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Original Article

The impact of malnutrition on dental health of 12-year-old children: a study on permanent teeth caries, cariogenic bacteria and salivary IgA

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Abstract

Introduction: Malnutrition in children is epidemic in developing countries. Several health issues and consequences are believed to develop due to this phenomenon. Children's oral health is also affected by malnutrition. The main aspects of oral health status are caries experience, the existence of cariogenic bacteria, and salivary immunoglobulin A.

Materials and methods: This comparative study included 87 school children aged 12 years. Participants with systemic disease were excluded. An oral examination was conducted to record the DMFT score, then saliva samples were collected in the morning using an unstimulated method. Salivary IgA were analyzed using Sandwich ELISA technology. Malnutrition was based on body mass index (BMI) which was computed as weight/height^2 (kg/m^2). Ethical approval was granted by the ethical committee at the Faculty of Dentistry. Informed consents from children's parents were gained prior to the start of the study.

Results: Compared to the normal weight group, the results of this study showed that overweight and obesity are inversely correlated with the mean DMFT and the number of *S. mutans* and *S. sobrinus*. Salivary IgA was negatively correlated with overweight and obesity, compared to normal weight group.

Conclusions: Children suffering from malnutrition are at risk of developing oral health diseases. Treating malnutrition will therefore improve children's overall oral health.

Keywords

cariogenic bacteria, dental caries, malnutrition, pediatric dentistry, salivary immunoglobulin A

Introduction

Malnutrition is a condition characterized by deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients. It can result from an inadequate or unbalanced diet, or from impaired nutrient absorption due to medical conditions. Malnutrition has a profound impact on health, leading to various negative outcomes such as stunting, wasting, micronutrient deficiencies, and increased susceptibility to infections.[1]

The significance of adequate nutrition for the growth and development of children cannot be overstated. Despite efforts to address the issue, child malnutrition remains a persistent global health challenge, affecting approximately 8% of children worldwide.[2] Malnutrition develops when there is an imbalance between the body's nutrient and energy requirements for growth, maintenance, and physiological processes and the availability of these essential nutrients.[2,3]

Moreover, malnutrition during critical periods of growth and development can have long-term consequences. It can

alter the body's metabolism and increase the risk of developing chronic diseases such as obesity, diabetes, and cardiovascular disease later in life.[4] Childhood obesity, in particular, has emerged as a significant public health concern, with the prevalence increasing over time. The long-term health effects of pediatric obesity are still being unraveled, and the measurement of body mass index (BMI) has been used to assess the severity of the problem in children.[5]

This mutually dependent relationship highlights the close link between adequate nutrition and excellent oral health. When individuals receive proper nutrition, it contributes to promoting good oral health, and conversely, maintaining good oral health also supports overall nutritional health. On the other hand, in situations of malnutrition, the equilibrium in the oral cavity may be disturbed, leading to the progression of oral diseases. Malnutrition can weaken the body's ability to fight microbial biofilm and hinder the natural tissue healing process.[6]

Dental caries is a widespread and chronic infection caused by cariogenic bacteria, mainly *Streptococcus mutans*, which attach to the teeth. These bacteria metabolize sugars to generate acid, gradually demineralizing the tooth structure over an extended period of time.[7]

Obesity has been linked to an increased risk of dental caries due to factors such as elevated consumption of sugary foods, changes in salivary flow, and disruptions in the oral microbiome.[8] The presence of mutans streptococci, a group of bacteria associated with dental caries, has been found to be higher in obese individuals.[9]

A previous study investigates the effect of BMI on salivary IgA levels. The study observed that overweight/obese children have increased salivary IgA levels. The research also established a connection between BMI and body fat percentage. As a result, the findings supported the hypothesis that obesity can impact immunological and inflammatory mechanisms.[10] Salivary IgA plays a crucial role in the immune response within the oral cavity, preventing the attachment of bacteria to the epithelium and neutralizing toxins.[11]

By examining the existing literature, we can gain insights into the complex interplay between malnutrition, obesity, and oral health and highlight the need for integrated approaches that address both nutritional and oral health concerns.

Aim

The objective of this study was to explore the correlation between malnutrition and oral health outcomes in terms of dental caries, cariogenic bacteria, and salivary IgA in school children.

Materials and methods

This study is a comparative study comprising 87 children aged 12 years. The study group consisted of 23 underweight children, 23 children with normal weight, 23 overweight children, and 18 obese children. Participants with systemic diseases such as diabetes mellitus, chronic heart disease, acquired immunodeficiency syndrome, or those who had taken antibiotics within the past three months, were excluded from the study.

Ethical approval

The study protocol was approved by the scientific committee at the Al-Esraa University, College of Dentistry, Baghdad, Iraq, on 23/11/2022. (project No. 235820).

Samples collection

Samples were taken in the dental clinics of the Pediatrics and Prevention Department at Al-Israa University in the morning and before 11 am by four dentists specializing in preventive dentistry.

The weight was measured using an electronic digital scale and rounded to the nearest kilogram. BMI was computed by dividing the weight by height squared, the weight in kilograms and the height in meters. BMI was categorized into underweight (BMI<18.5), normal (BMI 18.5–24.9), overweight (BMI 25–30) and obese (BMI>30).[12]

Each subject underwent an oral examination following the criteria recommended by the World Health Organization in 2013.[13] The subjects were examined while seated on a dental chair. The clinical examination of dental caries was conducted using a dental explorer and mouth mirror, examination was started from the upper right quadrant and ended with the lower right quadrant in an orderly method, a tooth was already included if any part of it was evident. The assessment of the dental caries was registered in a special form of DMFT.

Unstimulated saliva samples were collected from the children in the morning between 9 am and 11 am. The children were instructed to rinse their mouth with distilled water for one minute and then relax for five minutes before saliva collection. Saliva was collected by spitting into sterilized cups with graduations.[14] Then 0.1 ml of saliva was taken by micropipette to make serial dilutions for bacterial counting, and the remaining saliva was divided into two parts, one part centrifuged at 3000 rpm for 15 minutes, then the supernatant of saliva was taken and stored in a freezer at −20°C.

The determination of salivary IgA levels was carried out using sandwich ELISA technology.

Statistical analysis

The data analysis was conducted using SPSS ver. 26.0 and Excel 2013. The data from the current study underwent thorough testing for normality to determine whether it followed a parametric or non-parametric distribution. Consequently, chi-square tests and the Least Significant Difference (LSD) One-way ANOVA post hoc analyses were conducted.

Results

Table 1 shows the demographic data of sex distribution in the study groups. There was a predominance of males compared with females in the study groups, with a statistically non-significant difference ($p>0.05$).

Table 1. Sex distribution in the study groups

Study groups	Female	Male	Total
Normal	12 (23.1%)	11 (31.4%)	23 (26.4%)
Overweight	15 (28.8%)	8 (22.9%)	23 (26.4%)
Obese	13 (25.0%)	5 (14.3%)	18 (20.7%)
Underweight	12 (23.1%)	11 (31.4%)	23 (26.4%)
Total	52 (100 %)	35 (100 %)	87 (100 %)
Chi-squared, (p value)	0.467		

In **Table 2**, significant differences ($p<0.05$) in DMFT were observed among the study groups (overweight, obese, underweight) when compared to the normal group. The obese group had the highest DMFT score, while the overweight group had the lowest. The obese group exhibited the highest mean *S. mutans* value, while the normal group displayed the lowest. The underweight group showed the highest mean *S. sobrinus* value, followed by the obese, overweight, and normal groups, respectively. Statistically significant differences ($p<0.05$) were found in the values of *S. sobrinus* and *S. mutans* across all groups. Regarding the level of salivary IgA in all groups, a statistically significant difference was evident. The obese group presented the highest mean salivary IgA value, followed by the overweight, underweight, and normal groups in descending order.

Table 3 shows a statistically significant difference between the normal weight and obese groups ($p=0.005$). Conversely, no significant differences were observed between the normal weight group and the overweight and underweight groups. Furthermore, the findings revealed a significant difference between the overweight and obese groups ($p=0.001$), whereas no significant difference was found between the overweight and underweight groups ($p=0.141$). When comparing the obese and underweight groups, a statistically significant difference was noted ($p=0.041$).

Table 4 presents the outcomes of the multiple comparisons of *S. mutans* levels among the various groups. A statistically significant difference was observed between the normal weight and obese groups ($p=0.001$). However, no significant differences were found between the normal weight group and the over and underweight groups. Additionally, the results indicated a significant difference between the over and obese groups ($p=0.001$), while no significant difference was detected between the over and underweight groups ($p=0.141$). In terms of the comparison between the obese and underweight groups, the findings demonstrated a statistically significant difference ($p=0.029$).

Table 2. Descriptive statistics of DMFT, cariogenic bacteria, and salivary IgA

Malnutrition	Mean±SD			
	DMFT	*S. mutans* $\times 10^5$ CFU/ml	*S. sobrinus* $\times 10^5$ CFU/ml	Salivary IgA µg/ml
Normal weight	2.35±1.722	12.63±4.48	1.122±0.563	9.85±5.33
Overweight	2.00±1.732	12.87±3.67	1.139±0.494	13.48±5.03
Obese	4.06±2.043	17.62±4.59	2.139±1.065	16.20±5.65
Underweight	2.83±2.059	14.67±4.19	2.413±1.046	11.57±5.55
Total	2.74±1.997	14.26±4.57	1.678±0.999	12.58±5.76
F	4.443	5.820	14.923	5.175
P-value	0.006	0.001	0.0001	0.003

Table 3. Multiple comparison of DMFT among groups

(I) Study groups	(J) Study groups	Mean difference (I-J)	*P*-value
Normal weight	Overweight	0.348	0.534
	Obese	−1.708	0.005
	Underweight	−0.478	0.392
Overweight	Obese	−2.056	0.001
	Underweight	−0.826	0.141
Obese	Underweight	1.229	0.041

Table 4. Multiple comparison of *S. mutans* among groups

(I) Study groups	(J) Study groups	Mean difference (I-J)	*P*-value
Normal weight	Overweight	−0.2435	0.846
	Obese	−4.9862	0.001
	Underweight	−2.0348	0.106
Overweight	Obese	−4.7428	0.001
	Underweight	−1.7913	0.154
Obese	Underweight	2.9514	0.029

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Table 5 illustrates the results of the multiple comparisons of *Streptococcus sobrinus* levels among the groups. A statistically significant difference was observed in the comparisons between the normal weight group and both the obese and underweight groups ($p<0.05$). However, no significant difference was found between the normal weight group and the overweight group ($p>0.05$). Furthermore, the results indicated a significant difference among the overweight group and both the obese and underweight groups ($p<0.05$). When comparing the obese and underweight groups, the findings revealed a statistically non-significant difference ($p=0.291$).

Table 6 displays the results of the multiple comparisons of salivary IgA levels among the groups. A statistically significant difference was observed between the normal weight group and both the overweight and obese groups ($p<0.05$). However, there was no significant difference between the normal weight group and the underweight group ($p>0.05$). Conversely, the results indicated a non-significant difference between the overweight group and both the obese and underweight groups ($p>0.05$). However, when comparing the obese and underweight groups, a statistically significant difference was observed ($p=0.008$).

Table 5. Multiple comparisons of *S. sobrinus* among groups

(I) Study groups	(J) Study groups	Mean difference (I-J)	*P*-value
Normal weight	Overweight	−0.0174	0.943
	Obese	−1.0171	0.000
	Underweight	−1.2913	0.000
Overweight	Obese	−0.9998	0.000
	Underweight	−1.2739	0.000
Obese	Underweight	−0.2742	0.291

Table 6. Multiple comparisons of salivary IgA level among groups

(I) Study groups	(J) Study groups	Mean difference (I-J)	*P*-value
Normal weight	Overweight	−3.63174*	0.025
	Obese	−6.34517	0.000
	Underweight	−1.71391	0.283
Overweight	Obese	−2.71343	0.113
	Underweight	1.91783	0.230
Obese	Underweight	4.63126	0.008

Discussion

The results of this study showed that overweight and obesity groups are negatively correlated with the mean DMFT score compared to the normal weight group. Likewise, there was a negative correlation between overweight, obesity, and the mean number of *S. mutans*. The same results were shown for *S. sobrinus*, but the negative correlation included the underweight too. Salivary IgA was negatively correlated with overweight and obesity when compared to the normal weight group.

The present study added some insight into the relationship between malnutrition and dental caries in terms of DMFT, cariogenic bacteria (*S. mutans* and *S. sobrinus*), and salivary IgA. The new information pertains to schoolchildren who are 12 years old in the Middle Eastern country of Iraq. Such a study could be helpful as a baseline for prospective studies concerning the same topic in the same geographic area.

However, a small sample size could be an issue; hence, we cannot generalize these results unless we have a larger sample size representative of the whole population. Despite the fact that malnutrition was based on a BMI scale, we could not assure if malnutrition in children was chronic or acute because we did not have previous measures of BMI of the participants. Additionally, we need better design studies, such as cohort studies, to test the correlation between malnutrition, dental caries, cariogenic bacteria, and salivary IgA to be able to conclude a causative relationship between malnutrition and dental caries, cariogenic bacteria, and salivary IgA.

A recently published research on Iraqi children concluded that having normal BMI is associated with lower DMFT score in children.[15] In agreement with this study, our results showed that overweight and obesity are negatively correlated with the mean DMFT score compared to the normal weight group. In contrast to these results, an Iraqi study found that no significant differences were found in caries experience between chronic malnourished children and well-nourished ones.[16] Nevertheless, developing countries, in general, suffer from malnutrition and elevated dental caries experiences, as one study found that dental caries prevalence was higher in permanent teeth in severely malnourished children than in normal Indian children.[17]

Likewise, there was a negative correlation between being overweight or obese and the mean number of *S. mutans*. The same results were shown for *S. sobrinus*, but the negative correlation included the underweight too. Previous studies concluded the same results concerning the presence of high infection of mutans streptococci compared to well-nourished children.[16,17]

According to earlier studies, children who were moderately malnourished had lower salivary IgA concentrations than children who were fed properly.[18] Our results showed a similar observation that salivary IgA was negatively correlated with overweight and obesity, compared to normal weight group.

The secretory immunity may be impaired in malnourished children due to decreased levels of immunoglobulin A in secretions.[18] The mechanisms by which malnutrition affects secretory IgA may be related to the deficiency of dietary protein or a specific vitamin.[19] A systematic review demonstrated that the underlying mechanisms of immu-

nological alterations that are associated with malnutrition in children are still inadequately understood.[20]

The data of this study could not extensively investigate the relationship between malnutrition and caries experience in terms of DMFT, cariogenic bacteria, and salivary IgA, as there are several confounders that could affect this correlation. These confounders include biological, socio-demographic, and hereditary factors. Future research needs to address this issue with larger data and more complex statistical models to control such confounders and have more precise results.

Conclusion

Malnutrition is a predisposing factor for oral health disorders in children. Urgent action and continued research are needed to develop effective strategies that prevent and mitigate the impact of malnutrition on oral health, ensuring a brighter future for children.

Patient consent for publication

Written informed consent was obtained from all patients in the present study for the publication of their data and any related images.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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The authors report no involvement in the research by the sponsor that could have influenced the outcome of this work.

Conflict of interest

All the authors declare no commercial or financial conflict of interest.

Author contributions

A.A.F.: conceptualization, data curation, formal analysis, investigation, methodology, resources, writing – original draft, writing – review and editing; F.Y.A.: review and editing; S.S.A.: review and editing; SKH: review and editing

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Влияние неполноценного питания на здоровье зубов 12-летних детей: исследование кариеса постоянных зубов, кариесогенных бактерий и секреторного IgA в слюне

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Резюме

Введение: Недоедание у детей является эпидемией в развивающихся странах. Считается, что из-за этого явления развиваются несколько проблем со здоровьем и последствий. Здоровье полости рта у детей также страдает от недоедания. Основными аспектами состояния здоровья полости рта являются наличие кариеса, наличие кариесогенных бактерий и секреторного иммуноглобулина А в слюне.

Материалы и методы: В это сравнительное исследование были включены 87 школьников в возрасте 12 лет. Участники с системными заболеваниями были исключены. Был проведён осмотр полости рта для регистрации индекса DMFT, затем утром были собраны образцы слюны с использованием нестимулированного метода. Анализ секреторного IgA в слюне проводился с использованием технологии Sandwich ELISA. Недоедание основывалось на индексе массы тела (ИМТ), который рассчитывался как вес/рост^2 (kg/m^2). Этическое одобрение было предоставлено этическим комитетом факультета дентальной медицины. До начала исследования были получены информированные согласия родителей детей.

Результаты: По сравнению с группой с нормальным весом результаты этого исследования показали, что избыточный вес и ожирение обратно коррелируют со средним DMFT и количеством S. mutans и S. sobrinus. Секреторный IgA в слюне отрицательно коррелировал с избыточным весом и ожирением по сравнению с группой с нормальным весом.

Заключение: Дети, страдающие от недоедания, подвержены риску развития заболеваний полости рта. Таким образом, лечение недоедания улучшит общее состояние полости рта у детей.

Ключевые слова

кариесогенные бактерии, кариес зубов, недоедание, детская стоматология, секреторный иммуноглобулин А в слюне