

Assessment of Relationship Between Body Mass Index (BMI) And Oral Health Among Age Group Between 5 To 13 Yrs In Nizamabad: A Cross Sectional Study

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ABSTRACT

Introduction: Dental caries is a multifactorial infectious disease initiated by cariogenic microorganisms influenced by a combination risk factors such as poor dietary habits, high consumption of sugar-rich foods and beverages including obesity as one. Addressing these factors together can promote better overall health in children. The primary objective of this study was to investigate the nature of the relationship between dental caries and obesity in children aged 6 to 13 years residing in the Nizamabad population zone.

Aim : The present study is done to evaluate the relation between the body mass index and oral health status among 6-13 year children in nizamabad population

Methodology: A descriptive cross sectional study to assess the oral health status in relation to body mass index carried out in 5 to 13year old children of government and private schools. The BMI of the patients was calculated and OHIS was measured according to green and vermilion and individuals scoring was recorded. The OHIS was established on selected index tooth surfaces with WHO periodontal probe. According to Knutson, Henry Klien, Carole Palmer the number of filled teeth, decayed teeth and missing teeth calculated for DMFT and extracted teeth for deft for primary tooth.

Results : The results indicated that the majority of the participants (83.5%) were classified as underweight. The average DMFT score was 1.473. Highest OHIS scores were noticed in overweight group 1.01 ± 0.52 . Obese group reported an OHIS score of 0.90 ± 0.43 and also the DMFT scores were highest in the overweight group followed by the other groups. On comparison of DMFT scores based on BMI group, a statistically significant difference was noticed on comparison of DMFT scores with different BMI groups ($p=0.000^*$).

Conclusion: Overweight children had higher OHIS scores in overweight group. Similarly, DMFT scores were higher among obese children highest DMFT scores were noticed in obese group. However, despite these observations, the statistical analysis showed no significant correlation between BMI and either DMFT or OHIS scores.

Keywords : Body mass index, Dental caries, OHIS, Obesity

INTRODUCTION:

Food stands at the top of the hierarchy of human necessities not only for maintaining health but also plays a role in the development of disease. Food is defined as any substance consumed to provide nutritional benefits. Locally, food affects the tissues it comes into contact with, while systemically, it supports overall health, growth, cellular regeneration, tissue repair, and immune function.¹

Dental caries exemplifies a local effect of food on the oral environment.¹ The interaction between food remnants and oral bacteria leads to plaque formation producing metabolic by products during this

interaction affecting both soft and hard oral tissues, contributing to dental caries. At the same time, obesity among school-aged children has emerged as a growing public health issue across both developed and developing countries which is characterized by an excess of body fat relative to lean mass.²

Obesity involves complex factors including changes in metabolism, psychological patterns, social behavior, and body composition. A primary cause is the consistent consumption of calories beyond the body's energy needs, often combined with insufficient physical activity. Sedentary lifestyles like excessive use of smartphones, online gaming, and limited parental supervision within nuclear family setting have been recognized as key contributors to obesity.³

The Body Mass Index (BMI) remains the most commonly used method for classifying individuals as underweight, normal weight, overweight, or obese. Haliti F. et al⁴ found that children categorized as obese within the BMI-age percentile groups specifically 12-year-olds had higher OHI-S scores and a greater number of DMFT score. A cross-sectional study conducted at Jouhar et al⁵ evaluated factors such as dietary habits, physical activity, sleep patterns, media usage, and brushing practices and found that 42.2% of participants had a high prevalence of dental caries, and 55.3% were either overweight or obese.

The relationship between dental caries and obesity remains complex process. According to Bernabe et al⁶ in the United States reported no significant association between the dental caries and obesity in school-aged children, highlighting the complexity. In contrast, a study conducted in England suggested a positive correlation between dental caries and obesity in white children, likely due to higher sugar consumption, while among non-white populations, the relationship was inverse⁷. Similarly, A research from New Zealand concluded that there was no observable link between childhood obesity and dental caries, reinforcing the idea that this relationship is influenced by multiple, interrelated factors.⁸

Prior documented literature analysing the relationship between obesity and dental caries yielded contradictory results making it difficult to understand the actual association. Furthermore no such study has been conducted in the Nizamabad region till date and no data was available about the association between dental caries and obesity in the school children in this region. Hence, the present study was designed to examine and report the type of relationship between dental caries and obesity among school children in the 6-13 yrs school going children in nizamabad population region

MATERIAL AND METHODS

Study Area : A descriptive cross sectional study was carried out for a period of 6 months to assess the oral health status in relation to body mass index which was carried out among 5 to 13 years school going children attending the Out Patient of Department of Pediatric and Preventive Dentistry, Meghna Institute Of Dental Sciences and Private/Govt schools of Nizamabad

Sampling size Determination

The dental caries prevalence in the current study population estimated from formulae

$$n = \frac{Z \times p \times q}{d^2}$$

n = Sample size

Standard normal value (Z value) = 2.58, d:

Precision = 3% (0.03),

P = 0.49

q = 1 - p

For calculating the sample size, after substitution of the values the sample size was arrived at 1848, which was rounded off to 2000.

Study Design: An signed informed consent from their parents/guardians and Frankel's Definitely positive or Positive behavior children were included in the study and children excluded from the study are special health care children, Frankel's Negative definitely behavior, medically compromised children. A pilot study was conducted prior where it showed 52 % of DMFT scores in obese group. The sampling procedure involved Multistage stratified sampling procedure was used for the sampling selection. Where the Nizamabad district was divided into 3 strata urban, rural, tribal areas schools were random sampling (Lottery) method selected. In each area, one school from both private and government schools was selected from. Eligible children were selected randomly selected.

Ethical Clearance :Prior to the initiation of the study, ethical approval was secured from the Institutional Review Board of Meghna Dental College. The study protocol was reviewed and approved by the Institutional Ethical Committee under Approval Number: MIDS/MDS/PEDO/2022-2023/001

Study methodology: A single examiner was trained and calibrated pilot study on patients in the department of Pedodontics & Preventive Dentistry, Meghna dental college Nizamabad District to prevent any diagnostic variability among the study participants (Kappa value was 0.8). The investigator himself conducted all the clinical examinations with help of recording assistants. The height and weight were recorded, followed by an oral examination of the child. The child was asked to stand straight after removing their footwear. The standing height was estimated to be the closest full centimeter, utilizing a measuring scale. The weight was noted using an electronic librated scale, and rounded off to the nearest 1 kg. BMI was computed by dividing the weight by kilograms and height squared in meters. BMI was categorized into underweight (BMI < 18.5), normal (BMI 18.5–24.9), overweight (BMI 25–30) and obese (BMI > 30)The children were seated on a comfortable chair under natural light using sterile portable equipment, including a mirror, explorer and cotton pellets. Dental caries was diagnosed according to clinical examination for dental caries was performed. Caries was diagnosed using criteria proposed by the World Health Organization (WHO)¹⁵ and was quantified using the decayed and filled teeth index (i.e. dft and DFT for the deciduous and permanent dentitions, respectively)¹⁶.The ‘missing’ (i.e. ‘M’) component was not considered in this study population who were in the mixed-dentition stage as its inclusion would result in over-estimation of the caries experience and OHIS scoring was done according to Greene and vermilion using a WHO probe .

Statistical analysis: The acquired data were tabulated and subjected to statistical analysis. Descriptive statistics were explained by frequency, mean, and standard deviation. The measures of dispersion were analyzed using Chi-square and analysis of variance (ANOVA) test at a level of significance of 5% (P < 0.05).Intra comparison group was done by using paired t test and inter comparison group was done by one way ANOVA

RESULTS:

Table 1: Agewise distribution among study population

Age	N (%)	P value
<10 years	1067(53.3%)	0.214
>10 years	933 (46.7%)	

The study characteristics consists of 1067 were children aged below 10 years, and 933 children were above 10 years. Table 1 shows age wise distribution. Table 1 shows the age wise distribution of study participants, 53.3% of study participants were less than 10 years and 46.7% of study participants were more than 10 years (p > 0.214)

Table 2: BMI distribution among study population

BMI	N (%)	P value
Underweight	1669 (83.5%)	0.001*
Normal	272 (13.6%)	
Overweight	43(2.2%)	
Obese	16(0.8%)	

Table 2 shows the BMI distribution among study population 83.5% of study population were underweight,13.6% were normal, 2.2% were overweight and 0.8% were obese with a (p > 0.001).

Table 3: OHIS distribution among study population:

OHIS	N (%)	P value
Good	1760 (88%)	0.001*
Fair	233 (11.7%)	
Poor	7 (0.3%)	

Table 3 shows the distribution of study population based on OHIS, 88% of study population have good oral hygiene, 11,7% of study population have fair oral hygiene and remaining 0.3% have poor oral hygiene (p > 0.001)

Table 4 : Inter and Intra group comparison of OHIS Scores

	Groups	Mean ± SD	P value		Mean Difference	P value
OHI-S	Underweight (A)	0.83±0.41	0.000*	Group A vs Group B	-0.14	0.000*
	Normal (B)	0.98±0.46		Group A vs Group C	-0.18	0.000*
	Overweight (C)	1.01±0.52		Group A vs Group D	-0.07	0.826
	Obese	0.90±0.43		Group B vs Group C	-0.03	0.923
				Group B vs Group D	0.08	0.803
				Group C vs Group D	0.11	0.421

Interpretation: On comparison of OHI-s scores based on BMI group, a statistically significant difference was noticed on comparison of OHI-s with different BMI groups ($p=0.000^*$). Furthermore, on pairwise comparison between the individual groups a statistically significant difference was noticed between the underweight and normal group ($p=0.000^*$) and underweight and overweight group ($p=0.000^*$). However, there was no statistically significant difference between the other comparisons

Table 5: Inter and Intra group comparison of DMFT Scores

	Groups	Mean ± SD	P value		Mean Difference	P value
DMFT	Underweight (A)	1.58±1.97	0.000*	Group A vs Group B	0.63	0.000*
	Normal (B)	0.94±1.46		Group A vs Group C	0.98	0.000*
	Overweight (C)	0.60±0.82		Group A vs Group D	-0.41	0.812
	Obese (D)	1.99±3.40		Group B vs Group C	0.34	0.881
				Group B vs Group D	-1.05	0.000*
					Group C vs Group D	-1.39

Interpretation: On comparison of DMFT scores based on BMI group, a statistically significant difference was noticed on comparison of DMFT scores with different BMI groups ($p=0.000^*$). Furthermore, on pairwise comparison between the individual groups a statistically significant difference was noticed between the underweight and normal group ($p=0.000^*$) and underweight and overweight group ($p=0.000^*$). Similarly, a statistically significant difference was noticed between the normal a obese group as well as Overweight and Obese group ($p=0.000^*$) respectively. However, there was no statistically significant difference between the other comparison.

DISCUSSION

Dental caries is a microbial disease of the teeth that results in decalcification of calcified tissue and dissolution of un-calcified tissues of the teeth. The word caries derived from Latin word meaning 'rot' or 'decay'. Obesity and dental caries in children are significant health problems with a positive relationship between overweight/obesity. Dental caries in children aged 6 years and younger might be because children in their early years rely on parents for appropriate health behaviours such as dietary choices. Furthermore, it is reported that children with overweight or obesity tend to consume large amounts of obesogenic (energy-dense, high fat, and low-nutrient) and cariogenic (high sugar) diets that lead to protein-energy malnutrition. It has been hypothesised that children with overweight/obesity have a higher dental caries experience because they share certain common risk factors such as high-sugar diet, low SES, and low health literacy. Furthermore, the relationship between overweight/obesity and dental caries cannot be explained by consumption of high carbohydrate diet alone and consists of other important underlying factors, which possibly influence the role of diet. Obesity, a chronic non-communicable condition, has dramatically increased over the past two to three decades across all age groups. The prevalence of co-morbidities such as type 2 diabetes, fatty liver disease, gallstones, high blood cholesterol and triglycerides, orthopedic disorders, hypertension and other cardiovascular diseases, some types of cancer, and psycho-social issues is increased among the 30 to 50 percent of adult Indians who are overweight or obese.¹⁰ A BMI between 18.5 and 25 is generally regarded as normal. However, it is advised that Asians have a BMI of 18.5 to 23 because, even at lower BMIs, they typically have larger percentages of body fat than Caucasians and Europeans. Boys and girls experience growth spurts at

different ages, so gender-specific BMI centiles are utilized to evaluate their nutritional condition¹¹. Accordingly, children with a BMI below the 5th percentile are deemed undernourished, while those with a BMI below the 85th percentile are deemed normal, and those with a BMI above the 95th percentile are deemed overweight. Children's weight status is determined by calculating the body mass index (BMI) graded by age and gender.

In children obesity can result in a number of issues, including major illness and a shorter life expectancy. According to Davison et al¹³ the ecological model proposes that sedentary behavior, physical activity, and food consumption are risk factors for childhood obesity. One of the main causes of overweight and obesity in adulthood is thought to be overfeeding during infancy, childhood, and adolescence, as well as consuming junk or unhealthy meals. In addition, it appears that the propensity for obesity in families is hereditary. According to Fisher & Birch and Ricketts¹⁴ children who had thicker tricep skinfolds showed a greater taste for fat, and consumption of fat was positively correlated with their liking meals high in fat. Bamji¹⁵ discovered that when kids between the ages of two and five were exposed to kids whose food preferences were different from their own, they altered their own and ate more of a dish they didn't like. In the Nizamabad district, this study hypothesized an association between dental caries and BMI in the 5–13 age range. However, it showed no correlation between BMI and DMFT index and its constituent parts there was statistical significance in the outcomes. Obesity and dental caries have been linked in a variety of age groups. Caries in children in a specific age group was examined by Alishiri et al¹⁶. Differences in diet, eating habits, and physical activity, as well as in the timing of tooth eruption, may be influenced by gender. Furthermore, variations in body form, growth milestones, and hormonal impacts lead to gender-related disparities in body fat percentage. These could affect the link between dental caries and obesity prevalence. The majority of the included studies made an effort to uphold. But Alghamdi and Almahdy¹⁷ examined the link between obesity and dental caries in a population of solely boys, they found that boys had higher rates of dental caries. Kumar et al utilized an Indian growth chart, Farsi et al. used a Saudi chart, and Liang et al. used a Chinese chart. Different groupings are thus created by the various classification criteria. Additionally, there were irregularities in the research' BMI distribution and grouping technique. In order to preserve a normal distribution, it is advised that samples be divided throughout all BMI groups¹⁸. Americh-Torres et al¹⁹ on the other hand, divided the subjects into three groups: normal weight, overweight, and obese. According to Indian growth charts, the current study population's underweight BMI was 1669 (83.5%), followed by normal (272, 13.6%), overweight (43, 2.2%), and obese (16, 0.8). In the present study population were classified with under weight BMI were 1669(83.5%) followed by normal 272(13.6%), overweight 43 (2.2%) and obese 16(0.8) similar to that of Indian growth charts.

This study hypothesized a relationship between the dental caries and BMI among age group of 5 to 13 years in the Nizamabad district but demonstrated that a no correlation between BMI with DMFT index and its components the results were statistically significant. Larsson et al²⁰ found that children with higher OHIS values were more likely to be obese, which is consistent with these findings. The current study results also showed that girls had a higher BMI than boys, which could be because females are more prone to increased weight and obesity due to anxiety, stress and depression due to changes in puberty, leading to increased levels of cortisol promoting weight gain. As per a systematic review, 48% of the studies found no association between dental caries and BMI, 35% found a positive correlation, and 19% found a negative association. In the present study The OHIS scores in under weight, normal, overweight and obese was 0.83, 0.98, 1.01 and 0.90 respectively and the OHIS scores was high in overweight followed by normal . and least in the underweight the difference between the OHIS among the different categories of BMI which was found statistically significant which may be due to mastication ability, whereas the poor level of the composed question mealtimes are now longer . These findings agree with those of Sukhabogi et al found that children who were normal weight or under normal weight had greater DMFT indices than those who were overweight or obese.

There was no correlation between dental caries and obesity in a study that looked at the relationship between BMI and oral health in Korean adults. Liang and colleagues examined 32,461 children in China in 2016 and found that a higher BMI was associated with a decreased incidence of dental caries; as a result, obese children in their study had fewer teeth with cavities. Similar findings were found by Norberg et al in Sweden but youngsters who were overweight or obese did not have greater incidence of dental caries than others, while underweight children had a higher prevalence of dental caries than children of average weight. Alkarami HA²¹ also revealed a negative correlation between dental caries and BMI, which may be because early malnutrition increases the buildup of plaque, which in turn may lead to tooth caries. In our study, the range of BMI signifying overweight was 25–29.9, and the threshold for obesity was

defined as having a BMI of 30 or over. However, in the above mentioned study conducted on individuals from Korea, the ranges were defined as 23 –24.9 for the overweight individuals, and the threshold for obesity was defined as having a BMI of 25 and over. Therefore, we are of the opinion that comparing studies using different threshold values for BMI will not be appropriate. A no correlation was seen between the BMI and DMFT scores in my study. These results were similar to the study conducted by Venugopal reddy et al who also reported a no association between body weight and dental caries be due to the complex relationship between BMI and dental caries in children as the caries is higher in obese children due increased intake and prolonged exposure to carbohydrates in various dietary forms.²²

In the present study 1067(53.3%) of the study population were <10 years of age and 933(46.7%) of study population were >10 years of age. In the present study males contributed for 1016(50.8%) and females were 984(49.2%). Under weight BMI were 1669(83.5%) followed by normal 272(13.6%), overweight 43 (2.2%) and obese 16(0.8%). Most of the study population 1760(88%) has good OHI-score, 233(11.7%) has fair OHI-S and 7(0.3%) has poor OHI-S. The mean DMFT score among the study population was 1.473. The OHI-S scores in under weight, normal, overweight and obese was 0.83, 0.98, 1.01 and 0.90 respectively, The DMFT scores in under weight, normal, overweight and obese was 1.58, 0.72, 0.59 and 1.99 respectively and the difference among BMI categories and DMFT, OHI-S was statistically significant. A significant no relation or association was seen no significant correlation was found between the BMI and DMFT, BMI and OHI-S.

Limitation: One of the study's limitations was its cross-sectional design, which makes it impossible to determine a cause-and-effect link. To evaluate the impact of weight on dental caries in children and adolescents, more research is needed. Additionally, more research is advised to evaluate the link between OHI-S and dental caries in a prospective (cohort) approach.

CONCLUSION: The current study found no relationship between the children's BMI and dmft/DMFT. In order to address these children's health issues, dentists, pediatricians, and psychiatrists should take into account the intricate connections between diet, exercise, and dental health. Thus, it's critical to move on with additional study on obesity, physical activity, and dental health. The determinants of dental caries might be better understood thanks to longitudinal designs.

REFERENCES :

1. Maurya M, Bennadi D, Konakeri V. Association between Body Mass Index and Dental Caries among 6 To 12-Year-Old School Children in Mysore City: A Cross-Sectional Study. *Annals of the Romanian Society Cell Biology*. 2021 Jun 25;7608-14
2. Shailee F, GM S, KR S. Association between dental caries and body mass index among 12 and 15 years school children in Shimla, Himachal Pradesh. *Journal of Advanced Oral Research*. 2013 Jan;4(1):6-10.
3. Mustafa AE, Assery AA, Asiri FM, Alfarhan NM, Alqarni AM, Alqahtani FM. Childhood obesity and its relation with dietary habits among children in Aseer region, Southern Saudi Arabia. *J Family Med Prim Care* 2021;10:3760-1
4. Haliti F, Murtezani A, Tahirbegolli B, et al. Association between Oral Health and Body Mass Index among Schoolchildren. *World J Dent* 2021;12(1):84-88.
5. Jouhar R, Ahmed MA, Khurshid Z, Bokhari SA. Association of BMI, diet, physical activity, and oral hygiene practices with DMFT index of male dental students at King Faisal University, Al-Ahsa. *Nutrients*. 2021 Jan 14;13(1):224.
6. Bernabé E, Sheiham A. Age, period and cohort trends in caries of permanent teeth in four developed countries. *Am J Public Health* 2014;104:e115-21
7. Okuya Y. The epidemiological study of the relation between caries incidence and sugar consumption on the second molar. *J Dent Res* 1960;60:1120-34
8. Te Morenga L, Mallard S, Mann J. Dietary sugars and body weight: systematic review and meta-analysis of randomised controlled trials and cohort studies. *BMJ* 2012;346:e7492
9. Greene, J. C., & Vermillion, J. R. (1960). The Oral Hygiene Index: A method for classifying oral hygiene status. *Journal of the American Dental Association*, 61(3), 172-179
10. Sudhakar K, RSharath P, Shanthi M, Fareed N, Sudhir KM. Relationship between Dentition status and Body Mass Index among 5 to 15 years old age group children of an orphanage in Nellore city. *J Indian Assoc Public Health Dent*. 2010;8(15):45.
11. Sharma A, Hegde A. Relationship between body mass index, caries experience and dietary preferences in children. *J Clin Pediatr Dent*. 2009;34(1):49-52.
12. Yee R, McDonald N. Caries experience of 5-6-year-old and 12- 13-year-old schoolchildren in central and western Nepal. *International dental journal*. 2002 Dec;52(6):453-60.
13. Davidson K, Schroth RJ, Levi JA, Yaffe AB, Mittermuller B-A, Sellers EAC. Higher body mass index associated with severe early childhood caries. *BMC Pediatr*. 2016;16:1-8
14. Fisher-Owens SA, Gansky SA, Platt LJ, Weintraub JA, Soobader MJ, Influences on children's oral health: a conceptual model. *Pediatrics*. 2007;120:510-20
15. Bamji MS, Kamala Krishnaswamy and Brahmam GNV. *Text Book of Human Nutrition*, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, Third Ed. 2009
16. Alshihri, A.A.; Rogers, H.J.; Alqahtani, M.A.; Aldossary, M.S. Association between Dental Caries and Obesity in Children and

Young People: A Narrative Review. *Int. J. Dent.* 2019, 2019, 9105759

17. Ahmed Abdullah Alghamdi, Ahmed Almahdy Association Between Dental Caries and Body Mass Index in Schoolchildren Aged Between 14 and 16 Years in Riyadh, Saudi Arabia *J Clin Med Res.* 2017;9(12):981- 986
18. Shehri, Hamdan & Al-Qahtani, Awad & Shaikh, Ibrahim & Hassan, Moaiah & Al-Qahtani, Saeed & Al- Qahtani, Ali & Alabas, Mosab. Assessment of lifestyle and eating habits among undergraduate students in Najran University, Najran, Saudi Arabia. *International Journal of Medical Science and Public Health.* 638. 2017-2017. 10.5455/ijmsph.2017.1059801122016.
19. T. Almerich-Torres, J. M. Montiel-Company, C. Bellot-Arc'is, and J. M. Almerich-Silla, "Relationship between caries, body mass index and social class in Spanish children," *Gaceta Sanitaria*, vol. 31, pp. 499-504, 2016
20. Larsson B, Johansson I, Hallmans G, Ericson T. Relationship between dental caries and risk factors for atherosclerosis in Swedish adolescents. *CommunityDent Oral Epidemiol* 1995; 23: 205-10
21. Sukhabogi JR, Shekar C, Hameed IA, Ramana IV, Sandhu G. Oral health status among 12- and 15-year-o children from government and private schools in Hyderabad, Andhra Pradesh, India. *Ann Med Health Sci Res* 2014;4:272-7
22. Doichinova L, Bakardjiev P, Peneva M. Assessment of food habits in children aged 6-12 years and the risk of caries. *Biotechnol Biotechnol Equip.* 2015;29(1):200-204.