Turkish Journal of Public Health Dentistry
Volume 2, Issue 2, Page No: 13-22
Available Online at: www.tjphd.com

ISSN: 3062-3359

Original Article

The Impact of Obesity and Demographic Factors on Periapical Lesions, Dental Caries, and Oral Health in Adults

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ABSTRACT

The World Health Organization (WHO) reports that more than two billion people worldwide are classified as overweight or obese, with numbers steadily increasing, including in Saudi Arabia, where it has become a significant public health concern. This growing problem places a financial strain on 16.5% of Saudis, especially those without insurance, as they allocate more than 10% of their income to costly dental procedures such as endodontic treatments or root-filled teeth (RFT). These procedures may be associated with the increasing prevalence of obesity and chronic periapical lesions, which affect the hard and soft tissues surrounding teeth and lead to bone loss, microbial activity, and release of toxins into the pulp, which can be observed through radiographic images. A cross-sectional observational study conducted at a dental school in Jeddah, Saudi Arabia, examined the relationship between obesity, RFTs, and periapical lesions, as well as other demographic factors such as age, gender, educational background, and waist circumference. The study collected data from 317 patients attending the endodontics department and performed quantitative and statistical analyses using the IBM SPSS 24 software package. The findings showed that there was a positive and significant correlation between obesity, waist circumference, age, and male gender with the presence of root-filled teeth and periapical lesions, while no significant correlation was found with educational levels. Based on the results, the researchers suggested that public health policymakers should implement taxes on sugary foods and soft drinks and increase healthcare insurance premiums for individuals classified as obese.

Keywords: Obesity, Health policy, Oral health, Public health, Demographics, Endodontics

Introduction

With the increase in catastrophic dental expenditure (CDE), where individuals spend 10% of their income on dental care, 16.5% of the population in Saudi Arabia faces the financial strain of paying for various dental treatments, including endodontics and root canal procedures, due to lacking insurance coverage. This results in a significant economic burden on the Saudi population [1]. Additionally, CDE may be linked to the rising prevalence of obesity in Saudi Arabia, which has become a critical and escalating public health issue globally [2]. As reported by Salem *et al*. Saudi Arabia has higher obesity rates than the global average, with more than 35% of its population affected, compared to just 13% worldwide [3]. A study by Althumiri *et al*. in 2020 found that obesity rates across thirteen Saudi provinces, with a BMI above 30, ranged from 20-25% of the population [4]. According to the WHO, by 2016, the number of obese and overweight adults surpassed those who are underweight. Over 2 billion adults globally are overweight, with 25% of them classified as obese. Weight categories, defined by body

HOW TO CITE THIS ARTICLE: Wu K, Yin W, Liang X, Yang Z. The Impact of Obesity and Demographic Factors on Periapical Lesions, Dental Caries, and Oral Health in Adults. Turk J Public Health Dent. 2022;2(2):13-22. https://doi.org/10.51847/MzsbLBIXDE

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Received: 05/06/2022
Accepted: 04/10/2022

mass index (BMI), include underweight, normal, overweight, and obese, with BMI calculated as weight divided by height squared [5].

Obesity is recognized as a significant risk factor for numerous systemic health conditions, such as type 2 diabetes, hypertension, hyperlipidemia, cholelithiasis, arteriosclerosis, and both cerebrovascular and cardiovascular diseases [6]. Saudi Arabia experiences some of the highest obesity and overweight rates globally. Contributing factors include enduring traditional cultural practices, extreme weather conditions, modern cultural shifts, and economic growth, all of which promote unhealthy eating habits, sedentary behavior, and weight gain [7]. The rate of obesity among adults in Saudi Arabia has risen from 22% between 1990 and 1993 to 36% in 2005, with projections suggesting a rise to 41% in men and 78% in women by 2022 [8]. In terms of obesity, its link to periodontal inflammation is well-documented in existing literature. The potential relationship between chronic oral infections and systemic health has become a major area of interest within the dental and medical research communities [9]. Studies have shown that obesity is associated with an increased occurrence and prevalence of periodontal disease in adults [10, 11].

Research conducted in Saudi Arabia found a positive correlation between obesity and age. It also revealed that men tended to have larger waist circumferences compared to women [12].

Higher BMI values have been found to correlate positively with the severity of periodontal attachment loss [13]. Obese individuals also face a higher risk of periodontal disease progression, and while results have varied, numerous studies have explored the connection between obesity and dental caries in adults [14]. A variety of studies have linked obesity to an increased incidence of dental caries [15-19]. Additionally, some research suggests a relationship between obesity and early tooth movement during orthodontic treatment [20, 21]. This raises the possibility that obesity might also contribute to periapical lesions (PLs).

A recent study conducted in Jeddah, Saudi Arabia, in 2022 found that women had higher dental knowledge and awareness, along with better oral health outcomes than men. Furthermore, individuals with higher education levels demonstrated improved oral health [22].

Kim *et al*. [23] conducted an observational study in South Korea, which revealed that dental decay and caries leading to root-filled teeth were directly associated with obesity, older age, and notably, women. Schmidt *et al*. [24] also concluded that obesity negatively affects oral health, contributing significantly to poor periodontal status and an increased occurrence of carious lesions [24].

Educational attainment is typically categorized as having a college degree or higher, high school, middle school, elementary school, or no education. Research by Min and Jung [25] involving 191 elderly individuals (aged 65 years and older) showed that a higher level of education was positively associated with better oral health. A 2020 study in Saudi Arabia by Mosli *et al*. [26] found a negative correlation between obesity prevalence and educational levels, although it was noted that individuals with higher income but lower education levels had higher obesity rates in the Kingdom.

Periapical lesions (PL) are a result of a defensive response to bacterial invasion from an infected root canal, leading to persistent inflammation [27]. Several studies have highlighted the connection between PL and various systemic conditions. For instance, radiolucent PLs have been observed in patients with coronary artery disease and those who have suffered from acute myocardial infarctions [28, 29]. Additionally, a well-established relationship exists between type 2 diabetes and PL [30-33]. Patients with radiolucency have also shown a higher likelihood of hepatic complications [34]. Although there has been limited research linking PL presence in obese individuals, a single study has addressed this topic [15]. Therefore, the primary aim of this study is to explore the potential link between obesity and radiographic signs of PL in dental patients. This clinical research investigates the connection between root-filled teeth (RFT), PL, obesity, waist circumference, and demographic factors such as gender, age, and educational background. The study concludes by evaluating and ranking the influence of these demographic variables and obesity on both PL and RFT.

Materials and Methods

The period between July 2019 and February 2020 saw the implementation of this cross-sectional research at Ibn Sina National College of Dentistry in Jeddah, Saudi Arabia. The research team recruited participants from dental patients who visited the college's dental clinics for the first time. A total of Three hundred seventeen patients, both male and female, who met the inclusion and exclusion criteria, were enrolled in the study. Inclusion criteria required patients to be twenty years or older and consent to undergo clinical and radiographic assessments as well

as anthropometric measurements. Exclusion criteria excluded smokers (current or former), diabetic individuals, pregnant women, and those with fewer than 20 remaining teeth. The study was approved by the institutional ethics committee, and informed consent was acquired from all participants before enrollment. Data collection was performed in three phases: intraoral examination, radiographic evaluation, and measurements of body height and weight. All patient data were gathered during the same visit.

A single calibrated examiner performed a thorough clinical examination of each patient's mouth. Dental caries were assessed by counting the number of carious teeth. The teeth were visually inspected after being dried and probed on all surfaces. Periodontal health was evaluated by measuring the presence of plaque, probing depths, and bleeding upon probing. Each tooth was examined at six different sites or surfaces: mesiobuccal, midbuccal, distobuccal, and 3 corresponding lingual/palatal sites. The total number of remaining teeth was also recorded.

The presence of identifiable periapical lesions, root-filled teeth, and RFTs with detectable PL was assessed through the examination of digital panoramic and periapical radiographs by a specialized endodontist. A tooth was classified as root-filled if a radiopaque substance was observed within the root canal system. The periapical condition was evaluated based on predefined criteria. Each tooth was scored as 0 for normal, meaning the periodontal ligament space and surrounding alveolar bone showed no changes in the periapical region, and scored as 1 for periapical lesion, which was defined by the presence of apical radiolucency or the expansion of the periodontal ligament space in the apical area to more than twice its normal width [35]. Multi-rooted teeth were considered as one unit. A standardized approach was followed in the radiographic image analysis. Third molars were excluded from both clinical and radiographic assessments.

To evaluate obesity, the BMI was determined by dividing the participant's weight in kilograms by the square of their height in meters. A clinician measured each participant's weight and height consistently using a medical scale, and the BMI was then calculated. Participants were instructed to remove their heavy clothing and shoes before measurement. The BMI values were categorized following the WHO guidelines into four groups: underweight, normal weight, overweight, and obese [36]. All categories were included in the analysis.

The collected data were organized and analyzed using SPSS statistical software for Windows. A P value of 0.05 or lower was considered to indicate statistical significance.

Results and Discussion

A total of 317 participants were included in the research. The participants were classified into 4 groups based on their BMI values. After 6 months of data collection, the researchers understood that among the 317 participants, 123 (38.8%) had at least 1 root-filled tooth (RFT), and 108 (34.1%) had periapical lesions (PL).

For qualitative data, frequencies and percentages were used for description. To compare categorical variables between groups, the Chi-square test was applied. Quantitative data were summarized using mean and standard deviation for normally distributed data, and an independent t-test was used to compare two independent groups. Statistical significance was considered at the 5% level, with two-tailed probabilities reported. To assess the effect of BMI on dental diseases, regression analysis was performed.

When examining the relationship between root-filled teeth and demographic factors based on BMI categories, it was found that 83.7% of the participants with RFT were classified as obese.

Regarding education level, the incidence of root-filled teeth was notably higher in individuals with lower levels of education, showing a significant correlation between education level and the presence of RFT **(Table 1)**.

Table 1. Breakdown of the patient groups based on essential demographic information.

	Number	**Percent**
Gender		
Male	244	77.0
Female	73	23.0
Age group		
< 25 years	82	25.9
25-50 years	202	63.7
> 50 years	33	10.4
Age	20.0-60.0	
Range	34.8801	

Mean SD	10.54608	
Level of Education		
No education	74	23.3
Primary school	75	23.7
Middle school	33	10.4
High school	72	22.7
College	63	19.9
BMI category		
Underweight	62	19.6
Normal weight	70	22.1
Overweight	44	13.9
Obese	141	44.5
BMI Range Mean SD	17.10-58.5 30.81 7.146	
W.C Range Mean SD	52.0-142.0 105.30 14.95	

Age also showed a significant relationship with RFT, with the majority of individuals in the 25-50 years age group (84.6%) exhibiting root-filled teeth. Lastly, a higher incidence of RFT was observed in males compared to females, as illustrated in **Table 2**.

Table 2. Association between fundamental demographic factors and the occurrence of root-filled teeth.

BMI category	**Root filled teeth**			
	Negative		**Positive**	
	No	**%**	**No**	**%**
Underweight	50	25.8	12	9.8
Normal weight	66	34.0	4	3.3
Overweight	40	20.6	4	3.3
Obese	38	19.6	103	83.7
X^2 P	128.150 0.0001*			
Level of Ed				
No education	40	20.6	34	27.6
Primary school	47	24.2	28	22.8
Middle school	28	14.4	5	4.1
High school	41	21.1	31	25.2
College	38	19.6	25	20.3
X^2 P	10.001 0.040*			
Age group				
< 25 years	70	36.1	12	9.8
25-50 years	98	50.5	104	84.6
> 50 years	26	13.4	7	5.7
X^2 P	38.154 0.001*			
Gender				

Male	139	71.6	105	85.4
Female	55	28.4	18	14.6
X^2		7.990		
P		0.003*		

The connection between periapical lesions and demographic factors based on BMI categories revealed that about 82.4% of individuals with periapical lesions were obese. This indicates a significant correlation between higher BMI and the occurrence of periapical lesions.

Regarding education levels, no notable association was found between the occurrence of periapical lesions and educational background. However, a significant relationship was observed between age and the presence of periapical lesions, with 89.0% of cases in the 25-50 years age range. Lastly, gender differences showed that males exhibited a significantly higher incidence of periapical lesions compared to females, as presented in **Table 3**.

Table 3. The connection between fundamental demographic information and the prevalence of periapical lesions

	Periapical lesion			
BMI category	**Negative**		**Positive**	
	No	**%**		
Underweight	50	23.9	12	11.1
Normal weight	67	32.1	3	2.8
Overweight	40	19.1	4	3.7
Obese	52	24.9	89	82.4
X^2		0.001*		
P				
Level of Ed				
No education	45	21.5	29	26.9
Primary school	51	24.4	24	22.2
Middle school	28	13.4	5	4.6
High school	42	20.1	30	27.8
College	43	20.6	20	18.5
X^2		8.266		
P		0.082		
Age group				
< 25 years	70	33.5	12	11.1
25-50 years	113	54.1	89	82.4
> 50 years	26	12.4	7	6.5
X^2		25.193		
P		0.001*		
Gender				
Male	151	72.2	93	86.1
Female	58	27.8	15	13.9
X^2		7.719		
P		0.003*		

The association between basic demographic data and the occurrence of root-filled teeth showed that the average BMI for positive cases was 34.09 ± 6.92, while for negative cases it was 29.12 ± 6.67, indicating a significant rise in BMI among those with root-filled teeth.

For age, the mean for positive root-filled teeth cases was 38.44 ± 8.19 years, while for negative cases it was 33.03 ± 11.15 years, with an important increase in age observed in the positive group.

Waist circumference (WC) in positive cases was 114.36 ± 11.63, while in negative cases it was 100.61 ± 14.33, showing a notable increase in WC among those with root-filled teeth.

Regarding the association between demographic factors and periapical lesion incidence, the mean BMI in positive cases was 34.47 ± 6.95, compared to 28.50 ± 6.25 in negative cases, demonstrating an important increase in BMI for those with periapical lesions.

The age for positive periapical lesion cases was 39.03 ± 7.97 years, while negative cases had an average age of 32.24 ± 11.13 years, with a significant rise in age observed in positive cases.

Waist circumference in positive cases for periapical lesions was 114.79 ± 11.02, compared to 99.28 ± 13.98 in negative cases, indicating an important increase in Waist circumference for those with periapical lesions.

Table 4 presents the relationship between the number of root-filled teeth with periapical lesions and the number of root-filled teeth about WC, BMI, and age. An important positive correlation was observed between both the number of root-filled teeth with periapical lesions and the total number of root-filled teeth with WC, BMI, and age. This indicates that as WC, BMI, and age increase, so does the number of root-filled teeth with periapical lesions and the overall number of root-filled teeth.

Table 4. The relationship between the number of root-filled teeth with periapical lesions and the total number of root-filled teeth in connection with BMI, WC, and age.

		Number of root-filled teeth having periapical lesions	**Number of root-filled teeth**
BMI	Pearson Correlation	.292**	.304**
	P-value	.000	.000
Age	Pearson correlation	.176**	.226**
	P-value	.002	.000
WC	Pearson correlation	.428**	.413**
	P-value	.000	.000

Table 5 presents the multivariable linear regression analysis of various risk factors on root-filled teeth (RFT). The results from this model indicate that RFT was influenced by several risk factors, with BMI showing the strongest effect, followed by gender, WC, and age. The education level, however, was found to have no significant impact on this model.

Table 5. Multivariable linear regression analysis of various risk factors associated with root-filled teeth.

Model	**Unstandardized coefficients**		**Standardized coefficients**	**T**	**Sig.**
	B	**Std. Error**	**Beta**		
Constant	-.775	.192		-4.028	0.0001*
Age	.008	.002	.173	3.576	0.004*
Gender	-.165	.053	-.143	-3.129	0.002*
WC	.007	.002	.216	3.291	0.001*
Level of Ed	-.018	.015	-.056	-1.219	0.224
BMI category	.134	.026	.328	5.223	0.0001*
a. Dependent Variable: Root-filled teeth					

Table 6 presents the multivariable linear regression analysis of various risk factors on periapical lesions. The findings from this model indicate that periapical lesions were influenced by various risk factors. The most prominent risk factors were an increase in BMI, followed by gender, WC, and age. The education level, however, showed no significant effect in this model.

This study aimed to investigate the potential link between root-filled teeth and obesity, as well as the presence of periapical lesions, through radiographic examination in dentate individuals visiting dental school clinics. Additionally, the research compared participants categorized by their BMI, considering various dental and demographic factors such as gender, age, and education levels.

Table 6. Multivariable linear regression analysis of various risk factors associated with periapical lesions.

Model	**Unstandardized coefficients**		**Standardized coefficients**	**T**	**Sig.**
	B	**Std. error**	**Beta**		

Constant	-.595	.200		-2.967	.003*
Age	.005	.002	.120	2.307	.022*
Gender	-.158	.055	-.140	-2.873	.004*
WC	.006	.002	.195	2.772	.006*
Level of education	-.014	.016	-.044	-.901	.368
BMI	.112	.027	.283	4.197	.0001*
a. Dependent variable: Periapical lesion					

The current findings demonstrated a strong relation between the presence of periapical lesions (PL) and obesity in the sample, with a similar correlation observed between obesity and root-filled teeth (RFT). Research exploring the connection between obesity and periapical lesions, particularly examining the number of periapical lesions as part of a dental index, remains limited [15]. The results of this study indicate that the impact of obesity on the number of periapical lesions teeth is noteworthy.

In this investigation, a majority of RFTs were found to have PL across all four groups. While we did not assess the quality of the endodontic fillings in these RFTs, previous studies have shown that inadequately performed root canal treatments are closely linked to the radiographic presence of PL within the Saudi population [37-39]. This could be because most endodontic procedures in Saudi Arabia are conducted by general dentists [40, 41]. The relatively small number of specialized endodontists in the country and the limited tendency of general dentists to refer patients might contribute to the suboptimal standard of care in endodontic treatments [40]. However, it is important to note that the RFT identified with periapical lesions in this research might have been in a healing phase, as we lacked data on the timing of the treatments.

Obese individuals tend to exhibit poorer oral health behaviors. Research has indicated that those with a higher BMI often show worse dental health, evidenced by an increased number of missing teeth, more decayed teeth, and more severe periodontal disease [10]. Another study found that obese patients were less likely to use interdental brushes or floss regularly and had a higher number of missing teeth [42]. Additionally, individuals with a higher BMI showed a positive correlation with bleeding on probing [43]. Obese individuals were also found to have poorer oral hygiene habits, such as brushing their teeth less frequently, using fewer supplementary oral products, and making irregular dental visits [19, 44].

Periapical radiographs and cone beam computed tomography are known to be more accurate in detecting radiolucent periapical lesions (PLs) [45]. A comparison between orthopantomograms and periapical radiographs revealed no significant differences in detecting periapical radiolucency [46, 47]. In this research, digital panoramic radiographs were used, as the digital panoramic machine was available at the college hospital. OPG provides the advantage of examining all teeth in a single image, which also results in a relatively lower radiation dose. To avoid the influence of smoking and diabetes on the frequency of periapical lesions, individuals who were current or former smokers and those with diabetes were excluded from the study. Previous reports have shown a significant association between radiolucent PL and both smoking and diabetes [31, 38], particularly with the increasing prevalence of these conditions among the Saudi population [48, 49].

In this study, BMI was utilized as an indicator of obesity. However, BMI is not considered the definitive method for diagnosing obesity, and there are differing opinions regarding the use of BMI versus other obesity indices to predict obesity [50]. Therefore, using BMI as an assessment tool for obesity remains controversial, and various results could emerge when other obesity measures are used.

A limitation of this study is its cross-sectional design, which prevents the determination of causal relationships. Additionally, the sample was drawn from a single institution in one city, meaning the results are preliminary and cannot be generalized to the entire population of Saudi Arabia. Furthermore, several potentially significant factors were not included in this analysis, such as biochemical assessments of inflammatory markers and the impact of socio-demographic variables. Lastly, the results might have been affected by the unequal distribution of participants across the BMI categories.

Given that Saudis are among the highest consumers of carbonated beverages globally, ranking fourth in the world, these findings highlight the need to address obesity as a national public health concern. This underscores the importance of implementing effective prevention strategies and policies to curb its prevalence across various age groups and prevent its further escalation. Potential measures may include imposing taxes on sugary foods and drinks and increasing healthcare insurance premiums for individuals with obesity.

Conclusion

Despite the acknowledged limitations of this study, the results revealed a significant association between obesity, as measured by BMI, and the presence of periapical lesions (PL), as well as root-filled teeth (RFT) observed through panoramic radiographs.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: Ethical approval was granted by the institutional ethics committee at Umm Al-Qura University, Kingdom of Saudi Arabia.

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