Original Article

Dental Caries and Its Association with Body Mass Index among School Children of Riyadh, Saudi Arabia

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Background: Few studies have investigated the relationship of dental caries with obesity among Saudi Arabian population. Hence, this study was conducted to assess the association of obesity with dental caries among school children. Materials and Methods: A cross-sectional, descriptive study was conducted among 12- and 15-year-old government school children of Riyadh. A total of 2247 children were examined from 24 schools of Riyadh. Caries status (decayed, missing, and filled teeth [DMFT]) was recorded according to World Health Organization (WHO) Oral Health Survey 2013. Height and weight measurements were recorded after clinical examination. According to body mass index (BMI) percentiles, the children were classified as underweight, normal weight, overweight, or obese. Chi-square test was used to find association between variables for categorical data. Mean ± standard deviation (SD) was calculated for continuous measurements and to find the difference between the groups unpaired t test/analysis of variance was used. A value of \( P < 0.05 \) was considered statistically significant. Results: Dental caries prevalence was 83.7% and mean DMFT was 5.31 ± 3.88 in the study population. A statistically significant difference was found for mean decayed, mean filled teeth, and overall mean DMFT between 12 and 15 years old \( (P < 0.001) \), but not for mean missing teeth \( (P = 0.137) \). There was no association between BMI categories and mean DMFT for both the age groups. Conclusion: The dental caries was found to be high among the study subjects compared to WHO norms. Older children had higher DMFT values than the younger children and there was no association between dental caries and BMI. Keywords: Body mass index (BMI), dental caries, Saudi Arabia, school children, WHO

INTRODUCTION

It is well established from the previous and recent studies on trends that obesity is increasing rapidly irrespective of age, gender, and ethnicity.\(^1\-^3\) Data available from Saudi Arabia indicate that there is high prevalence of obesity.\(^4\) Obesity is a multifactorial, lifestyle-related disease with major contributory factors being excessive consumption of junk and processed food, lack of exercise, sedentary life, and stress.\(^5\-^7\) The imbalance in the energy intake and spent is the cause of obesity.\(^8\)

Obesity is a known risk factor for several diseases such as type II diabetes mellitus, hormonal imbalance, dyslipidemia, hypertension, cardiovascular diseases, respiratory problems, and psychosomatic disorders.\(^8\-^12\) Its impact on oral health is not well explored compared to general health. Both dental caries and obesity have several common risk factors, such as dietary

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habs, sociodemographic background and stress, which warrants a common risk factor approach.\textsuperscript{[13]} But, correlation between obesity and dental caries is relatively new concept. There are studies showing a relationship between obesity and dental caries, few reported a positive relationship, few negative, whereas remaining studies have shown no relation.\textsuperscript{[14-19]} There are few studies conducted among children in Saudi Arabia to show the prevalence of dental caries but drawback was small sample size.\textsuperscript{[20]} Hence, this study was conducted to assess and compare dental caries among school children of Riyadh and to find its association with obesity.

**Materials and Methods**

A cross-sectional, descriptive study was conducted to include 12- and 15-year-old government school children of Riyadh city as they are the indicator age group to assess dental caries. The survey was organized by the Community Division, PNU. The research was approved by the Institutional Review Board (IRB), PNU (Log No. 17-0110). The data presented are a part of the detailed oral health survey conducted according to World Health Organization (WHO) Oral Health Survey Form 2013. A total of 2247 female children aged 12 and 15 years studying in various government schools of Riyadh comprised the sample. Children who were present on the day of examination, gave assent, and informed consent by parents were included in the study.

**Training and calibration**

Six examiners underwent training and calibration for recording WHO Oral Health Survey Forms under the supervision of an expert (MH) in the dental school. The $\kappa$ value for inter-examiner agreement ranged from 0.82 to 0.90.

**Sample size**

The sample size calculation equates to understanding the number of subjects needed for a sufficiently narrow 95% confidence interval estimating the binomial parameter of prevalence. The dental caries prevalence was estimated to be 50%, which yields the maximum sample size. With 2.5% allowable error, the sample size was estimated to be 2000.

**Sample design**

This survey used a multistage sample selection. List of schools was provided by Ministry of Education. Accordingly there are a total of 222 elementary and 149 middle government schools in Riyadh city. These schools formed the sampling frame. Sampling was carried out to ensure unbiased representation of the five geographic areas of Riyadh: East, West, North, West, and Central regions.

In total, 24 government elementary and middle schools (12 each) from five geographic regions throughout Riyadh were selected. As schools vary significantly in terms of size within each of the five regions and with the desire to ensure that enough numbers of students are recruited, it was decided to use larger schools within each region. Among the five regions, 24 schools were conveniently selected from the larger schools. These schools were representative of all the government schools of Riyadh city. For the second stage, permission to conduct the screening and to schedule visits for selected schools were obtained. Replacement schools were selected from the same geographical area if any school declines to participate. The third stage involved the selection of all 12- and 15-year-old children from sixth and ninth grades in the school. Students were explained about the study and mentioned participation was voluntary. Children who gave assent were included in the study. Date and time was decided based on the availability of students.

**Clinical examination**

As the oral health examination was conducted at the school site, portable dental equipment was used. After obtaining the demographic data, type III examination was conducted. Sterile mouth mirrors, tweezers, cotton rolls, and Community Periodontal Index (CPI) probes were used for examination. Caries status (decayed, missing, and filled teeth [DMFT]) was recorded according to WHO Performa 2013.\textsuperscript{[21]} A total of 12 trained and calibrated examiners and recorders performed the examination. After the examination, each child received a toothbrush and toothpaste and a referral cards were given to class teacher to send it to the parents.

**Calculation of body mass index**

Height and weight were recorded after clinical examination. Weight of each child on barefoot was measured after calibrating weighing before use. Height was measured to the nearest 0.1 cm using a height measuring scale attached to the wall. According to Table 1, body mass index (BMI) was calculated and based on it, children were categorized into four groups: underweight, normal, overweight, and obese.

**Statistical analysis**

The data were analyzed using Statistical Package for the Social Sciences (SPSS) software program, version 24.0 (IBM, Chicago, Illinois, USA). Percentages were calculated. Chi-square test was used for categorical data. Mean ± standard deviation (SD) was calculated.
for continuous measurements and unpaired t test/analysis of variance (ANOVA) was used for intergroup comparison. Pearson correlation was used for test the correlation between obesity and DMFT. A value of $P < 0.05$ was considered statistically significant.

**RESULTS**

A total of 2247 children examined accounting to 93.6% participation rate. BMI percentiles are presented in Table 1.

Overall 83.7% had decayed teeth, 12.7% had missing teeth, and 31.5% had filled teeth. Prevalence of DMFT was 89.9%. Table 2 shows statistically significant difference between DMFT in 12 and 15 years old.

Table 3 shows that overall mean decayed teeth was 4.28 ± 3.6, mean missing teeth was 0.27 ± 0.92, and mean filled teeth was 0.76 ± 1.53. Mean DMFT was 5.31 ± 3.88. There was statistically significant difference in mean decayed, filled teeth, and overall mean DMFT between 12 and 15 years old ($P < 0.001$), but not for missing teeth.

No statistically significant association was found between BMI categories and dental caries and BMI with DMFT for both the age groups [Table 4].

Pearson correlation showed positive correlation for combined ages between BMI and DMFT.

**DISCUSSION**

The Community Dentistry Division conducts a regular oral examination, awareness, and health education programs as a part of social responsibility. This study was a part of one of the programs. Age groups of 12 and 15 years were selected as they are the WHO age groups for assessing dental caries. The WHO Oral Health Survey 2013 form for children was used to assess dental caries as there are no studies conducted for caries assessment using this form in Saudi Arabia. There is no difference with regard to dental caries assessment by 2013 compared to the 1997 form. The sample represented female children from government school of Riyadh city. Although the sample size was optimum, only female subjects were examined due to cultural norms. As children from government schools were selected, the results need to be generalized with caution. It is believed that government schools have more treatment needs than the private schools.[22-26] Hence, as a first step government schools were selected to assess the caries status, and provide oral health education and referral for the treatment. This will be extended later to private schools children.

Overall 90% children had dental caries. As per the WHO, only cavitated lesions were considered as dental caries. Signs of initial caries such as white spot lesion, demineralization, or loss of translucency were not considered, and no radiographs were used. This could have led to underestimation of caries. Despite of which, caries prevalence can be considered high among the study population.

The difference in the caries prevalence among the age groups was statistically highly significant ($P < 0.001$). The overall mean DMFT was 5.31 ± 3.88. The difference in mean DMFT between 12 and 15 years old was also significant with higher scores for 15 years old. DMFT is a cumulative, irreversible index, and increase in scores can be expected with increase in age. A study among Saudi children showed that the prevalence of dental caries was lower in the permanent teeth compared to this study.[27] This could be due to younger age group and inclusion of both genders. When dental caries of primary and permanent teeth were combined, the prevalence was similar to this study.[27]

| Percentile* | BMI cutoff value |
|-------------|------------------|
|             | 12 years | 15 years |
| <5 (underweight) | 14.27    | 16.17    |
| 5–85 (normal)   | 25.4     | 28.4     |
| 85–95 (over weight) | 29.8     | 33.35    |
| >95 (obese)     | >29.8    | >33.35   |

BMI = body mass index

*BMI categorization is based on BMI percentile of study subjects

| Number of subjects | Decayed teeth | Missing teeth | Filled teeth | DMFT |
|--------------------|---------------|---------------|--------------|------|
|                    | N(%)          | N(%)          | N(%)         | N(%) |
| 12 years (983)     | 760(77.3)     | 87(8.9)       | 222(22.6)    | 835(84.9) |
| 15 years (1264)    | 1120(88.6)    | 198(15.7)     | 485(38.4)    | 1184(93.7) |
| Total (2247)       | 1880(83.7)    | 285(12.7)     | 707(31.5)    | 2019(89.9) |
| $P$ Value          | <0.001*       | <0.001*       | <0.001*      | <0.001* |

DMFT = decayed, missing, and filled teeth

*Statistically significant (chi-square test applied)
A study by Ashi et al. [28] showed that DMFT was low compared to this study. It could be due to less sample size and their main objective was not to assess the prevalence of dental caries.

There was no statistically significant association between caries prevalence and BMI for both age groups in this study. The overall results could not be combined as BMI category was different for 12 and 15 years, which was based on percentile for each age category. This was in contrast to study conducted by Farsi DJ, where significant association was found for deciduous teeth but not for permanent teeth. [27]

No statistically significant difference was found between BMI and mean DMFT. This was in contrast to a study conducted by Willerhausen et al. [15] mean DMFT scores increased across the BMI categories, although the mean DMFT was low compared to this study. The low DMFT scores of their study could be due to the fact that it was conducted in a low caries prevalence area.

The findings of this study showed that overweight/obesity was not correlated to dental caries, which was in agreement with a number of studies, [28-33] although conflicting results are presented in various studies. Some studies have found positive relation, [13,15] whereas other studies have shown negative relation. [27,34,35]

Modéer et al. [13] showed that dental caries was associated with obesity after adjusting for all the potential confounders. Conflicting results were found in a study conducted by Köksal et al. [36] which could be due to different age groups. Another study showed that dental caries was high among obese children compared to normal weight children. [33] A recent systematic review [20] and narrative review [37] conducted in Saudi Arabia supports the result of this study. The systematic review included nine studied conducted among children of different age groups and the result was inconclusive. It showed a weak positive correlation between DMFT and BMI and statistical significance could be due to large sample size. [29]

Dental caries as a multifactorial disease with factors such as oral hygiene, diet composition and consumption frequency, socioeconomic status, salivary flow, amount of bacteria, and fluoride exposure are well established. BMI can be an associated factor and certainly not an isolated risk factor for dental caries. [15] This study was

**Table 3: Distribution of study subjects according to age and mean DMFT**

| Number of subjects | Decayed teeth Mean (SD) | Missing teeth Mean (SD) | Filled teeth Mean (SD) | DMFT Mean (SD) |
|--------------------|-------------------------|-------------------------|------------------------|----------------|
| 12 years (983)     | 3.05 ± 2.77             | .24 ± 1.00              | .41 ± 1.93             | 3.70 ± 3.00    |
| 15 years (1264)    | 5.23 ± 3.89             | .30 ± .85               | 1.04 ± 1.82            | 6.56 ± 4.03    |
| Total (2247)       | 4.28 ± 3.61             | .27 ± .92               | .76 ± 1.53             | 5.31 ± 3.88    |
| *P Value*          | <0.001*                 | <0.001*                 | <0.001*                |                |

**Table 4: Distribution of study subjects according to BMI categories and DMFT**

| BMI category | Number of subjects | DMFT = 0 | DMFT ≥ 1 | Mean DMFT (SD) |
|--------------|--------------------|----------|----------|----------------|
| 12 years (983) |                    |          |          |                |
| Under weight  | 49(5)              | 5(10.2)  | 44(89.8) | 4.10(3.05)     |
| Normal weight | 785(79.9)          | 114(14.5)| 671(85.5)| 3.74(3.00)     |
| Over weight   | 100(10.1)          | 18(18)   | 82(82)   | 3.18(2.80)     |
| Obese         | 49(5)              | 11(22.4) | 38(77.6) | 3.67(3.25)     |
| Total         | 983                | 148(15)  | 835(85)  |                |
| *P Value*     | 0.27*              |          |          |                |
| 15 years (1264) |                    |          |          |                |
| Under weight  | 64(5.1)            | 4(6.3)   | 60(93.7) | 6.95(3.62)     |
| Normal weight | 1011(80)           | 64(6.3)  | 947(93.7)| 6.52(4.06)     |
| Over weight   | 126(10)            | 11(8.7)  | 115(91.3)| 6.24(4.01)     |
| Obese         | 63(4.9)            | 1(1.6)   | 62(98.4)| 7.42(3.96)     |
| Total         | 1264               | 80(6.3)  | 1184(93.7)|               |
| *P Value*     | 0.30*              |          |          |                |

**DMFT = decayed, missing, and filled teeth, BMI = body mass index, SD = standard deviation**

*Chi-square test applied

**Analysis of variance (ANOVA) applied

Conflicting results are presented in various studies. Some studies have found positive relation, [13,15] whereas other studies have shown negative relation. [27,34,35]

Modéer et al. [13] showed that dental caries was associated with obesity after adjusting for all the potential confounders. Conflicting results were found in a study conducted by Köksal et al. [36] which could be due to different age groups. Another study showed that dental caries was high among obese children compared to normal weight children. [33] A recent systematic review [20] and narrative review [37] conducted in Saudi Arabia supports the result of this study. The systematic review included nine studied conducted among children of different age groups and the result was inconclusive. It showed a weak positive correlation between DMFT and BMI and statistical significance could be due to large sample size. [29]

Dental caries as a multifactorial disease with factors such as oral hygiene, diet composition and consumption frequency, socioeconomic status, salivary flow, amount of bacteria, and fluoride exposure are well established. BMI can be an associated factor and certainly not an isolated risk factor for dental caries. [15] This study was
conducted in a relatively homogenized population, such as only female students, government schools, and single city which can minimize the sociobehavioral variation. Government schools may be considered as proxy for socioeconomic status and could further increase the chances of uniformity among subjects with regard to oral hygiene practices, dietary habits, and dental visits. Hence, an attempt was made to find a relation between dental caries and BMI. Further studies can be aimed at involving both the genders and private schools.

**CONCLUSION**

The prevalence of dental caries was high compared to WHO norms. Older children had higher DMFT values than the younger children and there was no statistically significant correlation between dental caries and BMI. Irrespective of existence or absence of the association, future preventive programs should be targeted to create awareness regarding healthy dietary habits to control both the conditions to follow the common risk factor approach.

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**Conflicts of interest**

There are no conflicts of interest.

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