

Association between body mass index and dental caries among special care female children in Makkah City

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BACKGROUND: Dental caries and obesity are multifactorial diseases with diet being a common contributory factor.

OBJECTIVE: The main purpose of the present study was to investigate the association between dental caries and obesity among special care female school children in Makkah City, Saudi Arabia.

DESIGN: Analytical cross-sectional study.

SETTING: Special schools in Makkah City.

STUDY POPULATION AND METHODS: Schools were chosen by lottery and female children were randomly selected. Dental caries detection was performed according to the World Health Organization criteria. The medical evaluation assessed the body mass index (BMI).

MAIN OUTCOME MEASURES: With appropriate sample weighting, relationships between dmft/DMFT (decayed, missing, filled teeth for deciduous and permanent dentition) and obesity were assessed using multilevel logistic regression.

RESULTS: In 275 special care children, the prevalence of dental caries was 56.7 percent. The mean dmft and DMFT scores for the entire study population were 3.9 (4.8) and 3.2 (4.1), respectively. Forty percent of children were mentally retarded, 22.2% presented with deafness, blindness or both, 18.9% presented with Down syndrome and 14.9% were autistic. From the total sample, the mean BMI was 20.2 (2.8). When adjusted for covariates, the logistic regression model showed strong association between caries and obesity (adjusted odds ratio=2.9; 95% CI=1.2-4.9).

CONCLUSION: This study demonstrated a significant association between caries frequency and overweight/obesity in special care school children.

LIMITATIONS: Since the data was cross-sectional, causal relationships cannot be established and the observed association could be due to other unexplored factors. Because of cultural and ethical consideration, including segregation of gender in Saudi Arabia, only female children were included in the present study, which limited the findings.

Dental caries and high body mass index (BMI) constitute important health problems worldwide.¹ Globally, the prevalence of childhood obesity varies from 30% in USA² to less than 8% in sub-Saharan Africa.³ A few point prevalence studies in Saudi Arabia have shown the prevalence of overweight and obesity to be 13.8% to 23.3%,⁴⁻⁶ respectively. The national prevalence of dental caries in Saudi Arabia is

estimated to be 80% in the primary dentition with a mean dmft score of 5.0, and it is estimated to be 70% for children's permanent dentition with a mean DMFT score of 3.5.⁷ Both dental caries and obesity are multifactorial diseases with diet being a common contributory factor.⁸ Few researchers have studied the relationship between dental caries and BMI, but results to date have been inconclusive. Some authors have found a positive as-

sociation between weight and caries in the primary and permanent dentition,⁹⁻¹⁶ but other authors have not.^{2,17-21} Children with special health care needs are defined as "those who have or are at increased risk for a chronic physical, developmental, behavioral, or emotional condition and who also require health and related services of a type or amount beyond that required by children generally".²² The global prevalence of special care children varies from 11.8% to 18% across all countries.²¹ National survey data showed overall prevalence of special care children in Saudi Arabia is 6.3%.²² Previous studies have shown that children with special care needs present with a high prevalence of untreated dental caries, periodontitis, and poor oral hygiene status.²³⁻²⁵ The severity of oral disease depends on the age, severity of impairment and living conditions. A few point prevalence studies conducted among special care children in Saudi Arabia showed a high prevalence of untreated caries with poor oral hygiene status.^{26,27} A search of the literature did not retrieve any previous studies finding an association between BMI and dental caries status among special care children. The present study is conducted with an aim to investigate a possible association between BMI and dental caries status among special care children in Makkah City, Saudi Arabia.

STUDY POPULATION AND METHODS

A cross-sectional study was conducted at various special need schools in Makkah City, Saudi Arabia during the 3-month period October to December 2016. Only female children were chosen for inclusion in this study owing to segregation of gender in Saudi Arabia. Based on previous studies, the prevalence of obesity among Saudi children has been calculated to be 23%, and based on pilot study, at least 50% of our population would have caries. With this anticipated population proportion of 0.05 and a power of 80%, a sample of 275 special care children were needed for this study. A total of 300 special care children were selected to compensate for the nonresponse bias. The number of special care schools in Makkah City was 25 (2014 to 2015 data). A two-stage probability random sampling method was followed, with schools as the primary sampling unit and individual special care children the unit of enquiry. Nineteen (75% of total schools) special care schools were selected by lottery to meet the sample size of 300. The children were selected proportionate to the number of special care children in each school (15 to 20 children from each school). All the participants were residents of communities with low natural fluoride content (<0.4 mg/L) in drinking water. Ethical approval for the study was granted by the administration of pub-

lic education in Makkah City, school health department (16/427). Written informed consent was procured from all the parents of the participants prior to the commencement of the study.

All children received a semi-structured questionnaire to be filled out by parents. Questionnaires were used to obtain demographic data, dietary, and oral hygiene habits. For each child, the information about age (years and months), sugar consumption, and oral hygiene habits (tooth brushing frequency and use of fluoridated toothpaste) were collected. Dietary information was obtained from structured 72-hour recall interviews which spanned different days of the week, including 2 weekdays and a weekend day. Frequency of meals consumed and sugar exposure in terms of form, frequency, consistency and time of intake were recorded. Sugar consumption was considered present if the children consumed snacks (cookies, candies, cakes, ice-creams, chocolate, and biscuits), fruit juice, non-diet or other sugar-containing drinks. No quantification was done on the amount of sugar consumed/day. Toothbrushing frequency was dichotomized as 'once a day or less', (≤ 1 /day) versus 'more than once a day' (≥ 2 /day). The type of special care or disability were divided into six categories: mental retardation (MR), autistic disorder (A), cerebral palsy (CP), Down syndrome (DS), deafness or blindness or both (DB), and others (OT) with multiple disability or other syndromes (**Appendix A**). The reliability of the questionnaire was assessed by asking 20 parents to complete it by face to face interview. Cronbach alpha was used as a measure of reliability ($\alpha=0.75$).

A weight scale was used to check the weight of the children and it was calibrated prior to measurement of the weight of each child. Weight was measured by the child dressed in a minimum amount of clothing, which permitted the children to stand erect and relaxed. Weight was considered to the nearest 100 g. A stadiometer was used to measure the height. This measurement was done with the child standing barefoot, maintaining the head in a neutral position, with the neck, spinal column and knees in physiological extension and the soles of both feet totally supported on a horizontal surface. Body mass index (weight/height in kg/m^2) was calculated. According to the age- and gender-specific criteria recommended by Al-Herbish et al,²⁸ children were classified into four categories: underweight – less than 5th percentile; normal weight – 5th percentile to less than 84th percentile; overweight – 85th to less than 95th percentile; and obese – equal to or greater than the 95th percentile.

Oral examination of special care children was car-

Table 1. Body mass index (BMI) categories according to characteristics of children.

Variable	BMI categories			
	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)
Type of disability				
MR (n=79)	4 (5.06)	38 (48.1)	20 (25.3)	17 (21.5)
A (n=41)	2 (4.8)	23 (56.1)	7 (17.1)	9 (21.9)
CP (n=17)	2 (11.7)	9 (52.9)	3 (17.6)	3 (17.6)
DS (n=52)	3 (5.7)	24 (46.1)	13 (25)	12 (23.07)
DB (n=61)	4 (6.5)	32 (52.4)	11 (18.03)	14 (22.9)
OT (n=25)	2 (8)	14 (56)	4 (16)	5 (20)
Kruskal-Wallis H, P value	0.18	0.07	0.03	0.08
Mann-Whitney U	NA	NA	MR > A	NA
Age in years				
6-11 (n=195)	12 (6.1)	101 (51.7)	39 (20)	43 (22.05)
12-17 (n=80)	5 (6.2)	39 (48.7)	19 (23.7)	17 (21.2)
Chi-square test, P value	0.16	0.09	0.07	0.19
Sugar consumption				
Yes (n=203)	14 (6.9)	101 (49.7)	44 (21.6)	44 (21.6)
No (n=72)	3 (4.1)	39 (54.1)	14 (19.4)	16 (22.2)
Chi-square test, P value	0.07	0.08	0.13	0.11

Data are mean (standard deviation) or number (percentage). MR: mental retardation, A: autism, CP: cerebral palsy, DS: Down syndrome, DB-: deafness or blindness or both, OT: others (children with multiples disability, syndromes).

ried out using plane mouth mirrors and CPI probes under natural light. Instruments were sterilized by autoclaving. No radiographs/transillumination were used for ethical reasons. The same examiner examined all children. Diagnosis of dental caries (dmft: decayed, missing, filled teeth for deciduous dentition. DMFT: decayed, missing, filled teeth for permanent dentition) was established according to World Health Organization guidelines.²⁹ Frank cavitation and visual caries in interproximal surfaces were recorded. The intra examiner calibration was performed with respect to the diagnostic criteria of caries. There was a significant correlation with Kappa value of 0.92, $P < .05$ for dental caries.

Descriptive summary statistics were obtained for all independent and outcome variables. Differences in proportion was tested using Kruskal-Wallis H followed by Mann-Whitney U test for intergroup comparison, and chi-square tests. Differences in means were tested using analysis of variance (ANOVA) followed by Tukey post hoc and independent sample t test as necessary. Relationships between dmft/DMFT, obesity and type of disability were assessed using multilevel logistic regression. Adjusted odds ratios (ORs) and their 95 percent confidence intervals (CI) were calculated. In evaluating the association, we adjusted for the following confounders: age, sugar consumption and oral hygiene habits. Multilevel logistic regression included age, BMI, sugar consumption, oral hygiene habits and type of disability as predictors and caries as outcome. Analysis was performed using IBM SPSS version 17, Armonk, New York). All statistical tests were two-sided and the significance level was set at $P < .05$.

RESULTS

Of 275 children included in the present study, 40% were mentally retarded, 22.2% presented with deafness or blindness or both, 18.9% presented with Down syndrome, 14.9% were autistic and 6.2% presented with cerebral palsy. From the total sample, the mean BMI was 20.2 (2.8). Six percent of the children were underweight, 50.8% had a normal weight, 21.1% were overweight and 21.8% were obese. Fifty-seven percent of children presented with caries (dmft/DMFT >0). Mean caries score dmft and DMFT for the entire study population was 3.9 (4.8) and 3.2 (4.1), respectively.

Table 1 presents BMI categories according to age, type of disability and sugar consumption. The mentally retarded children were presented with higher percentage (25.3%) of overweight compared to autistic children (17.1%) and the difference was statistically significant (Kruskal-Wallis H test, P value=.03).

Table 2 presents distribution of mean caries scores (dmft/dmfs; DMFT/DMFS) according to age, type of disability, sugar consumption, BMI and oral hygiene habits. Statistically significant differences were seen between mean caries score and age, sugar consumption, type of disability, BMI and oral hygiene habits. Children with mental retardation presented with high mean caries score compared to autistic children and Down syndrome children. Children with overweight and obesity presented with high mean caries score compared to normal weight children.

Table 3 provides unadjusted and adjusted ORs with CI of dental caries for age, type of disability, BMI, sugar consumption and oral hygiene habits (tooth

Table 2. Caries score (dt, dmft, ds, dmfs, DT, DMFT, DS, DMFS) according to variables.

Variables	n	dt	dmft	ds	dmfs	DT	DMFT	DS	DMFS
Age in years									
6-11	195	2.3 (3.1)	3.9 (4.1)	4.2 (4.9)	5.3 (6.2)	0.3 (0.9)	0.5 (1.1)	0.5 (1.2)	0.9 (1.8)
12-17	80	0.01 (0.02)	0.01 (0.02)	0.02 (0.04)	0.02 (0.04)	2.9 (3.2)	3.2 (4.1)	3.9 (4.1)	4.02 (4.1)
t test, P value		0.03	0.04	0.001	0.001	0.02	0.03	0.001	0.001
Type of disability									
MR	79	1.02 (1.8)	1.7 (2.1)	2.3 (2.9)	2.5 (3.01)	1.3 (1.9)	1.6 (1.8)	1.9 (2.3)	2.1 (2.8)
A	41	0.3 (0.8)	0.5 (0.9)	1.1 (1.4)	1.3 (1.8)	1.2 (1.7)	1.5 (2.01)	1.6 (1.9)	1.8 (2.1)
CP	17	0.02 (0.06)	0.04 (0.06)	0.06 (0.08)	0.08 (0.1)	0.09 (0.1)	0.09 (0.2)	0.1 (0.3)	0.4 (0.7)
DS	52	0.8 (1.1)	1.0 (1.5)	0.9 (1.4)	1.0 (1.5)	1.1 (1.6)	1.4 (1.7)	1.5 (1.7)	1.5 (1.8)
DB	61	0.9 (1.2)	1.1 (1.6)	1.2 (1.7)	1.4 (1.9)	1.6 (1.9)	1.5 (1.7)	1.5 (1.7)	1.8 (2.1)
OT	25	0.05 (0.08)	0.09 (0.1)	0.06 (0.08)	0.08 (0.09)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)	0.4 (0.5)
ANOVA, P value	0.03	0.001	0.001	0.001	0.04	0.07	0.04	0.001	
Tukey post hoc	MR > DS, MR > A	MR > A	MR > A > DS	MR > DS, MR > DB	MR > CP	NA	MR > CP	MR > CP, MR > OT	
Sugar consumption									
Yes	203	1.7 (1.9)	2.3 (2.7)	2.2 (2.6)	2.9 (3.1)	1.8 (2.1)	2.5 (2.8)	2.1 (2.6)	2.9 (3.1)
No	72	0.8 (2.1)	1.2 (1.8)	1.1 (1.6)	1.8 (1.9)	0.9 (1.1)	1.0 (1.3)	1.4 (1.8)	1.7 (1.9)
t test, P value		0.07	0.04	0.06	0.02	0.08	0.02	0.03	0.03
BMI									
Underweight	17	0.01 (0.06)	0.01 (0.06)	0.02 (0.08)	0.02 (0.08)	0.01 (0.04)	0.01 (0.04)	0.02 (0.06)	0.02 (0.06)
Normal weight	140	1.3 (1.8)	1.8 (2.3)	1.5 (1.8)	2.0 (2.3)	1.5 (1.9)	1.8 (2.3)	1.6 (1.9)	2.1 (2.6)
Overweight	58	1.9 (2.3)	2.2 (2.7)	2.4 (2.9)	2.9 (3.2)	2.1 (2.6)	2.8 (3.1)	2.2 (2.6)	2.8 (3.1)
Obese	60	1.8 (2.01)	2.0 (2.4)	2.1 (2.6)	2.8 (3.1)	2.3 (2.9)	3.1 (3.5)	2.6 (2.8)	3.2 (3.6)
ANOVA, P value	0.07	0.04	0.06	0.03	0.04	0.001	0.04	0.001	
Tukey post hoc	NA	OW > NW,	NA	OW > NW, O > NW	O > NW, OW > NW	O > NW, OW > NW	O > NW	O > NW	
Oral hygiene habits									

Variables	n	dt	dmft	ds	dmfs	DT	DMFT	DS	DMFS
Tooth brushing frequency									
≤1 time/day	211	1.1 (1.9)	2.3 (3.1)	2.9 (3.6)	3.1 (3.8)	1.5 (1.9)	1.9 (2.3)	2.2 (2.9)	2.8 (3.1)
≥2 times/day	64	0.9 (1.4)	1.4 (1.9)	1.8 (2.3)	2.2 (2.8)	1.1 (1.6)	1.4 (1.8)	1.8 (2.1)	2.0 (2.6)
t test, P value	0.07	0.04	0.03	0.06	0.13	0.17	0.07	0.04	
Fluoridated tooth paste									
Yes	148	1.4 (2.1)	1.8 (2.6)	2.1 (2.9)	2.9 (3.6)	1.1 (1.7)	1.8 (2.5)	2.1 (2.9)	2.6 (3.1)
No	89	0.9 (1.5)	1.3 (1.9)	1.9 (2.4)	2.2 (2.8)	1.6 (2.1)	2.1 (2.7)	2.4 (3.2)	2.9 (3.6)
Don't know	38	0.2 (0.6)	0.2 (0.6)	0.6 (0.8)	0.6 (0.8)	0.4 (0.9)	0.5 (1.1)	0.8 (1.3)	0.8 (1.3)
ANOVA, P value	0.07	0.09	0.12	0.13	0.06	0.07	0.14	0.09	

Data are mean (standard deviation) MR: mental retardation, A: autism, CP: cerebral palsy, DS: Down syndrome, DB: deafness or blindness or both, OT: others (children with multiples disability, syndromes). ANOVA: Analysis of variance, NA: Not applicable, BMI: body mass index, OW: overweight, NW: normal weight, O: obese, for the ANOVA, Epidemiology. The DMF Index (<https://www.dentalcare.com/en-us/professional-education/ce-courses/ce368/epidemiology-the-dmf-index>). Analysis of variance with Tukey post-hoc comparisons. dmft/DMFT: for deciduous and permanent dentition.

brushing frequency and use of fluoridated dentifrice). Subjects with mental retardation were 2.17 times (adjusted ORs=2.2; 95% CI=1.2-3.1) more likely to have caries compared to those without mental retardation. Subjects who were overweight and presented with obesity were 2.98 times (adjusted Ors=2.9; 95% CI=1.2 - 4.9) more likely to have dental caries compared to underweight and normal weight subjects. Subjects with sugar consumption were 1.9 times (adjusted ORs=1.9; 95% CI=0.1-2.9) more likely to have dental caries than subjects with no sugar consumption.

DISCUSSION

Dental caries and obesity are multifactorial diseases with diet being a common contributory factor.⁸ Previous studies have shown that children with special care needs present with the high prevalence of untreated dental caries and poor oral hygiene status.²³⁻²⁷ In this study, a total of 275 special care children were enrolled to examine the relationship between dental caries and obesity, controlling covariates like, age, type of disability, sugar consumption and oral hygiene habits. Results showed that 21% of the children were overweight and 21.8% were obese. The result is consistent with other studies related to childhood obesity⁴⁻⁶ in Saudi Arabia. The overall prevalence of caries was 56.7% and mean caries score (dmft=3.9, DMFT=3.2) for the entire study population was high, bringing our findings closer to the Saudi national survey data.⁷

In the present study, the caries prevalence was high among mentally retarded children (77.2%), autistic children (65.8%) and Down syndrome children (61.5%). Regression analysis showed strong association between mentally retarded children (adjusted OR=2.2), autistic children (adjusted OR=1.2), Down syndrome children (adjusted OR=1.2) and caries prevalence. This result is in accordance with numerous other studies which showed a higher prevalence of caries among special care children.²³⁻²⁷

Exploration of the link between weight and oral health in children has been controversial. In our study, the results appear to show a strong association between overweight and obesity and the prevalence of dental caries. The data showed that special care children who were overweight and obese have a significantly greater risk for developing dental caries. Children who were overweight and obese were 2.9 times greater risk of developing dental caries compared to underweight and normal weight children. This is in line with previous studies which showed a strong association between obesity and caries.⁹⁻¹⁶ Marshall et al,¹¹ suggested that obesity neither increases the risk of caries nor that car-

Table 3. Association between age, type of disability, BMI, sugar consumption, oral hygiene habits, and the dependent variable dental caries.

Variable	Dental caries n yes/no	Dental caries % yes/no	Un-adjusted odds ratio (CI)	Adjusted odds ratio (CI)*
Age in years				
6-11	112/80	57.4/41.02	0.9 (0.1-1.8)	0.9 (0.1-1.9)
12-17#	44/36	55/45		
Type of disability				
MR (Yes)	61/18	77.2/22.7	2.1 (1.1-3.04)**	2.2 (1.2-3.1)**
MR (No)#	95/101	48.4/51.5		
A (Yes)	27/14	65.8/34.2	1.1 (0.9-1.9)*	1.2 (0.9-2.03)*
A (No)#	129/105	55.1/44.9		
CP (Yes)	9/8	52.9/47.05	0.7 (0.1-2.4)	0.7 (0.1-2.5)
CP (No)#	147/111	56.9/43.02		
DS (Yes)	32/20	61.5/38.5	1.1 (0.5-2.03)*	1.2 (0.6-2.1)*
DS (No)#	124/99	55.6/44.4		
DB (Yes)	37/24	60.6/39.3	0.9 (0.1-1.9)*	0.9 (0.1-2.03)*
DB (No)#	119/95	55.60/44.4		
OT (Yes)	13/12	52/48	0.6 (0.01-1.5)*	0.6 (0.05-1.2)*
OT (No)#	143/107	57.2/42.8		
BMI				
Underweight and normal weight#	72/85	45.8/54.2		
Overweight and obese	84/34	71.2/28.8	2.9 (1.2-4.9)**	2.9 (1.2-4.9)**
Sugar consumption				
Yes	125/78	61.6/38.4	1.9 (0.1-2.9)*	1.9 (0.1-2.9)*
No#	31/41	43.05/56.9		
Oral hygiene habits				
Tooth brushing frequency				
≤1 times/day	137/74	64.9/35.07	2.3 (0.8-3.1)**	2.7 (0.8-3.1)**
≥2 times/day#	19/45	29.7/70.3		
Fluoridated dentifrice				
Yes#	65/83	43.9/56.08		
No and Don't know	91/36	71.6/28.3	2.6 (0.5-3.9)**	2.6 (0.5-3.9)**

Analysis of multilevel logistic analysis. #-Reference, *P<.05, **P<.001, CI – Confidence interval, +adjusted for age, type of disability, BMI: body mass index, oral hygiene habits (tooth brushing frequency, fluoridated dentifrice). MR: mental retardation, A: autism, CP: cerebral palsy, DS: Down syndrome, DB-: deafness or blindness or both, OT: others (children with multiples disability, syndromes).

ies increases the risk of obesity, but rather a common risk factor increased the likelihood of both diseases. Dietary factors, especially sugar consumption were hypothesized to be common risk factors that potentially link obesity and dental caries. Our study indicates children who consume sugar have a 1.9 times greater risk for developing caries than children who do not consume sugar.

Our results demonstrated that irregular tooth brushing (≥ 1 per day) is associated with dental caries. Children who were brushing their teeth ≥ 1 per day were 2.7 times greater risk of dental caries. Previous publications agree with this finding.^{30,31} These results vouch for the need to establish measures that promote habits for adequate oral hygiene.

However, some limitations must be observed in the present study. Since the data was cross-sectional, causal relationships cannot be established and the observed association could be due to other unexplored factors. Dietary information was obtained from 72-hour recall interviews which spanned different days of the week, including 2 weekdays and a weekend day. This in turn enhanced the chance of recall bias. Dental caries detection was carried out visually and no X-rays

were taken. Because of cultural and ethical, including segregation of gender in Saudi Arabia, only female children were included in the present study, which limited the finding of association between caries and gender.

To conclude, the results of this study support an association between dental caries and overweight and obesity among special care children. This finding has important implications for the prevention and management of dental caries among special care children by focusing on specific risk factors associated with two diseases: dental caries and obesity with a common risk factor. There is a need for an integrated effort from all sectors, professionals and individuals to implement the practical solutions to prevent and manage the obesity and caries among special care children. Future research should incorporate complete dietary assessments, oral hygiene compliance and other factors that may act as confounders or effect modifiers. Study of dental caries at an individual level must account for these variables. In future preventive programs, strategies should aim at nutrition control to avoid weight gain as well as caries, including meal frequency control and reduction in fermentable carbohydrates.

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