ORIGINAL RESEARCH

Dental Caries, Body Mass Index, and Diet among Learners at Selected Primary Schools in Pretoria, Gauteng Province, South Africa

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Abstract

Aim: To assess whether the prevalence of dental caries (DC) was associated with the body mass index (BMI), socioeconomic status (SES), and diet of grade six learners in Pretoria, South Africa (SA).

Materials and methods: A cross-sectional study was carried out. Learners underwent an oral and anthropometric examination, while the information on dietary intake and SES were collected using a standardized questionnaire.

Results: Of a possible 529 learners, 440 (83%) participated of whom 53% were boys. The mean age was 11.8 years, and 50% fell into the "medium" SES category. The prevalence of DC was 43%. The mean decayed, missing and filled teeth (DMFT) score was 1.19 (SD = ±1.79), of which the decayed (D) component was the largest 1.07 (SD = ±1.59). Two-thirds (62%) of learners had a normal BMI, and 26% were underweight. Less than half (47%) reported brushing their teeth twice a day; 71% claimed to drink up to one and a half glasses of sugar-sweetened beverages (SSBs), and 67% reported eating one to three sweets a day. The prevalence of DC was not significantly associated with BMI, diet, or SES, although having no caries was associated with eating less than three sweets a day.

Conclusion: The mean DMFT score was relatively low with much of the decayed teeth being untreated. Most learners were classified having a normal BMI, despite having bad eating habits. Oral health in this group of learners may be more influenced by healthcare-seeking behavior and access to healthcare services than by diet alone.

Clinical significance: The decayed component was fairly high, which means that there is a huge need for dental treatment, and although prevention and oral health promotion is important, learners with decayed teeth should have access to curative services.

Keywords: Body mass index, Cross-sectional study, Dental caries, Diet, School children.

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Introduction

There has been a steady increase in both childhood obesity and DC across the globe, and this poses a serious public health challenge.[1] Studies have reported that childhood obesity may be a risk factor for adult obesity and its associated health conditions such as cardiovascular disease and type II diabetes.[2–4] Dental caries is one of the largest unmet health needs among children worldwide, and those with DC in their primary dentition have a much higher probability of developing DC in their permanent dentition.[5] In addition, untreated DC in young children (both deciduous and permanent dentitions) results in stunted physical and mental development, inability to attend school, impaired daily activities, and a reduced ability to learn.[6,7] Both DC and obesity are more likely to occur in children who consume excessive amounts of sugary foods and foods rich in refined carbohydrates.[8] Despite this causative link, the association between DC and obesity has not been resolved, and there is conflicting evidence for a link between childhood obesity and the presence of DC. There is inconclusive evidence for the link between obesity and caries.[8] Recent meta-analyses reviewed several cross-sectional studies and could not identify a clear association between DC and obesity.[9] Chen et al. did various subgroup analyses and found that obese children in developed countries were more likely to have caries, whereas there was no evidence for an association between obesity and caries in children from developing countries.[9] Interestingly, the link between DC, diet, and obesity has been confirmed in various cohort studies.[1,10,11] Marshall and coworkers followed a group of children from the USA, through the ages of one through five, and found that children were more likely to have DC if their parents were less qualified, had lower family incomes, had obese, or overweight mothers, and if they consumed more sugary drinks per day. Children who were at risk of obesity were more likely to have DC.[11] The relationship between DC and obesity is often confounded by SES, which often influences health-seeking or preventative behavior.[12] The SES of individuals living in developed or developing countries plays a large role in healthcare-seeking behavior and access to health care. In developed countries, such as Germany, children from low socioeconomic (SE) backgrounds had more DC than children from high SE backgrounds.[12] Winter et al. also tested the effects of introducing an intensive tooth brushing program

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at kindergarten schools and found that class differences became negligible if children had access to the same preventative behavior. In developing countries such as Mexico, obese adolescents in rural areas had more DC compared with urban adolescents although urban adolescents ate more sweets. However, urban adolescents reported to have better access to preventative services, and this could have contributed to their low DC prevalence.[13] Few studies have assessed the relationship between DCs and obesity in Africa. In Nigerian adolescents who attended private schools, DC was not associated with BMI.[7] In Mozambique, children in suburban areas were more likely to be malnourished than children in urban areas, but were also more likely to have caries.[14] While these studies[7,14] reported relatively low DMFT scores (0.3–1.0), previous studies from SA reported DMFT scores as high as 3.7 for 12-year-old children.[15,16] In SA, the prevalence of DC has been linked to SES, race, and sugar intake,[16,17] but no studies have linked BMI as a contributing factor to DC. Childhood obesity in SA is on the rise especially for white children living in high SES conditions and black children experiencing economic transition.[18] This study assessed whether DMFT scores were associated with BMI of 12-year-old learners in a district in Pretoria, SA. The associations between DMFT, SES, and nutrition were also tested.

Materials and Methods

Ethical clearance was obtained from the Research Ethics Committee of the Faculty of Health Sciences at the University of Pretoria (442/2016), and all information was strictly confidential. This cross-sectional study took place in 2017 and included grade 6 learners from the Tshwane West District of Pretoria. This district was randomly selected from Pretoria's four districts.

The sample size calculation was based on the grade 6 learners (11,265), who were enrolled in 2016 at all the public schools in the Tshwane West District. The Tshwane West district has 93 primary schools. These schools were clustered into four geographic areas (north, south, west, and east), and one school from each cluster was selected using a convenience sampling technique.

With an assumed obesity prevalence of 23%,[19] a confidence level of 95% and a marginal error of ±0.05, a minimum sample of 372 learners was required.

In this study, 529 learners were included who each received assent and consent forms for their parents to sign. Data were collected in three parts, namely a clinical oral examination, recording anthropometric scores, and a questionnaire to determine the SES and diet (Appendix A). A single dentist performed the oral examinations in classrooms under natural light. Most of the grade 6 learners were 12 years old, and only permanent dentition was included as most of the primary dentition had exfoliated. The dentist assessed the caries status according to the World Health Organization (WHO) criteria for DMFT and pulpal involvement, ulceration, fistula, and abscess (PUFA). The mean DMFT scores were categorized as follows: 0 = no caries; 0.1–2.6 = moderate caries; and >2.7 = high caries similar to other studies and for ease of analysis.[20] A single operator recorded the height and weight of each learner, which was used to compute the BMI. The height was recorded using a mobile stadiometer, and the results were rounded off to the nearest 0.5 cm. The weight was recorded using an electronic digital scale, and the results were rounded off to the nearest 0.5 kg.

The BMI was categorized as follows: "underweight" (<15.99 kg/m^2); "normal" (16.00–21.99 kg/m^2); "overweight" (22.00–25.00 kg/m^2); and "obese" (>25.01 kg/m^2).[21] The SES, dietary intake, and oral hygiene practices were recorded using a modified questionnaire based on previous studies.[22,23] Current SES was based on parental employment, and the highest educational level passed. The points were awarded as follows: one point for the parent/guardian being employed; one for having passed primary; two for secondary; and three for a tertiary education per parent. The scores ranged between 2 and 15, a lower score indicating a low SES. The SES scores were categorized into low (2–6); medium (7–10); or high (11–15). Information on dietary intake was obtained by reporting the composition of food eaten during breakfast, lunch, and supper. The foods were grouped into protein (eggs, cheese, and meat), starch (maize), and junk foods (fried chips, cakes, SSBs, and sweets). Oral hygiene practices were measured by asking participants how often they brushed their teeth and whether they used fluoridated toothpaste. The data were analyzed using SPSS version 23. Descriptive and inferential statistical tests were used to test for significance between the different variables.

Results

Of the 529 learners invited, 83% (440) agreed to participate and had their consent forms signed and approved by their parents/guardians. Learners who did not have signed consent forms or who were not present on the day of the examinations were excluded. Those participants who were unaware of their parents' employment status or the last school grade passed were only excluded from the SES analysis but were included in all other statistical analyses. The participant's mean age was 11.8 years (SD = ±0.98; range 10–15) with 53% being male (Table 1). Most of the fathers (72%) and mothers (50%) were employed, and most had completed high school (Table 1).

Around half of the learners (n = 227, 52%) were classified as having a medium SES, and 30% (n = 134) a high SES. Although not significant, learners with a low SES had the lowest mean DMFT scores, while learners with high SES had the highest mean BMI scores (Table 2).

The DC prevalence was 43% (189/440), and the mean DMFT score was 1.2 (SD = ±1.77). The mean decayed (D) component was significantly higher than the missing (M) and filled (F) components (p = 0.00) and made up 90% of the mean DMFT score. Although the prevalence of DC and mean DMFT scores did not differ between genders, the DC and mean DMFT scores tended to be higher in boys than in girls (Table 3). None of the learners were present with PUFA (Table 3). The caries prevalence and mean DMFT scores were determined according to gender (n = 440). Learners had a mean

Table 1: Demographic characteristics of the learners (n = 440)

Gender (%)		*Mean age in years (±SD)*	*Mean age (±SD)*
Female	207 (47)	11.6 (±0.93)	11.8 (±0.98)
Male	233 (53)	11.9 (±1.01)	

Mother (n = 420) (%)		*Father (n = 381) (%)*	
Employed	*Unemployed*	*Employed*	*Unemployed*
208 (50)	212 (50)	273 (72)	108 (28)

Mother (n = 272) (%)			*Father (n = 219) (%)*		
Primary school	*High school*	*Tertiary*	*Primary school*	*High school*	*Tertiary*
9 (3)	234 (86)	29 (11)	9 (4)	186 (85)	24 (11)

Table 2: Association between grade 6 learners' SES, DMFT, and BMI scores

SES category	*n (%)*	*Mean DMFT (SD)*	*p value*	*Mean BMI (SD)*	*p value*
Low	79 (18)	0.9 (±1.9)	0.34	17.7 (±3.4)	0.33
Medium	227 (52)	1.2 (±1.7)		17.5 (±2.6)	
High	134 (30)	1.2 (±2.0)		18.1 (±3.6)	
Total	440 (100)	1.1 (±1.9)		17.8 (±3.2)	

Table 3: Caries prevalence and mean DMFT scores according to gender ($n = 440$)

Gender n (%)	*Caries prevalence n (%)*	*Decayed mean (±SD)*	*Missing mean (±SD)*	*Filled mean (±SD)*	*Total DMF mean (±SD)*
Girls, 207 (47)	84 (40)	1.0 (±1.58)	0.0 (±0.15)	0.0 (±0.15)	1.0 (±1.64)
Boys, 233 (53)	105 (45)	1.1 (±1.60)	0.1 (±0.36)	0.1 (±0.76)	1.3 (±1.91)
Total ($n = 440$)	189 (43)	1.1 (±1.59)	0.0 (±0.25)	0.1 (±0.45)	1.12 (±1.77)

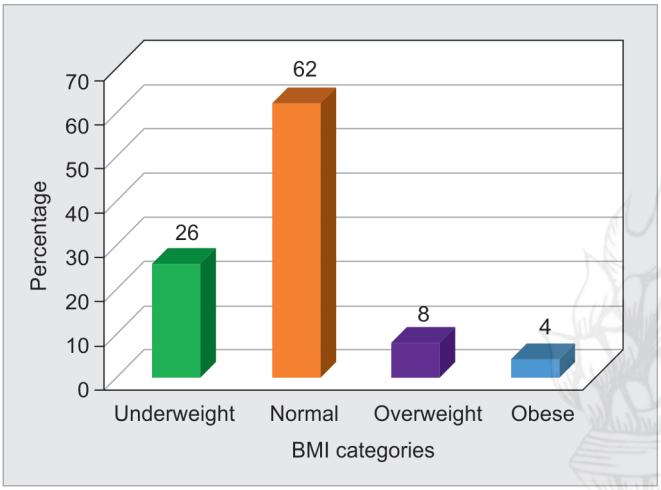

Fig. 1: BMI classification of learners ($n = 440$)

Table 4: Diet and oral health practices of learners ($n = 440$)

Brushing teeth (n = 434)				*n (%)*
Once a day				159 (36)
Twice a day				203 (46)
More than twice a day				72 (16)
Number of sweet beverages consumed (n = 435)				
1–1.5 glasses				307 (71)
2 and more glasses				128 (30)
Number of sweets consumed (n = 395)				
1–3 sweets				264 (67)
4 or more sweets				131 (33)
Meals	*Starch*	*Proteins*	*Combination*	*Junk*
Breakfast ($n = 373$)	185(50)	4 (1)	172 (46)	12 (3)
Lunch ($n = 430$)	98 (23)	5 (1)	203 (47)	124 (29)
Supper ($n = 436$)	14 (3)	2 (1)	415 (95)	5 (1)

BMI of 17.7 (±3.00) kg/m^2 with two-thirds of learners (62%) falling in the "normal" range and 26% in the "underweight" category (Fig. 1).

Fewer than half (46%) of learners indicated that they brushed their teeth twice a day, and all of them (98%) reported using fluoridated toothpaste (Table 4).

Regarding diet, almost three quarters (71%) reported to consume on a daily basis, between one and one-and-a-half glasses of SSBs and 67% reported eating one to three sweets daily. Half of the participants (50%) reported eating only starch (e.g., soft porridge and bread) for breakfast. For their lunch and supper, most learners consumed a mixture of starch (potatoes and rice) and proteins (beef, meat, fish, and cheese) and almost a third of the learners reported eating junk food such as potato fries, bread, and pickle relish dipped in oil for lunch (Table 4).

Mean DMFT was not significantly associated with BMI or SES. Older learners were associated with higher DMFT scores ($p < 0.05$). Learners with no caries were associated with eating fewer than three sweets a day ($p < 0.01$) (Table 5).

Discussion

Grade six learners from the Pretoria West District of Tshwane in SA had a low prevalence of DC and low mean DMFT scores. This was similar to a systematic review and meta-analysis conducted by Hayden et al. and the results obtained in the National Oral Health Children Survey conducted in 2004.[1,24] Although the scores were similar, the national survey was conducted approximately 15 years ago and comparisons need to be interpreted with caution. Unfortunately, there is a lack of robust studies on 12-year-olds in SA, and as a result, it was difficult to determine any changes in the trends of caries within this age group. Most of the learners in this study had a normal BMI and had an average SES. Given the low prevalence of caries, it is not surprising that no association was found. Of concern, however, is that most of the caries were untreated.

Dental Caries

The prevalence of DC was 43% with a mean DMFT of 1.2, which is classified by the WHO, as low.[25] Although the DMFT score was relatively low, 90% of this was as a result of the decayed component. The high-decayed component was similar to other studies in which the D component was ranged between 83% and 96% of the total DMFT score.[15,24,25,27–31] This high proportion of untreated carious teeth could be due to various reasons including limited access to oral health facilities, the high cost of dental treatment, fear of treatment, or poor dental knowledge.[7,26,27]

Older participants had a significantly higher prevalence of DC, and this could be due to the prolonged exposure of teeth to risk factors. The PUFA score in this study was zero, which is probably due the oral examination being confined to the permanent dentition and the caries not being able to progress to the pulp.

Table 5: Association between DMFT categories and mean age, BMI, SSBs, and sweets

DMFT	*Age years mean (±SD)*	*p value*	*BMI mean (±SD)*	*p value*	*SSBs mean (±SD)*	*p value*	*Sweets mean (±SD)*	*p value*
No caries (DMFT = 0)	11.7 (±0.96)	0.00*	17.7 (±3.20)	0.56	1.5 (±0.89)	0.34	2.6 (±2.11)	0.01*
Moderate caries (DMFT = 0.1–2.6)	11.7 (±0.97)		17.5 (±2.35)		1.5 (±0.77)		3.4 (±2.74)	
High caries (DMFT ≥ 2.7)	12.1 (±0.98)		18.0 (±3.58)		1.6 (±1.15)		3.2 (±3.44)	

*Level of significance at $p < 0.05$

Body Mass Index

Almost two-thirds (62%) of learners had a normal BMI, while 8% fell into the "overweight" category. This was similar to a study by Delonye et al., which reported that 78% and 88% of participants had a normal weight, and between 3% and 19% were overweight.[7] The prevalence of overweight learners in this study was slightly lower than the WHO global prevalence of 10%.[18,32,33] However, authors agreed that these WHO categories are based on an unequal distribution of data from both first and third world countries and from a combination of different ages.[33]

In the current study, a quarter (26%) of learners fell in the "underweight" category and this was similar to other studies that reported a prevalence of nutritional disorders of between 18% for stunting and 4% for wasting.[34] A possible reason for the prevalence of underweight learners in the current study might be that some of them were from a low SES and that many had a poor diet.

Diet

Most of the learners (67%) consumed one to three sweets daily, which may be due to the ease of its accessibility. In contrast, a study by Zhu et al. reported that 70% of Chinese learners consumed in excess of 4 sweets daily.[35] In the current study, 96% of learners reportedly ate breakfast consisting of starch and proteins. In SA, the staple diet is maize (starch), which is often served as a porridge. During lunch, less than half (47%) of learners consumed a combination of starch and proteins while 29% reported eating junk food. For supper, most learners (95%) consumed both starch and proteins, presumably because this was the only time parents prepared a balanced nutritious meal.

Oral Health Habits

Dental professionals widely promote brushing teeth twice daily, since regular tooth brushing has been shown to prevent DC and maintain good oral hygiene.[6,35] Fewer than half (47%) of learners reported brushing their teeth twice daily with a fluoride toothpaste, which was similar to another study where 44% of participants brushed their teeth twice daily.[36] The low rate of frequent brushing may be due to learners and their parents not knowing about the benefits of regular tooth brushing or due to the high cost of toothpastes and toothbrushes.

Socioeconomic Status

More than half of respondents were classified as having a medium SES, and this could be due to the fact that the majority of parents, either one or both of them, were employed. This could be due to the high levels of education among the parents. It was surprising that more than 10% of all parents had received a tertiary education given the fact that these schools were located in semi-urban areas where the unemployment rate is expected to be high.

Association between DC and Diet, and BMI and SES

In this study, DC status was not significantly associated with BMI. However, learners with a high mean BMI score tended to have higher DMFT scores. Learners with higher BMI scores consumed more SSBs, and this may have contributed to a higher DMFT score. This finding was similar to other studies by Nicolau et al., Chen et al., and Hooley et al., that highlights the importance of a healthy diet in maintaining a healthy oral health status.[8,9,37] Those children with no caries tended to eat fewer than three sweets per day.

There was a statistically significant association between the prevalence of DC and the number of sweets consumed daily.[33] This was similar to other studies by Delonye et al. and Elangovan et al. that stressed the importance of the consumption of refined sugars and its role in the initiation and progression of DC.[7,38]

Those with moderate DMFT scores tended to consume more sweets and SSBs compared with those with no or low DMFT scores.[9,38] These results confirm that the association between diet and DC is a complex multifactorial relationship, and factors such as oral hygiene and dental habits also influence the progression and initiation of DC. As a result, preventive policies or strategies should include a common risk factor approach, which would address the various risk factors that contribute to the initiation and progression of DC. Although not significant, learners with low SES had the lowest mean DMFT, and this could be due to consuming less-refined carbohydrates, which are relatively expensive.

Limitations

This study is of cross-sectional study design, and hence, past experiences were not taken into account nor could causality be inferred. Dietary information was based on self-reported data collected during interviews with learners. Learners may have been reluctant to answer truthfully, and thus, the results may not truly reflect the relationship between DC, diet, and BMI. Additionally, although employment status of the parents was reported, some young learners did not know of their parents' employment status or their level of education. In addition, the parents' salary and the number of siblings of the participants were not recorded.

Recommendations

Oral health promotion should be carried out at primary schools. Oral health education should be included into the general school curriculum, and harmful dietary practices should be constantly taught. Learners should be assisted when purchasing food and drinks at schools by regulating the type of food sold at cafeterias and vendors. Learners with dental problems should have access to curative services.

Conclusion

Although the mean DMFT score was relatively low, many teeth were decayed. The PUFA score was zero, and most participants fell into the normal BMI category. There were no significant associations between DC and the mean BMI nor between DC and SES of the learners. Learners who ate less than three sweets per day and those who were younger tended to have a lower DMFT score. Fewer than half of the learners brushed daily, and most had a balanced diet at supper.

Clinical Significance

The decayed component was fairly high, which means that there is a huge need for dental treatment, and although prevention and oral health promotion is important, learners with decayed teeth should have access to curative services.

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Appendix A: Data Collection Sheet

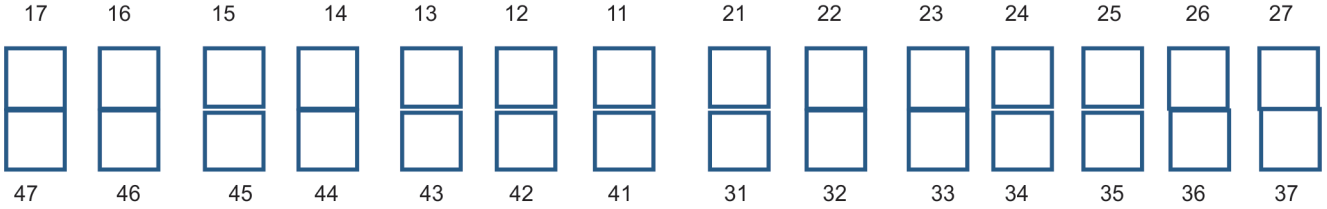
Demographics				
1. Age in years				
2. Gender			Male	Female
3. Parents			Employed	Unemployed
Mother				
Father				
4. What is the last grade or standard your parents passed?				
Mother				
Father				
5. Type of home where you stay			Tick the applicable one	
			Flat	
			House	
			Shack	
6. How many rooms does your family house comprise of?				
7. How many brothers or sisters do you have?				
8. How many people are living in the house?				
9. Does your home have DSTV/any satellite TV?			Yes	No
10. Height (meters)?				
11. Weight (kg)?				
Diet history				
Food type and amount	Breakfast	Lunch	Supper	
1. What kind of food do you eat				
2. Do you drink any soft drinks beverages e.g., Coke, Fanta orange or juice			Yes	No
If yes, how many cans do you drink per day				
3. Do you suck lollipop/eat sweets and chocolate?			Yes	No
If yes, how many per day?				
4. Do you eat from the feeding scheme at your school?	Breakfast Yes/No		Lunch Yes/No	
5. Do you participate in any sports activity e.g soccer, netball, rugby	Yes		No	
How many days in a week do you participate				

Oral health practices

	Yes	No
1. Do you brush your teeth?		
2. If yes times do you brush your teeth	Once daily	
	Twice daily	
	More than twice daily	
	Other	
	Yes	No
3. Do you use a toothpaste		
4. If yes, what type do you normally use		

DMFT and PUFA index

DMFT: 0=sound, D=decayed, M=missing, F=filled



PUFA: 0=healthy, P=pulpal involvement, U=ulcer, F=fistula, A=abscess