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THE RELATIONSHIP BETWEEN DENTAL CARIES AND BODY MASS INDEX AMONG PRIMARY SCHOOL CHILDREN IN MAKKAH CITY

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ABSTRACT

Purpose: To evaluate the association between dental caries and body mass index (BMI) among a sample of male primary school children in Makkah city, Saudi Arabia.

Population and Methods: This is a cross-sectional study carried out on a sample of 548 6-12-years-old children in Makkah City, western region of Saudi Arabia. Cluster random sampling technique was applied to select students from public as well as private schools. All the subjects were examined by a single operator using a dmft (decayed, missing, filled primary teeth) and DMFT (decayed, missing, filled, permanent teeth) indices and BMI after obtaining the informed consent.

Results: The study included children with mean age 9.5±1.8 years. Of the examined children, 91.2 % had dental caries. Obese children represented 16.8% of the participants whereas underweight represented 11.6% of them. Caries prevalence in primary and permanent teeth among caries-affected children was 67.60% and 86.40% respectively. Underweight children exhibited the highest prevalence and severity of dental caries in both primary and permanent teeth. Correlation analysis showed significant negative relations with BMI, dmft [$r = -0.627$, $p < 0.01$] and DMFT [$r = -0.205$, $p < 0.01$].

Conclusions: Most of 6-12-years-old primary school children in Makkah had dental caries in both primary and permanent teeth. Underweight children were more likely to have dental caries in both primary and permanent teeth compared to children with other BMI categories.

KEY WORDS: Dental caries, Body mass index, Primary school children.

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INTRODUCTION

Dental caries and obesity are critical health problems worldwide and have been associated with a great number of negative health outcomes [1,2]. Dental caries is the most common infectious and transmissible childhood disease worldwide. It still affects many school children, despite all the efforts made in prevention programs. If caries is untreated, it may lead to discomfort, pain and finally loss of teeth. Furthermore, untreated dental caries affects general health, quality of life, productivity, developmental milestones and educational performance of children [3-7].

Analyzing and integrating several causative factors such as fluoride, microbial plaque, diet, salivary activity, social and life style related behavioral factors could evaluate the risk of dental caries [8,9]. Accordingly, for caries prevention and maintenance of oral health, several factors such as food low in fermentable carbohydrates, oral hygiene techniques, fluoride supplements, in addition to regular dental examinations have to be taken into consideration. Different preventive programs during the last decades lead to a significant decrease in dental caries, particularly in children [10-12].

Obesity is one of major public health problems in modern societies. Children are amongst the fastest growing group of the overweight and obese population. Childhood obesity is verified to be associated with numerous risk factors as cardiovascular diseases, type 2 diabetes mellitus and other chronic diseases [13-16].

Childhood obesity and overweight are mainly due to intake of low-density foods instead of vegetables and fruits and also due to high fat and high carbohydrate foods. Moreover, sedentary activities and certain socioeconomic factors are involved [17,18].

The prevalence of obesity and overweight among children and adolescents in some of the developed countries had increased over the last four decades. The percentage of obesity and overweight among Canadian children has increased significantly [19]. In Australia, National Health Survey data 2014–15 revealed that childhood obesity and overweight increased from 25.7% in 2011–12 to 27.4% in 2014–15 [20]. The prevalence of obesity among German school children increased from 1.8% in 1982 to 2.8% in 1997 [21]. In Saudi Arabia, a noticeable rise in childhood obesity level over the past two decades was evident. The prevalence of obesity in Saudi Arabia was significantly higher in 2013 than 2008 [22-25].

Body mass index (BMI) is the most commonly used measure for revealing the prevalence of obesity and overweight. It measures height for weight, which is frequently used to categorize underweight, overweight, and obese individuals [26]. Among children and teenagers, the amount of body fat differs between boys and girls. It also changes as the body grows. Hence, BMI assessments for children and teenagers take the growth and gender differences into account. These specific BMI values for children are referred to as "BMI-for-age." [27].

The association between dental caries and obesity in children has been evaluated in several studies; however, the results have always been different and generally contradictory [28-34].

Whereas, malnutrition manifested by obesity or underweight are common problems among children in developing countries and KSA society is not an exception. Also, dental caries is very prevalent despite efforts done to reduce its burden. There have been little researches documented in literature in this part of Saudi Arabia assessing the prevalence of dental caries in relation to BMI. Therefore, the current study was designed to assess the association between dental caries and BMI among 6-12-years-old primary school children in Makkah City.

MATERIALS AND METHODS

Study sample

The present cross-sectional study was carried out on a group of 6-12-years-old children in Makkah City in the western region of Saudi Arabia. The sample consisted of 548 primary school children. Public as well as private schools were randomly chosen, and 6–12-years-old children were randomly selected from the data of the school records using the cluster random sampling procedure.

The exclusion criteria included: pupils who are physically challenged, those with systemic illness and uncooperative children. Pupils with dentofacial deformities or any syndrome were also excluded.

Data collection procedure

All subjects were examined by a single operator using a dmft (decayed, missing, filled primary teeth) and DMFT (decayed, missing, filled, permanent teeth) indices and body mass index (BMI) after obtaining the informed consent.

A non-invasive dental examination was performed using mirror, No. 23 explorer and cotton rolls, with optimal illumination of the oral cavity. Determination of carious lesions was carried out visually without radiographic examination. Cavities and significant discolorations around the restorations were diagnosed as carious lesions. The clinical examination of dental caries for all participants constituting the sample was entirely done by a single investigator who was trained and calibrated for recording the WHO Oral Health Performa (WHO, 1997) for oral diseases [35].

The dmft was categorized according to the caries severity, based on previously suggested scores: dmft 0 = no caries; dmft 1 to 5 = low severity; and dmft ≥6 = high severity [36-38]. While, the DMFT index was categorized based on the severity scale to indicate very low prevalence with DMFT 0 to 1.1; low prevalence 1.2 to 2.6; moderate prevalence 2.7 to 4.4; high prevalence 4.5 to 6.5; and very high prevalence when the DMFT is greater than or equal to 6.6 [39, 40].

The height and weight of each child were recorded in a separate sheet. BMI was calculated according to the following formula: BMI= Weight in kg Height in m^2.

The value obtained was then plotted on age and gender–specific percentiles given by the Centers for Disease Control and Prevention (CDC) [41]. Children were accordingly categorized into four groups based on their BMI percentiles as follows:

- Underweight group children with BMI-for-age $<5^{th}$ percentile.
- Normal group children with BMI-for-age $\geq 5^{th}$ percentile and $<85^{th}$ percentile.
- Overweight group children with BMI-for-age $\geq 85^{th}$ percentile and $<95^{th}$ percentile.
- Obese group children with BMI $\geq 95^{th}$ percentile.

Data analysis

Analysis of the data was compiled by a descriptive method using frequency and percentage. Statistical analysis was performed by the computer program SPSS (Statistical Package for Social Sciences, version 22.0). Chi-square test was used to measure the association between categorical variables and p-value less than 0.05 was considered statistically significant.

Ethical considerations

Permission to conduct the survey in the selected schools was obtained from the respective school authorities and was planned over a period of eight weeks. To respect the participant's autonomous choices and integrity, they were informed verbally that the study is voluntary, and if somebody changed his mind before or while conducting the examination, he was allowed to discontinue the participation.

Parent/child was given a written consent following explanation of the information sheet. Research reports and manuscripts for publication contained no material that allowed identification of individual participants. The local research ethics committee was approached for approval to undertake the study.

RESULTS

The current study included 548 school children, their age ranged between 6 and 12 years with a mean and (±SD) of 9.5±1.8 years. Out of the 548 examined children, 500 (91.2 %) were caries-affected. Distribution of caries prevalence with respect to age is presented in table 1. The means for the dmft and DMFT indices in caries-affected children were 3.43 ± 3.24 and 1.69 ± 1.14 respectively. Body mass index (BMI) distribution showed that obese children represented 16.8% of the participants whereas overweight represented 10.4%, figure 1.

TABLE (1) Distribution of caries prevalence in relation to children's age.

Age (Years)	No.	%
6 (n=41)	36	87.80
7 (n=44)	41	93.18
8 (n=88)	82	93.18
9 (n=81)	74	91.36
10 (n=103)	94	91.26
11(n=106)	96	90.57
12 (n=85)	77	90.59
Total (548)	500	91.24

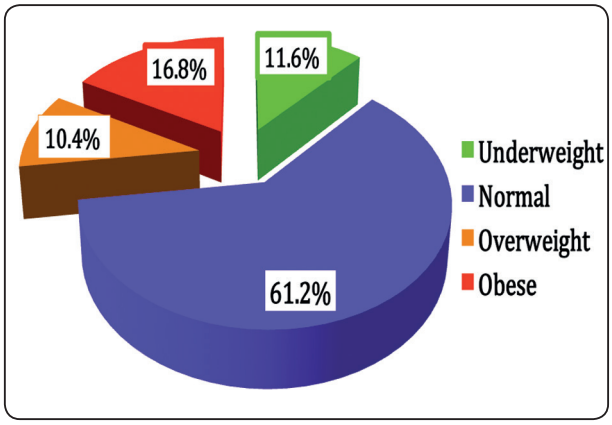

Fig. (1) Distribution of school children according to BMI categories.

The relation between age and BMI categories of caries-affected children is presented in table 2. Obesity was highest among children aged 12 years (31.2%), lower in those aged 10 years (21.3%) and lowest among 6-years-old children (5.5%). Overweight was highest among children aged 9 years (18.9%) and lowest among those aged 6 years (2.8%). Most underweight children (16.7%) were 6-years-old. The association between children's ages and BMI categories was statistically significant (p=0.008).

TABLE (2) Age and BMI categories distribution among caries-affected children

Age (Years)	Under weight		Normal		Over weight		Obese	
	No.	%	No.	%	No.	%	No.	%
6	6	16.7	27	75.0	1	2.8	2	5.5
7	6	14.6	29	70.7	2	4.9	4	9.8
8	10	12.2	50	61.0	8	9.7	14	17.1
9	5	6.7	48	64.9	14	18.9	7	9.5
10	14	14.9	53	56.4	7	7.4	20	21.3
11	11	11.5	61	63.5	11	11.5	13	13.5
12	6	7.8	38	49.4	9	11.7	24	31.2
X^2=35.50, p=0.008								

The prevalence of dental caries in primary teeth among caries-affected children was 67.60%, figure 2. The highest prevalence was reported among children aged 6 years (100%), whereas the lowest prevalence was reported among those aged 12 years (18.18%). The difference was statistically significant, p<0.001, table 3.

The prevalence of permanent teeth caries among affected children was 86.40%. The highest prevalence was reported among children aged 12 years (98.70%) whereas the lowest prevalence was reported among 6-years-old children (5.56%). The difference was statistically significant, p<0.001, figure 3 and table 3.

TABLE (3) Primary and permanent teeth caries prevalence according to age

Age	Primary teeth		Permanent teeth	
	N	%	N	%
6 (n=36)	36	100.00	2	5.56
7 (n=41)	38	92.68	20	48.78
8 (n=82)	73	89.02	79	96.34
9 (n=74)	56	75.68	71	95.95
10 (n=94)	75	79.79	91	96.81
11 (n=96)	46	47.92	93	96.88
12 (n=77)	14	18.18	76	98.70
	X^2=325.99, p<0.001		X^2=42.497, p<0.001	

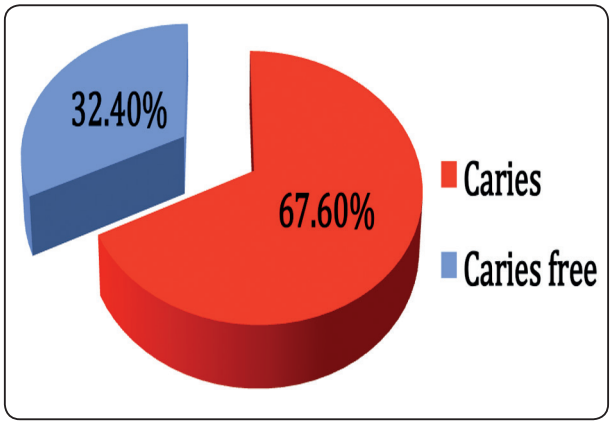

Fig. (2) Prevalence of primary teeth caries among caries-affected children

Underweight children reported the highest prevalence of primary teeth caries (94.82%) and the lowest prevalence was reported among obese children (30.95%). The association between BMI and the prevalence of primary teeth caries was statistically significant, p<0.001, table 4.

Normal weight children reported the lowest prevalence of permanent teeth caries (81.70%) whereas the highest prevalence was reported among overweight children (96.15%). The association between BMI and prevalence of permanent teeth caries was statistically significant, p>0.001, table 4.

TABLE (4) Primary and permanent teeth caries prevalence according to BMI categories

BMI categories	Primary teeth		Permanent teeth	
	N	%	N	%
Under weight (n=58)	55	94.82	52	89.66
Normal (n=306)	228	74.50	250	81.70
Over weight (n=52)	29	55.77	50	96.15
Obese (n=84)	26	30.95	80	95.24
	X^2=107.75, p=0.001		X^2=160.85, p=0.001	

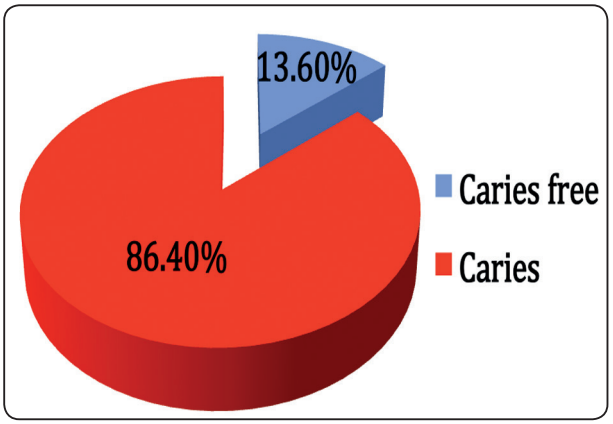

Fig. (3) Prevalence of permanent teeth caries among caries-affected children

The means for dmft and DMFT indices concerning children's ages and BMI categories are presented in table 5.

Regarding caries severity of primary teeth, high severity was reported among children aged 6 years (72.22%), followed by those aged 7 years (60.98%) whereas the percentage of high severity was zero among children aged 11 and 12 years. The difference was statistically significant, p<0.001 as shown in table 6.

High caries severity of primary teeth was reported among underweight children (56.90%) than other categories (normal "28.43%", overweight "25.00 %" and obese "4.76 %"). The difference was statistically significant, p<0.001, table 6.

Regarding caries severity of permanent teeth, none of them reported neither very high nor high caries severity. Moderate severity was reported among children aged 8-12 years with the highest scores, 37.50% among children aged 11 years and 65.52% among underweight children. Very low caries severity, 100% and 76.19%, were reported among 6-years-old and obese children respectively. The difference was statistically significant, p<0.001, tables 7.

TABLE (5) Distribution of dental caries (primary dentition: dmft index; permanent dentition: DMFT index) relative to Age and BMI categories

		Mean value (±SD)	
		dmft	DMFT
Age (years)	6 (n=36)	6.86 (±2.36)	0.06 (±0.23)
	7 (n=41)	6.15 (±2.97)	0.37 (±0.70)
	8 (n=82)	5.93 (±3.22)	1.68 (±0.95)
	9 (n=74)	3.91 (±2.97)	1.64 (±0.75)
	10 (n=94)	3.45 (±2.22)	2.00 (±1.17)
	11(n=96)	0.93 (±1.10)	2.30 (±1.08)
	12 (n=77)	0.35 (±0.76)	2.09 (±0.92)
BMI categories	Underweight (n=58)	6.88 (±3.83)	2.91 (±1.34)
	Normal (n=306)	3.50 (±2.81)	1.60 (±1.13)
	Overweight (n=52)	2.85 (±3.05)	1.65 (±0.76)
	Obese (n=84)	1.14 (±2.10)	1.20 (±0.53)

TABLE (6) Caries severity of primary teeth according to age and BMI categories

		No caries (dmf=0) N=162		**Low severity** (dmf 1-5) N=201		**High severity** (dmf ≥ 6) N=137		
		N	%	N	%	N	%	
Age (years)	6 (n=36)	0	0.00	10	27.78	26	72.22	X^2=441.00, p<0.001
	7 (n=41)	3	7.32	13	31.71	25	60.98	
	8 (n=82)	9	10.98	25	30.49	48	58.54	
	9 (n=74)	18	24.32	33	44.59	23	31.08	
	10 (n=94)	19	20.21	60	63.83	15	15.96	
	11 (n=96)	50	52.08	46	47.92	0	0.00	
	12 (n=77)	63	81.82	14	18.18	0	0.00	
BMI Category	Under weight (n=58)	0	0.00	25	43.10	33	56.90	X^2=237.56, p<0.001
	Normal (n=306)	78	25.49	141	46.08	87	28.43	
	Over weight (n=52)	24	46.15	15	28.85	13	25.00	
	Obese (n=84)	60	71.43	20	23.81	4	4.76	

TABLE (7) Caries severity of permanent teeth according to age and BMI categories

		Very low (DMFT 0-1.1) N= 238		**Low** (DMFT 1.2-2.6) N=163		**Moderate** (DMFT 2.7-4.4) N= 99		
		N	%	N	%	N	%	
Age (years)	6 (n=36)	36	100	0	0.00	0	0.00	X^2=438.58, p<0.001
	7 (n=41)	36	87.80	5	12.20	0	0.00	
	8 (n=82)	42	51.22	27	32.93	13	15.85	
	9 (n=74)	37	50.00	29	39.19	8	10.81	
	10 (n=94)	41	43.62	29	30.85	24	25.53	
	11 (n=96)	26	27.08	34	35.42	36	37.50	
	12 (n=77)	20	25.97	39	50.65	18	23.38	
BMI categories	Under weight (n=58)	8	13.79	12	20.70	38	65.52	X^2=185.95, p=0.001
	Normal (n=306)	144	47.06	107	34.97	55	17.97	
	Over weight (n=52)	22	42.31	25	48.08	5	9.62	
	Obese (n=84)	64	76.19	19	22.62	1	1.19	

Correlation analysis showed that BMI had a negative correlation with both dmft [r = -0.627, p< 0.01] and DMFT [r = -0.205, p< 0.01], table 8.

TABLE (8) Correlation between BMI, dmft and DMFT

		dmft	DMFT	BMI
dmft	Pearson Correlation	1	-.100(*)	-.627(**)
	Sig. (2-tailed)	.	.026	.000
	N	500	500	500
DMFT	Pearson Correlation	-.100(*)	1	-.205(**)
	Sig. (2-tailed)	.026	.	.000
	N	500	500	500
BMI	Pearson Correlation	-.627(**)	-.205(**)	1
	Sig. (2-tailed)	.000	.000	.
	N	500	500	500

**** Correlation is significant at the 0.05 level (2-tailed).***

***** Correlation is significant at the 0.01 level (2-tailed).***

DISCUSSION

Worldwide dental caries and obesity represent public health problems among children as they have been associated with adverse health outcomes [1, 42, 43]. This study was thus prompted to investigate the relationship which exists between dental caries and body mass index (BMI) among Saudi primary school children in Makkah city.

Of the examined 548 children, 91.2 % had dental caries. This observation is consistent with a study carried out on 6-15-years-old school children in Jazan, Saudi Arabia, where caries prevalence was 91.3% [44]. Whereas, in Dammam, caries prevalence was 73% among school children aged 6-12 years [45].

The World Health Organization (WHO) and World Dental Federation (FDI) oral health goals to be achieved by the year 2000 reported that prevalence of dental caries in 5-6-year-olds should be less than 50% [46]. The results of our study revealed that approximately 88% of 6-years-old children were suffering from dental caries, and this is considered quite high compared with the WHO and FDI oral health goals [46].

In the current study, the mean dmft index in caries-affected children was nearly consistent with Farooqi et al., (2015) [45] who reported 3.66±3.13 mean dmft value among Saudi children. While the mean DMFT index in caries-affected children was 1.69 ± 1.14, which confirms the data of a previous study on the caries prevalence in 7-11-years-old Saudi primary school children in Riyadh where the DMFT index was 1.6 ± 1.5 [47].

Statistical analysis of the results revealed that BMI has a negative correlation with both dmft and DMFT, where high caries severity of both primary and permanent teeth was reported with underweight children. These findings reveal a significant association between dental caries severity and underweight in contrast to what has been reported in previous studies where a significant association between caries and obesity was reported [2, 32, 48].

However, the findings of the current study are in agreement with a previous study where an inverse association between dental caries severity and BMI among children aged 6-11 years was observed [49]. Also, other studies reported an inverse relationship between dental caries experience and BMI [50, 51]. On the other hand, several studies [29, 52-54] revealed no significant association between dental caries experience and BMI.

It has been documented that in the developing countries, including Saudi Arabia, young population suffers from a dual sequelae of malnutrition in the form of obesity and underweight [55]. This cannot be explained by defective food supply alone but other

factors such as maternal educational level, family size and economic class influence the nutritional status of children.

Regarding the association between underweight and severity of dental caries observed in the present study, it has been reported that disturbed sleep as a result of pain can affect glucosteroid production in the body, which impairs the growth [56]. Another possible mechanism for the effect of dental caries on growth of children could be related to chronic inflammation from pulpitis and dental abscess. Both of these conditions change the metabolic pathways resulting in increased cytokine production [57-59].

The association between dental caries and underweight observed in the present study could be explained on the bases that severe dental caries can affect individuals by causing dietary restrictions via difficulty in chewing, possibly compromising their nutritional status and well-being [56, 60]. It is also known that feeding problems have a great potential effect on the health status, because of which the dentition and oral mucosa are affected [57].

Among the important limitations of the present study is neglecting the specific dietary habits such as intake of sugar-sweetened drinks, frequency of sugar intake, and frequency of food intake between meals as well as dental hygiene details in analysis, which are considered as risk factors for both dental caries and childhood weight status. Moreover, caries detection was carried out visually without radiographic examination.

CONCLUSION

Majority of primary school children in Makkah city had dental caries in both primary and permanent teeth. More than one-quarter of them were either overweight or obese whereas more than 11% were underweight. The prevalence of dental caries is still high considering the World Health Organization and World Dental Federation future oral health goals. Underweight students were more likely to have dental caries in both primary and permanent teeth compared to other BMI groups.

RECOMMENDATIONS

Oral health education for mothers and their children at health centers and schools is recommended. Encourage physical training and promote healthy eating pattern among primary school children. Encourage mothers to attend regularly with their children to dentists for early detection of dental caries and to be advised for proper dental hygiene. BMI should be estimated and included in the standard case history of children, as it can help in detection of potential health problems in children. Carry out further research including in depth investigation of eating pattern and oral hygiene practice.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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