The association between obesity and dental caries among school children in Benghazi city: A secondary data analysis

By

Intesar Abdalla Awnalla

Supervisor:

Dr. Arheiam Arheiam

This thesis Submitted in Partial Fulfilment of the Master's Degree in Dental Public Health

University of Benghazi

Faculty of Dentistry

Feb 2022

Copyright

University of Benghazi **Faculty of Medicine**

Department of Dental Public Health

The association between obesity and dental caries among school children in Benghazi city: A secondary data analysis

By

Intesar Abdalla Awnalla

This Thesis was Successfully Defended and Approved on **15.2.2022**

Supervisor:

Dr. Arheiam Arheiam

Signature: **……..**

Dr……..……..……. (**Internal examiner)**

Signature: ……..……..

Dr……..…….…… (**External examiner)**

Signature: ……..…….

(Dean of Faculty) **(Director of Graduate studies and training)**

Declaration

By signing this document, I certify that this thesis represents my original work, which was completed after registering for the master's degree at Benghazi University, and that it has not previously been included in a thesis or dissertation submitted to this or any other institution for the purposes of obtaining a degree, diploma, or other qualification. I have read and understood the University's current research ethics guidelines, and I have attempted to identify all risks associated with this research that may arise in the course of conducting this research. I have obtained the appropriate ethical and/or safety approval (where applicable), and I have recognized my own obligations as well as the rights of the research participants.

Acknowledgment

First, I am extremely grateful to my supervisor Dr. Arheiam Arheiam for his valuable advice, patience and continues support during my graduate study. His immense knowledge and plentiful experience have encouraged me in all my academic research and daily life. It has been great journey and all thanks again to Dr. Arheiam Arheiam.

Dedication

Finally, I would like to express my gratitude to my parents, the reason I exist in this world. There are no words to describe your ultimate support and passion towards me and my siblings until we became what we are today. Thank you for every single happy moment in our life. Also, I would like to thank my siblings for the continues support throughout my study and life in general. A special gratitude to my husband Ibrahim Alfrergani who was a great support to me during my study and all the way as always. He has been nothing but a partner and a best friend whom I could depends on in my difficult times during my research. In addition, I would like to thank my family in law for their wise counsel and sympathetic ear. Thank you for being there for me and care about my future as I was your own daughter. I will be missing the happy face of my father in law, may Allah have mercy on his soul. Moreover, I would like to thank whoever were the reason for the research to succeed. Thank you for your great support and contribution. Specially, Marwa Alshara and Basma Alwarfalli. It would be impossible for me to achieve all this without you.

Table of Contents

List of tables

List of figures

Abbreviations

WHO- World Health Organization

GBD- Global Burden of Disease

BMI- Body Mass Index

BAZ-BMI-for-age z-score

DMFT- Decayed, Missing Filled Tooth (index for permanent dentition)

DMFS- Decayed, Missing Filled Surface (index for permanent dentition)

DT- Decayed permanent Tooth

FT- Filled permanent Tooth

MT Missed permanent Tooth

dmft- decayed, missing filled tooth for primary dentition (index for primary dentition)

PUFA- Pulp, Ulceration, Fistula, Abscess

ICDAS- International Caries Detection and Assessment System

SDA- Secondary Data Analysis

AC- Anthropometric Calculator

IA- Individual Assessment

NS- Nutritional Survey

SD- Standard Deviation

SPSS- Statistical Package for Social Science

IOTF- International Obesity Task Force

The association between obesity and dental caries among school children in Benghazi city: A secondary data analysis

By

Intesar Abdalla Awnalla

Supervisor: Dr. Arheiam Arheiam

Abstract

Introduction: Obesity and caries in children are issues of public health concern. Even though research into the relationship between this two noncommunicable problems has been conducted for many years, to date the results remain equivocal. The aim of this paper was to examine the association between obesity and dental caries among 12-year-old Libyan school children. **Methods and subjects:** This study is a Secondary Data Analysis (SDA) of data collected as part of a cross-sectional survey conducted among 12-year-old school children in Benghazi city during the year 2017. The data was taken with the permission of the primary author on an excel file. In the light of the aims of the present study, the original dataset was checked for completeness of information. Incomplete data, in which the date of birth, height, or weight were missing, was removed. As a result, the study sample went down from 1,134 to 788. Statistical analysis using SPSS 25 software was conducted to compare caries and obesity, P value for all statistical tests was set

at ≤0.05. **Results:** children who were in underweight had a lower number of decayed teeth and DMFT (0.84, SD=1.27 & 0.93, SD= 1.30, respectively) than normal weight and overweight/ obese children groups which have nearly equal average number of decayed teeth and DMFT (0.93, SD= 1.45 & 1.04, SD= 1.51, 0.94, SD=1.56 & 1.05, SD= 1.61, respectively). **Conclusion:** Evidence of an association between BMI and caries was inconsistent. The present study found that the average height, weight, BMI and age-adjusted Z score for BMI in caries free children were higher compared to children with dental caries, however, this difference was not statistically significant.

Chapter 1

Introduction

1.1 Overview

Obesity in children is increasingly recognized as a serious, public health concern [1]. It is a chronic, multifactorial and highly prevalent condition that negatively affects the quality of life of children and adults, alike [2,3]. Globally, obesity is considered as the fifth common cause of death worldwide and may cause a group of serious diseases that affect the overall health and life expectancy of population [4,5]. The Global Burden of Disease (GBD) collaborators estimate that more than two thirds of deaths related to high bodyweight were due to cardiovascular disease [4]. According to the World Health Organization (WHO), obesity prevalence has tripled since 1975 [6]. This rapid increase is believed to be caused by changes in the life style towards increased consumption of unhealthy foods and decreased physical activities [7].

Children and adolescents are becoming increasingly affected by obesity, which in turn affects the metabolic health, growth and sexual development, and increased the risk of being obese in adulthood [8]. Obese child may also have a risk for developing many other diseases such as respiratory, skeletal and hormonal disorder [9]. Additionally, obesity is associated with psychological problems in young people including attention deficit hyperactivity disorder, anxiety, depression, poor self-esteem, and problems with sleeping [10]. Therefore,

establishing healthy behaviors among youngster is crucial for preventing life-long consequences of obesity.

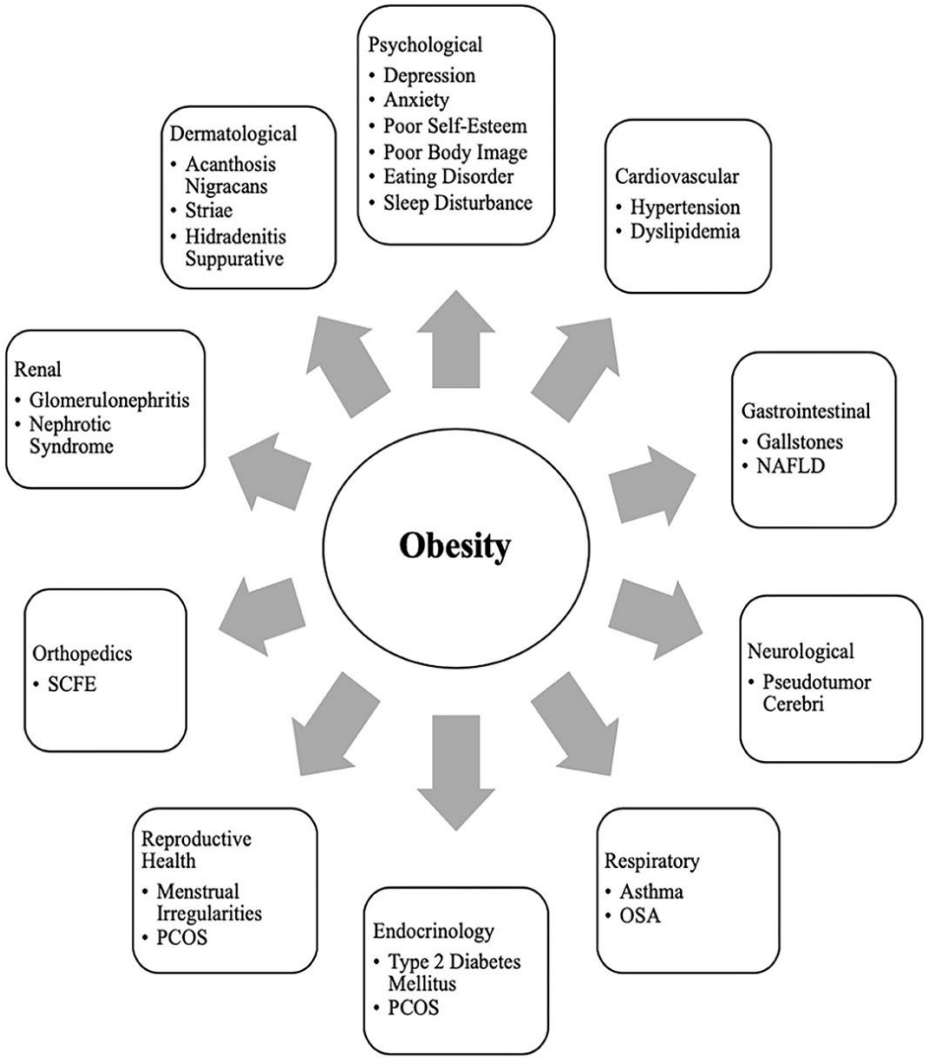


Figure 1-1: Comorbidities related to obesity [18]

1.2 Obesity and caries

The fact that obesity is a common risk factor for many health conditions is well-documented. However, obesity also shares some risk factors with other

conditions. Of these conditions, dental caries is widely spread health problem which shares with the obesity the overconsumption of sugar, as a common risk factor. Untreated dental caries in deciduous and permanent dentition is a global health problem [(11)]. Dental caries is still a major oral disease that mainly affect school children. According to the WHO, caries prevalence reaches 60-90% among children [(12)]. In 2015, the WHO has recommended that sugar intake should not exceed 10% of the daily energy in order to prevent obesity and its associated conditions as well as dental caries [(13)]. This recommendation was based on systematic synthesis of evidence. However, the evidence on the association between obesity and caries remains inconsistent. This is partly ascribed to contextual and methodological differences in studies conducted in different regions.

1.3 Statement of problem

Given the high costs and quality of life impacts of obesity and comorbidities, prevention strategies are paramount, particularly in low-income and middle-income countries that are open to global trade liberalization, economic growth and rapid urbanization, with resultant nutritional transitions in the form of increased consumption of animal fat and protein, refined grains, and added sugar.

In Libya, available data suggest that 30.5% of Libyan adults, 16.9% of children aged 5 or younger, and 6.1% of children aged between 10 and 18 are obese. The rate of obesity progressively increases with age, from 4.2% in those aged between 10 and 12 to 46% in those aged between 55 and 64 [14]. However, there is limited literature on the risk factors and social determinants of obesity among the Libyans. On the other hand, during 2017, a Libyan study assessed caries prevalence among 12- year- old schoolchildren in Benghazi city and found that caries prevalence dropped from 57% to 42.8% which was ascribed to decreased intake of sugars during the civil conflict that domed the country [15].

Added sugars are well-known risk factor for both caries and obesity. Therefore, investigation of caries-obesity association at times of reduced sugar intake during the time of Libyan conflict may provide valuable information to effectively design preventive programs targeting both conditions.

Chapter 2

Literature review

Overview

This chapter provides a review of dental literature that examined the association between caries and obesity. It is structured in a way that gives an overview of different levels of evidence and different contexts.

2.1 Obesity in children

The WHO defined obesity as abnormal or excessive fat accumulation that presents risk to health [6]. Being overweight means that the Body mass index (BMI) is equal to or over 25, and over 30 is obese. It is a multifactorial, chronic, life threating condition that can cause a serious complication on person's health like cardiovascular disease, diabetes, musculoskeletal disorders and some cancers [2].

According to WHO, overweight and obesity are associated with more deaths worldwide than underweight, with over 4 million people dying each year as a result of being overweight or obese [6]. Obesity can affect both children and adults, however, obesity during childhood increase the chance of obesity, disability and premature death during adulthood [9]. Childhood obesity is an increasing health issue because of the early onset of comorbidities that have major adverse health impacts, and the increased likelihood of children with obesity going on to become adults with obesity [16]

2.1.1 Risk factors

The main causes of overweight and obesity is the imbalance between consumed and expended calories [6]. The two main risk factors for obesity are, therefore, dietary habits and physical activity. Globally, there has been increase in the consumption of energy-dense foods that are high in fat and sugar. At the same time, there has been a decrease in the physical activity due to changing ways of transportation and increasing urbanization [7].

However, a combination of individual and societal factors is involved in the complex pathophysiology of obesity (Figure 2-1) [17, 18]. At the individual level, biological, and physiological factors in the presence of ones' own genetic risk influence eating behaviors and tendency to gain weight. Societal factors include influence of the family, community and socio-economic resources that further shape these behaviors. For example, Moreover, Changes in dietary and physical activity patterns are often the result of environmental and societal changes associated with lack of supportive policies in sectors such as health, agriculture, transport, urban planning, environment, food processing, distribution, marketing, and education [6].

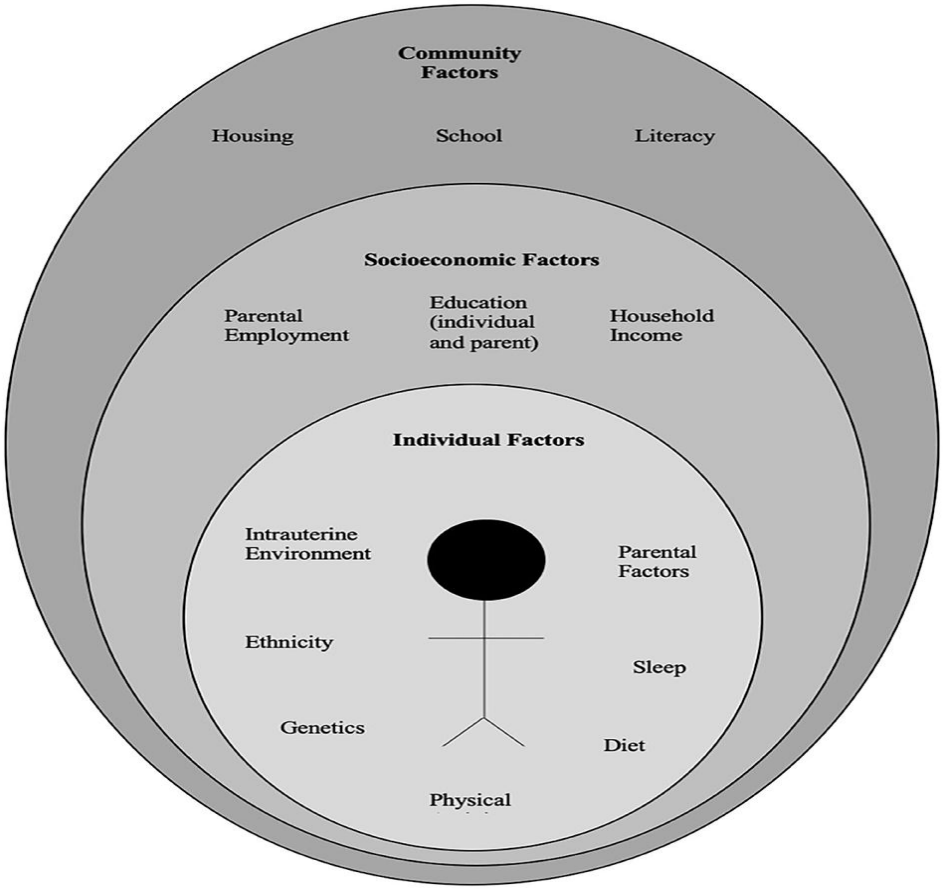


Figure 2-1: Individual and societal risk factors of obesity

Biologically, there is a complex neural and hormonal regulatory control of hunger and satiety. Sensory stimulation such as smell, sight, and taste, gastrointestinal signals, and circulating hormones further contribute to food intake [19]. In addition, psychiatric disorders can cause stress and sleeping disturbance that affected the biological rhythms, leading to increased appetite, and emotional eating [20].

Genetic causes of obesity can either be monogenic or polygenic types. Monogenic obesity is rare, mainly due to mutations in genes within the leptin/melanocortin pathway in the hypothalamus that is essential for the regulation of food intake/satiety, body weight, and energy metabolism [21]. Polygenic obesity is the more common form of obesity, caused by the combined effect of multiple genetic variants. It is the result of the interplay between genetic susceptibility and the environment [22].

Environmental changes, particularly easy access to high-calorie fast foods, increased consumption of sugary beverages, and sedentary lifestyles, are linked with mounting obesity [23]. For example, advancements in technology increased time spent on electronic devices, reduced time for physical exercise, causing poor sleeping habits, and altered eating patterns [24]. Although parents have significant role in children's behaviors, including dietary habits, toward the teenage, the children become independent in their food choices [25], with increased peer and busy school schedules leading to adoption of sedentary behaviors [19]. All these factors tip the energy imbalance towards more calories and fat deposition.

2.1.2 Measurements

Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults and children over 2

years of age. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2) [26]. For adults, WHO defines overweight and obesity as follows: person with a BMI greater than or equal to 25 is considered overweight; and person with a BMI greater than or equal to 30 is considered obese. While for children, when defining overweight and obesity, age needs to be considered. Moreover, for children aged between 5–19 years overweight and obesity are defined as follows: BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median is overweight; and BMI-for-age greater than 2 standard deviations above the WHO Growth Reference median is obese [6].While BMI provides a reasonable estimate of body fat indirectly in the healthy children, more sophisticated methods exist that can determine body fat directly, such as measuring skinfold thickness with a caliper, Bioelectrical impedance, Hydro densitometry, Dual-energy X-ray Absorptiometry (DEXA), and Air Displacement Plethysmography. However, these methods are costly and not readily available [27]. Therefore, BMI is an excellent screening method, but should not be used solely for diagnostic purposes [28].

Unlike in adults, Z-scores or percentiles are used to represent BMI in children and vary with the age and sex of the child. BMI Z-score cut off points of >1.0, >2.0, and >3.0 are recommended by the WHO to define at risk of overweight, overweight and obesity, respectively [29]. However, in terms of

percentiles, overweight is applied when BMI is >85th percentile <95th percentile, whereas obesity is BMI > 95th percentile [30–32]. Although BMI Z-scores can be converted to BMI percentiles, the percentiles need to be rounded and can misclassify some normal-weight children in the under or overweight category [29]. Therefore, to prevent these inaccuracies and for easier understanding, it is recommended that the BMI Z-scores in children should be used in research whereas BMI percentiles are best used in the clinical settings [30].

2.2 Dental caries

Dental caries is a biofilm mediated, life driven and dynamic disease that results in alternating phases of demineralization and remineralization of dental hard tissues. It is a localized destruction of susceptible dental hard tissue by acidic by-product from fermentation of dietary carbohydrates by bacteria [33]. Furthermore, dental caries is a multifactorial disease begins with the shift within the biofilm microbial complex and is affected by consumption of dietary sugars, salivary flow, exposure to fluoride, and by preventative behaviors (teeth brushing, flossing) [34].

Dental caries is a chronic disease that progresses slowly and occur both in permanent and primary dentitions, throughout the life, and affect the crown structure and, later in life, exposed root surfaces. Moreover, untreated dental

caries can damage gradually the enamel and dentin, and then damage the pulp of the tooth causing dental sepsis [35]. So, untreated dental caries can lead to sever pain and discomfort which have a negative impact on daily activity like sleeping and eating and the quality of life of the child [36].

2.2.1 Risk factors

Dental caries is a multifactorial disease that its biological and physical risk factors interplay with the social and behavioral risk factors. These risk factors are changeable and therefore can vary with time [37]. Biological and physical risk factors include high number of cariogenic bacteria, inadequate salivary flow and composition, insufficient fluoride exposure [38]. Dental caries related to poor behaviors involving poor dietary habits such as frequent ingestion of fermentable carbohydrate (sugars such as glucose, fructose, sucrose and maltose), poor oral hygiene and frequent use of oral medication that contain sugar.

Other factors related to caries risk include poverty, deprivation, or social status, education level, dental insurance coverage; use of dental sealants; use of orthodontic appliances; and poorly designed or ill-fitting partial dentures. Also, children with a history or evidence of caries or whose primary caregiver have severe caries are at increased risk for the disease [37, 38, 39]. Therefore, caries is described as process that is influenced by wider social determinants which

influence the life-style of individuals and ultimately tips the balance of caries process either towards caries or healing.

2.2.2 Measurement

For many years, dental caries has been measured worldwide using DMFT/dmft index. The main advantage of this index is that it is valid, simple to use, reliable, and is still being used very commonly for evaluating and comparing caries status among population. According to WHO, the DMFT/dmft index to measure dental caries is an aggregate measure of teeth with a visual distinct cavity in dentine (D/d), teeth missing due to caries (M/m) and filled (F/f) permanent [(40)]. However, there are two main problems with the DMF index in the current time as caries estimation moves toward detection of pre-cavitated or early lesions: This index is not useful in determining preventive treatment need. The DMF index score shows a total caries experience of an individual and it does not differentiate between untreated decay and well-restored tooth, as equal weights were given to decayed, missing because of caries, filled tooth, or tooth surface [(41)].

Moreover, another index has been developed to assess the consequences from untreated dental caries: the presence of a visible pulp (P/p), ulceration of the oral mucosa due to root fragments (U/u), fistula (F/f), or an abscess (A/a) [(42)]. additionally, a more recent index called International Caries Detection and

Assessment System (ICDAS) was used to measure the carious lesion in its early stage [43].

2.3 Common risk factors for obesity and caries

Dental caries and obesity share many issues. Both are major public health problem worldwide [2,3]. Both are complex, life-style related health issues. Literature provides evidence for the co-occurrence of dental caries and obesity, as they have common risk factors such as consumption of sugar-rich food and soft drink [44,45]. However, understanding how obesity and dental caries are linked could inform broader risk factor-based preventive strategies, and also facilitate cross disciplinary and collaborative approaches between public health, dental and medical specialist involved in the care of children [46].

Numerous studies have investigated the association between obesity and dental caries in different countries and in both dentitions. However, the findings are inconsistent [47, 48]. While some authors found that obesity was linked to a high number of caries lesion [49], others found no association between dental caries and obesity [50]. In addition, some studies found an inverse relationship, reporting an association between underweight and high caries experience [51][77]. Therefore, further assessment of this association and its confounding variable has been recommended by systematic review [52].

One possible reason for this variation is the cultural differences and dietary habits in different countries. Obesity and caries are multifactorial conditions and what cause caries is not necessarily associated with obesity. To put this clearly, although higher intake of sugar is common risk factor for caries and obesity, sugar pattern of consumption can influence the occurrence of both conditions. For caries, frequency of sugar intake is more detrimental than sugar quantity and vice versa for obesity [53, 54].

2.4 Evidence on caries and obesity association

So far, many systematic reviews have been published which recorded a contradictory finding. One review included five studies out of 48 articles published between 2004 and 2011, demonstrate mixed evidence on the association between dental caries and obesity in children and adolescent [55]. Positive association between dental caries, childhood body mass index (BMI) was found in two studies [56, 57], negative association was found in one study [58], and two studies found no significant association between BMI-for-age and dental caries prevalence in children [58, 59]. Another review [60], included 28 articles published between 2005 and 2012, included 13 studies in the final analysis. Of these, six found positive association between BMI score and caries experience, and no association between obesity and dental caries was found in the other 7 studies.

A systematic review and meta-analysis was published in 2013 [61], including articles published between 1980 and 2010. Out of 212 studies, only 14 studies that met the selection criteria and were included in the meta-analysis. The authors found a positive association between dental caries in permanent dentition and obesity in the studies using standardized measures for child obesity assessment. Sub-group analysis showed a significant association between obesity and dental caries when compared normal weight children, obese children from industrialized countries with those from newly industrialized countries. However, one of the main limitations in this study was the exclusion of the children who were in underweight group, and studies, which did not analyze by dentition type.

A more comprehensive systematic review which covered 1338 studies, and included 17 longitudinal studies in the final thesis [62], found an inverse association in two studies when dental caries was used consistently to predict anthropometric measurements . The remaining 15 studies found inconsistent association with results appearing to be affected by variation of clinical assessments and measurements; study setting, ethnicity and age of participant and other confounder factors of dental caries. The authors concluded that the association between anthropometric measures and caries is conflicting and remains inconclusive.

A relatively recent systematic review included studies published between the years 2005 and 2019. Of 146 articles initially selected, 16 articles were included after full assessment [63]. Of these, one study was case-control, one study was prospective cohort study and 14 studies were cross-sectional surveys. Overall, the systematic review presented three main patterns of association: no association (8 studies), a significant association (6 studies) and a negative association (2 studies). Similar conclusion of inconsistent evidence association between BMI and dental caries in children and adolescent ,were also reported in two more recent systematic reviews were published in 2019 [64, 65] ,

Overall, these reviews suggested that positive association between obesity and dental caries may be the result of shared common risk factors which influences the incidence of both conditions. These include dietary habits which includes poor food choices, frequent and excessive intake of fermentable carbohydrates, consumption of sweetened junk foods and cariogenic diet. In addition, lifestyle related factors such as reduced physical activity, increase snacks consumption time, and spent more time on TV. It has been suggested that both obesity and dental caries are more prevalent in certain communities due to lower parental education, unhealthy dietary pattern and inability to get a good health care and services.

On the other hand, some theories have been suggested that may explain the association between underweight and increased prevalence of dental caries. For example, dental caries has been reported to be one of the main factors that decrease the mastication efficiency which in turn decrease nutrition intake by children and young people. Additionally, in obese group saliva production increases by increasing food consumption so the incidence of the dental caries decreases by the buffering effect, protective effect and the mechanical cleansing of the saliva. Finally, many authors have suggested that poverty and low socioeconomic status could be a main contributing factor to being underweight and have dental caries.

To sum up, all of the reviews concluded an inconsistent pattern and reported insufficient evidence in the association between BMI and dental caries. Further, three patterns of association were summarized by the reviews: negative association, positive association and no association. However, controlling for potential confounding factors and heterogenicity in defining and measuring caries and obesity were the key limitations that all reviews mentioned. Finally, most of the reviewed studies were cross sectional in design so the causal mechanism of the association still unclear.

2.5 Studies on association between dental caries and anthropometric measures of children on middle east

Contradictory results were also reported by studies conducted among Middle East countries. A study investigated the relationship between dental caries and body mass index (BMI)-for-age among schoolchildren in Jazan region of kingdom of Saudi Arabia [66], reported that dental caries, snacks between meals and junk food were independent significant predictor variables for BMI. Dental caries was a strong predictor and the analysis reported that children with untreated caries had 81% higher chance of suffering from low BMI. However, another cross sectional study conducted to assess the prevalence of obesity/overweight in adolescent and to investigate any association between dental caries and obesity in Saudi Arabia [67], found that the obesity was more prevalent in boys attending private school. Moreover, the authors also found that the BMI index was not associated with prevalence of dental caries in permanent dentition. In Egypt, a recent cross sectional study in 2019 that explored the prevalence of dental caries among Egyptian children and adolescences and its association with age, socioeconomic status, dietary habits and other risk factors, reported that there was no significant association between dental caries and BMI [68].

2.6 Obesity in Libya

Libya is following the trend observed in developing countries of continuously increasing obesity, to the point where obesity has reached epidemic proportions in the twenty-first century; and continues to spread across all age groups. The prevalence of obesity (BMI ≥30 kg/m2) in the last three decades has more than double from 12.6% in 1984 to 30.5% in 2009, while the rate of overweight (BMI ≥25kg/m2) has more than tripled from 19.5 % in 1984 to 63.5 % in 2009 [69, 70]. Elmehdawi etal. concluded in his review in 2012 that 30.5% of Libyan adults, 16.9% of children aged 5 or younger, and 6.1% of children aged between 10 and 18 are obese. The rate of obesity progressively increases with age, from 4.2% in those aged between 10 and 12 to 46% in those aged between 55 and 64 [14]. The global burden of the disease (GBD) estimated that the obesity and overweight prevalence in Libyan adult in 2013 was 71.9% [71]. According to this estimation, Libya was ranked ninth in the list of the world's fattest countries [71, 72].

Chapter 3

Aims and Objective

3.1 Aim

The overall aim of the present study is to explore the association between obesity and dental caries among 12-year-old school children in Benghazi city.

3.2 Objectives

The objective of this study is to:

1. To compare caries experience according to DMFT index with obesity according to anthropometric measures.
2. Describe the distribution of obesity among 12-year-old children in Benghazi city.
3. To assess the correlation between self-reported sugar intake and obesity.
4. To assess sociodemographic factors associated with obesity.

Chapter 4

Methods

4.1 Study design

This study is a secondary data analysis (SDA) of data collected as part of a cross-sectional survey conducted among 12-year-old school children in Benghazi during the year 2017. In this type of studies, researchers use data collected by other investigators to answer different questions. The advantages of this design include saving time, money and efforts to answer the research question [73]. However, such approach limits researcher's control over the selection of study sample, variables, and collecting the primary data [74].

The process of SDA involves identifying appropriate research question and then identifying data sources or vice versa. In the present study, the dataset was available beforehand, for which the research question was then developed. The data was collected as part of oral health survey among 12-year-old in Benghazi. The aim of the primary data collection was to identify caries prevalence and its association with sugar intake during civil war in Libya. The data which was collected in the 2017, included anthropometrics measurements of study participants. This study's data belongs to the department of dental public health, faculty of Dentistry, University of Benghazi and hence the permission to use the data was obtained from the department officials.

4.2 Primary research

4.2.1 Setting

The data for this study was obtained from the Benghazi dental survey-2017, which was conducted among 12-year-old school children in Benghazi. The participants were recruited from both public and private schools in the city of Benghazi. Benghazi, which is located on the Libyan coast, is the second largest city in the country with nearly a million inhabitant who come from different families and tribes and hence this population is deemed representative to the whole Libyans.

4.2.2 Sampling

The whole study population was estimated to be 13,000 12-year-old schoolchildren in the academic year 2016/2017. The sample was selected using a two-stage random sampling strategy. At the first stage, a random sample of 40 schools were selected proportionally from 8 districts. The average number of students in each classroom was 30 and their age was about 12-year-old. Therefore, one classroom was selected randomly from each school. Informed consent was first sought from the parents which was sent to them through the school administrator's office. The aim of the study was explained to the children, and verbal assents were implied by accepting to attend the dental examination. Of 1200

children invited to take part in the survey, 1134 parents returned signed consent forms and completed questionnaires which were usable for data analysis, giving a response rate of 94%. Only children who lived in the city of Benghazi since their birth were recruited for the study. Children undergoing orthodontic treatment, had hypoplastic teeth or moderate to severe dental fluorosis, were excluded

4.2.3 Data collection:

Dental caries lesions in the original study were assessed according to World Health Organization (WHO) diagnostic criteria (at dentine level) by using DMFT, DMFS indices (Appendix). The dental examination was conducted for all participants in a separate room under natural daylight while the participant was seated on an ordinary chair, using disposable diagnostic kits. Three dentists were trained and calibrated to carry out the clinical dental examinations. The training sessions were provided at the Department of Community and Preventive Dentistry, University of Benghazi. In the original study Intra-examiner reliability and inter-examiner reliability were tested before commencing the data collection of the main study. Kappa coefficients ranged from 0.88 to 0.96.

The investigators also conducted the anthropometric measurements. Height was measured with the child standing without shoes using a portable stadiometer. Weight was measured using a pre-calibrated digital Seca scale, with children

wearing light clothes and no shoes. The measurements for height and weight were taken to the nearest 0.1 cm and 0.1 kg, respectively. Body mass index (BMI; kg/m^2) was calculated as body weight (kg) divided by height squared (m^2).

A trained assistant handed out questionnaires to the children to complete in their homes with the assistance of their parents. The questionnaire was developed from previous studies, guided by the study's research questions. The questionnaire was then validated by testing its clarity and readability among a group of dental patients, before commencing data collection. In the first section of the questionnaire the following information was collected: children's name, children's date of birth, gender and date of filling up the questionnaire. In addition, the second section was consisted of a set of questions numbered from A to Z. These questions were about how frequently the consumed sugary drinks and foods (never, often, or every day), whether they brushed their teeth on a regular basis (never/sometimes vs daily) and level of parental educational attainment (university or higher, and less than university level)

4.3 Secondary data analysis:

First of all, the data was taken with the permission of the primary author on an excel file [15]. In the light of the aims of the present study, the original dataset was checked for completeness of information. Incomplete data, in which the date

of birth, height, or weight were missing, was removed. As a result, the study sample reduced from 1,134 to 788.

4.3.1 Data management

The data was then entered into the WHO anthroplus software [75], which generates the z score of height for age and the BMI for age. This software was created to enable the application of the WHO Reference 2007 for 5-19 years to monitor school-age children and adolescents' growth, weight and body mass index as they get older (Individual assessment module) and to analyze survey data including preschool, school age children and adolescents (Nutritional survey module) [76]. Thus, Anthro-Plus facilitates thinness, underweight, overweight and obesity detection in individuals and populations from 0-19 years. The WHO Anthro-Plus consists of three modules:

- Anthropometric calculator (AC)
- Individual assessment (IA)
- Nutritional survey (NS)

Each module has a certain purpose, i.e., to evaluate an individual's nutritional status, monitor a child's growth from birth to 19 years, and carry out nutritional surveys covering the same age group, respectively.

4.3.2 Data analysis

In the present research, the third model of WHO Anthro-Plus was used to analyze the primary data which were filtered and edited on excel. The data which were imported in this module were survey date, date of birth, weight, height and BMI and Z scores height for age and body mass index for age were calculated to detect thinness, underweight, overweight and obesity for individuals aging 12 years.

For this age group, Z score weight for age was not calculated by the WHO Anhtro-plus, During the pubertal growth spurt, it may seem that kids are having extra weight comparing to their age where it is actually normal because in fact, they are tall. This is why weight for age was not calculated as the results will not be meaningful. Therefore, the recommended indicator for thinness, overweight and obesity in children between 10-19 years is the BMI for age measure [(75)]. The children were grouped into four categories according to the body mass index for age: low weight, normal weight, overweight, and obese, in accordance with the cut-off points

Of < −2SD, ≥−2SD — +1SD, >+1SD—+2SD, and >+2SD z-scores respectively.

The data was then uploaded on SPSS 25 software for analysis. Descriptive statistics were conducted provide summary of sample profile, regular dietary habits, height, weight, z scores of heights for age and body mass index for age and DMFT. Bivariate comparison using Mann-Whitney U test and Kruskal Wallis test, was the conducted for body mass index for age (Z score) as an outcome variable.

Chapter 5

Results

5.1 Sample profile

Data from 788 children, aged 12 years old, was included in the analysis. The majority were from public schools (75%). More than have of the participants were females (54%) and had caries (55.9%). Less than half of mothers attained university education (42.6%) and small proportion, less than 10 percent, attained primary education (Table 5-1).

Variables		Frequency	Percent
School	Private	191	24.4%
	Public	591	75.6%
Gender	Male	360	46%
	Female	422	54%
Caries	Present	437	55.9%
	Absent	345	44.1%
Sugary drinks intake	Frequent	325	41.6%
	Infrequent	457	58.4%
Maternal education	Primary school	67	9.7%
	Secondary school	329	47.7%
	University	294	42.6%

Table 5-1: Demographic, behavioral and clinical characteristics of study sample (n=788)

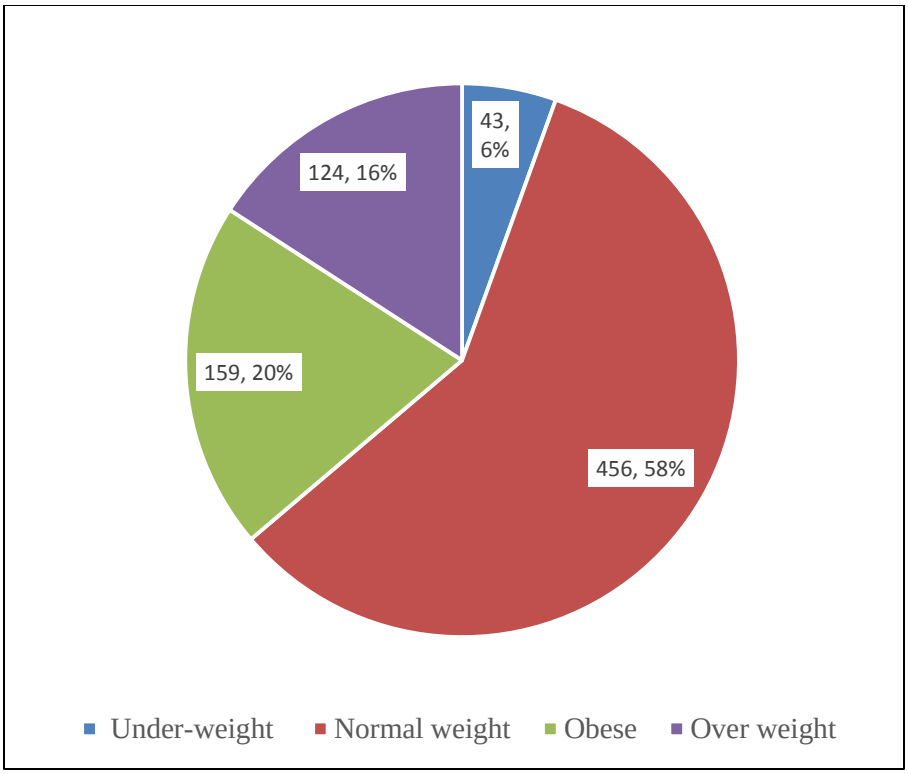


Figure 5-1: The distribution of adiposity in the study sample (N=788)

As shown in (Figure 5-1) Normal weight was observed in majority of the participants (58%), whereas obese children represent 20% of participants and as few as 5.9% were underweight

Table 5-2 shows summary statistics for anthropometric measures and caries experience of study participants. The average weight and height were 43.76 (SD=12.09) and 146.21 (SD=9.97), respectively. The average BMI and Age-adjusted Z score were 20.42 (SD=4.99) and 0.46 (SD=1.52), respectively. The numbers of decayed teeth and DMFT score ranged from 0 to 11, with an average of 0.93(SD=1.48) and 1.04 (SD=1.54), respectively. The numbers of filled and missing teeth ranged from 0 to 4 and the averages were almost equal 0.05 and 0.06, respectively.

Variable	Minimum	Maximum	Mean	Std. Deviation
Height	78	173	146.21	9.966
Weight	20	114	43.76	12.086
BMI	11.48	50.67	20.42	4.98802
BAZ	-5.01	5.73	.4564	1.51629
DT	0	11	.93	1.481
MT	0	4	.05	.304
FT	0	4	.06	.313
DMFT	0	11	1.04	1.537

Table 5-2: Summary statistics of anthropometric measurements and DMFT index

5.2 Socio-behavioral factors and obesity

Table 5-3 shows comparison of anthropometric measurements by school type. Children in private school had a statistically significantly higher average BMI and weight (21.46± 5.3, 45.97±15) than children in public school (20.11±5.9), 43.05±11.03), ($p<0.05$). The average age-adjusted Z score for BMI (0.62(SD=1.52)) was also higher in children in private school than in children in public school (0.40(SD= 0.40)), but this difference was not statistically significant ($p>0.05$).

Anthropometric measure	SCHOOL	Mean	Std. Deviation	P value
BMI	Public	20.11	4.85	0.003
	Private	21.35	5.3	
Height	Public	146.31	10.4	.618
	Private	145.90	8.78	
Weight	Public	43.05	11.03	0.004
	Private	45.97	14.70	
BAZ	Public	0.40	1.48	0.078
	Private	0.62	1.52	

Table 5-3: Comparison of anthropometric measurements by school type.

Table 5-4 shows comparison of anthropometric measurement according to gender. Female showed higher average height, weight and BMI (147.5(SD=10), 45.41±12.5), 21.8±5.04) as compared to the males and difference was statistically significant. P<0.05. There was a numerical difference in age-adjusted Z score for BMI between male and female (0.45±1.53) Vs 0.46±1.50)), however, it is not statistically significant (P>0.05).

Anthropometric measure	GENDER	N	Mean	Std. Deviation	P value
Height	Male	360	144.74	10.3	.000
	Female	422	147.47	9.51	
Weight	Male	360	41.83	11.36	.000
	Female	422	45.41	12.45	
BMI	Male	360	19.98	4.89	.023
	Female	422	20.79	5.04	
BAZ	Male	360	.45	1.53	.968
	Female	421	.46	1.50	

Table 5-4 Comparison of anthropometric measurements by gender.

Table 5-5 shows the comparison of anthropometric by maternal education. Results indicated that non-statistically significant differences in the average height, weight, BMI and age adjusted Z score for BMI when compared across mother's education levels. Children of mothers attained university degree or higher appeared to have trivially higher average BMI and Z-scores than their peers whose mothers had lower education levels.

Table 5-5 Comparison of anthropometric measurements by maternal

Anthropometric measure	Mother education	N	Mean	Std. Deviation	P value
height	University or higher	294	145.87	9.88	.483
	No-university	396	146.41	10.31	
weight	University or higher	294	43.90	12.36	.993
	No-university	396	43.91	12.33	
BMI	University or higher	294	20.57	5.15	.757
	No-university	396	20.45	5.09	
BAZ	University or higher	293	.52	1.46	.474
	No-university	396	.44	1.55	

Table 5-6 shows comparisons of the anthropometric measurements of study participants according to their self-reported sugary drinks consumption. Children who reported consuming sugary drinks in regular manner had higher average weight (45±13.12), and BMI (21±5.5)) compared to irregular consumers of sugary drinks (P=0.004 & 0.005, respectively). Although the average age-adjusted Z score for BMI among regular consumers of sugary drinks regular (0.53±1.52)) is higher than that among irregular consumers (0.35±1.51)), but this difference was not statistically significant(P=0.103). Likewise, there was no significant difference between the average height for both groups (P=0.842).

Anthropometric measure	Sugary drinks	N	Mean	Std. Deviation	P value
Height	Regular	457	146.3	10.06	.842
	Irregular	325	146	9.85	
Weight	Regular	457	44.81	13.12	.004
	Irregular	325	42.29	10.39	
BMI	Regular	457	20.84	5.46	.005
	Irregular	325	19.82	4.46	
BAZ	Regular	457	.53	1.52	.103
	Irregular	325	.35	1.51	

Table 5-6 Comparison of anthropometric measurements according to sugary drinks consumption.

Table 5-7 presents comparison of anthropometric measurement according to caries experience. The results show that the average height, weight, BMI and age-adjusted Z score for BMI in caries free children (147±9.25, 44.35±12.80), 21±.06 & 0.47±1.5, respectively) were higher than that observed among children with caries experience. However, these differences were not statistically significant (P≥0.05).

Anthropometric measure	caries	N	Mean	Std. Deviation	P value
height	Present	345	145.57	10.79	.106
	Absent	437	146.73	9.25	
weight	Present	345	43.01	11.10	.124
	Absent	437	44.35	12.8	
BMI	Present	345	20.35	4.91	.720
	Absent	437	20.48	5.06	
BAZ	Present	344	.44	1.66	.764
	Absent	437	.47	1.49	

Table 5-7 Comparison of anthropometric measures according to caries experience

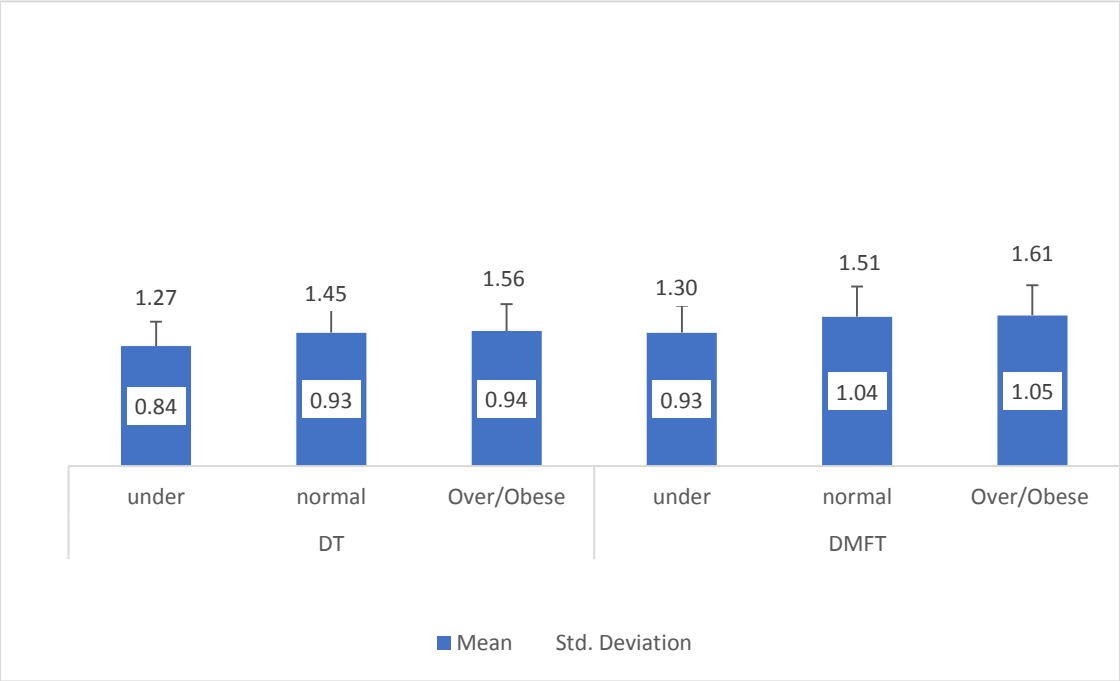


Figure 5.2: Results of the association between anthropometric measurement and the prevalence of dental caries.

As shown in figure 5-2, children who were in underweight had a lower number of decayed teeth and DMFT (0.84, SD=1.27 & 0.93, SD= 1.30, respectively) than normal weight and overweight/ obese children's groups which have nearly equal average number of decayed teeth and DMFT.

Chapter 6

Discussion

The primary aim of this research was to assess the association between dental caries and anthropometric measures among 12-years school children in Benghazi city based on a secondary data analysis and to find the possible factors underlying these associations. To authors' knowledge, this is the first study to assess the association between obesity and dental caries in permanent dentition among school children in Benghazi city.

This research found that the average height, weight, BMI and age-adjusted Z score for BMI were almost equal in to children with dental caries and caries free children. Likewise, the severity of caries was comparable among overweight/obese children and normal weight children. These findings suggest that there is no direct association between caries and obesity among school children in Benghazi city. As mentioned in the review there are three patterns of caries-obesity association. These are positive, negative and no association [62, 63, 64, 65].

Therefore, the present study supports the existing evidence that there is no association between dental caries and obesity, which is consistent with other studies conducted in other Arab countries. For example, non-significant association between dental caries and anthropometric measurement was in agreement with studies conducted in Egypt and Saudi Arabia [68, 67]. Although the Egyptian study used the BMI values were plotted on age and gender- specific percentiles given by

Centers for Disease Control and Prevention, two previous studies conducted in Brazil and Taiwan, which used z-scores for height and weight based on WHO growth references data 2007 and considered anthropometric measures on a continuous scale [76], have found similar non-significant association between dental caries and children's height and weight [78, 79]. Similarly, the non-significant association between dental caries and anthropometric measurements was in agreement with previous studies [80], that used the BMI classification based on internationally recognized classification system given by the International Obesity Task Force (IOTF) and children were categorized as underweight (BMI < 20), normal weight (BMI 20–24.9), overweight (BMI 25–30), and obese (BMI > 30) [81].

However, studying the association between BMI and dental caries is hindered by controlling for potential confounding factors and heterogenicity in defining and measuring caries and obesity and therefore comparing with other study findings would be a problematic [55-65]. To summarize, several methodological problems need to be considered. Most of the mentioned studies used different BMI categorization and used different cut-off points or non-standardized BMI cut off points. These differences affected the study findings and made study comparisons difficult. Also, differences in caries prevalence and severity measurement have an important role on the associations, as inactive or

arrested dental caries are more likely to be free from symptom, but the active lesions are more likely to be associated with pain and other negative consequences [82], hence negatively associated with child's weight [36]. The inconsistent patterns of association may be due to biases in the study population (studies conducted in a single school or a specific area) and due to failure to consider individual level socio-economic factors [83].

The present study was unable to rule out several potential factors that could have associated with childhood obesity, including birthweight, breast-feeding in infant stage, long-term dietary habits, family function, and a family history of obesity [3, 14, 54]. As a result, the observed results should be approached with caution since may have been influenced by these factors which were not considered. For example, the primary cause of obesity and overweight in Libyan children could be the excessive consumption of dietary fats [84]. In this case, increased intake of fatty food has less effect on caries development than sugary diet. This may be one of the reasons for the lack of association between obesity and caries presence.

Although the present study did not find a direct association between caries and obesity measures, it appears that dental caries and obesity have some common risk factors. In the present study, BMI was significantly higher in females, private school children and those who regularly consume sugars. Previous study assessing

dental caries among the same Libyan population suggested that caries is higher among females, high sugar consumers and private school children [15]. This observation while support common risk approach for health promotion, it suggests different and complex pathophysiology of both obesity and dental caries.

Previous studies have shown conflicting findings on the association between caries and obesity when adjusted for social and behavioral risk factors. For example, Kumar et al. reported in their study which conducted to determine the association of BMI and dental caries and the influence of socio-economic status in 11-14-year-old Indian schoolchildren that the association of BMI with dental caries varied by socio-economic status: children who were overweight and from high socio-economic class were at lower risk of experiencing dental caries [85]. Despite the potential effect of socio-economic factors, Alves et al conducted a study among 12-year-old Brazilian children and reported no significant association after adjustment for socio-economic variables [78]. Although the present study did not assess the impact of social and behavioral risk factors, it appears that the study findings are in line with the idea of common of risk factors shared between caries and obesity. For example, a diet with high sugar, including beverage, is considered as a predisposing factor for developing many problems such as dental caries, obesity and poor diet quality [44, 45]. In line with this, previous studies among

Libyan school children highlighted the role of sugar intake in caries prevalence and severity.

A secondary aim of the present study was to investigate the prevalence of obesity among children in Benghazi city. The data showed that 20% and 16% of participants were obese and overweight, respectively. These figures are way higher than what previously reported among Libyan children (less than 10%) [14]. However, comparison with these studies should be cautious because of differences in methodology, sampling and data collection. However, such increase in the proportion of obese could be a reflection of changes of the increased popularity of fast food and sedentary lifestyle with the introduction of videogames [86]. However, these remains possibilities and further research is needed to understand this observation.

This research was a secondary analysis of data collected as part of a cross sectional survey conducted in Benghazi during the year 2017. One of the main advantages was that this study design has the advantages of time saving, easy access to primary data and economic [73]. The obtained data was large and representative. For example, the study comprised of participants who come from different social classes and comparable proportions of those with caries and caries free as well as sugar intake habits. However, there are a number of limitation

inherent in this study. Firstly, the associations reported in this study did not indicate a causal relationship due to the cross-sectional design of the primary research [87]. Therefore, a Long-term follow-up studies are needed to evaluate the inter-relationship between caries and childhood obesity. Secondly, the WHO criteria were used to evaluate each child's dental caries experience in the primary research. The carious lesions were assessed at dentin level and hence, full caries spectrum was not measured. Therefore, further studies are needed using comprehensive assessment of dental caries status of schoolchildren using the International Caries Detection and Assessment System (ICDAS) [88]. Thirdly, the authors had limited control over the quality of the primary data [74]. Despite its frequent use, BMI has some limitations [89]. It can wrongly classify a muscular individual as obese or an individual with a high percentage of body fat with normal weight as healthy as it does not factor in the composition of the body mass.

Chapter 7

Conclusion & Recommendation

7.1 Conclusion

In summary, the present study found no direct association between caries and obesity among 12-year-old school children in Benghazi city. However, both conditions share common risk factors such sugar intake, gender, and school type.

The prevalence of obesity among school children in Benghazi city appeared to be higher than previously reported figures in published literature despite differences in the methodology of obesity measurements.

7.2 Recommendations

- Further studies are required to assess the association between caries and obesity using longitudinal design and comprehensive caries assessment.
- Further studies are required to investigate the potential risk factors of obesity in Libyan children to fully understand the ecological and environmental risk factors.
- Efforts should be made to increase awareness about the increasing level of obesity among Libyan children
- Sugar consumption should be targeted as a common risk factor for both obesity and caries, particularly among private schools.

References

1. Han, J. C., Lawlor, D. A., & Kimm, S. Y. (2010). Childhood obesity. Lancet (London, England), 375(9727), 1737–1748.
2. Hruby, A., & Hu, F. B. (2015). The Epidemiology of Obesity: A Big Picture. PharmacoEconomics, 33(7), 673–689.
3. Maffeis, C., & Tatò, L. (2001). Long-term effects of childhood obesity on morbidity and mortality. Hormone research, 55 Suppl 1, 42–45.
4. Dai, H., Alsalhe, T. A., Chalghaf, N., Riccò, M., Bragazzi, N. L., & Wu, J. (2020). The global burden of disease attributable to high body mass index in 195 countries and territories, 1990-2017: An analysis of the Global Burden of Disease Study. PLoS medicine, 17(7), e1003198.
5. Ford, N. D., Patel, S. A., & Narayan, K. M. (2017). Obesity in Low- and Middle-Income Countries: Burden, Drivers, and Emerging Challenges. Annual review of public health, 38, 145–164.
6. World Health Organization, 2020. Obesity And Overweight. Available at: https://www.who.int/news-room/factsheets/detail/obesity-and-overweight> [Accessed 22 November 2020].
7. Martorell, R., Kettel Khan, L., Hughes, M. L., & Grummer-Strawn, L. M. (2000). Overweight and obesity in preschool children from developing countries. journal of the International Association for the Study of Obesity, 24(8), 959–967.

8. Marcovecchio, M. L., & Chiarelli, F. (2013). Obesity and growth during childhood and puberty. World review of nutrition and dietetics, 106, 135–141.
9. GBD 2015 Obesity Collaborators, Afshin, A., Forouzanfar, M. H., Reitsma, M. B., Sur, P., Estep, K., Lee, A., Marczak, L., Mokdad, A. H., Moradi-Lakeh, M., Naghavi, M., Salama, J. S., Vos, T., Abate, K. H., Abbafati, C., Ahmed, M. B., Al-Aly, Z., Alkerwi, A., Al-Raddadi, R., Amare, A. T., Murray, C. (2017). Health Effects of Overweight and Obesity in 195 Countries over 25 Years. The New England journal of medicine, 377(1), 13–27.
10. Güngör N. K. (2014). Overweight and obesity in children and adolescents. Journal of clinical research in pediatric endocrinology, 6(3), 129–143.
11. Kassebaum, N. J., Smith, A., Bernabé, E., Fleming, T. D., Reynolds, A. E., Vos, T., Murray, C., Marcenes, W., & GBD 2015 Oral Health Collaborators (2017). Global, Regional, and National Prevalence, Incidence, and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990-2015: A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. Journal of dental research, 96(4), 380–387.
12. World Health Organization, 2020. What Is The Burden Of Oral Disease?Availableat(https://www.who.int/oral_health/disease_burden/global/en/). [Accessed 22 November 2020]
13. World Health Organization guideline: sugars intake for adults and children. 2021 [cited 26 December 2021]. Available from: (https://www.who.int/publications-detail-redirect/9789241549028)

14. Elmehdawi, R. R., & Albarsha, A. M. (2012). Obesity in Libya: a review. The Libyan journal of medicine, 7, 10.3402/ljm.v7i0.19086.
15. Arheiam, A. A., Harris, R. V., & Baker, S. R. (2020). Changes in dental caries and sugar intake before and during the conflict in Libya: A natural experiment. Community dentistry and oral epidemiology, 48(3), 201–207.
16. Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. The New England journal of medicine, 337(13), 869–873.
17. Brown, C. L., Halvorson, E. E., Cohen, G. M., Lazorick, S., & Skelton, J. A. (2015). Addressing Childhood Obesity: Opportunities for Prevention. Pediatric clinics of North America, 62(5), 1241–1261.
18. Kansra, A. R., Lakkunarajah, S., & Jay, M. S. (2021). Childhood and Adolescent Obesity: A Review. Frontiers in pediatrics, 8, 581461.
19. Chaudhri, O. B., Salem, V., Murphy, K. G., & Bloom, S. R. (2008). Gastrointestinal satiety signals. Annual review of physiology, 70, 239–255.
20. Labarthe, A., Fiquet, O., Hassouna, R., Zizzari, P., Lanfumey, L., Ramoz, N., Grouselle, D., Epelbaum, J., & Tolle, V. (2014). Ghrelin-Derived Peptides: A Link between Appetite/Reward, GH Axis, and Psychiatric Disorders?. Frontiers in endocrinology, 5, 163.
21. Ranadive, S. A., & Vaisse, C. (2008). Lessons from extreme human obesity: monogenic disorders. Endocrinology and metabolism clinics of North America, 37(3), 733–x.

22. Hetherington, M. M., & Cecil, J. E. (2010). Gene-environment interactions in obesity. Forum of nutrition, 63, 195–203.
23. Romieu, I., Dossus, L., Barquera, S., Blottière, H. M., Franks, P. W., Gunter, M., Hwalla, N., Hursting, S. D., Leitzmann, M., Margetts, B., Nishida, C., Potischman, N., Seidell, J., Stepien, M., Wang, Y., Westerterp, K., Winichagoon, P., Wiseman, M., Willett, W. C., & IARC working group on Energy Balance and Obesity (2017). Energy balance and obesity: what are the main drivers?. Cancer causes & control, 28(3), 247–258.
24. Caitlyn, F., Eric, L., & Steven, H. (2017). Bedtime Use of Technology and Associated Sleep Problems in Children. Global Pediatric Health, 4, 1–8.
25. Kraak, V. I., Gootman, J. A., & McGinnis, J. M. (Eds.). (2006). Food marketing to children and youth: threat or opportunity?. National Academies Press, Washington, 105–107.
26. Adab, P., Pallan, M., & Whincup, P. H. (2018). Is BMI the best measure of obesity?. British Medical journal, 360, k1274.
27. Sahoo, K., Sahoo, B., Choudhury, A. K., Sofi, N. Y., Kumar, R., & Bhadoria, A. S. (2015). Childhood obesity: causes and consequences. Journal of family medicine and primary care, 4(2), 187–192.
28. Lazarus, R., Baur, L., Webb, K., & Blyth, F. (1996). Body mass index in screening for adiposity in children and adolescents: systematic evaluation using receiver operating characteristic curves. The American journal of clinical nutrition, 63(4), 500–506.
29. Anderson, L. N., Carsley, S., Lebovic, G., Borkhoff, C. M., Maguire, J. L., Parkin, P. C., & Birken, C. S. (2017). Misclassification of child body

mass index from cut-points defined by rounded percentiles instead of Z-scores. BMC research notes, 10(1), 639.

30. Must, A., & Anderson, S. E. (2006). Body mass index in children and adolescents: considerations for population-based applications. International journal of obesity (2005), 30(4), 590–594.
31. Flegal, K. M., Wei, R., & Ogden, C. (2002). Weight-for-stature compared with body mass index-for-age growth charts for the United States from the Centers for Disease Control and Prevention. The American journal of clinical nutrition, 75(4), 761–766.
32. Himes, J. H., & Dietz, W. H. (1994). Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. The Expert Committee on Clinical Guidelines for Overweight in Adolescent Preventive Services. The American journal of clinical nutrition, 59(2), 307–316.
33. Limeback, H. (Ed.). (2012). Comprehensive preventive dentistry. John Wiley & Sons, United Kingdom, 233–234.
34. Featherstone J. D. (2008). Dental caries: a dynamic disease process. Australian dental journal, 53(3), 286–291.
35. Pitts, N. B., Zero, D. T., Marsh, P. D., Ekstrand, K., Weintraub, J. A., Ramos-Gomez, F., Tagami, J., Twetman, S., Tsakos, G., & Ismail, A. (2017). Dental caries. Nature reviews. Disease primers, 3, 17030.
36. Ballo, L., Arheiam, A., & Marhazlinda, J. (2021). Determinants of caries experience and the impact on the OHRQOL of 6-year-old Libyan children: a cross-sectional survey. BMC oral health, 21(1), 320.
37. Shaffer, J. R., Polk, D. E., Feingold, E., Wang, X., Cuenco, K. T., Weeks, D. E., DeSensi, R. S., Weyant, R. J., Crout, R., McNeil, D.

W., & Marazita, M. L. (2013). Demographic, socioeconomic, and behavioral factors affecting patterns of tooth decay in the permanent dentition: principal components and factor analyses. Community dentistry and oral epidemiology, 41(4), 364–373.

38. Martignon, S., Roncalli, A. G., Alvarez, E., Aránguiz, V., Feldens, C. A., & Buzalaf, M. (2021). Risk factors for dental caries in Latin American and Caribbean countries. Brazilian oral research, 35(01), e053.
39. Noaman, B. R., & Fattah, L. D. (2021). The Relationship of Caries Risk and Oral Hygiene Level with Placement and Replacement of Dental Restorations.
40. World Health Organization. (2013). Oral health survey: basic methods 5th ed. Geneva, Switzerland, 47.
41. Castro, A., Vianna, M., & Mendes, C. (2018). The knowledge and use of population-based methods for caries detection. BMC oral health, 18(1), 153.
42. Monse, B., Heinrich-Weltzien, R., Benzian, H., Holmgren, C., & van Palenstein Helderman, W. (2010). PUFA--an index of clinical consequences of untreated dental caries. Community dentistry and oral epidemiology, 38(1), 77–82.
43. Dikmen B. (2015). Icdas II criteria (international caries detection and assessment system). Journal of Istanbul University Faculty of Dentistry, 49(3), 63–72.
44. Locker D. (2000). Deprivation and oral health: a review. Community dentistry and oral epidemiology, 28(3), 161–169.
45. Moynihan, P. J., & Kelly, S. A. (2014). Effect on caries of restricting

sugars intake: systematic review to inform WHO guidelines. Journal of dental research, 93(1), 8–18.

46. Sheiham, A., & Watt, R. G. (2000). The common risk factor approach: a rational basis for promoting oral health. Community dentistry and oral epidemiology, 28(6), 399–406.
47. Kantovitz, K. R., Pascon, F. M., Rontani, R. M., & Gavião, M. B. (2006). Obesity and dental caries--A systematic review. Oral health & preventive dentistry, 4(2), 137–144.
48. Chen, D., Zhi, Q., Zhou, Y., Tao, Y., Wu, L., & Lin, H. (2018). Association between Dental Caries and BMI in Children: A Systematic Review and Meta-Analysis. Caries research, 52(3), 230–245. https://doi.org/10.1159/000484988
49. Sakeenabi, B., Swamy, H. S., & Mohammed, R. N. (2012). Association between obesity, dental caries and socioeconomic status in 6- and 13-year-old school children. Oral health & preventive dentistry, 10(3), 231–241
50. Paisi, M., Kay, E., Kaimi, I., Witton, R., Nelder, R., Potterton, R., & Lapthorne, D. (2018). Obesity and caries in four-to-six year old English children: a cross-sectional study. BMC public health, 18(1), 267.
51. Shailee, F., GM, S., & KR, S. (2013). Association Between Dental Caries and Body Mass Index Among 12 and 15 years School Children in

Shimla, Himachal Pradesh. Journal of Advanced Oral Research, 4(1), 6 10.

52. Alshehri, Y., Park, J. S., Kruger, E., & Tennant, M. (2020). Association between body mass index and dental caries in the Kingdom of Saudi Arabia: Systematic review. The Saudi dental journal, 32(4), 171–180.
53. Van Loveren C. (2019). Sugar Restriction for Caries Prevention: Amount and Frequency. Which Is More Important?. Caries research, 53(2), 168–175.
54. Faruque, S., Tong, J., Lacmanovic, V., Agbonghae, C., Minaya, D. M., & Czaja, K. (2019). The Dose Makes the Poison: Sugar and Obesity in the United States - a Review. Polish journal of food and nutrition sciences, 69(3), 219–233.
55. Hooley, M., Skouteris, H., Boganin, C., Satur, J., & Kilpatrick, N. (2012). Body mass index and dental caries in children and adolescents: a systematic review of literature published 2004 to 2011. Systematic reviews, 1, 57.
56. Gerdin, E. W., Angbratt, M., Aronsson, K., Eriksson, E., & Johansson, I. (2008). Dental caries and body mass index by socio-economic status in Swedish children. Community dentistry and oral epidemiology, 36(5), 459–465.
57. Hong, L., Ahmed, A., McCunniff, M., Overman, P., & Mathew, M. (2008). Obesity and dental caries in children aged 2-6 years in the United States: National Health and Nutrition Examination Survey 1999-2002. Journal of public health dentistry, 68(4), 227–233.
58. Kopycka-Kedzierawski, D. T., Auinger, P., Billings, R. J., & Weitzman, M. (2008). Caries status and overweight in 2- to 18-year-old US children:

findings from national surveys. Community dentistry and oral epidemiology, 36(2), 157–167.

59. Macek, M. D., & Mitola, D. J. (2006). Exploring the association between overweight and dental caries among US children. Pediatric dentistry, 28(4), 375–380.
60. Silva, A. E., Menezes, A. M., Demarco, F. F., Vargas-Ferreira, F., & Peres, M. A. (2013). Obesity and dental caries: systematic review. Revista de saude publica, 47(4), 799–812.
61. Hayden, C., Bowler, J. O., Chambers, S., Freeman, R., Humphris, G., Richards, D., & Cecil, J. E. (2013). Obesity and dental caries in children: a systematic review and meta-analysis. Community dentistry and oral epidemiology, 41(4), 289–308.
62. Li, L. W., Wong, H. M., Peng, S. M., & McGrath, C. P. (2015). Anthropometric measurements and dental caries in children: a systematic review of longitudinal studies. Advances in nutrition (Bethesda, Md.), 6(1), 52–63.
63. Shivakumar, S., Srivastava, A., & C Shivakumar, G. (2018). Body Mass Index and Dental Caries: A Systematic Review. International journal of clinical pediatric dentistry, 11(3), 228–232.
64. Paisi, M., Kay, E., Bennett, C., Kaimi, I., Witton, R., Nelder, R., & Lapthorne, D. (2019). Body mass index and dental caries in young people: a systematic review. BMC pediatrics, 19(1), 122.
65. Alshihri, A. A., Rogers, H. J., Alqahtani, M. A., & Aldossary, M. S. (2019). Association between Dental Caries and Obesity in Children and Young People: A Narrative Review. International journal of dentistry, 2019, 9105759.

66. Quadri, M. F., Hakami, B. M., Hezam, A. A., Hakami, R. Y., Saadi, F. A., Ageeli, L. M., Alsagoor, W. H., Faqeeh, M. A., & Dhae, M. A. (2017). Relation between Dental Caries and Body Mass Index-for-age among Schoolchildren of Jazan City, Kingdom of Saudi Arabia. The journal of contemporary dental practice, 18(4), 277–282.
67. Farsi, D. J., & Elkhodary, H. M. (2017). The prevalence of overweight/obesity in high school adolescents in Jeddah and the association of obesity association with dental caries. Annals of Saudi medicine, 37(2), 114–121.
68. Abbass, M., Mahmoud, S. A., El Moshy, S., Rady, D., AbuBakr, N., Radwan, I. A., Ahmed, A., Abdou, A., & Al Jawaldeh, A. (2019). The prevalence of dental caries among Egyptian children and adolescences and its association with age, socioeconomic status, dietary habits and other risk factors. A cross-sectional study. F1000Research, 8, 8.
69. Lemamsha, H., Papadopoulos, C., & Randhawa, G. (2018). Understanding the risk and protective factors associated with obesity amongst Libyan adults - a qualitative study. BMC public health, 18(1), 493.
70. World Health Organization, (2022). Libya - STEPS 2009. Retrieved 16 January 2022, from https://extranet.who.int/ncdsmicrodata/index.php/catalog/8
71. Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E. C., Biryukov, S., Abbafati, C., Abera, S. F., Abraham, J. P., Abu-Rmeileh, N. M., Achoki, T., AlBuhairan, F. S., Alemu, Z. A., Alfonso, R., Ali, M. K., Ali, R., Guzman, N. A., Ammar, W., … Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a

systematic analysis for the Global Burden of Disease Study 2013. Lancet (London, England), 384(9945), 766–781.

72. World Health Organization, (2022). Noncommunicable diseases: Risk factors. Retrieved 16 January 2022, from https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/ncd-risk-factors

73. Johnston, M. (2017). Secondary Data Analysis: A Method of which the Time Has Come. Qualitative And Quantitative Methods In Libraries, 3(3), 619-626.

74. Smith, A. K., Ayanian, J. Z., Covinsky, K. E., Landon, B. E., McCarthy, E. P., Wee, C. C., & Steinman, M. A. (2011). Conducting high-value secondary dataset analysis: an introductory guide and resources. Journal of general internal medicine, 26(8), 920–929.

75. World Health Organization. (2009). WHO AnthroPlus for personal computers manual. Software for Assessing Growth of the World's Children and Adolescents.

76. World Health Organization, 2020. Growth Reference Data For 5-19 Years. Available at:https://www.who.int/toolkits/growth-reference-data-for5to19-years [Accessed 4 December 2020].

77. Benzian, H., Monse, B., Heinrich-Weltzien, R., Hobdell, M., Mulder, J., & van Palenstein Helderman, W. (2011). Untreated severe dental decay: a neglected determinant of low Body Mass Index in 12-year-old Filipino children. BMC public health, 11, 558.

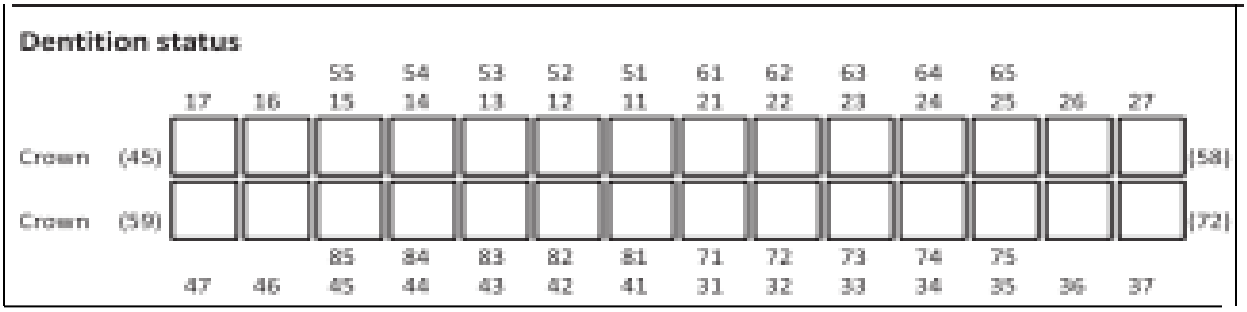
78. Alves, L. S., Susin, C., Damé-Teixeira, N., & Maltz, M. (2013). Overweight and obesity are not associated with dental caries among 12-year-old South Brazilian schoolchildren. Community dentistry and oral epidemiology, 41(3), 224–231.

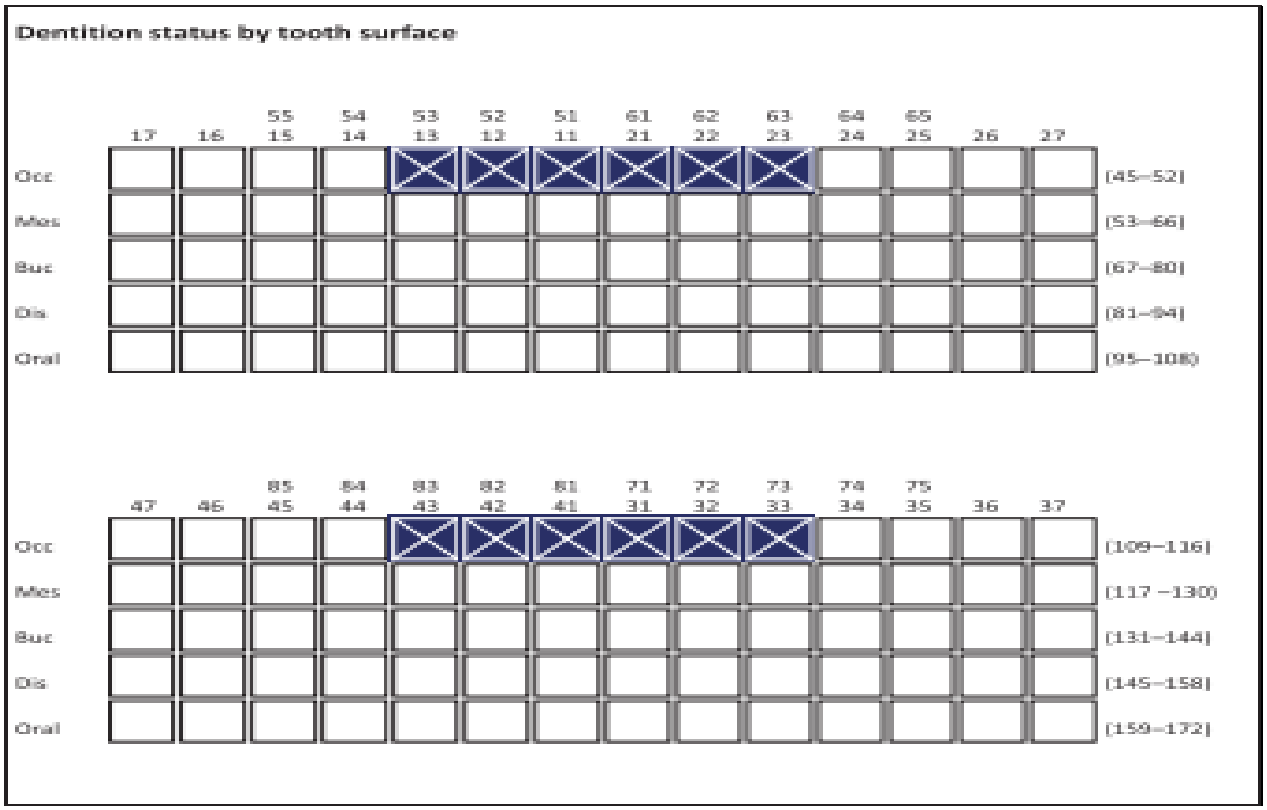
79. Yen, C. E., Lin, Y. Y., & Hu, S. W. (2021). Anthropometric Status, Diet, and Dental Caries among Schoolchildren. International journal of environmental research and public health, 18(13), 7027.
80. Kottayi, S., Bhat, S. S., Hegde, K. S., Peedikayil, F. C., Chandru, T. P., & Anil, S. (2016). A Cross-sectional Study of the Prevalence of Dental Caries among 12- to 15-year-old Overweight Schoolchildren. The journal of contemporary dental practice, 17(9), 750–754.
81. Gonzalez-Casanova, I., Sarmiento, O. L., Gazmararian, J. A., Cunningham, S. A., Martorell, R., Pratt, M., & Stein, A. D. (2013). Comparing three body mass index classification systems to assess overweight and obesity in children and adolescents. American journal of public health, 33(5), 349–355.
82. Fontana M. (2019). Nonrestorative Management of Cavitated and Noncavitated Caries Lesions. Dental clinics of North America, 63(4), 695–703.
83. Delgado-Rodríguez, M., & Llorca, J. (2004). Bias. Journal of Epidemiology and Community Health (1979-), 58(8), 635–641.
84. Lemamsha, H., Randhawa, G., & Papadopoulos, C. (2019). Prevalence of Overweight and Obesity among Libyan Men and Women. BioMed research international, 2019, 8531360.
85. Kumar, S., Kroon, J., Lalloo, R., Kulkarni, S., & Johnson, N. W. (2017). Relationship between body mass index and dental caries in children, and the influence of socio-economic status. International dental journal, 67(2), 91–97.
86. Rosiek, A., Maciejewska, N. F., Leksowski, K., Rosiek-Kryszewska, A., & Leksowski, Ł. (2015). Effect of Television on Obesity and

Excess of Weight and Consequences of Health. International journal of environmental research and public health, *12*(8), 9408–9426.

87. Setia M. S. (2016). Methodology Series Module 3: Cross-sectional Studies. *Indian journal of dermatology*, *61*(3), 261–264.
88. Ekstrand, K. R., Gimenez, T., Ferreira, F. R., Mendes, F. M., & Braga, M. M. (2018). The International Caries Detection and Assessment System - ICDAS: A Systematic Review. Caries research, 52(5), 406–419.
89. Buss J. (2014). Limitations of body mass index to assess body fat. Workplace health & safety, 62(6), 264.

Appendix: forms used for examination of dentition status





العلاقة بين السمنة وتسوس الأسنان بين أطفال المدارس في مدينة بنغازي:

تحليل بيانات ثانوي

قدمت من قبل:

انتصار عبدالله عون الله

تحت اشراف:

د.ارحيم ارحيم

الملخص

المقدمة: تعتبر السمنة والتسوس لدى الأطفال من المشاكل التي تؤثر علي صحة المجتمع. وعلى الرغم من أن الأبحاث حول العلاقة التي تربط بين هذين المرضين قد أجريت لسنوات عديدة، إلا أن النتائج لا تزال متضاربة. لذلك كان الغرض من هذه الورقة البحثية هو فحص العلاقة بين السمنة وتسوس الأسنان بين أطفال المدارس في مدينة بنغازي و البالغة أعمارهم 12 عاما. **طرق البحث:** هذه الدراسة عبارة عن تحليل ثانوي لبيانات تم جمعها كجزء من دراسة مقطعية تم إجراؤها في سنة 2017 لأطفال المدراس البالغة أعمارهم 12 عاما في مدينة بنغازي. تم استخدام البيانات بإذن من الباحث الأساسي وبعد أن تم إزالة البيانات التي لا تتماشى مع الدراسة الحالية

انخفضت عينة الدراسة من 1134 إلى 788. **النتائج:** الأطفال الذين يعانون من نقص في الوزن كان متوسط تسوس الأسنان ومعامل التسوس لديهم أقل (0.84، (انحراف معياري= 1.27) و 0.93، (انحراف معياري=1.3) على التوالي) من الأطفال الذين كان وزنهم طبيعي والأطفال الذين يعانون من الوزن الزائد والسمنة والذي كان متوسط تسوس الأسنان ومعامل التسوس فيهم متقارب . (0.93(انحراف معياري= 1.45) و 1.04(انحراف معياري=1.51)، 0.94(انحراف معياري= 1.56) و 1.05(انحراف معياري=1.61) على التوالي). تم إجراء التحليل الإحصائي باستخدام برنامج ال SPSS لمقارنة تسوس الأسنان والسمنة. تم ضبط قيمة P لجميع الاختبارات < =0.05. **الاستنتاج:** إن الدليل على وجود علاقة بين مؤشر كتلة الجسم وتسوس الأسنان غير متفق عليه. حيث وجد هذا البحث أن متوسط الطول والوزن ومؤشر كتلة الجسم في الأطفال الذين لا يعانون من تسوس الأسنان كانت أعلى مقارنة بالأطفال الذين يعانون من تسوس الأسنان ، ومع ذلك فإن هذا الاختلاف لم يكن ذا دلالة إحصائية.

العلاقة بين السمنة وتسوس الأسنان بين أطفال المدارس في مدينة بنغازي:

تحليل بيانات ثانوي

قدمت من قبل:

انتصار عبدالله عون الله

تحت اشراف:

د.ارحيم ارحيم

قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في صحة الأسنان العامة وطب الأسنان الوقائي

جامعة بنغازي

كلية طب وجراحة الفم والأسنان

فبراير 2022