Research Article

Exploring the Relationship Between Dental Caries and Obesity in Makkah Children

Abdullah A Marghalani[1*], Ibrahim Alnefaie[2], Abdullah Hazzazi[2], Raed Alghamdi[2], Abdelaziz Khatry[2], Ahmed Balkhour[1], Salem Dehom[3]

[1]Department of Preventive Dentistry, College of Dental Medicine, Umm Al-Qura University, Makkah, 21955, Saudi Arabia
[2] College of Dental Medicine, Umm Al-Qura University, Makkah, 21955, Saudi Arabia.
[3]School of Nursing, Loma Linda University, Loma Linda, USA.

ABSTRACT

Background: Obesity and dental caries are global severe public health concerns. In Saudi Arabia, both diseases are increasing among children. This study aimed to evaluate the relationship between dental caries and obesity in children living in Makkah city.

Methods: The study design was cross-sectional. The sample was obtained from a dental teaching hospital at Umm Al-Qura University (UQU) and an elementary school in Makkah. Dental caries was measured using the Decayed, Missing, or Filled Teeth (DMFT/dmft) index. Obesity was measured using age and gender-specific Body Mass Index (BMI). Several covariates were collected, including diet, lifestyle, demographic, and socioeconomic status, including diet, lifestyle, demographic, and socio-economic status, were collected.

Results: The total sample size included 184 children. The mean dental caries measured by DMFT/dmft was 5.37 with a standard deviation of (3.8). About 25 (13.7%) of the included children were underweight; 112 participants (61.2%) had a normal weight; 18 participants (9.8%) were overweight, and 28 participants (15.3%) were obese. In the crude and adjusted analysis, underweight children had higher dental caries than average weight, and overweight/obese children had less dental caries than normal-weight children. Moreover, the socioeconomic status of the parents showed a positive relationship with dental caries experience.

Conclusions: Dental caries experience differed by BMI status. Overweight children had lower dental caries experience and underweight children had higher dental caries experience.

1. INTRODUCTION

At global and local levels, paediatric obesity and dental caries are major public health issues. Both dental caries and obesity share several risk factors, such as genetic, nutritional, environmental, and behavioural factors (Tinanoff & Holt 2017). Dental caries' high prevalence and severity can adversely affect children's oral and general health. In addition, the prevalence of pediatric obesity is concerning, and its health and social consequences can be harmful.

On a national level, dental caries and obesity in children showed high prevalence and might add a needless burden on the current healthcare system (Marghalani et al., 2014). In various regions of Saudi Arabia, dental caries and its link to obesity in children have been explored. Epidemiological studies showed that 19% of Saudi children were overweight, and 23.3% were obese (Al-Dossary et al., 2010). The prevalence of dental caries in Saudi Arabia, pooled from 29 studies, in primary dentition ranged from 21% to 100% (Alshammari 2021).

The relationship between dental caries and obesity in children showed positive and negative findings, emphasising incorporating confounding variables, in a systematic review published in 2018 that included 14 studies. Collectively, there was no significant difference between dental caries and Bod Mass Index (BMI) categorisation. However, significance was observed in obese and overweight children in their primary dentition for those living in high-income countries (Chen et al., 2018). In a study conducted in Dammam, Saudi Arabia, obese male adolescents had a high mean of DMFT than their non-obese classmates (Al-Ansari & Nazir, 2020). In a study that recruited schoolchildren from 915 elementary schools in Jeddah, the researchers found that higher BMI and waist circumference were associated with lower dental caries prevalence (Farsi et al., 2016). In another study conducted in Jeddah among school children aged 6-8 years, the authors found an inverse linear relationship between dental caries and BMI (Alkarimi et al., 2014). In Makkah, Saudi Arabia, a study recruited only special needs female children from schools; a strong association was observed between dental caries and obesity (Ashour et al., 2018).

The current study aimed to evaluate the relationship between dental caries and obesity in children living in Makkah. The null hypothesis: there was no difference between obesity, measured by BMI, and dental caries, measured by DMFT/dmft, in subjects aged 6-12 years from Makkah city.

2. MATERIALS AND METHODS

2.1 Study design

This study was designed as a -cross-sectional study. The participants for this study were children visiting the dental teaching hospital at Umm Al-Qura University (UQU), college of dental medicine, and from a primary school in Makkah. The eligibility criteria were healthy children aged 6-12; any child younger or older than this age group or with a medical condition, physical disabilities, or developmental or congenital anomalies were excluded. Ethical approval was obtained from Umm Al-Qura University.

2.2 Methods

Dental caries experience was measured using the decayed, missing, and filled primary teeth (dmft) index. The 'd' portion was defined as cavitated caries, the 'm' portion was defined as extracted teeth due to caries and the 'f' portion was defined as filled teeth due to caries. The same was applied for DMFT but for permanent teeth. Two paediatric dentists completed the examination with intra- and inter-examiner reliability, measured by kappa statistics, being more than 85%.

Obesity was evaluated using BMI, which is age and sex-specific for children and teenagers. Calculating BMI using the BMI Percentile Calculator involves measuring the height and weight and then calculating the BMI using the child and teen BMI calculator (https://www.cdc.gov). After calculating, BMI was expressed as a percentile obtained from either a graph or a percentile calculator. If the BMI value was less than five percentiles, the child was considered underweight; if it was from 5 to less than 85 percentiles, the child was considered average weight. If it was from 85 to less than 95 percentiles, the child was considered overweight; if it was equal to or greater than 95 percentiles, the child was considered obese.

2.3 Statistical Analysis

The whole sample was described using descriptive statistics, the mean and standard deviation for continuous variables, and frequency with percentages for categorical variables. Total dental caries experience was defined as the summation of dmft in primary teeth and DMFT in permeant teeth for each subject. Total dental caries experience approximated normal distribution, so parametric testing was an option. Total dental caries experience was compared with BMI categories and all the listed covariables using t-test or ANOVA with pairwise testing while adjusting for alpha error. A multiple linear regression model was used to estimate the effect of BMI, as the primary exposure, on total dental caries experience, as the outcome variables while adjusting for selected covariates. Statistical significance was assumed at 0.05 as a cut-off value. STATA 15.1 (StataCorp LP, College Station, Texas, USA) was used for all statistical analyses.

3. RESULTS

The total sample size was 184 subjects. In this sample, the prevalence of dental caries was 87.5% (161/184). The mean value for total caries experience, measured by dmft in primary and DMFT in permanent teeth, was 5.37 with a standard deviation (SD) of 3.8. About 25 (13.7%) of the sample were underweight; 112 (61.2%) were average weight; 18 (9.8%) were overweight, and 28 (15.3%) were obese. The mean age was 8.67, with an SD of 1.93. The mean age and SD were 8.67 and 1.93, respectively. The parents' overall perception of their child's health was 82 (44.8%) as excellent, 71 (38.8%) as very good, 26 (14.2%) as good, and 4 (2.1%) as fair to poor. About 109 (59.6%) of the sample were Saudi, and 147 (80.3%) had regular dental visits.

Approximately 84 (45.9%) were from the dental college, and 99 (54.1%) were from the elementary school. The other possible risk factors are displayed in Table 1.

For the relationship between dental caries and BMI, there was a significant difference between the three defined BMI levels (P-value <0.0001). From the pairwise comparison, concerning the healthy weight group, the underweight group had a marginally significantly (P-value 0.071) higher dental caries; the overweight/obese group had a significantly lower dental caries (P-value 0.002). Higher education (P-value <0.0001), being employed (P-value <0.0001), and higher family income (P-value 0.007) were all associated with lower caries experience. Being male (P-value 0.09) and self-reported regular exercise (P-value 0.076) were marginally associated with lower caries experience.

The relationship of caries experience with the other covariates is listed in Table 2. The relationship between BMI and dental caries was also maintained with the multiple linear regression analysis adjusting for sugary drinks, fast food snacks, family income, age, gender, dental visits, and regular exercise; the underweight group (P-value 0.052) and overweight/obese group (P-value 0.002) were significantly associated with caries experience.

4. DISCUSSION

This study sampled children aged 6-12 years from Makkah city; we found that underweight children had higher dental caries experience and overweight/obese children had lower dental caries experience. This relationship was still significant in the multivariable analysis controlling for important covariates. Several socio-economic variables showed a statistically significant relationship with dental caries experience, including parental education, income, and employment status.

The literature on the relationship between dental caries and obesity in children has been mixed, inconsistent, and inconclusive, with various descriptions of the relationship found. The relationship seemed to differ between countries (Chen et al., 2018). This could be partly explained by the shared cultural oral habit practices, typical dietary consumption, and society-specific lifestyle behaviours that could contribute to the aetiology of dental -

Table 1, Clinical and demographic characteristics of the collected sample.

		Count	%
BMI Interpretation	Under-weight	25	13.7%
	Healthy weight	112	61.2%
	Over-weight	18	9.8%
	Obese	28	15.3%
Clinic/School	Clinics	84	45.9%
	School	99	54.1%
Age	4-6	30	16.3%
	7-9	84	45.9%
	10-12	69	37.7%
Frequency of snacks between meals	None	9	4.9%
	One time	63	34.4%
	Two times	73	39.9%
	3 times or more	38	20.8%
Regular dental visits	No	147	80.3%
	Yes	36	19.7%
Regular exercise	No	142	77.6%
	Yes	41	22.4%
Parents' estimation of child's health	Excellent	82	44.8%
	Very good	71	38.8%
	Good	26	14.2%
	Fair	3	1.6%
	Poor	1	0.5%
Educational level of the parent/guardian	High school of less	48	26.2%
	Diploma	21	11.5%
	BSc	66	36.1%
	Graduate	48	26.2%
Employment status of the father	Employed	158	86.3%
	Unemployed	25	13.7%
Employment status of the mother.	Employed	69	37.7%
	Unemployed	114	62.3%
Total income of the family	< 10,000	44	24.0%
	10,000 - 20,000	60	32.8%
	> 20,000	33	18.0%
	Prefer not to answer	46	25.1%
Gender	Male	149	81.4%
	Female	34	18.6%
Nationality	Saudi	109	59.6%
	non-Saudi	74	40.4%

Table 2, Comparison of total dental caries experience by the investigated variables.

		N	Mean	SD	*P*-value
BMI Interpretation	Under-weight	25	7.4	4.8	<0.001*
	Healthy	112	5.7	3.5	
	Over-weight/obese	46	3.5	3.0	
The educational level of the parent/guardian	High school	48	7.7	3.7	<0.001*
	Diploma	21	4.0	3.7	
	BSc	66	5.1	3.7	
	Graduate	48	4.0	3.0	
Mother's educational level	High schools of less	72	6.1	3.9	0.080*
	Diploma	25	5.2	4.2	
	BSc	66	5.0	3.6	
	Graduate	20	3.9	3.2	
Employment of the parent	Employed	158	4.9	3.6	<0.001**
	Unemployed	25	8.1	3.7	
Nationality	Saudi	109	5.1	3.7	0.236**
	Non-Saudi	74	5.8	4.0	
What is your perceived assessment of your child's health	Excellent	82	5.4	3.8	NA
	Very good	71	5.4	3.8	
	Good	26	5.1	3.6	
	Fair	3	4.3	3.8	
	Poor	1	11.0	NA	
How many times a day does your child have a sugar-containing drink (juices/soft drinks)	None	17	5.8	4.2	0.772*
	One time	59	5.4	3.9	
	Two times	64	5.0	3.0	
	3 times or more	43	5.7	4.5	
How many snacks does your child have between main meals	None	9	5.6	4.0	0.949*
	One time	63	5.3	3.9	
	Two times	73	5.5	3.9	
	3 times or more	38	5.1	3.4	
Gender	Female	34	6.9	4.0	0.09**
	Male	149	5.0	3.7	
Does your child regularly visit the dental clinic	No	147	5.5	3.7	0.520**
	Yes	36	5.0	4.3	
Does your child	No	142	5.6	3.9	0.076**

exercise regularly	Yes	41	4.4	3.4	
Total family income per month	< 10,000	44	6.5	4.1	0.007*

*Comparison was performed using a two-sample independent t-test.
** Comparison was performed using ANOVA. NA: Not analysed due to low sample size in some cells; N: sample size; SD: standard Deviation.

caries and obesity in children. Some studies found no significant association between childhood obesity and dental caries (José Frias-Bulhosa et al., Sadeghi et al., 2011). In a study by José Frias-Bulhosa et al., 2015, the underweight group represented only 3.3% and was conducted on 13-year-old adolescents. Some other studies showed a positive association between childhood obesity and dental caries (Shahraki et al., 2013; Willerhausen et al., 2007; Pikramenou et al., 2016; Qomsan et al., 2017); These studies showed a direct relationship in which dental caries was more in children with higher BMI.

Consistent with our findings, some studies showed increased dental caries in underweight children (Kopycka-Kedzierawski et al., 2008; 18) Marshall et al., 2007; Elangovan et al., 2012). Nationally representative data from the US suggested that at risk of overweight and overweight children 6-11 years of age were less likely to have dental caries in the primary dentition. Moreover, in permanent dentition, overweight children were less likely to experience dental caries (Kopycka-Kedzierawski et al., 2008). Another study from the US indicated the importance of including socio-economic factors when studying dental caries and obesity. The authors also showed common risk factors for dental caries and obesity, suggesting a common risk factor approach (Marshall et al., 2007).

In a study by Elangovan et al., 2012, higher caries in underweight children was observed in primary dentition; dietary analysis showed that obese children consumed more fatty food while underweight consumed more carbohydrates (Elangovan et al., 2012). In the study by Liang, 2016, overweight children had 27%, and obese children had 34% lower odds of dental caries in primary dentition than normal-weight children. Noteworthy, the sample made 32,461 students in China. The authors described the relationship as A-shaped (Liang et al., 2016). In a study from India with 2033 children aged 6-15, the relationship between dental caries and BMI was described as a U-shaped relationship between underweight and overweight children with higher dental caries (Subramaniam et al., 2011).

Limitations of this study included the cross-sectional nature that did not allow the development of dental caries over time. The self-reporting for some variables might be considered a limitation. Moreover, the sample was not randomly selected and can't be used to generalise the findings over Makkah City.

5. CONCLUSION AND RECOMMENDATION
Within the limitations of this study, underweight children had higher dental caries experience, and overweight/obese children had lower dental caries experience. Collaborative preventive dental programs in children might also include efforts to reduce childhood obesity since dental caries differ by obesity level.

AUTHOR CONTRIBUTION
AAM: Conceptualization, Methodology, Formal analysis, Supervision, Writing and Editing. IA: Data Collection, Validation, Investigation and Writing. AH: Data Collection, Validation, Investigation and Writing. RA: Data Collection, Validation, Investigation and Writing. AK: Data Collection, Validation, Investigation, Writing. AB: Methodology, Formal analysis, Supervision, Writing and Editing. SD: Formal analysis, Writing and Editing. All authors critically reviewed and approved the final version and are responsible for the manuscript's content.

CONFLICT OF INTEREST

No conflict of interest to declare.

REFERENCES

About child & teen BMI [Internet]. Centers for Disease Control and Prevention. Centers for Disease Control and Prevention; 2021 [cited 2022Jul28]. Available from: https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html

Al-Ansari, A., & Nazir, M. (2020). Relationship between Obesity and Dental Caries in Saudi Male Adolescents. International Journal of Dentistry, 2020, 1–7. https://doi.org/10.1155/2020/8811974

Al-Dossary, S.S., Sarkis, P.E., Hassan, A., Ezz El Regal, M., Fouda, A.E. Obesity in Saudi children: a dangerous reality. (2010). East Mediterr Health J. 16(9):1003-8. PMID: 21218729.

Alkarimi, H. A., Watt, R. G., Pikhart, H., Sheiham, A., & Tsakos, G. (2014). Dental Caries and Growth in School-Age Children. PEDIATRICS, 133(3), e616–e623. https://doi.org/10.1542/peds.2013-0846

Alshammari, F. R., Alamri, H., Aljohani, M., Sabbah, W., O'Malley, L., & Glenny, A.-M. (2021). Dental caries in Saudi Arabia: A systematic review. Journal of Taibah University Medical Sciences, 16(5), 643–656. https://doi.org/10.1016/j.jtumed.2021.06.008.

Ashour, N. A., Ashour, A. A., & Basha, S. (2018). Association between body mass index and dental caries among special care female children in Makkah City. Annals of Saudi Medicine, 38(1), 28–35. https://doi.org/10.5144/0256-4947.2017.31.12.1515

Chen, D., Zhi, Q., Zhou, Y., Tao, Y., Wu, L., & Lin, H. (2018). Association between Dental Caries and BMI in Children: A Systematic Review and Meta-Analysis. Caries Research, 52(3), 230–245. https://doi.org/10.1159/000484988

Elangovan, A., Mungara, J., & Joseph, E. (2012). Exploring the relation between body mass index, diet, and dental caries among 6-12-year-old children. Journal of Indian Society of Pedodontics and Preventive Dentistry, 30(4), 293. https://doi.org/10.4103/0970-4388.108924

Farsi, D., Elkhodary, H., Merdad, L., Farsi, N., Alaki, S., Alamoudi, N., Bakhaidar, H., & Alolayyan, M. (2016). Prevalence of obesity in elementary school children and its association with dental caries. Saudi Medical Journal, 37(12), 1387–1394. https://doi.org/10.15537/smj.2016.12.15904

José Frias-Bulhosa, Nicole, P., Gomes, E. S., Lucia, M., & Elisa, M. (2015). Association between body mass index and caries among 13-year-old population in Castelo de Paiva, Portugal. 56(1), 3–8. https://doi.org/10.1016/j.rpemd.2015.02.001

Kopycka-Kedzierawski, D. T., Auinger, P., Billings, R. J., & Weitzman, M. (2008). Caries status and overweight in 2- to 18-year-old US children: findings from national surveys. Community Dentistry and Oral Epidemiology, 36(2), 157–167. https://doi.org/10.1111/j.1600-0528.2007.00384.x

Liang, J., Zhang, Z., Chen, Y., Mai, J., Ma, J., Yang, W., & Jing, J. (2016). Dental caries is negatively correlated with body mass index among 7-9 years old children in Guangzhou, China. BMC Public Health, 16(1). https://doi.org/10.1186/s12889-016-3295-3

Marghalani, A. A., Alsahafi, Y. A., & Alshouibi, E. N. (2014). The cost of dental caries in Saudi Arabia. Putting numbers into context. 35(1), 93–94.

Marshall, T. A., Eichenberger-Gilmore, J. M., Broffitt, B. A., Warren, J. J., & Levy, S. M. (2007). Dental caries and childhood obesity: roles of diet and socioeconomic status. Community Dentistry and Oral Epidemiology, 35(6), 449–458. https://doi.org/10.1111/j.1600-0528.2006.00353.x

Pikramenou, V., Dimitraki, D., Zoumpoulakis, M., Verykouki, E., & Kotsanos, N. (2016). Association between dental caries and body mass in preschool children. European Archives of Paediatric Dentistry, 17(3), 171–175. https://doi.org/10.1007/s40368-016-0222-3.

Qomsan, M. A. A. E., Alasqah, M. N., Alqahtani, F. A., Alobaydaa, M. A., Alharbi, M. M., & Kola, Z. (2017). Intricate Evaluation of Association between Dental Caries and Obesity among the Children in Al-Kharj City (Saudi Arabia). The Journal of Contemporary Dental Practice, 18(1), 29–33. https://doi.org/10.5005/jp-journals-10024-1983.

Sadeghi, M., Lynch, C. S., & A. Arsalan. (2011). Is there a correlation between dental caries and body mass index-for-age among adolescents in Iran? 28(2), 174–177.

Shahraki, T., Shahraki, M., & Omrani Mehr, S. (2013). Association Between Body Mass Index and Caries Frequency Among Zahedan Elementary School Children. International Journal of High Risk Behaviors and Addiction, 2(3), 122–125. https://doi.org/10.5812/ijhrba.10220.

Subramaniam, P., & Singh, D. (2011). Association of Age Specific Body Mass Index, Dental Caries and Socioeconomic Status of Children and Adolescents. Journal of Clinical Pediatric Dentistry, 36(2), 175–179. https://doi.org/10.17796/jcpd.36.2.e7665621805156uj.

Tinanoff, N., & Holt, K. (2017). Introduction to proceedings of healthy futures: engaging the oral health community in childhood obesity prevention national conference. Journal of Public Health Dentistry, 77, S5–S7. https://doi.org/10.1111/jphd.12218.

Willerhausen, B., Blettner, M., Kasaj, A., & Hohenfellner, K. (2007). Association between body mass index and dental health in 1,290 children of elementary schools in a German city. Clinical Oral Investigations, 11(3), 195–200. https://doi.org/10.1007/s00784-007-0103-6.