Association of Dental Caries with Body Mass Index in Patients Attending Dental OPD of Armed Forces Institute of Dentistry: A Cross-Sectional Study

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ABSTRACT

Objective: To evaluate the association of carious lesions with body mass index (BMI) using the International Caries Detection and Assessment System (ICDAS) system.

Study Design: Analytical cross-sectional study.

Place and Duration of Study: Armed Forces Institute of Dentistry, Rawalpindi, Pakistan from Mar to Aug 2024.

Methodology: A total of 104 subjects were evaluated for this study with BMI of each participant grouped into four BMI categories: underweight, normal, overweight and obese, and ICDAS system was used for caries detection. Descriptive statistics were evaluated in Microsoft Excel and statistical analysis was done between BMI and dental using Fisher's exact test where a *p*-value < 0.05 was considered as statistically significant.

Results: Mean BMI among males was 32.69 ± 8.58 kg/m^2 and among females was 25.06 ± 5.15 kg/m^2. Code 00 was not observed and codes 03, 04, 21, 31, 52 and 62 were most frequently found ICDAS codes among the subjects. A statistically significant difference (*p*-value <0.001) in the distribution of ICDAS scores across all BMI categories (underweight, normal, overweight, and obese) was observed.

Conclusion: ICDAS score was highest among obese subjects and a positive association was observed between dental caries and BMI.

Keywords: Body Mass Index, Carious Lesions, Dental Caries, Restoration.

INTRODUCTION

Dental caries is one of the most common chronic oral diseases in the world and is prevalent in all ages, which if untreated, can cause pain, tooth loss, decreased oral function, and an overall reduction in quality of life.[1,2] With a general incidence of 60% in Pakistan,[3] its risk factors include reduced flow of saliva, preexisting defects in the tooth, frequent carbohydrate-rich diet intake, and improper fluoride exposure.[4-7] There are numerous reports assessing the relationship between BMI and dental caries, with 39% of studies demonstrating a positive association between high BMI and caries but 50% of the studies indicated no association.[8] Similarly, overweight and obese individuals had significantly higher caries prevalence than individuals with normal BMI with people having obesity reporting significantly higher mean DMFT score (Decayed, Missing, Filled Teeth) (12.4±5.6) than those of normal weight subjects (9.8±4.9, *p*=0.003)[9]. In contrast, underweight patients might also have increased risk of caries, possibly attributed to enamel hypomineralization or developmental abnormalities, with the International Caries Detection and Assessment System (ICDAS) being more sensitive and specific for the detection of early lesions than the conventional DMFT index.[10] Despite various studies examining this association, there have been no reports of studies utilizing the ICDAS system to determine the association between BMI and dental caries among the Pakistani population. Thus, the objective of the present study is to determine the association between BMI and dental caries based on the ICDAS system in patients visiting a tertiary care dental center in Pakistan.

METHODOLOGY

This analytical cross-sectional study comprised of patients who attended the Department of Operative Dentistry, Armed Forces Institute of Dentistry (AFID), Rawalpindi, Pakistan, from March to August 2024. Approval for conducting this study was obtained from the Institutional Review Board of the Armed Forces Institute of Dentistry, Rawalpindi, via letter no. 918/Trg dated 27 December 2023. The sample size was calculated by power estimation of 0.80, and an assumed medium effect size of 0.3 for the association

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between body mass index (BMI) and dental caries, based on the general trends reported,[11] and alpha level of 0.05. Demographic data was obtained through a structured questionnaire from the patients after receiving informed consent.

Inclusion Criteria: Patients of either gender with age ranging from 19 to 70 years, presenting in Outpatient Department were included.

Exclusion Criteria: Pregnant females, having diabetes mellitus or ischemic heart disease or any previous history of arrhythmia, were excluded.

The patient's body weight and height were measured, and computation of BMI was done by dividing the weight (in kg) and square of height (in m^2). The participants were grouped into four categories on the basis of their BMI: underweight (BMI: 18.5), normal (BMI 18.5-24.9), overweight (BMI 25-30), and obese (BMI>30). Oral examinations were done following the ICDAS system with assessment of the condition of teeth on smooth surfaces and in the occlusal region in both dry and moist conditions using this system's codes,[12] where ICDAS follows a binary digit system of codes, where the first digit indicates any previous restorations or presence of sealant (range of codes from 0-8), and the second digit indicates the progressive state of carious lesions (range of codes from 0-6) while other four distinctive codes in this system provide an elaborative representation of dental health that makes it easier to comprehend the diagnosis and treatment of caries (where code 96 entails no tooth surface can be examined, 97 indicates missing tooth due to caries, 98 indicates other reasons for missing tooth and 99 indicates unerupted tooth). After recording each dental surface of the patient's tooth, the caries condition was inspected. The calibration between both examinations was then assessed by the Kappa correlation coefficient and was calculated to be 0.91. Patient data was entered and analyzed using Statistical Package for Social Sciences (SPSS) to calculate descriptive statistics such as Mean±SD for continuous variables such as age, height, weight and BMI while frequency and percentage were determined for categorical variables such as gender, BMI categories (underweight, normal, overweight, obese), and ICDAS scores. Fisher's Exact Test was employed to determine the correlation between categorical variables such as BMI status and caries/restorations categorized according to their ICDAS classification as either present or not present

and a *p*-value of ≤0.05 was considered as statistically significant.

RESULTS

Among the total 104 patients, 61(58.65%) males compared to 43(41.34%) females, with a mean age of 33.63±8.9 years. The mean height was 176.53±20.5 cm, and the mean weight was 80.68±25.0 kg. The average BMI among males was 32.69±8.58 kg/m^2 and among females was 25.06±5.15 kg/m^2. The BMI distribution among male patients showed 4(6.66%) were underweight, and 18(30.00%) had normal BMI. Similar percentage of patients (n=19, 31.67%) were observed in overweight and obese BMI categories while 5 (11.63%) patients were underweight, 16(37.21%) had normal BMI, 17(39.53%) were overweight and 5(11.63%) were obese among the female patients as shown in Table-I.

Table-I: Distribution of Study Participants According to Body Mass Index (BMI) Categories by Gender, (n=104)

BMI category	Males n(%)	Females n(%)	Total n(%)
Underweight	4 (6.66)	5(11.63)	9(8.65)
Normal	18 (30)	16(37.21)	35(33.65)
Overweight	19(31.67)	17(39.53)	36(34.62)
Obese	19(31.67)	5(11.63)	24(23.08)

Unsealed and unfilled teeth were found in 10(9.62%) cases, 2(1.92%) patients had lost or fractured restorations, 13(12.50%) patients had teeth restored with porcelain, veneer crowns, or porcelain-fused-to-metal (PFM) crowns, 14(13.46%) with stainless steel crown and none had temporary restorations while a total of 10(9.62%) patients had sound tooth surface however, 43(41.35%) patients showed incipient caries limited to the enamel, 40(38.46%) patients displayed prominent changes in enamel or dentin adjacent to the margin of a restoration or sealant, 10(9.62%) patients presented with carious lesions with discoloration and only 1 patient (0.96%) had marginal caries in enamel, dentin or cementum alongside a sealant or restoration as shown in Table-II.

Among 15 patients with amalgam restorations, 13 (86.7%) patients exhibited signs of marginal leakage, indicating permanent changes of tooth structure. Similarly, among those with composite fillings, 60% of the patients had lesions around their restorations. A statistically significant difference (*p*<0.001) was observed in the distribution of ICDAS score 1 across all the BMI categories (underweight, normal, overweight and obese) as shown in Table-III.

Table-II: IDCAS Score Distribution by Carious State versus Restoration, (n=104)

ICDAS Score for Carious State	n (%)	ICDAS Score for Restoration	n (%)
1	10(9.62%)	1	10(9.62%)
2	43(41.35%)	2	0(0%)
3	40(38.46%)	3	21(20.19%)
4	10(9.62%)	4	17(16.35%)
5	1(0.96%)	5	27(25.96%)
6	0(0%)	6	14(13.46%)
7	0(0%)	7	13(12.5%)
	-	8	2(1.92%)

Statistically significant difference was also detected between the distributions of ICDAS restoration scores by BMI categories (*p*<0.001). Higher frequencies of compromised restorations (ICDAS scores 2–3) were found in obese and overweight subjects, indicating that there was a greater necessity for restorative treatments in these groups than for normal weight and underweight groups as shown in Table-IV.

conformity with earlier research reporting a positive association of higher BMI with dental caries prevalence which reported statistically significant correlation between obesity and caries progression, mainly due to the regular consumption of fermentable carbohydrates among those with higher BMI.[11] In the current study, 31.67% of men and 11.63% of women were found to be obese, and this group had the highest ICDAS scores (scores 5-7), reflecting extensive carious lesions and restoration failure. Another study also observed that overweight and obese children had significantly increased rates of dental caries, especially among low socio-economic status children. Significantly, in the present research, 48.08% of the overweight subjects had ICDAS score 5 (discoloration showing dentin involvement), which is similar to the 47.3% prevalence of caries among overweight children found in the same study.[12] Children with higher BMI presented a 15-20% higher risk of acquiring carious lesions, indicating the potential of both genetic and environmental factors in this association.[13] The present research, although in adults, also showed that

Table-III: ICDAS Score 1 (Carious State) Distribution Across Different BMI Categories, (n=104)

Weight Category	ICDAS Score for Carious State							*p*-value
	0 n(%)	2 n(%)	3 n(%)	4 n(%)	5 n(%)	6 n(%)	7 n(%)	
Normal	2(1.92)	20(19.23)	13(12.5)	0(0)	0(0)	0(0)	0(0)	
Obese	0(0)	0(0)	0(0)	0(0)	9(8.65)	13(12.5)	2(1.92)	<0.001
Overweight	0(0)	0(0)	4(38.46)	27(25.96)	5(48.08)	0(0)	0(0)	
Underweight	8(76.92)	1(0.96)	0(0)	0(0)	0(0)	0(0)	0(0)	

Table-IV: ICDAS Score 2 (Restorations) Distribution Across Different BMI Categories, (n=104)

Weight Category	ICDAS Score for Restoration					*p*-value
	0 n(%)	2 n(%)	3 n(%)	4 n(%)	0 n(%)	
Normal	9 (8.65)	24 (23.08)	0 (0)	1 (0.96)	1 (0.96)	
Obese	0 (0)	12 (11.54)	10 (96.15)	2 (1.92)	0 (0)	< 0.001
Overweight	0 (0)	7 (6.73)	28 (26.92)	1 (0.96)	0 (0)	
Underweight	1 (0.96)	0 (0)	2 (1.92)	6 (5.77)	0 (0)	

DISCUSSION

The current research identified a significant association between body mass index (BMI) and dental caries in adults visiting a tertiary care dental clinic (*p*<0.001). The maximum caries burden, as indicated by ICDAS scores, was found in obese and overweight subjects, while underweight subjects showed the minimum number of carious lesions. Also, failed restorations were more common in overweight and obese categories, suggesting higher restorative requirements in these groups. These results are in

overweight and obese patients had a significantly higher caries prevalence than those with normal or underweight BMI (*p*<0.001), which supports the contribution of common lifestyle aspects like eating habits. On the other hand, lower caries were experienced in overweight and obese children, providing an indication that the association between BMI and caries is not age-independent.[14] Moreover, the present study found that 96.15% of obese individuals had compromised restorations (ICDAS restoration score 2), a trend similarly reported by

another study which demonstrated a significantly higher prevalence of defective restorations and gingivitis among overweight school children.[15] One study highlighted reduced masticatory function and caries as the determinants for BMI in preschool children,[16] although our adult sample demonstrated increased BMI as a risk factor for impaired oral health. Notably, the underweight subjects in the current study had low caries burden, which opposes the results obtained in other studies that have associated malnutrition with enamel hypomineralization and caries risk,[17,18] once again highlighting to the age-dependent nature of this association.

LIMITATIONS OF STUDY

The cross-sectional nature of the study precludes the establishment of cause-effect relation between BMI and dental caries. The size of the study was small and only included patients at a single tertiary care dental center, which may limit generalization to the general Pakistani population. Moreover, confounding variables related to oral hygiene behavior or dietary habit, salivary flow rate, and/or socioeconomic potential cofactors for both BMI and caries increment were not examined in this study.

CONCLUSION

The current study adds to the developing research that indicates a positive association between dental caries and BMI, particularly in areas with unhealthy eating behaviors and insufficient means of getting dental care, the outcomes are consistent with several other studies that have indicated comparable findings. Nonetheless, there is a complicated association between BMI and caries that may be impacted by a number of variables, such as oral hygiene habits, nutrition, and the standard of dental care.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

TK & NAR: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

MHS & SHN: Conception, data analysis, drafting the manuscript, approval of the final version to be published.

AA & ZR: Data acquisition, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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