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Relationships between Dental Caries and Body Mass Index

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ABSTRACT

Dental caries is one of the most prevalent chronic diseases among children and adults. Risk factors of dental caries include physical, biological, environmental, and individual-related factors: such as a proportion of cariogenic bacteria, sugar intake, inadequate saliva flow, inadequate fluoride use, poor oral hygiene, and poverty. Obesity has been linked to several conditions. Obesity shares several risk factors with dental caries such as diet, socioeconomic status, and environmental factors. Additionally, oral health might affect general health, while general health such as weight could affect oral health. Therefore, this review aimed to assess the relationship between dental caries and body mass index (BMI). The literature was searched on Medline, PubMed, Cochrane library, Google Scholar, Scopus, and relevant Internet-based papers from January 2000 to the present. The result showed great controversy on the relationship between dental caries and BMI. In conclusion, several studies reported a positive association while others showed no association between BMI and dental caries. Also, there was an inverse association between BMI and dental caries. More longitudinal studies should be conducted to understand the relationship between BMI and dental caries.

Keywords: BMI, Dental caries, Diet, Environmental factor, Obesity, Oral hygiene, Risk factors

Abbreviations: DXA: Dual X-ray Absorptiometry; FM: Body Fat Mass; FFM: Body Fat-Free Mass; BMI: Body Mass Index; DMFS: Decay Missing Filing Surfaces; dmft: Decayed Missing Filing Deciduous Tooth; DMFT: Decayed Missing Filing Tooth; FHP: Family Health Programme; GDP: General Dental Practitioner: NHNES: National Health and Nutrition Examination Survey; PUFA: Pulp, Ulceration of Soft Tissue, Fistula and Abscess; S-ECC: Severe Early Childhood Caries; SSI FS: Swedish Radiation Protection; TAC: Total Antioxidant Capacity Level; VPI: Visible Plaque Index; WHO: World Health Organization

BACKGROUND

Dental caries is one of the most prevalent chronic diseases among children and adults. People are susceptible to caries throughout their lives. Risk factors of dental caries include physical, biological, environmental, and individual-related factors: such as a proportion of cariogenic bacteria, sugar intake, inadequate saliva flow, inadequate fluoride use, poor oral hygiene, and poverty [1].

Obesity has been linked with several medical diseases, such as cardiovascular disease, high cholesterol, cancer, and type II diabetes. Being overweight and obese were associated with multiple co-morbidities and recommended, more studies should be taken to explore the biological mechanism that links overweight and obesity to co-morbidities [2]. The prevalence has increased dramatically over the last 20 years [3]. Being overweight in childhood increases the risk of adulthood obesity and its related complications [4]. It is undeniable that diet choices and socioeconomic status can have an impact on the development of obesity [4]. The daily intake of food has a very strong impact on oral health; meanwhile, oral health can play an important role in nutritional intake and general health. Therefore, the dentist must be aware of nutrition status and its impact on general and oral health. It is clear that a diet with high sugar intake is connected to several health problems, such as dental caries and obesity [5]. Furthermore, overweight children might consume less fatty food than those within normal-weight children might, but their huge consumption of sweets may lead them to gain more weight, as well as suffer the

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development of dental caries [6].

RESEARCH METHOD

The literature is searched on Medline, PubMed, Cochrane library, Google Scholar, Scopus, and relevant Internet-based papers from January 2000 to the present. Several papers and articles were identified, and then examined; filtered and only English and relevant articles were included in this review.

RESULTS/DISCUSSION

Risk Factors of Dental Caries and Obesity

Dental caries and obesity are multifactorial diseases and share many factors. The common risk factors associated with obesity and dental caries (diet and socioeconomic status) were explored in several studies. The results of these studies were contradictory. These studies will be discussed under the following sections.

Diet

Dietary choices such as high levels of sugars consumption play a key role in the development of both dental caries and obesity. A number of studies identified that and examined the association between dental caries and obesity, reported that diet is sharing risk factor for both conditions.

Costacurta [7] assessed the relationship between dental caries and obesity in a cross-sectional study, the author investigated the effect of dietary intake, oral hygiene and lifestyle on the prevalence of dental caries among pediatric obesity in children aged between 6 and 11 years. The sample consisted of 96 healthy children who had been classified according to body composition and McCarthy growth chart cut-offs [8]. The body composition was analyzed by a Dual X-ray Absorptiometry (DXA) beam scanner to obtain the body fat mass (FM) and body fat-free mass (FFM) measurements [9]. The dental status of the subjects was then examined by evaluating decayed missing filing deciduous tooth (dmft) and decayed missing filing tooth (DMFT), in addition the children were asked to complete a questionnaire covering diet intake, oral hygiene, and lifestyle. The results indicated that there was a direct correlation between FM percentage and dental caries. Additionally, following a modified diet, dmft/DMFD and FM% were analyzed using DXA, it was found that there were specific diet habits (like intake of sugar-sweetened food, frequency of sugar intake limited to main meals and between meals) that might be considered risk factors for both obesity and dental caries [7].

However, there are some limitations in the study, including the external validity, as the target population was not defined; therefore, the result cannot be generalized. Furthermore, food intake, oral hygiene and lifestyle information were collected retrospectively, which might introduce recall bias.

Another cross-sectional study was published in May 2015. The study aimed to identify association between dental caries, diet and weight deviations in children 12-15 years of age in Panchkula District, India. The study population consisted of 810 children; a multistage examination technique was used for the subjects' selection. All the schools in the area were included in the sampling frame and a random sample was selected. Data relating to the children, their family income, past dental history, medical history and diet history for five days were collected via questionnaire, prior to the examination. Two trained and calibrated examiners carried out clinical examinations; one examined caries status using a mouth mirror and explorer under natural light/torch, and the other examiner measured BMI [10].

The result showed that the overweight children had the highest DMFT 3.21, which was followed by underweight DMFT 2.31, while the DMFT of normal weight children was 2.23. The binomial regression showed that females were 1.293 times at risk of developing caries as compared to males. Children with reasonable and poor oral hygiene were 3.920 and 4.297 times (male and female respectively), at risk of dental caries in comparison to good oral hygiene. While children with high socioeconomic status had a high risk of developing caries. Underweight, overweight, and obese children had 2.7, 2.5 and 3-times caries risk more than normal BMI children, respectively. The study concluded that both conditions were linked to wide contributing factors, including diet, socioeconomic status, lifestyle and other environmental factors [10].

Some sort of diet such as sweets can influence dietary intake. A cross-sectional study evaluated the sweet test perception of dietary habits. They found that sweet test perception effect dietary habit and encourage on the consumption of more sugary snacks [11].

A recent study assessed the diet as a shared risk factor between dental caries and obesity, reported that the dietary sugar was associated with dental caries and being overweight. This study recommended that during analysis the relationship between dental caries and BMI should consider sugar and carbohydrate as the main variable [12].

Some types of diet have a significant impact on body weight and at the same time, this sort of diet plays an important role in creating dental caries. Carbohydrates, such as sugar and particularly added sugar, have been linked to increased body weight. Therefore, World Health Organization (WHO) put the nutrition at the forefront of public health policies and programmes [13]. Berkey [14] showed this relationship in a prospective cohort study in the USA. The study included a cohort of >10,000 children (boys and girls) aged between 9 and 14 years old who were observed periodically for three years from 1996 to 1998. The study aimed to investigate BMI change over that given period. All beverage intake was assessed for each BMI change every year of the corresponding period. The added sugar was found to be associated with a small BMI change. This association was adjusted for energy drink intake. The report concluded that

added sugar beverages may contribute in BMI gain and that this is confounded by energy drink consumption [14].

The study findings provided good evidence that added sugar contributes to weight gain in children for the following reasons: firstly, the large size of the study sample; secondly, the study methods, which included a longitudinal study that can observe BMI changes over time; and finally, most beverages were controlled, thus the confounding bias was eliminated.

On the other hand, the lack of a risk factors relationship approach between BMI and dental caries was reported in another cross-sectional study. This study sought to explore the role of diet in BMI groups and dental caries; the study recruited 510 children from 6 to 12 years of age. Caries examination was carried out according to WHO criteria and under bright daylight conditions identifying only the cavitated lesion. Diet analysis was carried out by a custom-made diet recording sheet completed for three days, including one weekend day. The prevalence of dental caries was higher among the obese group than the other BMI groups. Hence, the study highlighted that fatty food and snacks were more likely to be consumed by obese children than other groups. Although dental caries correlated to snacks, it was not associated with obesity in children. However, there were weaknesses in this study, similar to those studies where the caries assessment was carried out under daylight, which might have reduced the validity of dental examinations and might have introduced measurement bias. Another issue is that the diet assessment was focused on type of the diet without concerning consumed amount, thus it is a qualitative not a quantitative approach.

Conversely, Sharma and Hedge [15] reported that fatty food and sweet snacks were highly consumed by overweight and obese children who had a high prevalence of dental caries. In this cross-sectional study, five-hundred children aged 8-12 years were included. BMI was determined and caries experience Decay Missing Filing Surfaces (DMFS) was examined comprehensively. Diet frequency assessment was taken using a 35-item questionnaire. As a result, DMFS averages were 2.85 in obese, 2.48 is overweight and 1.58 in normal weight categories. Regarding the dietary preferences, fatty and sugary food was highly preferred and consumed by overweight and obese children (25.2% and 25.9%, respectively). Whereas, 27% of normal-weight children did not consume fatty and sugary foods and only 7% of them consumed fatty and sugary foods regularly [15].

Socioeconomic status

Socioeconomic status has a major impact on both conditions of dental caries and obesity. A number of studies have explored socioeconomic status as a contributing factor in both conditions, for example, a Swedish retrospective cohort study, consisted of 2,303 children who were born in 1991. Trained nurses carried out BMI measures at ages of 4, 5, 7 and 11 years according to standardized routines in the country. In the county of Östergötland, all children are called for routine dental check-ups from age 3 to 20 years. At the check-ups, the development of dental caries is identified with a mirror and a blunt probe under a good operating light. Bitewing X-rays are used on individual indications, and this controlled by the Swedish Radiation Protection SSI FS 1990:2 regulation. Dental caries in the 1991 birth year was retrieved from the County Council registers was assessed at different times, including 1997 (6 years of age), 2001 (10 years), and 2003 (12 years). Socioeconomic status was obtained from the census and included information on family income and social allowances, which was categorized into five classes (1 highest and 5 lowest) [16].

In conclusion, the relationship between overweight and dental caries was weak and it is suggested that the relationship may be obscured by fluoride use and correlated delay of disease activity, in addition narrowing of the variance in the study subjects. However, obese children at age 4 years developed more caries at age 12 than normal-weight children of the same age. On the other hand, children who reduced their weight at age 5 years developed fewer caries at age 12 years than children with normal weight throughout the study period. Hence, the study finding supported the concept that children should join a dental service programme at an early age [16].

The study is valid and representative as it addressed the focused question clearly and included all children born in 1991 in a given jurisdiction. The risk factor/ explanatory variable, which are socioeconomic status, and its correlation to outcomes (dental caries and being overweight), were examined. Additionally, age and gender were controlled for during the statistical analysis. Therefore, the study is externally valid and the findings can be generalizable. On the other hand, important risk factors such as fluoride use and diet habit were not considered, which might have introduced a confounder.

In addition, Oliveira [17] studied the relationship between dental caries and nutritional status in Brazilian preschool children (12-59 months) in a cross-sectional survey. The data was collected on dental caries, anthropometric measures, and data on socioeconomic status for 1,018 participants. Multi-linear logistic regression was used to identify the effect of nutrition status, socioeconomic and demographic factors on dental caries. In the result, the association between nutritional status and dental caries was found to be significant. A child that was underweight and from a low socioeconomic condition had a high risk of dental caries development [17].

However, the result of the study may coexist because of the amount and frequency of cariogenic food and drinks consumption, particularly in children with low socioeconomic status. Furthermore, there was no robust

evidence that being overweight was associated with dental caries. Moreover, multiple data were missed from the questionnaire, particularly that related to parental income and level of education. This was explored in an Indian study conducted in 2017, which showed that children whom are from a high socioeconomic status family experienced low caries risk, while this relationship was not found in other socioeconomic categories (low and middle) [18].

Marshall [19] also identified the high prevalence of dental caries amongst low socioeconomic status. He aimed to investigate the relationship between BMI and dental caries and to explore the risk factors (socioeconomic status and diet). All data related to socioeconomic status was collected by questionnaire including parental age, the level of parental education and family income. The study reported that both dental caries and obesity existed in low socioeconomic status participants [19].

Dental caries and obesity in children from low-income families were also considered in a cross-sectional survey in Goiania, Brazil. The study participants were 269 children aged 6 years. Early childhood caries was considered as a primary outcome. Data were collected by a trained research assistant, using a structured questionnaire that included questions about the child's family, e.g., total family income, participation in a family health programme (FHP) with or without a dental team, the mother's level of education. The research also included questions related to the age, gender, and oral health of the primary caregiver and the age, gender, and attendance at day care/school of each child. 6 dentists and 12 research assistants, who were trained in data collection by a professor who specializes in dental epidemiological surveys, carried out the dental examination. The weight and height of each child were measured according to World Health Organization (WHO) guidelines. The data were then analyzed by bivariate, logistic regression, and descriptive analysis. In conclusion, there was no association between BMI and dental caries. Children with families that had a high income had less caries experience. The mother's education level was not correlated to early childhood caries [20]. The result of this study is consistent with a cross-sectional study that assessed the association between dental caries, BMI, and socioeconomic status, reported that there is an association between dental caries, BMI and socioeconomic status, especially low socioeconomic status [21].

Fluoride use and oral hygiene

Oral hygiene status has a key role in the prevention of dental caries. Gupta and his colleagues have investigated the prevalence of dental caries in relation to body mass index, daily sugar intake and oral hygiene status in a cross-sectional study. The study included 100 children at age 12 years (50 boys and 50 girls) who were randomly selected from two different schools. The oral hygiene simplified index was used to evaluate oral hygiene status, and a 24 h recall frequency chart was used to record sugar intake. After analyzing the data using logistic regression, it was found that oral hygiene had a significant impact on caries prevalence, while body mass index and sugar intake was not significantly associated. The study concluded that oral hygiene status affects caries prevalence in 12 year old children and it recommended that more longitudinal studies should be conducted to investigate the association between body mass index and dental caries as both share the common risk factors [22]. A recent 4 years clinical trial has assessed the effect of fluoride use in oral hygiene, found that using fluoride could prevent dental caries [23].

Environmental factors

Environmental factors, such as leisure time activities and lifestyle, have a significant effect on body mass index and dental caries. Some studies have assessed the relationship between BMI and dental caries to investigate risk factors for both conditions. For instance, a Turkish and Finnish pre-adolescent cross-sectional study was conducted to evaluate any correlation between obesity, DMFT, TV watching, leisure activities and other lifestyle factors among pre-adolescents aged 6-12 years living in two countries Turkey (n=611) and (Finland n=338). Oral health and health behavior data of pre-adolescents and their mothers were obtained through a self-administrated questionnaire.

After collecting and analyzing the data, it was found that Turkish pre-adolescents were more obese and had poor oral health compared to their Finnish counterparts. Both preadolescent Turkish and Finnish participants who drink fizzy drinks more than 3 times a week tend to watch TV > or = 2 h on school days (odds ratio 1.51) compared to those who drink such beverages once a week or less (odds ratio 3.06) [24].

The study addressed the research question clearly as it included a large sample and the risk factor was targeted. Because the aim of study was to compare the prevalence between two groups of the population, the cross-section is a good design to answer the research question. The study populations were representative because the samples were selected randomly from different areas in both countries. An odds ratio was reported, which increased the result precision. Thus, this study, provided good evidence that lifestyle is a risk factor for obesity and dental caries [24].

Bener [25] reported that lifestyle is a predisposing factor for dental caries in a longitudinal cross-sectional study, which took place in Qatar over a period of 6 months. A random sample assessment of 1,248 children aged between 6 and 15 years of age (response rate 73%) was conducted. Multiple factors including lifestyle, dietary intake, and type of feeding during infancy, sociodemographic status, and information on family history and oral hygiene practices were obtained by a questionnaire. Trained health professionals and dental assistants also conducted standardized interviews with the

parents of the participants. The results showed that a number of children consuming sea food, cod liver oil, and vitamin-D-fortified milk less than once a week were at significantly higher risk for dental caries compared with those without caries. Highlighting that being female, overweight/obese and having a household income over US$2,747 (>=10,000 QAR) per month was an independent risk factor for dental caries [25].

In the summary, most aforementioned studies were cross-sectional studies, which makes establishing the relationship between BMI and dental caries slight challenging. However, conducting several small studies like a cross-sectional study can help in providing a good future base for big studies. For instance, establishing the prevalence of the disease and exploring risk factors. In addition, to observe the changes over time, a longitudinal study is also required.

The relationship between BMI and Dental caries

All the studies that are available in the literature evaluated the association between dental caries and BMI though the results were contrasting.

Positive association between BMI and dental caries

Some studies have shown a positive association such as, Willerhausen [26] mentioned a statistically significant association between BMI and dental caries after adjustment of age. The author noticed that 44.7% of underweight and 40.7% of normal-weight children had healthy natural teeth compared to overweight and obese children 30.5% and 31.7%, respectively [26].

Severe Early Childhood Caries (S-ECC) was linked to BMI in a case-control study. Two groups of children were matched on age and gender; 100 children with caries S-ECC subjects (50 boys and 50 girls) and 100 caries-free subjects (50 boys and 50 girls). The study showed a positive association between BMI and S-ECC, 51% caries-free and 45% S-ECC low weight children [27].

Yao [28] reported a positive relationship between BMI and dental caries in a cross-sectional study, which was conducted on primary school children (N= 67,956) of 5-14 years of age in the Wannan area, China. Dental caries data were collected from routine health screenings conducted between 2009 and 2013 and trained staff supervised by school nurses recorded BMI. Statistical analysis was performed by multivariate logistic regression, potential confounders, including age and gender, were adjusted.

The study findings showed that obese children have 1.908 times (OR =1.908; CI 95% = 1.750, 2.079) more caries development compared to low or normal-weight children. Overweight children were 1.547 times (OR = 1.547; CI 95% = 1.479, 1.618) more likely to experience caries when compared to underweight children or of a healthy weight. In addition, a statistically significant association was detected between year, grade, BMI categories and caries after adjusting for gender and age [28]. The study result is relevant and precise because the odds ratio is more than one and the confidence interval is narrow and did not include zero. Nevertheless, using routine screening in the detection of dental caries may lead to underestimating the prevalence of dental caries, as the examination of dental caries needs good lighting and cleaning and drying of the tooth surface, particularly in the early stages of dental caries.

Caries experience could be a future marker of being overweight in children. Lampert S.M (2014) evaluated the relationship between dental caries, BMI and subsequent change over a 6-year period of time and aimed to assess whether social classes altered these correlations. Data were collected from the European Youth Heart study and combined with data on caries from the Danish National Board of Health. Twenty-six percent of children/adolescents were caries-free at the beginning of the study and 39% at follow-up. Linear regression analysis was performed, showing that there was no association between caries and BMI or subsequent changes in BMI over 6 years of follow-up. Although, there was an inverse relationship between caries and BMI at the beginning of the study and subsequent changes over that period among children whose mothers were highly educated. The study reported that caries level might be a future marker for being overweight/obese to advantaged children while it may not be important among non-advantaged children. However, the author pointed out that the number of participants was low, which may overestimate the result. Thus, more studies need to be conducted to provide further evidence [29].

A longitudinal relationship between dental caries and obesity was assessed in a large cohort study in Hong Kong. The study recruited 668 participants aged 12 years old. The study extended 3 years with 2 rounds follow up. They reported that participants with high caries index have high BMI [30].

A descriptive study also found a positive association between BMI and dental caries. They noted that people with high weight and obesity tend to have advanced dental caries lesions, this was more associated with elderly women [31]. This might give a massage that dental caries and BMI share same common risk factors.

Lack of the association between BMI and dental caries

On the other hand, a lack of association has been shown in other studies. Macek and Mitola [32] reported that there was no association between dental caries and BMI. All covariates were controlled in this case-control study, including age, race/ethnicity, gender, and poverty. Data were collected from the National Health and Nutrition Examination Survey (NHNES) 1999-2002 in the USA, and the analysis was limited to children aged 2 to 17 years old. Despite the study hypothesis expected to find an association between age-specific BMI and prevalence and severity of dental caries, this relationship was not found [32].

Furthermore, Kopycka-Kedzierawski [33] in another study in the US identified the lack of this association. The National Health and (NHNES) 1999-2002 (the same source used in the aforementioned study) and the National Health and Nutrition Examination Survey (stage III) 1988-1994 (NHNES III) were used in this study. Potential confounders were controlled and logistic regression was carried out for 10,180 children aged 2-18 years from NHNESIII 1988-1994 and 7,568 children aged 2-18 years from NHNES 1999-2002 [33]. The two surveys provide no association. Even though these two previous studies conducted two different types of study designs, the results of both studies were consistent.

Additionally, Mojarad and Maybodi [34] had pointed out the lack of any association between obesity and dental caries in a cross-sectional study. A cluster random sample of 1,000 pupils was recruited, including 500 boys and 500 girls aged 6-11 years. After collecting and analyzing the data, the prevalence of dental caries was found to be higher in normal-weight children than in overweight children. Furthermore, 11.8% of underweight, 66.7% of normal weight and 9.8% of overweight children were caries-free but at risk of obesity [34].

Furthermore, a cross-sectional study was carried out in the Netherlands. This study aimed to assess the relationship between BMI and dental caries in children aged 5 to 8 years attending dental pediatric referral practice [35]. Two hundred and thirty children were recruited with a response rate of 98%, and a mean age of 7.0; 56.5% were girls. Dental caries experience was collected from a routine clinical examination supported with x-rays and using dmft and dmfs as indicators. Trained dentists using weight divided by height squared recorded BMIs. Additionally, sociodemographic information was gathered, including child's age, sex, ethnicity and mother's level of education. In the result, there was no statistically significant association between BMI and dental caries, despite the fact that the study was hypothesized to find a positive correlation. Although this study had some strength such as a high response rate (98%) and high prevalence of dental caries (80.4%), there were weaknesses as well. One of these limitations was that the result cannot be generalized to that population because the study subjects were selected only from a pediatric referral center and children with emotional and behavior issues were excluded. Another weakness was in the referral process; some parents were asked to refer their children instead of general dental practitioner (GDP) choices, this might increase the number of caries-free children. Furthermore, not all participants were examined by x-ray. The last two factors might have underestimated dmft and dmfs prevalence [35]. The result of this study was consistent with a cohort study that aimed to assess if dental caries can be a predictive for adolescent obesity or not. The study reported that there was no correlation between BMI and dental caries [36].

Inverse association between BMI and dental caries

The severity of obesity can also the oral health status. These relationships were investigated in some studies. The severity of obesity has a huge impact on caries level among obese individuals. This has been shown in a case-control study, aimed to assess caries experience in an adolescent population who were treated for severe obesity. Two groups were compared in this study: severely obese adolescents (n-41) and non-obese adolescents (n-41). Two groups were matched on age, gender, and socio-occupational categories. A Non-parametric test was used to evaluate the relationship; BMI and DMFT correlation were significant (p-value <0.001) in the obese group. In conclusion, severely obese children were found to be experiencing a high level of dental caries [37].

The level and severity of dental caries can be an indicator of BMI. The severity of dental caries may affect the weight of children, especially if associated with odontogenic infections. This relationship was presented in a representative cross-sectional study in a Filipino population [38]. This study was based on population classifications of the Philippines, using modified and stratified cluster sampling. The sample consisted of 1,951 schoolchildren aged 11-12 years from all 17 regions of the country. Caries was measured according to WHO criteria (WHO, 1997) and trained nurses measured BMI while socioeconomic status was taken into account as a potential confounder. In addition, the pulp, ulceration of soft tissue, fistula, and abscess (PUFA) index was used to determine infectious status.

In the result, the overall prevalence of caries (DMFT, dmft) was found to be 80.6% and prevalence of odontogenic infection (PUFA) was 55.7%. The BMI of 27.1% of the children was underweight and only 1% was overweight. The research concluded that children with an odontogenic infection had a high risk of reduced weight under normal conditions compared to those who did not have an odontogenic infection (odds ratio 1.47, CI 95% 1.19-1.80) [38].

Additionally, caries development among low weight children was stated in a population-based cross-sectional study [39]. The study was carried out in Southern Sweden and assessed 920 children at age 5 years. It emphasized that low weight children might be linked with eating habits that put them at risk of caries development. Although the result of the study was representative of the target population, such a study design cannot establish the cause-and-effect relationship, and the author recommended that a longitudinal study design would provide a piece adequate evidence.

In addition, reverse correlation was reported in a longitudinal study. The participants were followed up at three points; at birth, 18 months, and six years of age. It was a part of twin cohort study in Australia. The study concluded

that children with low BMI were associated with high caries index [40]. This is consistent with a Chinese study that assessed the bidirectional relationships, found that low weight children were exposed to more dental caries [41]. In contrast, Pérez [42] repoted that people with high BMI experienced less dental caries in a cross-sectional study that included 522 school children selected from public schools. Thus, the relationship between dental caries and BMI might occur in different ways.

Effects of obesity on oral health

Obesity has an impact on oral health, such as reduced saliva flow, which is a contributing factor to the development of dental caries. In a cross-sectional study, the effect of childhood obesity on reducing saliva flow was investigated. Two groups were recruited: obese adolescents (n=65) and normal weight (n=65) at mean age 14.5 and 14.2 years, respectively. A well-designed questionnaire was used to collect potential factors, including food intake, education, oral hygiene, sociodemographic situation and medical status. Clinical examination included dental caries (DMFT), dental plaque using the visible plaque index (VPI), bleeding on probing for gingival inflammation and saliva flow. Saliva was collected 2 times in the morning and afternoon, paraffin wax was given to participants to stimulate saliva and then collected in a test tube and calculated ml/min. After analyzing the data, an association was found between Obesity and saliva flow. The saliva flow rate was 2.0 ml/min for normal weight compared to 1.2 ml/min for the obese group. However, this study had a limitation in that saliva samples were taken at two different times which may have an effect on saliva flow rhythm [43].

Furthermore, obesity may have an effect on the nature and characteristics of saliva that reflect negatively on oral health and dentition. This relationship was highlighted in a case-control study in India. The study aimed to assess the antioxidant level of saliva, dental development and oral health in childhood obesity. The sample consisted of 120 participants aged 6 to 12 years selected randomly from several private schools. The subjects were divided into two groups and based on age and sex: 60 overweight/obese and 60 control or normal-weight participants. Phosphomolybdic acid and the spectrophotometric method were used to determine the total antioxidant capacity level (TAC). For oral health status, oral hygiene index-simplified, modified gingival index and dentition index was used, while dental development was examined clinically [44].

After the analysis, the study group (obese/overweight) was found to have very high levels of TAC compared to the control group. There was no difference in terms of oral health status in both groups. Dental development was relatively less in the obese group, which was not statistically significant. In conclusion, it was identified that salivary TAC and prevalence of dental caries were higher among the overweight/obese group than the normal weight group [44].

Despite the significance of the study findings, this research has some weaknesses. Firstly, the study population was selected from private schools only, which might introduce selection bias and not be representative of the other populations. Another point is that although the study groups were matched on age and gender, other potential cofounders include sweat intake, brushing habit and use of fluoride, which were not considered in the study design or at the analysis stage. This could have affected the result, especially the prevalence of dental caries.

CONCLUSION

In summary, several studies were conducted in different countries to investigate the relationship between BMI and dental caries, and explore the risk factors for both conditions. Most of the aforementioned studies had shown that overweight/obesity and dental caries were sharing common risk factors such as diet (particularly sugar), socioeconomic status, and lifestyle. Some of these studies revealed that there was no relationship between BMI and dental caries. The WHO guidelines have shown that free sugar contributes energy density of the diet and leads to a positive energy balance. Sugar is an important component of the diet in terms of balancing healthy body weight and ensuring ideal nutrient intake. However, there is concern raised towards the rise of free sugar consumption, specifically sugar-sweetened forms of beverages, which may lead to an increase the overall energy and decrease the other food components, thus leading to an unhealthy diet. In addition, consuming free sugar in large amount promotes weight gain and creates dental caries lesion. In recommendation, more longitudinal studies need to be conducted to understand the common risk factors between dental caries and obesity.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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