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Dental caries and body mass index in Mosul City schoolchildren

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ABSTRACT

Background: *There is a potential correlation between tooth loss and dental caries in both obese and underweight patients. The presence of extensive dental caries can delay the process of eating, leading to a subsequent decrease in body weight.* ***Purpose:*** *The objective of this study was to examine the correlation between dental caries and body mass index (BMI) in schoolchildren residing in Mosul City.* ***Methods:*** *The present cross-sectional study was conducted on a randomized sample of 7- to 10-year-old school students. The study assessed the clinical characteristics, namely the decayed, missing, and filled teeth (DMFT/dmft) index. The DMFT index represents the number of decayed, missing, and filled teeth in the permanent dentition, while the dmft index pertains to deciduous dentition. After adjusting for age, gender, height, and weight, BMI-age percentiles were determined using the BMI Percentile Calculator for Children and Teens. Children were then categorized as underweight, normal weight, overweight, or obese. In the statistical analysis, the Kruskal–Wallis test was employed to examine variations between categorical variables.* ***Results:*** *The prevalence of dental caries in primary dentition was found to be 80.33%, whereas in permanent dentition, it was 50.33%. The majority of children affected by caries were in the obesity and overweight categories, followed by those with normal weight, while the lowest proportion was observed among underweight children.* ***Conclusion:*** *The findings indicate variations in the occurrence of dental caries across different subgroups of children based on their BMI-age percentiles.*

Keywords: *body mass index; children; dental caries; obesity; overweight*
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INTRODUCTION

Dental caries is widely recognized as a prevalent oral infectious illness characterized by the demineralization and degradation of dental hard tissues, often resulting in the formation of cavities.[1] According to the World Health Organization (WHO), 60%–90% of caries cases are found in school-aged children and a certain number of adults worldwide.[2] Dental caries can affect individuals from toddlers to adults.[3] The identification of dental caries can be achieved through a combination of clinical examination and radiographic findings.[4]

The condition is widely known to be influenced by dietary factors. Multiple recent studies have indicated a strong association between an increase in caries incidence and the consumption of sugary foods.[5] While nutrition alone cannot be considered the sole causal factor, it is important to recognize that additional factors contribute to the current levels of caries. Substantial changes have been documented in the dietary patterns and behaviors of the population in recent decades, primarily as a result of rapid urbanization, industrialization, and economic progress. These changes include increased carbohydrate intake and reduced levels of physical activity, which have detrimental effects on overall health and dental well-being, particularly among younger individuals. These effects manifest in the form of dental caries and obesity.[5]

The above-mentioned conditions are regarded as chronic, prevalent, and complex, exerting a substantial influence on the well-being of children and adolescents.[6] Overweight and obesity result from an imbalance between energy intake and energy expenditure. Such an imbalance is often associated with multiple factors, including inadequate diet and lack of physical activity, which are influenced by environmental and societal characteristics.[7] The measurement of obesity in a population can be assessed using body mass index (BMI),

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which involves the mathematical calculation of height and weight to evaluate an individual's health status.[8]

BMI is a standard assessment used to indicate nutritional status by classifying individuals as thin, normal, overweight, or obese. BMI can also predict the occurrence of certain diseases, including dental caries.[9] Being overweight causes health problems in children, both immediately and over time, including type II diabetes, metabolic issues, high blood pressure, hypercholesterolemia, hyperandrogenism, orthopedic complications, sleep disorders, cardiovascular disease, and behavioral problems.[10]

In recent years, there has been a notable rise in the prevalence of overweight and obesity among children, primarily attributed to increased consumption of excessive amounts of food. Additionally, there has been growing recognition of the significance of research examining the correlation between dental caries and body weight, two factors closely linked to dietary patterns.[11–13] There is a potential correlation between tooth loss and caries in both obese and underweight patients. Weight loss may occur in children experiencing challenges with eating due to premature tooth loss and dental discomfort.

According to Manohar et al.,[14] the presence of extensive dental caries can delay eating, leading to a subsequent decrease in body weight. This study employed a standardized approach to investigate the materials and methods utilized in the research. The purpose of the study is to examine the correlation between BMI-for-age and dental caries in a sample of schoolchildren aged 7–10 years residing in Mosul City.

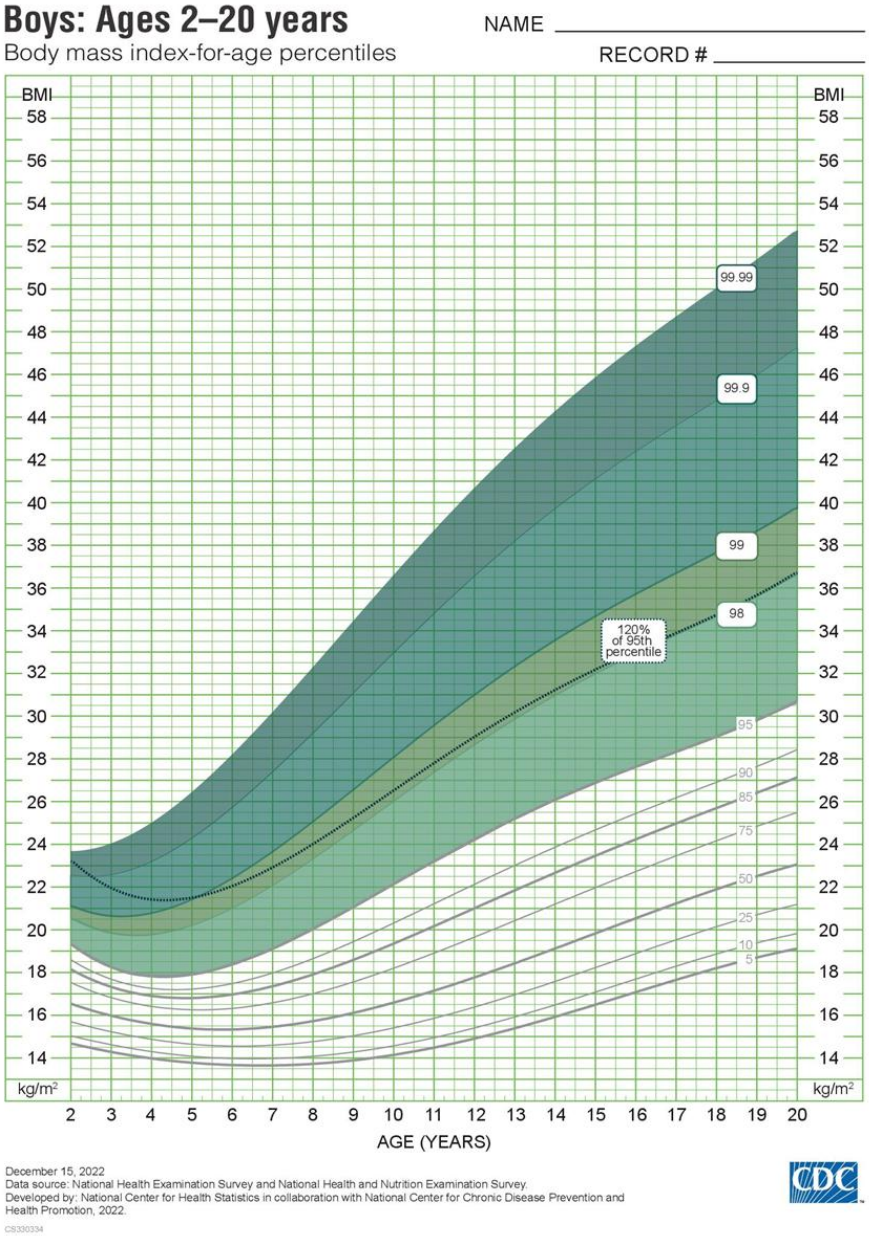

Figure 1. BMI-for-age — boys growth chart.[15]

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MATERIALS AND METHODS

A cross-sectional study was undertaken in Mosul City during the academic year 2022–2023 to assess oral health. The study lasted 6–12 months. A total of 300 schoolchildren, aged between 7 and 10 years, were chosen randomly from 10 primary schools by dividing Mosul City into the right and left banks of the Tigris River. Five random schools were selected from each bank.

The participants were categorized into four distinct categories. Children classified as underweight had a BMI-for-age that fell below the 5th percentile. Those classified as normal weight had a BMI-for-age between the 5th and 85th percentiles. Overweight children had a BMI-for-age between the 85th and 95th percentiles, while obese children had a BMI-for-age above the 95th percentile.[15] The sample consisted of 52 children classified as underweight, 97 as normal weight, 83 as overweight, and 68 as obese. The total sample size comprised 162 boys and 138 girls.

The researchers secured legal authorization from the educational directorate in Mosul City to conduct the survey, as well as consent from the families of the pupils. The study excluded children with a documented medical history of systemic disorders that could potentially impact their growth, as well as children with special needs who had mental or physical challenges. Information about chronic diseases was obtained from the children's parents with consent.

BMI was computed by utilizing measurements of body weight and height (expressed in kilograms per square meter) for each child. Weight was measured using a scale, with the

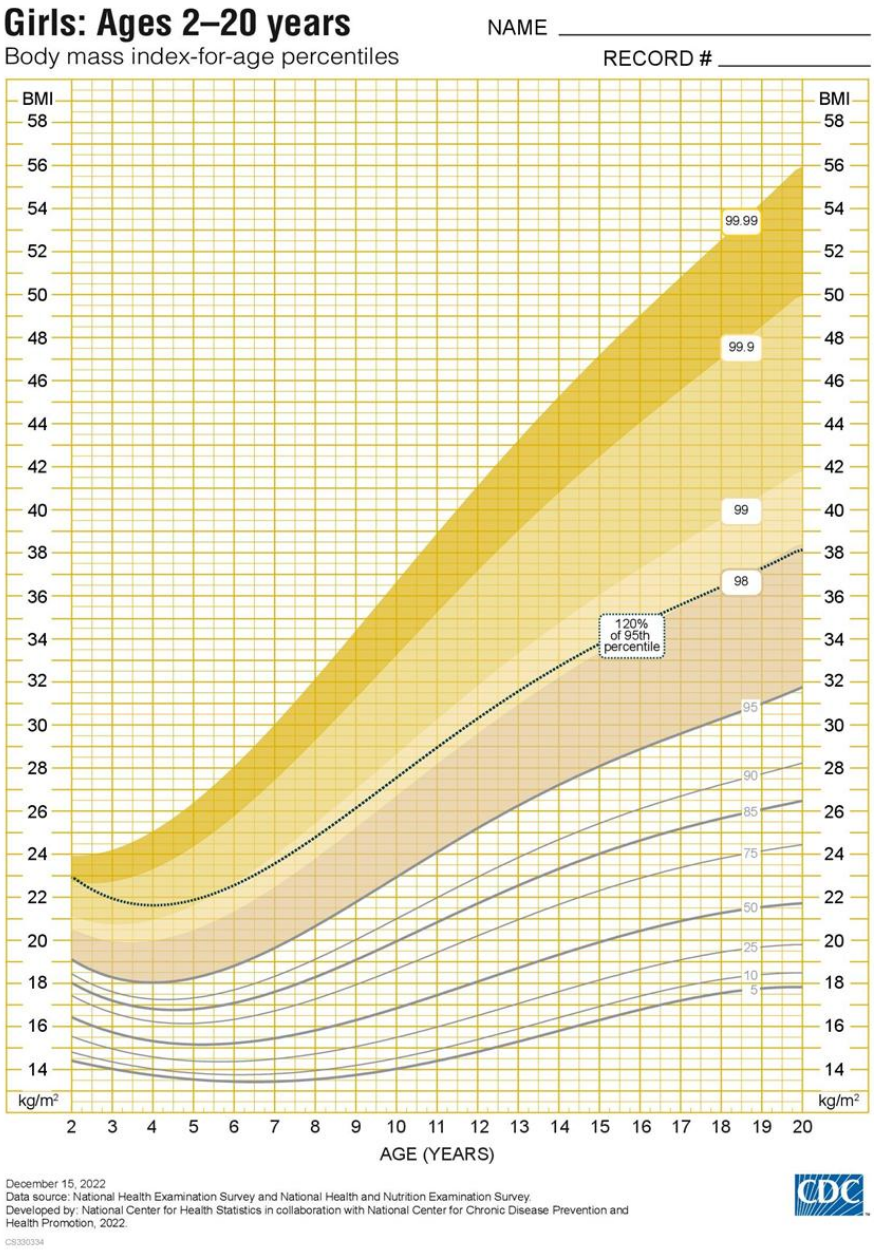

Figure 2. BMI-for-age — girls growth chart.[15]

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child wearing lightweight clothing and no footwear. Height was measured using a height-measuring ruler placed in contact with the child's head while they stood in a vertical position. The data were graphed on percentile curves specific to age and gender, as established by the Centers for Disease Control and Prevention (CDC). These results were then classified based on the BMI percentiles derived from the CDC chart (Figures 1 and 2).[15]

The examination and diagnosis of dental caries involved the use of visual inspection and probing techniques, following the diagnostic criteria for caries as outlined by the WHO.[16] A dental mirror and a diagnostic probe were used for assistance. Traditionally, the diagnosis of dental caries depended on the presence of noticeable alterations in color, shape, or texture, which appeared as pit, fissure, or smooth surface caries. The assessment of caries experience covered all teeth present in either the deciduous dentition (decayed, missing, and filled teeth [DMFT/dmft]) or the mixed dentition (dmft and DMFT). The study involved the assessment of DMFT and dmft indices in the permanent and deciduous dentitions of 8-year-old children. The permanent dentition included the central incisors, lateral incisors, and first molars in both the mandibular and maxillary arches. The dmft index was recorded based on the number of decayed, missing, and filled teeth in the deciduous dentition, as indicated in the dental charts.

Inter- and intra-examiner assessments were conducted to ensure the consistent application of diagnostic criteria for DMFT and dmft. Inter-examiner calibration was initially conducted on a sample of 10 children. These pupils were assessed twice, first by the researcher and then by an experienced specialist. After intra-examiner calibration, the researcher re-examined the same group of 10 children one hour after the initial assessment. The findings indicated that there were no statistically significant differences at a significance level of $p > 0.05$.

The data were analyzed using SPSS version 25, which included descriptive statistics such as means, standard deviations, and frequencies to provide information on variable values. The Kruskal–Wallis test was employed to assess differences in DMFT and dmft scores among four categories: underweight, normal weight, overweight, and obese children. The statistical significance of the results was determined at a threshold of $p \leq 0.05$.

Table 1. Comparative analysis of the mean DMFT among the four groups

Group	Number	Mean ±Std. Deviation	Kruskal–Wallis Test		*p*-value
			Mean Rank	Chi-Square	
Underweight	52	0.5052 ± 0.73773	127.76	17.197	0.001
Normal weight	97	0.6538 ± 0.76401	143.69		
Overweight	83	0.9036 ± 1.04315	158.83		
Obesity	68	1.0000 ± 0.79175	177.99		

Table 2. Comparative analysis of the mean dmft among the four groups

Group	Number	Mean ± Std. Deviation	Kruskal–Wallis Test		*p*-value
			Mean Rank	Chi-Square	
Underweight	52	1.9038 ± 1.31745	144.85	7.251	0.064
Normal weight	97	1.6495 ± 1.33885	134.70		
Overweight	83	2.2048 ± 1.76524	158.09		
Obesity	68	2.2794 ± 1.35873	168.10		

Table 3. Presents the prevalence of DMFT among the four groups

	underweight	Normal weight	Overweight	Obesity
DMFT = 0	27 (51.9%)	60 (61.8%)	41 (49.3%)	21 (30.8%)
DMFT ≥ 1	25 (48%)	37 (38.1%)	42 (50%)	47 (69.1%)
D = 0	29 (55.8%)	65 (67%)	49 (59%)	30 (44.1%)
D ≥ 1	23 (44.2%)	32 (32.9%)	34 (40.9%)	38 (55.88%)
M = 0	51 (98%)	95 (97.9%)	82 (98.7%)	63 (92.6%)
M ≥ 1	1 (1.9%)	2 (2%)	1 (1.2%)	5 (7.35%)
F = 0	47 (90.3%)	90 (92.7%)	72 (86.7%)	61 (89.7%)
F ≥ 1	5 (9.6%)	7 (7.2%)	11 (13.2%)	7 (10.3%)

Table 4. Presents the prevalence of dmft among the four groups

	Underweight	Normal weight	Overweight	Obesity
dmft = 0	6 (11.5%)	30 (30.9%)	16 (19.3%)	7 (10.3%)
dmft ≥ 1	46 (88.5%)	67 (69%)	67 (80.7%)	61 (89.7%)
d = 0	8 (15.3%)	34 (35%)	51 (61.4%)	12 (17.6%)
d ≥ 1	44 (84.6%)	63 (64.9%)	32 (38.6%)	56 (82.4%)
m = 0	43 (82.7%)	84 (86.6%)	71 (85.5%)	54 (79.4%)
m ≥ 1	9 (17.3%)	13 (13.4%)	12 (14.5%)	14 (20.6%)
f = 0	44 (84.6%)	80 (82.5%)	63 (75.9%)	54 (79.4%)
f ≥ 1	8 (15.4%)	17 (17.5%)	20 (24.1%)	14 (20.6%)

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RESULTS

The study found that the average DMFT values were highest in the obesity group (1.0000 ± 0.79175), followed by the overweight group (0.9036 ± 1.04315), the normal weight group (0.6538 ± 0.76401), and the underweight group (0.5052 ± 0.73773). These differences were statistically significant ($p = 0.001$), as shown in Table 1.

The average caries experience in deciduous dentition was also highest in the obesity group (mean = 2.2794 ± 1.35873), followed by the overweight group (mean = 2.2048 ± 1.76524), the underweight group (mean = 1.9038 ± 1.31745), and the normal weight group (mean = 1.6495 ± 1.33885). However, statistical analysis showed no significant differences between these groups ($p = 0.064$), as indicated in Table 2.

The occurrence rate of dental caries in the permanent teeth of children aged 7–10 years in Mosul City was 44% in the underweight group, 33% in the normal weight group, 41% in the overweight group, and 56% in the obesity group.

The prevalence of filled teeth also varied across weight categories. Specifically, fewer than 10% of individuals classified as underweight, 7% of those with normal weight, 13% of overweight individuals, and 10% of obese individuals had between one and two filled teeth. Additionally, the occurrence of missing permanent teeth differed by weight category, with 2% of underweight individuals, 2% of those with normal weight, 1% of overweight individuals, and 7% of obese individuals having missing permanent teeth, as presented in Table 3.

The study conducted in Mosul City examined the prevalence of decay in deciduous teeth among children aged 7–10 years. The findings revealed that the prevalence of dental caries was 85% in the underweight group, 65% in the normal weight group, 39% in the overweight group, and 82% in the obese group. The prevalence of filled teeth varied across different weight categories, with less than 15% of underweight individuals, 18% of those with normal weight, 24% of overweight individuals, and 21% of obese individuals having between one and four filled teeth. Additionally, the occurrence of primary missing teeth differed among weight categories. Seventeen percent of underweight individuals, 13% of those with normal weight, 15% of overweight individuals, and 21% of obese individuals experienced this condition (Table 4).

DISCUSSION

The DMFT dental caries index calculates the average number of decayed (D), missing (M), and filled (F) teeth for each person. This index is commonly used in dentistry to assess the level of dental health within a population. Many studies have shown that the proportion of overweight children in both developing and developed countries is increasing, making it a substantial public health concern.[10]

The assessment of caries prevalence in the study population was conducted through the evaluation of DMFT index scores. The findings derived from the descriptive statistics showed that the dmft score exceeded the mean DMFT score, suggesting that deciduous dentition was more adversely impacted compared with permanent dentition. The average deciduous decay score (d) of 1.48 was higher than the average permanent decay score (D) of 0.6.

These results align with the findings reported by Farooqi et al.,[17] where the average dmft value was 3.66, and the average DMFT value was 1.94. The findings provide a comparison of the mean DMFT among four different weight-status groups. The DMFT index expresses the average number of decayed, missing, or filled teeth in a group.

The lower mean DMFT in the "Underweight" group revealed fewer caries, while the higher mean in the "Obesity" group indicated a likely increase in the caries index with increasing weight.

This study found that the occurrence of dental caries was most prevalent among children who were obese, with rates of 69.1% in permanent teeth (DMFT) and 89.7% in primary teeth (dmft). The prevalence of a sedentary lifestyle among children has led to a notable increase in their dependency on video games, with an average daily usage of approximately four hours.[18,19] These factors contribute to a rise in body weight, thereby impacting BMI.

Weight and the index of dental decay can be influenced by various factors, including eating habits and physical activity levels. Obesity is associated with an increased risk of dental decay and gum disease. Several molecular factors play a role in this relationship, including increased saliva production. Obesity causes increased saliva production, which can lower the pH of the mouth, making teeth more prone to decay.[20]

The findings of Mohammed and Diab[21] and Kotha et al.[22] support the notion that individuals classified as obese exhibit a higher prevalence of caries compared with those classified as normal weight or underweight. However, the conclusions presented by Al-Kamal[23] regarding the mean value of DMFT in underweight children, as well as the research findings by Zainab et al.[24] regarding the mean DMFT value in normal-weight children, are inconsistent with previous research. Al-Kamal[23] reported higher mean DMFT values in the total sample for underweight children, while Zainab et al.[24] found higher mean DMFT values in normal-weight children.

In addition, citrine is an organic acid that prevents tooth decay by suppressing bacterial development. Obesity lowers citrine levels in saliva, potentially increasing the incidence of cavities.[25] Obesity also increases the formation of phosphoric acids in saliva, potentially raising the risk of tooth decay. Increased production of phosphoric acids in saliva, which are powerful acids, might result in tooth erosion.[26]

Antibacterial proteins have been demonstrated in studies to help protect teeth against cavity-causing bacteria.

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However, obesity reduces the quantities of these proteins in saliva, potentially increasing the risk of cavities.[27] It has also been shown that inflammation contributes to the formation of bacteria that cause caries in the mouth, and obesity raises inflammation levels in the gums, which may further increase the risk of caries.[27]

In addition to these subtle molecular aspects, obesity is linked to an increased risk of diabetes, which can lead to dental damage.[28]

There are also some potential links between nutritional habits, weight gain, and tooth disease, such as the consumption of sugars and soft drinks, which can lead to weight gain while also increasing the risk of tooth decay.[24] Personal health care, such as frequent tooth brushing and dental checkups, can influence the level of tooth decay and, consequently, the weight-to-tooth decay link. Research indicates a connection between dental decay, gingivitis, and overweight or obesity; however, the relationship is not consistent and varies depending on research and individual conditions. It is important to note that this relationship depends on various factors, including an individual's cultural and environmental milieu.

This study paves the way for future research to better assess these elements and understand the more nuanced aspects of this relationship. Medical background and other factors that may influence oral health, such as personal hygiene and heredity, must be considered. For reservations and future investigations, the current sample size may be small, and additional samples may be required to corroborate the conclusions. Long-term research is desirable for a better understanding of the impact of weight gain on the tooth decay index.

This study is the first attempt to investigate the correlation between BMI and oral health within the population of schoolchildren residing in Mosul City. It found a statistical relationship between weight status and the dental caries index. The ultimate interpretation should be based on further research and a thorough review of contributing circumstances.

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