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Investigating Dental Caries Prevalence and Associated Risk Factors Among Children under 18 Years Old in Tripoli and Derna, Libya

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ABSTRACT

Purpose: Despite existing studies on dental caries in children, limited research has comprehensively addressed the interplay of demographic, socioeconomic, behavioural, and environmental risk factors within the Libyan context, particularly in Tripoli and Derna. This study aims to investigate the prevalence of dental caries and the associated risk factors among children under 18 years in these cities, providing evidence-based insights for targeted interventions.

Materials and Methods: A cross-sectional survey design was employed, engaging 1,000 participants, equally divided between Tripoli and Derna, selected through convenience sampling. The study focused on children under 18 years, with parents completing the questionnaires for those aged under 16. The survey instrument was designed to assess demographic, socioeconomic, behavioural, and risk factors associated with the prevalence and severity of dental caries. Six hypotheses were tested, examining associations between caries prevalence and demographic variables, oral hygiene practices, dietary habits, access to dental care, cultural influences, and clinical risk indicators. The questionnaire underwent rigorous reliability and validity testing. Initially developed in English, it was translated into Arabic using the back-translation method, to ensure linguistic accuracy and cultural appropriateness. Data collection took place over the course of one year, utilizing both paper-based forms distributed during dental visits and online links shared via platforms such as WhatsApp and Facebook. Statistical analyses, including both descriptive and inferential methods, were conducted using SPSS version 28 to evaluate the six hypotheses.

Results: The study sample included 1,000 participants evenly split between Tripoli and Derna, with ages ranging from 3 to 18 years and a gender distribution of 55% male and 45% female. The findings revealed significant associations between demographic and socioeconomic factors, such as parental education and household income, and the prevalence of dental caries ($r(1000) = 0.215$, $p = 0.011$). Oral hygiene behaviours, including frequent tooth brushing and the use of fluoride toothpaste, were inversely correlated with caries severity ($r(1000) = -0.187$, $p = 0.023$). Dietary habits also showed strong associations: frequent consumption of sugary snacks was positively correlated with caries prevalence, while the consumption of non-sweet

snacks demonstrated a negative correlation (r(1000) = 0.198, p = 0.009). Access to dental care and cultural practices also significantly influenced caries prevalence and severity.

Conclusion: In conclusion, the findings of this study underscore the multifactorial nature of dental caries among children in Tripoli and Derna. Socioeconomic status, oral hygiene behaviours, dietary habits, and access to care all play critical roles in shaping paediatric oral health outcomes. These results support the need for tailored, multidimensional public health strategies to reduce the burden of dental caries among Libyan children.

Keywords: Dental Caries, Paediatric Oral Health, Risk Factors, Libya.

التحقق من عوامل الخطر المسببة في أنتشار تسوس الأسنان بين الأطفال دون سن 18 عامًا، في مدينتي طرابلس ودرنة في ليبيا

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ملخص البحث

على الرغم من وجود دراسات حول تسوس الأسنان لدى الأطفال، إلا أن الأبحاث التي تناولت بشكل شامل التفاعل بين العوامل الديموغرافية والاجتماعية والاقتصادية والسلوكية والبيئية في السياق الليبي، خاصة في طرابلس ودرنة، ما زالت محدودة. هدفت هذه الدراسة إلى التحقيق في انتشار تسوس الأسنان والعوامل المرتبطة به بين الأطفال دون سن 18 عامًا في هذه المدن، لتوفير رؤى قائمة على الأدلة للتدخلات المستهدفة.

تم استخدام تصميم دراسة مقطعية شملت 1000 مشارك، موزعين بالتساوي بين طرابلس ودرنة، تم اختيارهم باستخدام العينة المتاحة. ركزت الدراسة على الأطفال دون سن 18 عامًا، مع إكمال أولياء الأمور الاستبيانات نيابة عن الأطفال الذين تقل أعمارهم عن 16 عامًا. صُممت أداة الاستبيان لتقييم العوامل الديموغرافية والاجتماعية والاقتصادية والسلوكية ومخاطر انتشار وشدة تسوس الأسنان. تناولت الدراسة

ست فرضيات، استكشفت الروابط بين انتشار تسوس الأسنان والعوامل الديموغرافية، ممارسات نظافة الفم، العادات الغذائية، الوصول إلى الرعاية الصحية للأسنان، التأثيرات الثقافية، والمؤشرات السريرية للمخاطر. تم اختبار الاستبيان بدقة للتحقق من الموثوقية والصلاحية. تم تطوير الاستبيان في الأصل باللغة الإنجليزية، ثم تُرجم إلى اللغة العربية باستخدام تقنية الترجمة العكسية لضمان الدقة اللغوية والثقافية. امتدت عملية جمع البيانات على مدار عام واحد، باستخدام استمارات ورقية وزعت خلال زيارات المرضي علي عيادات الأسنان وروابط عبر الإنترنت عبر منصات مثل واتساب وفيسبوك. تم تحليل البيانات باستخدام الإصدار 28 من برنامج SPSS باستخدام طرق وصفية واستدلالية لاختبار الفرضيات الست.

تراوحت أعمار المشاركين بين 3 و18 عامًا، وشكّل الذكور نسبة 55%، والإناث 45%. كشفت النتائج عن وجود ارتباط ضعيف موجب بين بعض العوامل الديموغرافية والاجتماعية والاقتصادية، مثل تعليم الوالدين ودخل الأسرة، وانتشار تسوس الأسنان. ($r(1000) = 0.215, p = 0.011$) كما أظهرت النتائج وجود ارتباط عكسي ضعيف بين ممارسات نظافة الفم، مثل تنظيف الأسنان بانتظام واستخدام معجون أسنان يحتوي على الفلورايد، وشدة تسوس الأسنان. ($r(1000) = -0.187, p = 0.023$) أما من ناحية العادات الغذائية، فلوحظ ارتباط ضعيف موجب بين استهلاك الوجبات الخفيفة السكرية وانتشار التسوس، في حين ارتبط تناول الوجبات الخفيفة غير السكرية بارتباط ضعيف سلبي مع التسوس. ($r(1000) = -0.198, p = 0.009$) كذلك، كان لإمكانية الوصول إلى خدمات الرعاية الصحية للأسنان والممارسات الثقافية دور مهم في التأثير على انتشار وشدة تسوس الأسنان.

تشير هذه النتائج إلى أن تسوس الأسنان لدى الأطفال في طرابلس ودرنة يتأثر بعوامل مترابطة تشمل الوضع الاجتماعي والاقتصادي، وعادات نظافة الفم، والنظام الغذائي، ومدى توافر خدمات العناية بالأسنان، ما يعزز الحاجة إلى تدخلات موجهة لتحسين صحة الفم لدى الأطفال في ليبيا.

الكلمات الدالة: تسوس الأسنان، صحة الفم للأطفال، عوامل الخطر، ليبيا.

Introduction

Dental caries is a widely recognised public health concern that disproportionately affects children, particularly in developing countries. Notably, the burden of caries remains higher in regions with limited access to preventive care and oral health education. In Libya, studies have identified significant prevalence rates, which are attributed to systemic challenges, including inadequate infrastructure, insufficient public health campaigns, and growing consumption of sugar-laden diets.[1,2] Moreover, children in Libyan cities, such as Tripoli and Derna, experience poor oral health outcomes that are influenced by socioeconomic, behavioural, and systemic factors.[3] Furthermore, the Libyan oral healthcare system focuses primarily on treatment rather than prevention, leading to a lack of comprehensive data and interventions targeting paediatric

populations. Research indicates that factors such as poor oral hygiene practices, low parental awareness, and dietary habits, including frequent consumption of sugary foods and beverages, exacerbate the prevalence of dental caries in Libyan children.[4] For instance, in Tripoli, 78% of first-grade children presented with dental caries in their primary teeth, with socioeconomic variables playing a significant role.[2] Similarly, studies in Derna have revealed poor knowledge and attitudes towards oral health among primary schoolchildren, further contributing to high caries rates.[3] Thus, understanding the interplay of these factors across representative cities could provide valuable insights into paediatric oral health challenges in Libya.

Libya's oral healthcare system is characterised by a fragmented structure that emphasises emergency care over preventive strategies.[5] Consequently, systemic gaps in oral health education, fluoride programme implementation, and dietary awareness persist. Existing studies have focused on specific regions or age groups, leaving significant gaps in understanding the broader determinants of caries prevalence among Libyan children. Therefore, there is a need for comprehensive research that evaluates risk factors associated with dental caries across representative samples.

Additionally, demographic and behavioural factors, such as maternal employment, dental visit history, and toothbrushing practices, have been linked to caries prevalence.[1,6] However, these variables have not been adequately studied in a Libyan context, where cultural and socioeconomic disparities may play a critical role. Tripoli and Derna, being representative urban centres, offer an opportunity to assess the prevalence of dental caries and associated risk factors, addressing the need for data-driven interventions that are tailored to the Libyan population.

The lack of comprehensive studies that evaluate dental caries risk factors among children in Libya is a significant limitation in existing literature. Research by Elzahaf et al. and Alraqiq et al. highlights important correlations between poor oral hygiene practices and socioeconomic disparities.[2,3] However, these studies focus on isolated groups, failing to address broader population-level trends and multifactorial risk factors. Moreover, no recent investigations have provided actionable insights into how systemic and behavioural determinants interact to influence oral health outcomes in Libya. By including a representative sample of children under 18 from Tripoli and Derna, this study could address these gaps. It is expected to provide a detailed analysis of factors such as parental education, dietary habits, and oral health behaviours. Such research could, therefore, contribute to the development of tailored public health initiatives aimed at reducing the prevalence of dental caries in children across Libya.

While previous research has examined paediatric dental caries in Libya, the integration of behavioural, socioeconomic, and systemic risk factors remains underexplored. Studies, including those by Khan et al.[6] and Abdalrahman,[4] identify global and regional factors influencing caries, yet their applicability in the Libyan context has not been adequately addressed. Moreover, inter-regional comparisons between representative urban populations have not been conducted, leaving a significant gap in understanding the nationwide determinants of paediatric oral health. Addressing these gaps, this study aims to quantify the prevalence of dental caries among children under 18 in Tripoli and Derna, offering a representative overview of oral health in Libya, and to identify key behavioural, socioeconomic, and systemic risk factors associated with dental caries in these populations.

Hypotheses

1. **H1: Demographics and Socioeconomic Factors**
   The level of parental education, family income, and child's age are significantly associated with the prevalence and severity of dental caries.
2. **H2: Oral Hygiene Practices**
   Increased frequency of tooth brushing, the use of fluoride toothpaste, and mouth rinsing after meals are inversely correlated with dental caries prevalence and severity.
3. **H3: Dietary Habits**
   Frequent consumption of sugary snacks and beverages is positively associated, while regular consumption of non-sweet snacks (e.g., fruits and vegetables) is negatively associated with dental caries prevalence.
4. **H4: Access to Dental Care**
   Regular dental check-ups and availability of professional paediatric dental care services are associated with lower prevalence and severity of dental caries.
5. **H5: Behavioural and Cultural Factors**
   Family involvement in oral hygiene practices and cultural consumption of sweet foods during celebrations significantly influence dental caries prevalence.
6. **H6: Risk Factors Related to Prevalence**
   Symptoms such as tooth pain, visible cavities, and bleeding gums are associated with a higher prevalence and severity of dental caries.

These hypotheses integrate the study's objectives, linking independent factors such as demographics, behaviours, and access to resources to the dependent outcome of dental caries prevalence and severity among Libyan children.

Research Methodology

Study Design

A cross-sectional survey design was adopted to assess the prevalence of dental caries and its associated risk factors among children in Libya. This design enabled the simultaneous collection of data on demographics, oral hygiene practices, and dietary habits at a single point in time, facilitating the identification of correlations without requiring longitudinal follow-up. The method proved appropriate for the study's objectives and was particularly suited to the resource constraints present in the Libyan context.

Participants

Participants were children under the age of 18 residing in Tripoli and Derna. Eligibility required that participants had no systemic illnesses affecting oral health and were available during the recruitment period. Recruitment occurred via face-to-face contact at dental clinics and through online surveys distributed on social media. Informed consent was obtained from parents or guardians for children under 16 years of age.

Setting

Data collection took place in Tripoli and Derna to capture regional diversity. In Derna, participants were recruited from Maghar and Al-Hreesh Polyclinics, while in Tripoli, data were gathered from Tripoli Central, Abu Salim, and Souq Al-Jumua clinics. These sites were selected

for their accessibility to diverse populations and their relevance to primary oral health care services in urban and peri-urban Libyan settings.

Sampling technique and sample size

The convenience sampling technique was chosen for this study due to its practicality and feasibility in accessing participants within the target cities of Tripoli and Derna. This non-probability sampling approach was particularly appropriate given the logistical constraints and the need for rapid and efficient data collection.[7] Participants were recruited from dental clinics and through online platforms such as WhatsApp and Facebook, enabling the inclusion of individuals who were easily accessible and willing to participate. This method allowed for cost-effective data gathering, particularly in resource-limited settings, and ensured a sufficiently large sample size of 1,000 participants (500 from POHC at each city). While convenience sampling does not guarantee generalizability, it provides valuable insights into dental caries prevalence and associated risk factors within the studied population.

Sampling size

The sample size required for this study was calculated to ensure accurate representation of the population in Derna, which has an estimated population of 10,000. To achieve a confidence level of 98% and a margin of error of ±5%, the sample size was determined using the standard formula for finite population sampling:

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{e^2}$$

n *– The required sample size*

Z *– Z-value (Z-score)* Z=2.33Z for 98%),

p – Estimated proportion of the population

e *– Margin of error (or precision)* (e=0.05e = 0.05e=0.05).

For finite populations, the calculated sample size is adjusted using the finite population correction (FPC):

$$n_{adjusted} = \frac{n}{1 + \frac{n - 1}{N}}$$

where N represents the total population.

Calculations for Derna

First, the sample size for an infinite population was calculated:

$$n = \frac{(2.33)^2 \cdot 0.5 \cdot (1 - 0.5)}{(0.05)^2}$$

$$n = \frac{5.4289 \cdot 0.5 \cdot 0.5}{0.0025} = \frac{1.357225}{0.0025} = 542.89$$

This value was then adjusted for the finite population size of 10,000:

$$n_{adjusted} = \frac{542.89}{1 + \frac{542.89 - 1}{10{,}000}}$$

$$n_{adjusted} = \frac{542.89}{1 + 0.054189} = \frac{542.89}{1.054189} \approx 515$$

Sampling in Tripoli

In Tripoli, which has a larger estimated population of 50,000, the same statistical parameters were used to calculate the sample size: a 98% confidence level, a ±5% margin of error, and an assumed population proportion of p=0.5p = 0.5p=0.5. The finite population correction (FPC) was also applied to refine the sample size based on the population size.

Calculations for Tripoli

This value was adjusted for the finite population size of 50,000:

$$n_{adjusted} = \frac{542.89}{1 + \frac{542.89 - 1}{15{,}000}}$$

$$n_{adjusted} = \frac{542.89}{1 + \frac{541.89}{50{,}000}} = \frac{542.89}{1 + 0.036126}$$

$$n_{adjusted} = \frac{542.89}{1.036126} \approx 524$$

Response Rate for Derna and Tripoli

The required sample size for this study was calculated to ensure representative and reliable data collection. In Derna, with an estimated population of 10,000 (Assessment Capacities Project (ACAPS),[8] the sample size was determined using a confidence level of 98% and a margin of error of ±5%. Using the formula for finite population sampling and applying the finite population correction (FPC), the adjusted sample size was approximately 515 participants. For the study, 500 participants were successfully recruited from Derna, achieving a response rate of **97.1%** based on the adjusted required sample size.

Similarly, in Tripoli, with a larger population, the target sample size was also set at 500 participants to ensure consistent representation across both cities. The recruitment strategy ensured that the target sample size was met, reflecting a **100% response rate** for Tripoli.

Questionnaire Methods

The questionnaire was designed to align with the study's aims, drawing from prior research by Lemamsha et al.[9] and Lemamsha et al.[10] which provided a robust framework for examining the prevalence of dental caries and associated risk factors. The design process incorporated insights from these studies, particularly their focus on oral hygiene practices, dietary habits, and sociodemographic influences. To enhance relevance, the questionnaire consisted of seven structured sections, each targeting critical dimensions of risk factors, including demographics, oral hygiene practices, dietary habits, socioeconomic and environmental factors, access to dental care, risk factors related to caries prevalence, and behavioural and cultural influences. Each section employed a five-point Likert scale to facilitate nuanced responses, ranging from "Never" to "Always" or "Strongly Disagree" to "Strongly Agree," depending on the context. The clarity and comprehensibility of the questions were pretested through a pilot study involving 20 young adults, ensuring appropriateness for the intended population. The questions included key variables such as parental education levels, family income, toothbrushing frequency, the use of fluoride toothpaste, sugary snack consumption, and regular dental check-ups. Additional factors such as the use of traditional remedies and the influence of family

involvement on oral health were incorporated to address unique cultural and behavioural elements relevant to the Libyan context.

The questionnaire was initially developed in English and subsequently translated into Arabic using the back-translation technique to ensure accuracy and cultural relevance for Libyan participants. A professional translator first translated the questionnaire into Arabic, after which a second independent translator retranslated it back into English to verify consistency. This process, combined with input from Libyan experts familiar with regional linguistic nuances, ensured that the final Arabic version was both linguistically precise and contextually appropriate before piloting.

Measurement Validity and Reliability

In this study, the reliability and validity of the questionnaire items were evaluated to ensure accurate measurement of dental caries prevalence and associated risk factors among children under 18 in Tripoli and Derna. Reliability was assessed using Cronbach's alpha values, which are considered acceptable if they exceed 0.70, as suggested by Lemamsha et al.[11] The measurement scales in this study demonstrated strong internal consistency, with Cronbach's alpha values consistently above the threshold, indicating high reliability.

The seven sections of the questionnaire covered demographic data, oral hygiene practices, dietary habits, socioeconomic and environmental factors, access to dental care, risk factors related to caries prevalence, and behavioural and cultural influences. Each section was rigorously tested to ensure consistency and clarity. For example, the oral hygiene practices section included five items measured on a five-point Likert scale ranging from "Never" to "Always," while the socioeconomic section utilised a similar scale ranging from "Strongly Disagree" to "Strongly Agree." These scales allowed for a nuanced assessment of participants' behaviours, attitudes, and practices.

To ensure validity, the Average Variance Extracted (AVE) was calculated for each construct, with values exceeding 0.50, indicative of good convergent validity. This suggests that the items within each construct effectively measured their intended dimensions. For instance, items related to oral hygiene practices and dietary habits demonstrated strong correlations, confirming their relevance to dental caries risk factors. The robust validity and reliability of the measurement scales provide confidence in the questionnaire's ability to comprehensively assess the prevalence and determinants of dental caries in the Libyan context.

Table 1: Measurement reliability and validity.

Scale/Variable Name	Number of Items	Cronbach's Alpha
Demographic Data	5	N/A
Oral Hygiene Practices	5	0.88
Dietary Habits	5	0.91
Socioeconomic and Environmental Factors	5	0.85
Access to Dental Care	5	0.87
Risk Factors Related to Prevalence	5	0.90
Behavioural and Cultural Influences	5	0.89

Recruitment Process

The recruitment process was conducted using two distinct approaches to ensure diverse and representative participation from the cities of Tripoli and Derna. The protocol was approved by the relevant regional health ministries. One method involved face-to-face distribution of paper-based questionnaires during children's visits to dental clinics, allowing direct interaction and guidance for completing the survey. The second method utilised a digital format distributed via Google Forms, disseminated through popular social media platforms such as WhatsApp and Facebook. These platforms were selected due to their accessibility and widespread usage among the Libyan population, ensuring broader reach. The questionnaire was distributed over a one-year period, from 31 September 2023 to 30 September 2024, utilising both paper-based methods and Google Forms for comprehensive participant recruitment. A total of 1,000 participants were targeted, with 500 participants from each city, ensuring a balanced representation for the study.

Data Analysis technique

Data analysis was conducted using IBM SPSS Statistics version 28, employing a combination of univariate and bivariate statistical techniques to examine the research hypotheses systematically. The univariate analysis aimed to generate descriptive statistics that offered a foundational overview of the sample's demographic characteristics, oral hygiene behaviours, dietary practices, socioeconomic background, and other relevant variables. Measures of central tendency and dispersion, including means, standard deviations, frequencies, and percentages, were calculated to summarise individual variables. These metrics provided insights into the overall distribution and variability of responses, enabling the identification of key trends within the population.

For inferential analysis, a series of bivariate statistical tests were undertaken to assess relationships between predictor variables and the prevalence and severity of dental caries among children. The chi-square test (χ^2) was applied to determine associations between categorical variables, such as parental education, income level, and gender. This test facilitated the evaluation of whether the observed frequencies significantly deviated from expected distributions, thus identifying any statistically significant associations.

In addition, Spearman's rank-order correlation coefficient (Spearman's ρ) was employed to examine the strength and direction of associations between ordinal and continuous variables. This non-parametric test was appropriate due to the ordinal nature of many questionnaire items and the potential for non-normal data distribution. The Spearman correlation was used to explore six primary hypotheses, each relating to a distinct domain: (1) demographic and socioeconomic factors, (2) oral hygiene practices, (3) dietary habits, (4) access to dental care, (5) behavioural and cultural influences, and (6) risk factors related to caries prevalence. These analytical techniques enabled a comprehensive evaluation of the interrelations between various health, behavioural, and socioeconomic variables and dental caries prevalence, thereby facilitating a robust interpretation of the research hypotheses and supporting evidence-based conclusions.

Ethical Considerations

Ethical approval for the study was obtained from the regional health ministries of Tripoli and Derna, ensuring compliance with established guidelines. Participants were provided with detailed information about the study's purpose, procedures, and their rights, including

confidentiality and anonymity. Informed consent was obtained from all participants or their guardians before data collection. Measures were implemented to protect data security, including encrypted storage and restricted access. Data will be retained securely for six months after the study concludes before being permanently destroyed. These ethical protocols ensured that participant welfare and data integrity were prioritised throughout the study.

Findings

Table 2 illustrates the demographic distribution of the participants recruited for the study, comprising 1,000 individuals equally divided between Tripoli and Derna. The gender distribution shows that 55% of participants were male, while 45% were female. The largest age group was 13–18 years, comprising 35% of the sample, followed by 9–12 years (30%), 6–8 years (20%), and 3–5 years (15%). In terms of fathers' education levels, 30% had secondary education, 28% had technical education, 20% had a university degree, 12% had primary education or below, and 10% had postgraduate qualifications. Similarly, mothers' education levels showed that 32% had secondary education, 30% had technical education, 18% had a university degree, 14% had primary education or below, and 6% had postgraduate qualifications. Regarding family income, the most common category was moderate income (35%), followed by high income (30%), low income (20%), very high income (10%), and very low income (5%). The data in Table 1 provides a detailed overview of the demographic characteristics of the study sample, highlighting significant variations across gender, age, parental education, and income levels within the population.

Table 2: Demographic Distribution of Participants in Tripoli and Derna.

Variable	Category	Frequency (%)
Gender	Male	550 (55%)
	Female	450 (45%)
Child's Age	3–5	150 (15%)
	6–8	200 (20%)
	9–12	300 (30%)
	13–18	350 (35%)
Father's Education Level	Primary or below	120 (12%)
	Secondary	300 (30%)
	Technical	280 (28%)
	University	200 (20%)
	Postgraduate	100 (10%)
Mother's Education Level	Primary or below	140 (14%)
	Secondary	320 (32%)
	Technical	300 (30%)
	University	180 (18%)

	Postgraduate	60 (6%)
Family Income Level	Very Low	50 (5%)
	Low	200 (20%)
	Moderate	350 (35%)
	High	300 (30%)
	Very High	100 (10%)

Table 3 presents key findings on oral hygiene practices, dietary habits, and associated factors among 1000 participants from Tripoli and Derna. The frequency of tooth brushing had a mean score of 4.1 (±0.8), while the use of fluoride toothpaste was 3.9 (±0.9). Consumption of sugary snacks and sweetened beverages averaged 3.6 (±1.1) and 3.8 (±1.0), respectively, with a strong preference for sweet snacks noted at 4.2 (±0.7). Socioeconomic factors, such as affordability for dental check-ups (3.9 ±1.0) and access to fluoride toothpaste (4.0 ±0.9), were moderately rated. Risk factors highlighted frequent tooth pain (3.6 ±1.1) and visible cavities (3.8 ±1.0). Behavioural influences showed high assistance with brushing (4.0 ±0.9) and discussions on hygiene (3.9 ±1.0).

Table 3: Summary of Oral Hygiene Practices, Dietary Habits, and Associated Factors for 1000 Participants in Tripoli and Derna.

Variables	Mean (±SD)	Variables	Mean (±SD)
Oral Hygiene Practices			
How often does the child brush their teeth?	4.1 (±0.8)	How frequently does the child use fluoride toothpaste?	3.9 (±0.9)
Does the child brush their teeth before bedtime?	3.7 (±1.0)	Does the child rinse their mouth after meals?	3.4 (±1.2)
Does the child floss their teeth regularly?	2.9 (±1.3)		
Dietary Habits			
How often does the child consume sugary snacks between meals?	3.6 (±1.1)	How often does the child drink sugar-sweetened beverages?	3.8 (±1.0)
Does the child consume non-sweet snacks like fruits or vegetables?	3.5 (±1.2)	How often does the child eat before bedtime?	3.1 (±1.3)
Does the child prefer sweet snacks over other foods?	4.2 (±0.7)		
Socioeconomic and Environmental Factors			
The family can afford regular dental check-ups.	3.9 (±1.0)	The family has access to fluoride toothpaste or similar products.	4.0 (±0.9)

The child's living environment provides clean water and good sanitation.	3.8 (±1.1)	Parents have sufficient knowledge about oral hygiene practices.	3.7 (±1.1)
The family participates in cultural practices involving sweet food consumption.	3.5 (±1.2)		
Access to Dental Care			
Does the child visit the dentist for preventive care?	3.9 (±0.9)	How often does the child undergo dental check-ups?	3.8 (±1.0)
Does the child receive professional fluoride treatments?	3.7 (±1.1)	Does the family use dental health services during emergencies only?	3.6 (±1.1)
Are there nearby facilities offering paediatric dental care?	3.8 (±1.0)		
Risk Factors Related to Prevalence			
Does the child experience tooth pain regularly?	3.6 (±1.1)	Does the child have visible cavities?	3.8 (±1.0)
Does the child complain of bleeding gums when brushing?	3.5 (±1.2)	Has the child missed school due to dental issues?	3.3 (±1.3)
Has the child experienced tooth loss due to decay in the past year?	3.0 (±1.4)		
Behavioural and Cultural Influences			
How often does the child consume sweets during family or cultural celebrations?	4.1 (±0.8)	Does the family rely on traditional remedies for dental problems?	3.9 (±1.0)
How often do parents assist the child with toothbrushing?	4.0 (±0.9)	Are sugary beverages part of regular meals in the household?	3.6 (±1.1)
Does the family discuss oral hygiene practices with the child?	3.9 (±1.0)		

Table 4 shows that demographic and socioeconomic factors, including parental education level, family income, and child's age, demonstrated a significant association with the prevalence and severity of dental caries, with a correlation coefficient of $r(1000) = 0.215$, $p = 0.011$. This suggests that as these factors vary, so does the likelihood of dental caries. Oral hygiene practices, including the frequency of tooth brushing, the use of fluoride toothpaste, and mouth rinsing after meals, were inversely correlated with dental caries prevalence and severity, as

shown by a correlation coefficient of r(1000) = -0.187, p = 0.023. This indicates that improved oral hygiene practices are associated with a decrease in dental caries prevalence.

Table 3 also highlights that dietary habits play a significant role in dental caries prevalence, with frequent consumption of sugary snacks and beverages positively associated with caries, while the regular consumption of non-sweet snacks like fruits and vegetables was negatively associated. The correlation coefficient for this relationship was r(1000) = 0.198, p = 0.009. Access to dental care, including regular dental check-ups and the availability of professional paediatric dental services, was significantly associated with lower prevalence and severity of dental caries, with a correlation coefficient of r(1000) = -0.203, p = 0.007, emphasising the importance of access to preventive and treatment services.

Table 3 further shows that behavioural and cultural factors, such as family involvement in oral hygiene practices and the cultural consumption of sweet foods during celebrations, significantly influenced dental caries prevalence, with a correlation coefficient of r (1000) = 0.174, p = 0.015. Additionally, risk factors related to caries prevalence, including symptoms such as tooth pain, visible cavities, and bleeding gums, were positively associated with the severity of dental caries, as indicated by a correlation coefficient of r(1000) = 0.229, p = 0.004. These findings underline the significant associations between these variables and dental health outcomes in children.

Table 4: Summarises the correlation findings for each hypothesis, demonstrating significant associations between the variables and dental caries prevalence and severity.

Hypotheses	Correlation Coefficient (r)	Significance (p-value)
H1: Demographics and Socioeconomic Factors	r(1000) = 0.215	p = 0.011
H2: Oral Hygiene Practices	r(1000) = -0.187	p = 0.023
H3: Dietary Habits	r(1000) = 0.198	p = 0.009
H4: Access to Dental Care	r(1000) = -0.203	p = 0.007
H5: Behavioural and Cultural Factors	r(1000) = 0.174	p = 0.015
H6: Risk Factors Related to Prevalence	r(1000) = 0.229	p = 0.004

Discussion

The cross-sectional survey conducted in Tripoli and Derna involved 1,000 participants, evenly distributed between the two cities, to investigate the demographic distribution and factors influencing oral health among children. The study included male and female participants across various age groups. Parental education levels revealed a predominance of secondary and technical education, with fewer parents attaining primary or postgraduate qualifications. Family income levels varied, with moderate and high-income families being the most represented. These findings underscore the diversity in socioeconomic backgrounds and educational attainment among the participants, which could significantly influence oral health practices and outcomes. The study aligns with prior research, including Ballo et al.[1] and Aloshaiby et al.[5], which highlight the critical role of socioeconomic determinants in shaping health behaviours and access to care.

Oral hygiene practices, dietary habits, and associated factors, summarised in Table 2, revealed notable trends. Tooth brushing frequency was consistent among participants, with the use of

fluoride toothpaste slightly less frequent. Dietary behaviours showed a higher consumption of sugary snacks and beverages, coupled with a lower preference for non-sweet snacks such as fruits and vegetables. Risk factors, including frequent tooth pain and visible cavities, were prevalent among participants, reflecting gaps in preventive care and dietary management. These findings are consistent with studies by Elzahaf et al.[3] and Khan et al.[6], which emphasise the need to address behavioural, dietary, and socioeconomic factors to improve oral health outcomes. Practical implications include prioritising community-level interventions to increase fluoride availability, dietary education, and access to preventive dental services, aligning with global recommendations for enhancing oral health in resource-limited settings.

The study revealed that demographic and socioeconomic factors, including parental education level, family income, and child's age, were significantly associated with the prevalence and severity of dental caries, with a correlation coefficient of $r(1000) = 0.215$, $p = 0.011$. These findings suggest that higher parental education levels and family income are likely to be associated with a lower prevalence of dental caries, potentially due to increased access to dental care and awareness of oral hygiene practices. The influence of socioeconomic factors aligns with prior research by Elzahaf et al.[3] and Lemamsha et al.[12], which highlighted the role of education and financial resources in shaping health behaviours in Libyan populations. However, the variation in these associations could be influenced by regional disparities in healthcare infrastructure, as noted by Aloshaiby et al. (2024). While this study corroborates some existing literature, differences in findings might reflect specific local contexts or methodological approaches. Addressing these socioeconomic disparities could enhance public health strategies targeting paediatric oral health.

The study also demonstrated that oral hygiene practices, including frequent tooth brushing, the use of fluoride toothpaste, and mouth rinsing after meals, were inversely correlated with the prevalence and severity of dental caries, with a correlation coefficient of $r(1000) = -0.187$, $p = 0.023$. Improved oral hygiene behaviours appear to mitigate the risk of dental caries, supporting previous findings by Alraqiq et al.[2] and Ballo et al.[1], which emphasised the protective effects of regular oral hygiene practices. These findings likely reflect the benefits of consistent preventive care and public health education. However, the results also underscore potential gaps in adherence to recommended oral health practices, which could vary due to cultural norms or limited access to resources, as highlighted by Lemamsha et al.[9] Practical implications of these findings include the need for targeted oral health education campaigns to enhance parental awareness and promote preventive care, as well as improved accessibility to fluoride products and dental services in underserved regions.

The study found that dietary habits are significantly associated with dental caries prevalence and severity. Frequent consumption of sugary snacks and beverages was positively correlated with higher rates of dental caries, while regular consumption of non-sweet snacks, such as fruits and vegetables, demonstrated a protective effect ($r(1000) = 0.198$, $p = 0.009$). These findings align with prior research by Ballo et al.[1] and Lemamsha et al.[12], which identified sugar-rich diets as a critical risk factor for poor oral health among Libyan children and adults. However, the negative association with non-sweet snacks may be influenced by dietary patterns unique to this study's population, illustrating possible regional variations. It is plausible that the protective role of fruits and vegetables could also reflect broader health benefits that extend beyond oral health. Practical

implications of these findings include the necessity for community-level interventions to reduce sugar consumption and promote healthy dietary practices in schools and homes.

The study revealed that access to dental care, including regular dental check-ups and the availability of professional paediatric dental services, is significantly associated with lower prevalence and severity of dental caries ($r(1000) = -0.203$, $p = 0.007$). These results are consistent with findings by Aloshaiby et al.[5] and Alraqiq et al.[2], which emphasised the critical role of preventive dental care in mitigating oral health issues. However, the variability in access across different socioeconomic groups in Tripoli and Derna may explain some discrepancies between this study and previous findings. It is possible that limited availability of paediatric dental services in underserved regions may exacerbate inequalities in oral health outcomes. These findings suggest the importance of expanding access to affordable dental care services and implementing school-based dental health programmes.

The findings further indicate that behavioural and cultural factors, including family involvement in oral hygiene practices and the cultural consumption of sweet foods during celebrations, are significantly associated with dental caries prevalence ($r(1000) = 0.174$, $p = 0.015$). The results align with research by Elzahaf et al.[3] and Lemamsha et al.[11], which highlighted the role of family and cultural practices in shaping health behaviours among Libyan populations. However, differences in how oral hygiene practices are implemented across households may influence the strength of these associations. Family involvement in tooth brushing appears to mitigate risks, yet cultural norms promoting sweet consumption during celebrations may counteract these benefits. Practical implications include the development of culturally sensitive oral health education initiatives that address these dual influences.

Lastly, the study found that risk factors such as tooth pain, visible cavities, and bleeding gums were positively correlated with the severity of dental caries ($r(1000) = 0.229$, $p = 0.004$). These findings are consistent with studies by Khan et al.[6] and Abdalrahman,[4] which reported similar associations between untreated dental symptoms and increased caries severity. It is possible that these symptoms not only reflect existing oral health issues but also serve as indicators of delayed dental care, particularly in populations with limited healthcare access. These findings underscore the importance of early detection and treatment of dental symptoms to prevent worsening outcomes. Practical implications include implementing regular school-based oral health screenings and increasing public awareness of the importance of addressing early signs of dental issues.

Strengths and limitations

The study demonstrates notable strengths in its methodological design and scope, which could enhance its contribution to the understanding of dental caries prevalence and associated risk factors among children in Libya. The cross-sectional approach, involving a large and representative sample of 1,000 participants evenly distributed between Tripoli and Derna, ensures that findings reflect diverse socioeconomic and cultural contexts. **Additionally**, the inclusion of multiple factors—demographic, socioeconomic, dietary, behavioural, and cultural—provides a comprehensive analysis of the determinants of dental caries. The use of validated questionnaires and the integration of data collection methods, such as face-to-face surveys and online Google Forms, enhance the study's reliability and accessibility. **Moreover**, employing statistical techniques, including correlation analyses, allows for a robust

examination of associations between variables, thereby offering valuable insights for targeted interventions. These methodological strengths underscore the study's potential to address gaps in existing literature and contribute to regional oral health strategies.

Despite its strengths, certain limitations could impact the generalisability and scope of the study. The reliance on convenience sampling may have introduced selection bias, as participants were primarily drawn from dental clinics and social media platforms. This sampling technique, while practical, could limit the representation of children who do not regularly visit dental clinics or have limited access to social media. **Furthermore**, the cross-sectional nature of the study restricts the ability to establish causality between variables, as it captures data at a single point in time. For instance, while correlations between dietary habits and caries prevalence are evident, longitudinal studies would be required to confirm causal relationships. **In addition**, self-reported data on dietary habits and oral hygiene practices may be subject to recall bias, potentially affecting the accuracy of the findings.

Another limitation lies in the geographical focus of the study, which was restricted to Tripoli and Derna. While these cities represent urban centres in Western and Eastern Libya, rural areas were not included, potentially overlooking variations in dental health determinants across different settings. **Similarly**, the study did not account for genetic or environmental factors, which could influence dental caries risk and may have provided a more nuanced understanding of the observed associations. **Moreover**, the study's reliance on caregiver-reported information for younger children may have introduced subjective bias, as responses might reflect caregivers' perceptions rather than children's actual behaviours. Addressing these limitations in future research could enhance the robustness and applicability of findings, particularly in the development of comprehensive oral health policies for diverse populations.

Practical Implications

The study's findings could have significant practical implications for public health initiatives and policy development in Libya. Addressing the association between socioeconomic factors and dental caries prevalence could inform targeted interventions, particularly in communities where income inequality and limited access to education persist. Policymakers could develop subsidised dental care programmes and provide oral health education tailored to lower-income families, potentially mitigating disparities in oral health outcomes. Moreover, integrating oral health education into school curricula could improve awareness among children and their caregivers. Such educational efforts might emphasise the importance of regular tooth brushing, fluoride toothpaste usage, and reduced consumption of sugary snacks, thereby addressing key risk factors identified in this study. **Furthermore**, collaborating with community organisations to distribute affordable dental hygiene products could increase access to preventative measures in underserved areas.

Improved access to dental care services could also enhance oral health outcomes, particularly through the establishment of mobile dental clinics in rural regions. Findings highlighting the inverse relationship between regular dental check-ups and caries severity suggest that expanding access to preventative care could play a crucial role in addressing oral health disparities. **Similarly**, incentivising paediatric dentists to work in underserved areas might address gaps in service provision. **In addition**, government funding for routine oral health screenings in schools could allow early detection and treatment of dental issues, reducing long-term healthcare costs. These findings underscore the potential for multi-level interventions

involving policymakers, healthcare providers, and community organisations to create a comprehensive framework for oral health improvement.

Findings from this investigation could enhance understanding of the determinants of paediatric oral health in Libya, offering critical insights for policymakers and healthcare providers. In future, these findings may inform the development of targeted interventions, such as fluoride programmes, dietary education campaigns, and parental awareness initiatives. Furthermore, this research could contribute to global efforts addressing paediatric dental caries in resource-limited settings by providing evidence-based recommendations applicable to similar contexts.

Recommendation for the future studies

Future studies could focus on longitudinal designs to investigate how dental caries risk factors evolve over time among children in Libyan cities. A longitudinal approach might offer deeper insights into the causal relationships between socioeconomic conditions, dietary habits, and oral health outcomes. **Additionally**, examining how oral hygiene practices and access to dental care interact with cultural norms, such as the consumption of sweet foods during celebrations, could provide a nuanced understanding of behavioural influences. Further exploration of geographic disparities in dental care access, particularly between urban and rural settings, might also clarify regional variations in caries prevalence. Such research could inform region-specific strategies for reducing oral health inequalities.

Future research could also incorporate qualitative methods, such as interviews with caregivers and focus groups with children, to explore barriers to effective oral hygiene practices and dental care utilisation. **Moreover**, expanding the study to include additional Libyan cities or rural areas might enhance the generalisability of the findings. The integration of genetic and environmental factors into future studies could also provide a broader perspective on caries risk among children. Finally, leveraging advanced technologies, such as artificial intelligence and geospatial mapping, could offer innovative ways to identify high-risk populations and optimise intervention strategies. These recommendations emphasise the need for multidisciplinary approaches to address the complex determinants of dental caries in Libya.

Conclusion

The study has provided valuable insights into the prevalence and influential risk factors of dental caries among children under 18 in Tripoli and Derna, Libya. Through a cross-sectional survey involving 1,000 participants, including parents of younger children, the research has highlighted significant associations between socioeconomic factors, dietary habits, oral hygiene practices, and caries prevalence. Parental education levels and family income have shown a clear connection to dental health outcomes, while improved oral hygiene behaviours and reduced sugary snack consumption appear to correlate with lower caries rates. These findings emphasise unique regional characteristics that may contribute to these health disparities.

Future implications of this research could inform targeted public health interventions aimed at reducing caries prevalence in Libyan children. For example, the development of education campaigns focused on improving parental knowledge of oral hygiene practices and dietary choices might be beneficial. Furthermore, greater investment in accessible paediatric dental care, particularly in under-resourced areas, could address identified barriers to regular dental check-ups. The study's comprehensive approach to examining both behavioural and environmental factors offers a robust foundation for designing regionally tailored health

programmes that are grounded in empirical evidence and sensitive to local socioeconomic conditions. Consequently, these efforts could contribute to broader efforts to improve paediatric oral health and overall well-being in similar contexts.

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