف/ لا أتذكر

8. خلال الشهرالماضي، كم مرة دخنت النرجيلة؟

1. 5-1 مرات
2. 10-5
3. 25-10
4. أكثر من 25
5. يوميا"
6. أبدا"
7. لا أعرف/ لا أتذكر

9. هل يدخن أحد والديك (سجائر أو نرجيلة)؟

1. نعم، الأب
2. نعم، الأم
3. نعم، الأم و الأب
4. كلا، لا الأم و لا الأب (انتقل الى النهاية)

10.اذا كان أحد والديك من المدخنين (سجائر و نرجيلة), حدد المكان الذي غالبا ما يدخنون فيه؟

1. داخل غرف المنزل
2. على الشرفة
3. خارج المنزل فقط

جزيل الشكر لمشاركتكم

Appendix IV

SBS Child/Adolescent Assent Form

AUB Social & Behavioral Sciences Assent to Participate in Research

Study Title: تقييم صحة الفم في المدارس التكميلية والثانوية في لبنان: مقارنة بين المدارس العامة والخاصة

Researcher: كيتي بيطار، سوزانا المعالي

Purpose:

إننا نحاول درس كلّ ما يتعلق باسنانك وفمك: نظافة أسنانك ووجود التسوس بها وأيضا إذا كنت بحاجة الى تقويم أسنان. اذا قررت المشاركة فإنك ستكون ضمن دراسة تقوم بها البروفيسور مونيك شعيا من الجامعة الأميركية في بيروت لفحص العلاقة بين صحة فمك وطريقتك لتنظيف أسنانك وعاداتك وغذاؤك. سوف ندرس أيضا إذا كانت هناك اختلافات بصحة الفم بين طلاب المدارس الخاصة والعامة.

قد سمح لنا والديك أن تشارك بهذه الدراسة.

تتكوّن هذه الدراسة من جزئين:

1. فحص للفم والأسنان لن تتجاوز مدته عن ال-10 دقائق. إذا وافقت على أن يتم فحصك، فكلّ ما هو مطلوب منكم هو فتح فمك كي نستطيع فحص اسنانك. لن يكون هناك أيّ ألم او خطر خلال المعاينة. وفي حال الحاجة للمعالجة، فسوف يتمّ اعلامك واعلام والديك. سوف نتمكّن من معرفة حالة وصحّة اسنانكم والتأكّد إذا ما كنتم بحاجة لعلاج، وهذا يسمح لك على الحصول على العلاج اللازم.
2. الإجابة على أسئلة في استمارة. إذا وافقت على الإجابة على الأسئلة في الاستمارة، فكلّ ما هو مطلوب منك هو 5-10 دقائق من وقتك للإجابة على بعض الأسئلة عن صحة فمك وأسنانك بما يتعلق بالعناية بنظافة اسنانك بالإضافة الى عاداتك الغذائية.

لست مجبرا على المشاركة في هذه الدراسة. إذا قررت أن لا تشارك لن تحصل على أي عقاب ولن تخسر أي من حقوقك في المدرسة. كما وإنك لن تحصل على أي مكافآت مقابل السماح لنا بفحصك أو مقابل إجابتك على الأسئلة. يمكنك الموافقة على أي من جزئي الدراسة، وإذا وافقت على المشاركة في جزء واحد أنت لست مجبراً أن تشارك بالجزء الثاني. يمكنك التوقّف عن المشاركة في هذه الدراسة ساعة تشاء. يمكنك التوقف عن اجابة الأسئلة ساعة تشاء. يمكنك رفض الاجابة عن كلّ الاسئلة، حتى بعد توقيع القبول بالمشاركة. لن يرى احد أجوبتك غير فريق البحث. ستحصل كل استمارة على رقم تسلسل ولن يستخدم اسمك في هذه الدراسة. كل الإستمارات سوف تخزن في مكان مغلق وآمن.

للسؤال عن الدراسة يمكنك الاتصال ب:

- *البروفيسور مونيك شعيا، قسم الوبائيات، كلية العلوم الصحية، الجامعة الاميركيّة في بيروت، خلوي: 03-458143، بريد الكترونيّ: mchaaya@aub.edu.lb*
- *الدكتور كيتي بيطار، قسم تقويم الاسنان، الجامعة الاميركيّة في بيروت، خلوي: 03-414082، بريد الكترونيّ: kb30@aub.edu.lb*
- *الدكتور سوزانا المعالي، قسم تقويم الاسنان في الجامعة الاميركيّة في بيروت، خلوي: 71-520428، بريد الكترونيّ: sa152@aub.edu.lb*

للاتصال بفريق مستقل عن فريق البحث لأي استفسارات، أو مخاوف، أو شكاوى على البحث، أو استفسارات عن حقوق المدرسة أو الطلاب وأهاليهم، أو للمزيد من المعلومات، أو لمشاركة تجربتكم ، الرجاء الإتصال بلجنة الأخلاقيات:

Institutional Review Board (IRB)
Tel: +961-1-3500000 Ext: 5445 or Ext: 5454; Email: irb@aub.edu.lb

Signing the assent form

لقد قرأت (أو شخص قد قرأ لي) هذه الورقة و فهمت مضمونها.

Investigator/ Research Staff

القسم -1-	**القسم -2-**
الموافقة على فحص الأسنان والفم	الموافقة على تعبئة الاستمارة
.....	.....
التوقيع أو اسم الفرد	التوقيع أو اسم الفرد
.....**AM/PM**	..... **AM/PM**
التاريخ والوقت	التاريخ والوقت

لقد أوضحت للمشارك قبل طلب التوقيع أعلاه. لا توجد فراغات في هذه الوثيقة. وقد سلمت نسخة من هذا النموذج إلى المشاركين أو ممثله / ممثلها.

توقيع الشخص الحاصل على موافقة	اسم الشخص الحاصل على موافقة
AM/PM	
التاريخ والوقت	

This form must be accompanied by an IRB approved parental permission form signed by a parent/guardian.

Appendix V

Percent distribution of untreated adolescents (11-18 years) by molar/canine occlusion and type of school, adjusted for school cluster (n=656)

Occlusion	School type			P-Value
	Public (n=340) N (%)	Private (n=316) N (%)	Total (n=656) N (%)	
Right Molar				
Class II	28 (8.2%)	26 (8.2%)	54 (8.2%)	0.239
Half-cusp II	54 (15.9%)	74 (23.4%)	128 (19.5%)	
Class I	247 (72.6%)	201 (63.6%)	448 (68.3%)	
Half-cusp III	9 (2.7%)	14 (4.4%)	23 (3.5%)	
Class III	2 (0.6%)	1 (0.3%)	3 (0.5%)	
Left Molar				
Class II	20 (5.9%)	27 (8.5%)	47 (7.2%)	0.057
Half-cusp II	58 (17.1%)	69 (21.8%)	127 (19.4%)	
Class I	247 (72.6%)	202 (63.9%)	449 (68.5%)	
Half-cusp III	13 (3.8%)	17 (5.4%)	30 (4.6%)	
Class III	2 (0.6%)	1 (0.3%)	3 (0.5%)	
Right Canine				
Class II	22 (6.5%)	24 (7.6%)	46 (7.0%)	0.472
Half-cusp II	80 (23.5%)	86 (27.2%)	166 (25.3%)	
Class I	227 (66.8%)	192 (60.8%)	419 (63.9%)	
Half-cusp III	9 (2.7%)	13 (4.1%)	22 (3.4%)	
Class III	2 (0.6%)	1 (0.3%)	3 (0.5%)	
Left Canine [ɳ]				
Class II	19 (5.6%)	23 (7.3%)	42 (6.4%)	0.466
Half-cusp II	67 (19.7%)	73 (23.2%)	140 (21.4%)	
Class I	239 (70.3%)	196 (62.2%)	435 (66.4%)	
Half-cusp III	13 (3.8%)	20 (6.4%)	33 (5.0%)	
Class III	2 (0.6%)	3 (0.9%)	5 (0.8%)	

* p–value <0.05

[ɳ] Numbers in cells do not add up to total N column-wise because of inability to assess canine occlusion in 1 adolescent in the private school sample (unerupted)