



ORIGINAL ARTICLE

Caries prevalence and severity in association with sociodemographic characteristics of 9-to-12-year-old school children in Al-Madinah, Saudi Arabia



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Abstract *Aim:* This study was conducted to estimate the prevalence and severity of dental caries in 9-to-12-year-old schoolchildren in Al-Madinah, Saudi Arabia (SA); to compare its expression by mean of decayed, missing and filled teeth (dmft/DMFT) and the Significant Caries Index (SiC Index); to examine the association between caries experience and sociodemographic factors; and to determine whether schoolchildren in Al-Madinah are at greater risk for high levels of dental caries.

Materials and methods: Data of 1,000 schoolchildren aged 9–12 years old from a cross-sectional oral health survey in Al-Madinah, SA was obtained and analysed. Dental caries was measured using dmft/DMFT and the SiC Index which was computed into two groups: highest 30% DMFT scores (SiC³⁰) and highest 10% DMFT scores (SiC¹⁰). Sociodemographic variables included age, gender, nationality, school type (public or private) and family income. Descriptive and inferential were calculated to estimate caries prevalence and severity and its association with sociodemographic factors.

Results: Caries prevalence in primary or permanent teeth was 85.1%, with untreated caries of 76.1%. The mean dmft was 2.66 ± 2.63 while the mean DMFT was 1.43 ± 1.73 . Caries severity was significantly higher among males, Saudis, those from low-income families and those from public schools ($p < 0.05$). The mean values of SiC³⁰ (3.52 ± 1.57) and SiC¹⁰ (4.98 ± 1.77) were considerably higher than the overall average DMFT value.

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Conclusion: Dental caries persists as a public health challenge among schoolchildren in Al-Madinah, SA, with a very high prevalence and severity among schoolchildren. The use of the SiC Index highlighted the subgroups with more severe caries experience.

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1. Introduction

The introduction of community water fluoridation and massive investment in the health care system, including dental services, are the most widely used public health measures to reduce dental caries in Saudi Arabia (SA). However, there has been a very high prevalence of oral disease, especially dental caries, across all ages, comprising a persistent public health challenge (Al Ayyan et al., 2018; Alhabdan et al., 2018; Bahannan et al., 2018). Nationwide surveys of dental caries indicate that caries experience has increased by around 10% over the last decade (Al-shammery, 1999; AlDosari et al., 2004).

Similar to many other countries, the distribution of caries prevalence is expected to be skewed (Campus et al., 2003); thereby, the mean decayed, missing and filled (dmft/DMFT) values underestimate the actual burden of caries experience in highly affected subgroups. The prevalence is noticeably high and requires appropriate intervention. To date, only one systematic review has been conducted to assess the nationwide prevalence and severity of dental caries in children (Al Agili, 2013). The results show that caries prevalence was estimated to be 80% for primary dentition, with a mean dmft of 5.0 and a caries prevalence of 70% for children's permanent dentition with a mean DMFT score of 3.5 (Al Agili, 2013). Only a two-decades-old caries prevalence data of Al-Madinah school-age children was included in the review (Al Agili, 2013). The former study showed high mean dmft values of 6.4 in six-year-old children and 2.9 DMFT values among 12-year-old children in Al-Madinah, SA (Al-Tamimi and Petersen, 1998). Al-Ansari et al. (2019) reported the availability of caries-related data in Saudi Arabia using scientific publications. The study revealed that no current caries data was available for children aged 9–12 years old in the northern part of Saudi Arabia, including Al-Madinah. Therefore, there is an urgent need for updated and detailed data on caries prevalence and severity among schoolchildren to enable appropriate oral health policy planning and resource allocation. Hence, this study aimed to estimate the prevalence and severity of dental caries in primary and permanent teeth of 9-to-12-year-old schoolchildren in Al-Madinah, SA; to compare its expression by mean DMFT and the Significant Caries Index (SiC Index); to examine the association between caries experience and sociodemographic factors; and to determine whether schoolchildren in Al-Madinah are at greater risk for high levels of dental caries.

2. Material and methods

2.1. Study design

This cross-sectional study recruited a sample of 1,000 children aged 9–12 years old in the city of Al-Madinah. Al-Madinah is one of the major cities in SA, with a child (10-to-14-year-old)

population of 172,548 (General Authority for Statistics in Kingdom of Saudi Arabia., n.d.).

As for the selection of participating schools, a stratified random sampling design was applied to select schools. Schools selection was determined based on our knowledge of common area-based attributes of socioeconomic level including housing condition, basic services availability, income, education and occupation. Schools were stratified to high and low socioeconomic level. Afterwards, five schools from each stratum were randomly selected and included in the survey. For more precise analysis, it was not feasible to use area-based measures of socioeconomic position to control differences between students. Therefore, individual-level socioeconomic status was determined using each student's average family data.

Prior to each school visit, information sheets and questionnaires that included information on sociodemographic, family size and parental education level and occupation were sent to all parents of 9-to-12-year-olds in the schools to obtain consent.

2.2. Data collection and variables

The survey was planned by the University of Taibah, Department of Preventive Dental Sciences, and calibrated and trained staff from the department carried out the survey. Instructors with previous proficiency in oral health surveys following the WHO's guidelines led the training.

All 9-to-12-year-old students who attended the schools on the day of the survey, and whose parents provided consent, were included in the survey. A total of 1256 students were invited to participate in our survey. Only 1000 students have completed survey (completion rate 80%). The number of participants per school has ranged between 98 and 119.

The children were interviewed for self-reported oral health behaviour using the WHO oral health questionnaire for children. Oral examinations were performed following the WHO Oral Health Survey Methods (World Health Organization, 2013).

Dental screening for caries was performed in a classroom with each student seated on a chair under artificial light. Each tooth was assessed for caries experience by the dmft (in primary teeth) and DMFT (in permanent teeth). The dmft/DMFT index was calculated by adding the number of teeth that were affected by caries (including untreated caries, teeth that were filled but carious and teeth that were filled because of caries or removed because of caries).

Caries prevalence was expressed as the percentage of children with any caries experience (dmft/DMFT > 0) and untreated caries as the percentage of children with any decayed (d/D > 0) teeth. Caries severity was assessed by the unadjusted dmft/DMFT mean for the study sample. To identify the severity of the caries experience in the most affected individuals in the study sample, the SiC Index (Bratthall, 2000) was used at

two levels. Individuals in the study sample were sorted from highest to lowest according to their DMFT values. One-third (30%) of the sample with the highest DMFT scores was selected, and then only the 10% of the sample that had the highest DMFT scores was selected. The mean DMFT for each subgroup was calculated and presented as SiC³⁰ (for highest 30%) and SiC¹⁰ (for highest 10%).

Age was categorised into two groups: 9–10 years old and 11–12 years old. The nationality of the students was dichotomised into Saudis and non-Saudis. The type of school was also dichotomised as public or private. To determine level of deprivation, parents' (father and mother) occupations were used as a proxy for family monthly income, which was divided into three categories, low, medium and high, as described previously (Kassim et al., 2019).

2.3. Statistical analysis

Descriptive statistics were calculated to report the sociodemographic characteristics and caries severity and prevalence. Mean and standard deviation of dmft/DMFT and SiC Index values were analysed and were compared between groups using Student's t-tests, one-way ANOVA or Kruskal Wallis tests with significance levels set at 95%. Data entry was performed using Microsoft Office Excel 2018, and statistical tests were conducted using IBM SPSS software.

3. Results

3.1. Background characteristics

A total sample of 1,000 students from 10 schools were analysed in the study. The sample distribution was almost even for both public and private schools. The male participants were 60.10% of the total sample, and 39.9% were females. The mean \pm SD

age of the participating children was 10.97 ± 1.15 years. In all, 79.7% of students were Saudis, and 20.2% were other nationalities. As for family income, the majority of the children were living with middle- or low-income families [391 (39.7%) vs 314 (31.9%), respectively]. Table 1 shows the sociodemographic characteristics of the sample.

3.2. Descriptive analysis

Caries prevalence in primary or permanent teeth was 85.1%, with untreated caries at 76.1%. Caries prevalence in primary teeth was 70.4%, while in permanent teeth caries prevalence was 56.6%. Dental caries prevalence and untreated caries were more prevalent among children who are male, Saudi, from low-income families and from public schools (Table 2).

3.3. Severity of dental caries experience in primary or permanent teeth in relation to sociodemographic factors

The overall mean dmft was 2.66 ± 2.63 while mean DMFT was 1.43 ± 1.73 . In caries severity analysis in association with sociodemographic characteristics, most of the variables revealed statistically significant differences ($p < 0.05$) (Table 3). Students older than 10 years old had statistically significantly lower mean dmft scores compared with those aged 11–12 years old (3.27 ± 2.87 vs 2.34 ± 2.45 , $P = 0.0001$, respectively). On the other hand, the older age group was significantly more likely to experience higher average DMFT scores (1.81 ± 0.07) compared with its younger counterpart (1.04 ± 0.08 , $P = 0.0001$). In both primary and permanent teeth, caries levels were statistically significantly more likely to be higher in males than females (2.86 ± 2.6 vs 2.34 ± 2.65 , $P = 0.002$ and 1.65 ± 1.77 vs 1.09 ± 1.62 , $P = 0.0001$, respectively). Additionally, Saudis were more likely to have higher caries experience as their dmft and DMFT scores were significantly higher than that of the non-Saudi children (2.79 ± 2.65 for Saudis vs 2.13 ± 2.51 for non-Saudis, $P = 0.002$ and 1.52 ± 1.77 for Saudis vs 1.01 ± 1.56 for non-Saudis, $P < 0.01$, respectively). Children in public schools had significantly higher mean dmft (3.01 ± 2.78) and DMFT (1.82 ± 1.92) scores when compared to children in private schools (2.30 ± 2.44 and 1.04 ± 1.43 , respectively). Higher mean DMFT scores were observed in children from low-income households (1.76 ± 1.92) compared to their high-income counterparts (1.04 ± 1.63 , $P = 0.001$). However, there were no statistically significant differences found between the mean dmft scores of schoolchildren in relation to family income level ($P = 0.082$).

3.4. Significant caries index

The mean values of SiC³⁰ (3.52 ± 1.57) and SiC¹⁰ (4.98 ± 1.77) were considerably higher than the overall average DMFT value (1.43 ± 1.73) (Fig. 1). No significant differences were found based on the SiC Index cut-off values by age, nationality or family income. Children from public schools (3.72 ± 1.74) had significantly higher SiC³⁰ scores than privately schooled children (3.21 ± 1.21), and this difference was significant ($P < 0.01$) (Table 4). When the effect of gender in relation to SiC³⁰ was evaluated, a significant difference was found; female schoolchildren had higher DMFT values (4.13 ± 1.49

Table 1 . Sociodemographic characteristics of schoolchildren with (dmft/DMFT > 0) in Al-Madinah, SA (n = 1000).

Variables	F (%)
<i>Age (in years)*</i>	
9–10	342 (34.4)
11–12	653 (65.6)
<i>Gender</i>	
Females	399 (39.90)
Males	601 (60.10)
<i>Nationality*</i>	
Saudi	787 (79.8)
Non-Saudi	199 (20.2)
<i>School Type</i>	
Public	496 (49.60)
Private	504 (50.40)
<i>Family income*</i>	
Low	314 (31.9)
Medium	391 (39.7)
High	279 (28.4)

F (%) = frequency with percentages.

* Does not include missing data.

Table 2 Caries prevalence in primary and permanent teeth (dmft/DMFT > 0) across sociodemographic variables among schoolchildren in Al-Madinah, Saudi Arabia (n = 1000).

Variables	Primary teeth dmft > 0	Permanent teeth DMFT > 0	Primary or Permanent	
			(dmft or DMFT > 0)	Untreated Caries (d or D > 0)**
Total	703 (70.4)	565 (56.6)	851 (85.1)	761 (76.1)
<i>Age*</i>				
9–10	226 (78.0)	156 (45.7)	287 (83.9)	257 (75.1)
11–12	433 (66.3)	406 (62.2)	560 (85.8)	501 (76.7)
<i>Gender</i>				
Females	252 (63.3)	176 (44.2)	307 (76.9)	268 (67.2)
Males	451 (75.0)	389 (64.7)	544 (90.5)	493 (82.0)
<i>Nationality*</i>				
Saudi	569 (72.5)	471 (60.0)	684 (87.0)	622 (79.1)
Non-Saudi	124 (62.3)	82 (41.2)	155 (77.9)	128 (64.3)
<i>School Type</i>				
Public	374 (75.6)	332 (67.1)	451 (90.9)	427 (86.1)
Private	329 (65.3)	233 (46.2)	400 (79.4)	334 (66.3)
<i>Family income*</i>				
Low	235 (74.8)	205 (65.3)	280 (89.2)	265 (84.4)
Medium	273 (70.0)	235 (60.3)	341 (87.2)	304 (77.7)
High	184 (65.9)	115 (41.2)	217 (77.8)	179 (64.2)

* Does not include missing data.

** proportion of children with untreated decayed teeth in primary or permanent dentition.

Table 3 The association between dmft and DMFT and sociodemographic data in schoolchildren in Al-Madinah, SA (n = 1000).

Variables	dmft M ± SD	P value	DMFT M ± SD	P value
Total	2.66 ± 2.63		1.43 ± 1.73	
<i>Age</i>				
9–10	3.27 ± 2.87	0.0001*	1.04 ± 0.08	0.0001*
11–12	2.34 ± 2.45		1.81 ± 0.07	
<i>Gender</i>				
Females	2.34 ± 2.65	0.002*	1.09 ± 1.62	0.0001*
Males	2.86 ± 2.60		1.65 ± 1.77	
<i>Nationality</i>				
Saudi	2.79 ± 2.65	0.002*	1.52 ± 1.77	0.006*
Non-Saudi	2.13 ± 2.51		1.01 ± 1.56	
<i>School Type</i>				
Public	3.01 ± 2.78	0.0001*	1.82 ± 1.92	0.001*
Private	2.30 ± 2.44		1.04 ± 1.43	
<i>Family income</i>				
Low	2.82 ± 2.59		1.76 ± 1.92	
Medium	2.72 ± 2.64	0.082	1.45 ± 1.61	0.001*
High	2.36 ± 2.65		1.04 ± 1.63	

* Statistically significant at P value < 0.05.

, P = 0.001). However, when evaluated based on SiC¹⁰, males had significantly higher values than females (6.23 ± 2.17 vs 4.79 ± 1.64, P < 0.01).

4. Discussion

A high prevalence of dental caries among 9-to-12-year-old schoolchildren living in Al-Madinah was found, which is con-

sistent with previous studies from adjacent provinces (Al Agili and Alaki, 2014; Farooqi et al., 2015; Mahrous et al., 2016). The current prevalence highlights the fact that dental caries remains a serious and frequently occurring disease among schoolchildren in Saudi Arabia, which has not improved alongside economic development. The prevalence of untreated dental caries observed in both primary and permanent teeth was noticeably high and close to that observed in several stud-

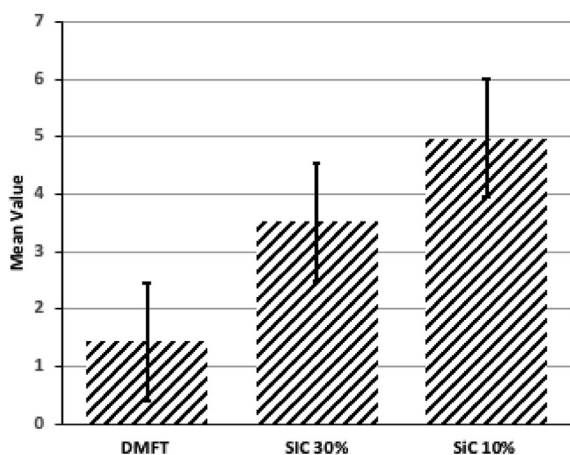


Fig. 1 Comparison between the mean DMFT, SiC¹⁰ and SiC³⁰ Indexes in schoolchildren in Al-Madinah, SA.

ies conducted in Iran and Turkey (Gökalp et al., 2010; Ramazani and Rezaei, 2017); however, it was nearly six times higher than that reported in the United States and the United Kingdom (Fleming and Afful, 2018; Masood et al., 2019).

The mean DMFT (caries prevalence) in our study appears to be low according to the WHO classification (World Health Organization, 2013). This finding might be due to the fact that susceptibility to caries is lower in permanent teeth (Lynch, 2013). However, the mean DMFT of one-third of the study group (SiC30) appears to fall within the range of moderate caries severity according to the WHO's DMFT classification. Although dmft/DMFT scores appear to be moderate, the prevalence of dental caries (number of children with any caries) is alarming and requires attention and intervention.

The use of the SiC Index in conjunction with DMFT provides a better understanding of the underlying distribution of caries experience in this child population. It is clear that caries was not normally distributed but that a smaller group of children experience more severe levels of the disease. This result might indicate an urgent need for effective, targeted and appropriate preventive dental program design, as current preventive programs focus mainly on oral health education (Baghdadi, 2011). As evidenced by the literature, this approach is insufficient and not effective in achieving behavioural change and subsequent improvements in oral health (Kay and Locker, 1998; Watt et al., 2001).

As reported by Bahannan et al. (2018), the evidence we found identified that male children are more likely to experience caries lesions than female children, whereas Farooqi et al. (2015) found no statistically significant gender differences in caries prevalence. Our results could be attributed to better oral health knowledge and practices among female schoolchildren, who tend to have better brushing and flossing behaviours (Farsi et al., 2004; Kuusela et al., 1997). Despite the free access to publicly funded dental services in Saudi Arabia for all citizens, the current results suggest that Saudi schoolchildren have higher caries prevalence and more severe caries experience than non-Saudi schoolchildren, and similar findings were observed by Farooqi et al. (2015). This could be attributed to behavioural factors, including poor oral hygiene and consuming a diet high in sugar. In addition, the majority of Saudis do not visit the dentist regularly for routine check-ups but only when they feel pain (AlHumaid et al., 2018; Murshid, 2016). In a recent paper it was reported that one in four children have never visited a dentist in Jeddah, SA (Al Agili and Farsi, 2020). Furthermore, studies have examined the fluoride level in drinking water supply in SA regions and found that fluoride level is less than the recommended level (Aldosari et al., 2003; Bakhurji and Alqahtani, 2018).

Table 4 Bivariate analysis of 30% and 10% Significant Caries Index (SiC) values in relationship to sociodemographic characteristics of schoolchildren in Al-Madinah, SA.

Variables	SiC ³⁰ (n = 300) M ± SD	P value	SiC ¹⁰ (n = 100) M ± SD	P value
Total	3.52 ± 1.57		4.98 ± 1.77	
<i>Age</i>				
9–10	3.42 ± 1.58	0.568	4.88 ± 2.23	0.785
11–12	3.55 ± 1.57		5.01 ± 1.68	
<i>Gender</i>				
Females	4.13 ± 1.49	0.001*	4.79 ± 1.64	0.006*
Males	3.36 ± 1.56		6.23 ± 2.17	
<i>Nationality</i>				
Saudi	3.53 ± 1.61	0.805	5.01 ± 1.82	0.648
Non-Saudi	3.46 ± 1.39		4.77 ± 1.48	
<i>School Type</i>				
Public	3.72 ± 1.74	0.003*	5.10 ± 1.94	0.290
Private	3.21 ± 1.21		4.68 ± 1.22	
<i>Family income</i>				
Low	3.59 ± 1.81	0.138	5.09 ± 2.12	0.283
Medium	3.37 ± 1.35		4.76 ± 1.56	
High	3.79 ± 1.46		5.09 ± 1.27	

*Statistically significant at P value < 0.05.

The current results confirm that poor and deprived individuals suffer a disproportionately greater caries burden, while people of higher socioeconomic status are in better dental health (Locker, 2000; Watt and Sheiham, 1999; Westin, 2002). Children of low socio-economic status are more likely to experience inadequate access to dental health care, high intake of carbohydrates, including sweets, and limited access to fluoride toothpaste (Alayadi et al., 2019; Tchicaya and Lorentz, 2014; Watt and Sheiham, 1999).

The strengths of this study are multiple. The study provides a current update for caries status for children in Al-Madinah and to our knowledge, no study has compared caries distribution between male and female schoolchildren using the SiC Index. Our study provides baseline statistics on several population characteristics to inform local authorities and international organisations (e.g., WHO) in order to evaluate and improve the oral health promotion programs that aims to reduce the burden of dental caries in children.

It is plausible that a number of limitations could have influenced these results. Because the cross-sectional nature of this study provides an overview of a real-time situation, causal paths cannot be elucidated. The study sample was limited to 9-to-12-year-old primary school children in Al-Madinah, which warrants caution in generalising the results to the entire country. Finally, we have used father and mother's occupations as a proxy for family income; this may introduce bias.

5. Conclusion

Dental caries persists as a public health challenge among 9-to-12-year-old schoolchildren in Al-Madinah, SA with a very high prevalence. The SiC Index was found to be considerably higher than the average DMFT value which reflects a group of children who are suffering from a higher caries level. The sociodemographic factors that were associated with caries were found to be children who are male, Saudi and of lower socioeconomic status.

Ethical statement

This study was carried out in accordance with the international standards established by the World Health Organization (WHO) (World Health Organization, 2013) with permission and ethical approval from Taibah University Ethics Committee in Al-Madinah and ethical approval from the Human Research Ethics Committee from The University of Western Australia (RA/4/20/5467). The study was conducted in accordance with the principles of the World Medical Association of Helsinki. Parental consent was obtained alongside child consent prior to all interviews. Participation in the study was voluntary, and anonymity was preserved.

CRedit authorship contribution statement

A. Aqeeli: Investigation, Analysis, Writing - original draft & editing. **H. Bakeer:** Data curation Writing - review & editing. **A. Alshareef:** Supervision, Writing - review & editing. **E. Kruger:** Supervision, Writing - review & editing. **M. Tennant:** Supervision, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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