



Caries experience and related risk factors among Libyan adolescents in Sirte: a cross-sectional study

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Abstract

Background: Dental caries remains a persistent global public health issue, yet region-specific epidemiological data were lacking for schoolchildren in Sirte, Libya. **Objectives:** This study aims to assess dental caries prevalence among 12- to 15-year-olds in Sirte and explore associated dietary, oral hygiene, and dental care access risk factors. **Methods:** A cross-sectional survey utilising self-administered questionnaires and classroom clinical examinations was conducted among 1,047 participants using a two-stage cluster random sample. Caries and its clinical consequences were measured using WHO DMFT and PUFA indices, and data were analysed using SPSS 25. **Results:** Overall caries experience DMFT ≥ 1 was 51.4%, with a mean DMFT score of 1.14 ± 1.54 . Pulpal involvement was found in 35.8% of students (mean PUFA P score 0.66 ± 1.06). Toothbrushing and toothpaste were reported by 97.52%, while dental floss usage was 11.75%. Significantly higher caries prevalence occurred among females ($p=0.001$), children of mothers with less than university education ($p=0.011$), and non-users of dental floss ($p=0.012$). **Conclusion:** Adolescents in Sirte experience a moderate overall caries burden alongside a high prevalence of advanced, untreated lesions and pulpal involvement. Significant demographic and behavioural disparities highlight an urgent public health need for targeted preventive initiatives and improved access to restorative care.

Keywords : Dental caries: Caries experience: Risk factors :Adolescen :DMFT :Index

Introduction

Dental caries remains one of the most prevalent and persistent public health problems affecting children and adolescents worldwide. Untreated, dental caries can cause pain, infection, and tooth loss, thereby impairing nutrition, school performance, and overall quality of life [1]. This condition is particularly concerning among children and adolescents because their developing permanent dentition is more vulnerable to environmental and behavioural influences [2]. Globally, the burden is especially severe in many developing countries, due to limited access to dental services, inadequate oral hygiene practices, and frequent consumption of sugary foods and beverages [3]. Socioeconomic inequalities further exacerbate the problem, with children from lower-income families being disproportionately affected [4]. In line with these global observations, several studies conducted in Libya have reported varying levels of dental caries among schoolchildren. A study by Arheiam et al. [5] in Benghazi found that 42.8% of 12-year-old schoolchildren had active untreated dentine decay, with a mean DMFT score of 1.09 ± 1.57 . A subsequent study by Arheiam et al. [6] reported a higher mean DMFT score of 1.55 ± 2.77 , with notable differences between students in public and private schools. Similarly, a previous report documented caries prevalence rates of

78% and 48.2% among investigated first- and seventh-grade students in Tripoli, respectively [7]. In another study, [8] reported that 44.1% of 12-year-old students in both public and private schools had active untreated dentine decay. Comprehensive and region-specific epidemiological data are periodically required for the development of effective public health strategies and targeted preventive programs. No such data were available for school children in Sirte, Libya. Therefore, this study aims to assess the prevalence of dental caries among students aged 12 to 15 years in Sirte, Libya, and to explore associated risk factors including dietary habits, oral hygiene practices, and access to dental care.

Material and Methods

Study Design:

A Cross-sectional epidemiological survey using both a self-administered questionnaire and clinical examination was conducted among adolescents in Sirte, Libya, during the period between September 2024 and December 2024.

Participants:

Schoolchildren aged 12-15 years of age were recruited for the current study. Only those who are Libyan, aged 12-15 years and citizens of Sirte since birth were included in the study. A list provided by the Sirte Monitoring Education Municipality Department,



including government and private schools, was used for a two-stage cluster random sample selection. At the first stage, schools were selected from the list, then classes were selected from these schools. A minimum sample size of 384 participants was found to be sufficient to estimate DF prevalence at a 95% confidence level and a 0.05 margin of error.

Ethical aspects:

Ethical approvals were obtained before commencing the study from the ethics committee at the faculty of dentistry, University of Benghazi. Permissions were obtained from related authorities in the Ministry of Education and the heads of selected schools. Informed written consent was obtained and requested for attending the clinical examination and returning the complete questionnaire.

Data collection:

Data were collected using a self-administered questionnaire and clinical examination of schoolchildren in the classroom. A questionnaire was designed to cover the study objectives and outcomes guided by previously validated and published studies. The questionnaire included the following sections: (general information, socio-demographic information, oral health behaviours, and dietary habits). Before every school visit, copies of the questionnaires were made; schoolchildren with signed informed consents were given the questionnaire in their classrooms and asked to complete it independently at the same time and place. An assistant researcher was available at the time of questionnaire completion to give any needed assistance and clarification.

Clinical examination

The children were examined in the classroom, while sitting on an ordinary chair, under daylight, using sterilised dental examination kits that contained a plain dental mirror, disposable probe, clinical tweezer, cotton rolls and a CPI probe, which was used for removing debris. The examiners, who were trained and calibrated, followed strict infection control guidelines such that disposable gloves and face masks were used throughout the survey. Dental caries was measured using the DMFT index (Decayed, Missing and Filled teeth) according to the World Health Organisation criteria. Clinical consequences of dental caries were assessed using PUFA index (Pulp involvement, ulceration, fistula, abscess).

Data analysis and Management

Data for the current study were uploaded and analysed using SPSS 25. Descriptive was used to describe the prevalence and severity of DF. Bivariate analysis was used to compare DF across subgroups at $p > 0.05$.

Results:

Table 1 shows the distribution of the study sample ($n=1047$) according to the socio-demographic characteristics. Slightly higher ratio of females (51.6%) than males. The majority of participants were studying in public schools (78.6%). The parental education is almost equally distributed among fathers, though university education was slightly higher (51.9%). On the other hand, the majority of mothers (67.4%) attained university education or higher. The age groups were evenly distributed for the 13 years, 14 years and 15 years age groups, but a lower proportion was observed in the 12 years age group (20%).

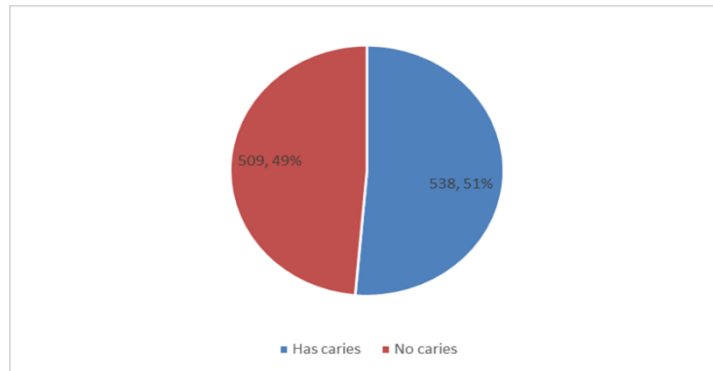
Table 1: Socio-demographic characteristics of the study sample

Variable	Subgroup	Frequency	%
Gender	Male	507	48.4
	Female	540	51.6
School type	Public	823	78.6
	Private	224	21.4
Father's education	University or higher	543	51.9
	Less than University	504	48.1
Mother's Education	University or higher	706	67.4
	Less than University	341	32.6
Age	12-years	209	20.0
	13-years	273	26.1
	14-years	279	26.6
	15-years	286	27.3

Caries experience and its consequences:

Caries experience was assessed using the DMFT index and PUFA index, and it is summarised in Table 5-2. Less than half of participants (46.4%) have decayed teeth, whereas the overall proportion of caries experience ($DMFT \geq 1$) was 51.4% (Figure 5-1). Nearly 5% have missing teeth and around (9 %) have filled teeth. Decay

leading to pulpal involvement was reported in more than a third of students (35.8%). Fistula, ulceration and abscess were reported on 11 occasions. The average number of decayed teeth was 0.96 ± 1.38 and ranged between zero and 8 teeth. The maximum number of teeth with pulpal involvement in one participant was six.

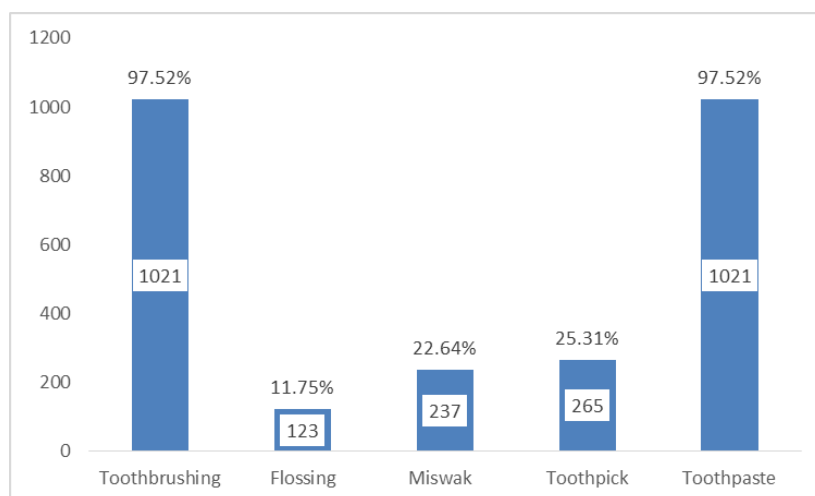
**Figure 1:** Caries prevalence**Table 2:** The distribution of caries according to DMFT index and PUFA index

Caries indicator	Frequency	Mean	Median	Std. Deviation	Minimum	Maximum
NO D	486 (46.4%)	0.96	0	1.38	0	8
NO M	50 (4.8%)	0.05	0	0.25	0	3
NO F	92 (8.8%)	0.14	0	0.56	0	8
DMF	538 (51.4%)	1.14	1	1.54	0	14
pufa P	375 (35.8%)	0.66	0	1.06	0	6
pufa U	2 (0.2%)	0	0	0.07	0	2
pufa F	4 (0.4%)	0	0	0.08	0	2
pufa A	5 (0.5%)	0	0	0.07	0	1

Oral hygiene measures:

Figure 5-4 is a bar chart for the frequency of using oral hygiene measures. Tooth brushing and toothpaste were the most popular tools (97.5%), followed by Miswak and

toothpick, which were used by around 23% and (25%), respectively. On the other hand, flossing was the least popular and practised by (11.75%) of respondents.

**Figure 2:** The frequency of using oral hygiene measures



The comparison of caries prevalence according to Socio-demographic characteristics:

The comparison of caries prevalence according to Socio-demographic characteristics of the study sample is presented in Table 5-3. Statistically significant differences were reported in relation to participants' gender, mother's education and the use of dental floss.

Higher caries prevalence was reported among females ($p=0.001$), less than university-educated mothers ($p=0.011$) and non-users of dental floss ($p=0.012$). Although a higher proportion of caries-affected children was reported among students from public schools, this difference was not statistically

Table 3: Distribution of caries prevalence according to Socio-demographic characteristics of the study sample

Variable	Subgroup	Have caries N (%)	P value
Gender	Male	234 (46.2%)	0.001**
	Female	304 (56.5%)	
Father education	University or higher	278 (51.7%)	0.900
	Less than university	260 (48.3%)	
Mother education	University or higher	345 (48.9%)	0.011*
	Less than university	193 (56.6%)	
Use dental floss	No	488 (52.8%)	0.012*
	Yes	50 (40.7%)	
School type	Public	434 (52.7%)	0.110
	Private	104 (46.3%)	

Chi-square test was used to compare subgroups. * $p \leq 0.05$, **

Discussion

The present study was conducted among 12 to 15-year-old schoolchildren in Sirte, Libya, to assess oral health status and treatment needs. To the best of our knowledge, this is the first large-scale study of its kind in Sirte, which is located in the middle of the Libyan coast. The study adopted a theoretical framework that recognised multi-level risk factors, such as socioeconomic and behavioural factors, for dental caries as the main outcome. However, the prevalence of treatment needs, gingival disease, dental fluorosis and dental trauma were also assessed.

Central to the study was the comprehensive examination of the target variables using a cross-sectional survey design. This methodological approach enabled the collection of data at a single point in time, providing a snapshot of the participants' oral health status. The design incorporated both self-reported information obtained through structured questionnaires and clinically assessed data collected by trained examiners, thereby ensuring a robust and multidimensional dataset. This combination of subjective and objective measures enhanced the validity and depth of the findings, allowing for a more nuanced understanding of the factors under investigation.

The findings revealed an average of 0.96 decayed teeth with a standard deviation of 1.38. The DMFT index reflects the cumulative caries experience and suggests that, on average, each child had slightly more than one tooth affected by decay, extraction due to caries, or restoration. Moreover, the PUFA index, which evaluates the clinical consequences of untreated dental caries, demonstrated that 35.8% of participants presented with decay extending to pulpal involvement. The mean PUFA value was 0.66 with a standard deviation of 1.06, indicating that while the overall burden of severe caries-related complications was moderate, a notable proportion of children had advanced stages of untreated decay. These findings highlight the persistence of unmet treatment needs and underscore the importance of preventive interventions and timely access to dental care within the studied population.

Previous studies conducted in Benghazi and Tripoli reported elevated rates of pulpal and periapical involvement among school-aged children, typically ranging from 8% to 12% [5], [9].

In comparison, caries prevalence and severity are comparable to those reported in a study conducted by Arheiam et al. (2020) [5], reporting a caries prevalence of 42.8% and a mean DMFT score of 1.09 ± 1.57 . The



Benghazi study was conducted during the period of armed conflict in the city, and compared caries prevalence and severity before and during the conflict, which were significantly lower than the pre-conflict values. The authors attributed this decline primarily to the reduced availability and consumption of sugar-containing products during the conflict, suggesting that changes in dietary patterns can exert a substantial influence on oral health outcomes [5]. A pre-conflict study conducted in Benghazi, Libya, among 12-year-old schoolchildren reported a higher prevalence of dental caries (57.8%) and a mean DMFT score of 1.68 ± 1.86 , indicating a greater caries burden than that observed in the present study population [10]. Therefore, it could be the case that similar environmental factors have led to the pattern of caries reported in the current study in Sirte, though there is no pre-conflict data. Nevertheless, the current study showed a positive correlation between caries and poor oral hygiene but no evidence of association between sugar amount and DMFT score.

The city was the scene of several armed conflicts since 2011 and suffered massive destruction that deteriorated the infrastructure, and many people, mainly professionals, fled the city. Therefore, it is not surprising that there are highly unmet treatment needs among the study sample, which is a manifestation of the lack of appropriate dental services. Nearly a quarter (24%) of participants were found to require immediate or urgent dental treatment, indicating the presence of conditions necessitating prompt professional intervention. These findings, while emphasising the importance of early detection and regular dental attendance to prevent the progression of oral diseases, more efforts at the state level are required to prioritise dental care and make dental services available.

The present study revealed that 46.4% of schoolchildren had at least one decayed tooth, with a mean decayed component of 0.96, while 51.4% exhibited caries experience as reflected by a mean DMFT score of 1.14. These values position Sirte within the lower to moderate range of caries burden when compared with the Middle East and North Africa (MENA) region, where prevalence among children has been reported to vary widely from 17.2% to 88.8%, and dmft/DMFT scores range from 0.6 to 8.5 [11]. When contrasted with global WHO surveillance data indicating a mean DMFT of approximately 1.67 for 12-year-olds, the caries experience in Sirte is comparatively lower [12]. However, despite these relatively favourable comparisons, the burden of untreated disease remains substantial. This is further highlighted by the PUFA findings, where 35.8% of children presented with clinical consequences of untreated caries and a mean PUFA score of 0.66. Such levels indicate a concerning degree of progression to pulp involvement and infection. Similar to broader regional patterns where limited access to restorative care frequently results in advanced caries,

Sirte's PUFA values align with MENA-region challenges associated with delayed treatment and insufficient preventive infrastructure [11]. Globally, WHO also reports that the severe consequences of untreated caries, as captured by the PUFA index, remain a major global public health concern, particularly in low- and middle-income countries [12]. Taken together, these findings suggest that although overall caries experience in Sirte may be moderate relative to some regional and global benchmarks, the high prevalence of advanced untreated lesions underscores the urgent need for strengthened preventive initiatives and improved access to timely dental treatment.

The study showed gender and social inequalities in caries distribution and severity. Statistically significant differences were reported in relation to participants' gender mother education. Higher caries prevalence was reported among females and mothers with less than university educated mothers. Although a higher proportion of caries-affected children was reported among students from public schools, this difference was not statistically significant ($p=0.110$). These findings, while reflect socio-economic inequalities, they can be explained by differences in oral health behaviors. For example, females may be more likely to consume sugars than males. On the other hand, less than university educated mothers could have negative influence on the oral health behaviours of their children. Moreover, users of dental floss demonstrated lower DMFT scores which suggests behavioural and social roots of the caries problem.

The socio-demographic disparities in caries prevalence observed in the present study, specifically higher rates among females and children of mothers with lower educational attainment are consistent with broader regional and global patterns. In the Middle East and North Africa (MENA) region, a systematic review documented that low maternal education, along with overall lower socioeconomic status, is among the most frequently reported determinants of increased caries risk in children [11]. On a global scale, research from low- and middle-income countries has shown that children whose mothers have only primary education face significantly higher odds of developing caries, potentially due to differences in health literacy, dietary practices, and oral hygiene behaviors [13].

These findings support the notion that the disparities in our sample are not isolated but reflect entrenched social gradients in oral health [14, 15]. further underscore the need for public health strategies that address not only clinical care but also the social and educational inequalities contributing to caries disease [16]. Wider national strategy for health promotion, along with appropriate preparation of dental workforce, are therefore mandated rather than current ineffective attempts that lacks long term goals and effectiveness [17, 18].



Limitations

The cross-sectional design captures data at a single point in time, restricting the ability to establish definitive causal relationships between identified risk factors and dental caries. Additionally, the study relies partly on self-administered questionnaires to assess behavioural aspects and dietary habits, which introduces potential recall or reporting bias. Finally, the investigation was geographically restricted to adolescents aged 12 to 15 years within Sirte, meaning the findings cannot be fully generalized to other age groups or regions across Libya.

Conclusion

This study provides the first recent comprehensive assessment of the oral health status of 12–15-year-old

schoolchildren in Sirte, Libya. Dental caries affected 46.4% of participants, with a mean DMFT score of 1.14, while 35.8% exhibited pulpal involvement (PUFA), indicating delayed treatment of dental caries. Gingivitis was highly prevalent, affecting 86.2% of 15-year-old participants, and the mean OHI-S score of 2.02 reflected generally fair oral hygiene. The low floss use was significantly associated with higher DMFT and PUFA scores. These findings highlight the need for school-based oral health promotion, dietary interventions, and improved access to preventive dental services to reduce the burden of oral diseases among Libyan schoolchildren.

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