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Table 1 to 7 are available in the Supplementary Files section.

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Abstract

Background: Sudanese refugee children living in Egypt may experience substantial oral health inequalities because of disrupted access to preventive dental care, financial constraints, and limited healthcare accessibility. However, evidence comparing their oral health-related quality of life (OHRQoL) with that of children from the Egyptian host community remains limited.

Objective: To compare caregiver-perceived OHRQoL, oral symptoms, dental visits, caregiver perceptions, perceived barriers to dental care, and clinical oral health status between Sudanese refugee children and Egyptian children, and to identify factors independently associated with poorer OHRQoL.

Methods: This comparative cross-sectional study included 192 child–caregiver pairs (96 Sudanese refugee children and 96 Egyptian children) aged 6–12 years. Caregivers completed a structured questionnaire based on domains of the Parental-Caregiver Perceptions Questionnaire, assessing oral symptoms, OHRQoL, dental visits, caregiver perceptions, and barriers to dental care. Clinical examinations recorded DMFT/dmft score, plaque index, and gingival index. Between-group comparisons were performed using chi-square, Monte Carlo Exact, and Mann–Whitney U tests, as appropriate. Multivariable ordinal logistic regression was used to identify factors independently associated with poorer OHRQoL.

Results: Sudanese refugee children demonstrated significantly poorer OHRQoL across functional, emotional, and social domains and experienced more frequent oral pain, pain during eating, gingival bleeding, oral malodor, and oral dryness than Egyptian children (all $p < 0.05$). Preventive dental visits were substantially lower among Sudanese children, whereas pain-driven dental visits, financial barriers, lack of health insurance, and perceived difficulties accessing dental services were significantly more common. Although the two groups had comparable DMFT/dmft scores ($p = 0.616$), Egyptian children exhibited slightly higher plaque and gingival index scores. In the multivariable ordinal logistic regression model, lack of health insurance emerged as the strongest independent factor associated with poorer OHRQoL (adjusted OR = 34.81, 95% CI: 13.99–86.60; $p < 0.001$), whereas clinical oral health measures were not independently associated with OHRQoL after adjustment.

Conclusions: Sudanese refugee children living in Egypt experience substantially poorer oral health-related quality of life despite having a comparable cumulative dental caries experience to Egyptian children. The findings indicate that healthcare accessibility and financial protection may influence children's everyday oral health experiences more strongly than clinical disease severity alone. Integrating caregiver-reported outcome measures with conventional clinical indicators may provide a more comprehensive assessment of oral health needs and support the development of equitable, culturally appropriate oral health policies and preventive programmes for refugee populations.

Keywords: Oral health-related quality of life; Sudanese refugees; Egyptian Children; Dental-care access.

Introduction

Oral diseases represent the most prevalent non-communicable diseases worldwide. Despite being largely preventable, they still lead to significant pain, infections, functional impairments, and disabilities. The World Health Organization (WHO) has reported that billions of people are affected by dental caries, periodontal disease, and tooth loss. These conditions share risk factors with other chronic diseases, such as high sugar intake, tobacco use, and unhealthy diets. Additionally, social and commercial determinants, including income levels, education, food availability, and access to healthcare, influence oral health. As a result, disadvantaged groups are often more severely affected by these conditions ¹.

Oral health has been receiving increased attention under universal health coverage. The World Health Assembly resolution of 2021, emphasized the importance of prevention, surveillance, and equitable access to dental care services ². Recent findings have highlighted that oral caries in primary teeth is common and burdensome for children and their parents, but they are also preventable ^{3,4}.

The childhood period is particularly vulnerable to rapid development of oral diseases, which can have long-lasting physical, psychological and educational repercussions. Untreated dental caries can cause pain, infections, disrupted sleep, difficulty eating and even lead to school absences. These negative impacts may affect growth, attention spans, learning abilities, social skills, and self-esteem. Poor oral health can be costly for parents and perpetuates poverty through increased school absenteeism. A systematic review and meta-analysis found that poor oral health and poverty consistently affected the quality of life due to oral diseases ⁵.

In Egypt, childhood oral diseases remain an important public health concern despite ongoing preventive initiatives. National and regional studies have consistently reported a high prevalence of untreated dental caries among children, with disease occurrence being associated with frequent sugar consumption, inadequate oral hygiene practices, limited exposure to fluoride, and restricted utilization of preventive dental services.⁶ Furthermore, studies conducted among Egyptian preschool and school-aged children have demonstrated that parental oral health practices, dietary behaviors, and socioeconomic conditions are important determinants of children's oral health status and early childhood caries.⁷ These findings indicate that oral health inequalities already exist within the host population and provide an appropriate context for comparing the additional challenges experienced by refugee children living in Egypt.

The WHO Global Oral Health Action Plan 2023–2030 emphasizes reducing oral health inequalities by integrating oral health into primary healthcare and strengthening surveillance using both clinical and patient-reported outcomes ².

The concept of Oral Health-Related Quality of Life (OHRQoL) focuses on the patient and describes how oral health impacts various aspects of life, including symptoms, functioning, psychological well-being, and social interactions. This approach allows for the assessment of outcomes that matter to patients, complementing traditional clinical indicators. Tools for evaluating OHRQoL are becoming increasingly prevalent in the area of dental patient-reported outcomes. Systematic mapping highlights the importance of using both clinical and patient-centered indicators in evaluations. Different conditions can affect individuals in various ways, influenced by factors such as the level of pain, the ability to cope with challenges, the availability of family support, and access to care. OHRQoL scales are responsive to interventions and changes following treatment. For example, a study conducted in Egypt demonstrated that children who received dental treatment under general anesthesia showed significant improvement in their OHRQoL ⁸.

Caregiver report is crucial for assessing younger children. Caregivers play a key role in monitoring children's oral hygiene, dietary intake, and any functional or emotional changes. Though caregiver report may resemble self-reports from children, yet they are not the same and provide additional information regarding the burden on families. This becomes particularly important when children do not reveal all their symptoms or accept chronic pain as normal part of their lives. The literature on caregiver-child agreement highlights the effectiveness of using caregivers as proxies for assessing oral health in pediatric patients ⁹.

The Parental-Caregiver Perceptions Questionnaire (P-CPQ) is a validated caregiver-reported instrument designed to assess the impact of oral conditions on children's oral symptoms, functional limitations, emotional well-being, and social well-being. The Arabic short forms of the P-CPQ and the Family Impact Scale have demonstrated satisfactory validity, reliability, and psychometric performance, supporting their use for assessing oral health-related quality of life in Arabic-speaking populations ¹⁰. Furthermore, cross-cultural validation of the French version of the P-CPQ confirmed excellent reliability and validity, highlighting the instrument's robustness and applicability across different linguistic and cultural settings ¹¹.

Increasing evidence indicates that clinical indicators and patient-reported outcomes represent complementary dimensions of oral health rather than interchangeable measures. Children with similar levels of dental caries may experience markedly different levels of pain, functional limitation, emotional distress, and social participation depending on their social circumstances, access to care, and family support. Consequently, reliance on clinical indices alone may underestimate the true burden of oral disease among socially disadvantaged and displaced populations. Integrating validated OHRQoL instruments with conventional clinical examination has therefore become increasingly recommended in contemporary oral epidemiology to provide a more comprehensive assessment of children's oral health needs ^{8,10}.

Forced displacement disrupts continuity of healthcare, oral hygiene practices, dietary habits, and access to preventive dental services, thereby increasing vulnerability to oral diseases. According to the UNHCR Global Trends Report, the number of forcibly displaced individuals has reached unprecedented levels, with children representing a substantial proportion of the affected population. Displacement may limit access to preventive dental care, oral hygiene products, fluoride exposure, and nutritious foods while increasing reliance on inexpensive, sugar-rich diets, thereby exacerbating oral health inequalities. Consequently, improving equitable access to preventive and therapeutic oral healthcare has become a priority for reducing unmet oral health needs among refugee populations ¹².

A growing body of evidence demonstrates that refugees experience poorer oral health and greater unmet dental treatment needs than host populations. A European scoping review reported a high burden of oral disease, delayed presentation for dental care, and multiple barriers to accessing services, including financial constraints, language difficulties, cultural differences, and challenges in navigating healthcare systems ¹³. Systematic reviews have further identified treatment costs, administrative complexity, limited availability of interpreter services, and fragmented models of care as major obstacles to oral healthcare utilization.¹⁴ Qualitative studies additionally highlight inadequate oral health awareness, unfamiliarity with healthcare systems and appointment procedures, perceived discrimination, and social stigma as important contributors to reduced access to dental care among refugee communities.^{15, 16}

Studies conducted among Syrian refugee children have consistently demonstrated a high burden of oral diseases, highlighting the urgent need for effective preventive oral health strategies in displaced populations.¹⁷ Furthermore, systematic reviews have reported poor oral health status, substantial unmet dental treatment needs, and persistent oral health inequalities among refugee children.¹⁸ These disparities are largely attributed to socioeconomic deprivation, disruption of daily routines, limited opportunities for preventive dental care, and the cumulative psychological stress associated with forced displacement.^{13, 17, 18}

Evidence also suggests that culturally appropriate interventions targeting caregivers can improve oral health outcomes among refugee children. A randomized clinical trial demonstrated that caregiver-centered preventive interventions significantly enhanced oral health behaviors and reduced disease burden, emphasizing the importance of family-oriented preventive strategies.¹⁹ Consequently, comprehensive assessment of refugee populations should incorporate both standardized clinical examinations and validated oral health-related quality of life (OHRQoL) measures to capture the full impact of oral conditions on children's daily lives.^{8, 19}

Since the onset of the armed conflict in Sudan in April 2023, Egypt has become one of the principal host countries for Sudanese refugees. Reports from the United Nations High Commissioner for Refugees (UNHCR) have documented the rapidly increasing humanitarian and healthcare needs of displaced Sudanese families.²⁰ Similarly, the United Nations Children's Fund (UNICEF) has

highlighted the growing pressure placed on health and social protection systems, particularly regarding the needs of refugee children.²¹

Although Egypt provides access to healthcare services for refugees, substantial financial barriers to dental care remain. The UNHCR Health Access and Utilization Survey identified treatment cost as one of the principal obstacles preventing refugees from seeking timely oral healthcare.²² Newly arrived Sudanese refugees may also experience additional vulnerabilities related to displacement, including financial insecurity, interrupted healthcare, unstable living conditions, and competing humanitarian priorities, which further restrict access to preventive dental services.²³ Consequently, oral healthcare utilization often shifts from preventive care toward symptom-driven management, with treatment frequently limited to pain relief and tooth extraction rather than early intervention and disease prevention.^{14, 22}

Despite the availability of validated instruments for assessing oral health-related quality of life, evidence regarding the oral health experiences of Sudanese refugee children living in Egypt remains extremely limited. Although previous studies conducted among Egyptian children have demonstrated that dental caries, poor dietary habits, and socioeconomic factors adversely affect children's oral health and quality of life,^{6,7} little is known about how forced displacement influences oral symptoms, access to dental care, and oral health-related quality of life among Sudanese refugee children residing in Egypt. Moreover, few studies have simultaneously evaluated caregiver-reported oral health-related quality of life, oral symptoms, healthcare access, and objective clinical oral health within the same refugee population. Such an integrated assessment is particularly important because clinical indicators alone may not fully reflect the broader functional, emotional, and social burden of oral disease experienced by displaced children.

Therefore, the present comparative cross-sectional study aimed to compare caregiver-perceived oral health-related quality of life, oral symptoms, dental visits, barriers to dental care, and clinical oral health status between Sudanese refugee children living in Egypt and Egyptian children from the host community. In addition, the study sought to identify demographic, socioeconomic, and clinical factors independently associated with poorer oral health-related quality of life using multivariable ordinal logistic regression analysis.

Materials and Methods

Ethical considerations

The study protocol was reviewed and approved by the Research Ethics Committee of Kafrelsheikh University (Approval No. KFSIRB200-599). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and all relevant institutional and ethical guidelines and regulations. Written informed consent was obtained from the parents or legal guardians of all participating children, and age-appropriate assent was obtained from children aged eight years or older. Participation was voluntary, confidentiality and anonymity were maintained throughout the

study, and participants were informed of their right to withdraw from the study at any stage without consequence.

Study design and setting

This comparative cross-sectional study evaluated caregiver-perceived oral health-related quality of life (OHRQoL) among Sudanese refugee children living in Egypt and Egyptian children from the host community. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies. In addition, the study assessed oral symptoms, dental visit patterns, caregiver perceptions, perceived barriers to dental care, and their relationship with children's clinical oral health status.

The study was conducted in selected school- and community-based settings in Cairo, Egypt. Sudanese participants were recruited from schools affiliated with the African Council for Special Education (Dokki and El Faisal branches), which serve large numbers of Sudanese refugee families and provide culturally familiar and accessible environments. Egyptian participants were recruited from Fadl Modern Private School (Faisal branch), located within the same geographical area to improve comparability between study groups.

Study population and sample size

The required sample size was calculated using Cochran's formula for cross-sectional studies, assuming a 95% confidence level.²⁴

formula was used as follows:

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

z is the selected critical value at the desired significance level ($z = 1.96$ for $\alpha = 0.05$), p is the estimated proportion of the attribute present in the population ($p = 0.5$), and e is the margin of error ($e = 0.1$). Based on this formula, The minimum required sample size was 96 participants per group, yielding a total sample of 192 child–caregiver pairs. Participants were recruited consecutively through a convenience sampling approach until the predetermined sample size was reached.

Eligibility criteria

Children were eligible if they were between 6 and 12 years of age, were either Sudanese refugees or Egyptian nationals, were free from systemic diseases known to influence oral health, and were cooperative during the clinical examination.

Children were excluded if they had systemic diseases known to influence oral health, were unable or unwilling to undergo clinical examination, or if caregivers declined participation or submitted incomplete questionnaires.

Questionnaire assessment

The questionnaire comprised structured sections assessing sociodemographic characteristics, dental visits, recent oral symptoms, oral health-related quality of life (OHRQoL), caregiver perceptions of children's oral health, perceived accessibility of dental services, willingness to participate in community-based preventive dental programs, and perceived barriers to regular dental attendance.

The questionnaire was developed based on domains commonly assessed by the Parental-Caregiver Perceptions Questionnaire (P-CPQ) and related caregiver-reported oral health instruments (Suppl. File, S1).

Sociodemographic information included child age and sex, caregiver age and educational level, monthly household income, health insurance coverage, and nationality.

Dental visits were categorized as regular preventive visits every six months, occasional visits, visits only during pain, or no previous dental visits.

Caregivers reported oral symptoms experienced during the preceding three months, including oral pain, pain during eating, gingival bleeding, oral malodor, and oral dryness. Responses were recorded using a four-point Likert scale (never, sometimes, often, and always).

Assessment of oral health-related quality of life outcomes

Caregiver-reported OHRQoL was evaluated across three domains: functional well-being, emotional well-being, and social well-being.

Functional items included difficulties with eating, drinking, speaking, and sleeping. Emotional items assessed embarrassment, sadness, self-confidence, reluctance to smile, and concerns regarding dental appearance. Social items evaluated school absence, bullying, avoidance of peer interaction, reduced participation in play, and avoidance of school activities.

Each item was scored using the same four-point Likert scale ranging from 0 (never) to 3 (always)²⁵, with higher scores representing greater negative impact on quality of life.

For multivariable analysis, an overall OHRQoL burden score was generated by summing the functional, emotional, and social domain scores. The summed OHRQoL score was categorized into low, moderate, and high burden for ordinal logistic regression analysis.

Caregiver perceptions and perceived barriers to dental care

Caregiver perceptions were assessed using questions addressing their evaluation of their child's oral health, the perceived importance of oral health, its potential influence on school performance, perceived accessibility of dental services, and willingness to participate in community-based programs providing free or low-cost dental care.

Perceived barriers to regular dental attendance were evaluated by asking caregivers whether financial constraints, lack of awareness, fear of dental treatment, transportation difficulties, or the belief that dental care was unnecessary limited their child's access to routine dental services.

Clinical Examination and Examiner calibration

All clinical examinations were performed by the same examiner under standardized field conditions using disposable mouth mirrors, WHO periodontal probes, adequate illumination, and standardized infection-control procedures. Dental caries experience was assessed according to World Health Organization diagnostic criteria using the DMFT/dmft index. Oral hygiene and gingival health were evaluated using the Silness and Loe Plaque Index ²⁶ and the Loe and Silness Gingival Index ²⁷, respectively.

Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA).

Categorical variables were summarized as frequencies and percentages, whereas continuous variables were presented as mean $\pm$ standard deviation (SD) or median and interquartile range (IQR), according to data distribution.

Between-group comparisons for categorical variables were performed using the Pearson chi-square test. The Monte Carlo Exact Test was applied when expected cell frequencies were insufficient for valid chi-square analysis. Non-normally distributed continuous variables, including DMFT/dmft index scores, plaque index, and gingival index, were compared using the Mann–Whitney U test.

An ordinal logistic regression model was constructed to identify factors independently associated with poorer oral health-related quality of life. The dependent variable consisted of three ordered OHRQoL categories (low, moderate, and high burden) derived from the summed functional, emotional, and social OHRQoL scores. Independent variables entered simultaneously into the model included refugee status, child age, sex, caregiver educational level, monthly household income, health insurance status, DMFT/dmft score, plaque index, and gingival index. Adjusted odds ratios (aORs) with 95% confidence intervals (95% CIs) were reported. Statistical significance was established at $p < 0.05$.

Results

Participant characteristics

A total of 192 child–caregiver pairs were included in the analysis, comprising 96 Sudanese refugee children and 96 Egyptian children. Although the two groups were comparable with respect to sex distribution, significant differences were observed in child age, caregiver age, caregiver educational level, monthly household income, health insurance coverage, and dental attendance patterns (Table 1). Sudanese refugee families demonstrated greater socioeconomic disadvantage, reflected by lower household income and markedly reduced health insurance coverage. They also exhibited substantially lower utilization of routine preventive dental services and a significantly greater reliance on pain-driven dental attendance than Egyptian children, suggesting important inequalities in access to oral healthcare.

Oral symptoms and oral health-related quality of life

Sudanese refugee children experienced significantly greater frequencies of caregiver-reported oral pain, pain during eating, gingival bleeding, oral malodor, and oral dryness than Egyptian children (Table 2), indicating a substantially greater burden of untreated oral conditions.

The negative impact of oral health extended across all domains of OHRQoL (Tables 3 and 4).

Marked differences in functional and emotional domains of oral health-related quality of life were observed between the two populations (Table 3). Compared with Egyptian children, Sudanese refugee children were significantly more likely to report avoiding solid foods, difficulty pronouncing words, sleep disturbances related to oral problems, prolonged eating time, and avoidance of hot or cold beverages ($p \leq 0.004$). Similarly, emotional wellbeing was consistently poorer among refugee children, who more frequently reported embarrassment regarding dental appearance, sadness, loss of confidence, reluctance to smile, and concerns about future dental appearance ($p \leq 0.005$). These findings demonstrate that oral conditions had a substantially greater impact on daily functioning and psychological wellbeing among Sudanese refugee children than among their Egyptian counterparts.

The impact of oral health extended beyond physical symptoms to affect children's social participation (Table 4). Although school absenteeism did not differ significantly between the groups ($p = 0.087$), Sudanese refugee children reported significantly greater social difficulties, including increased exposure to bullying ($p = 0.029$), greater avoidance of school socialization ($p = 0.004$), reduced participation in shared play ($p = 0.001$), and lower engagement in school activities ($p = 0.005$). These findings suggest that oral health problems may adversely influence children's social integration and interpersonal interactions within the school environment.

Caregiver perceptions of children's oral health and perceived barriers to dental care

Caregiver perceptions of children's oral health and perceived barriers to dental care differed significantly between Egyptian and Sudanese families (Table 5). Sudanese caregivers were significantly more likely to rate their children's oral health as poor, whereas Egyptian caregivers

more frequently described their children's oral health as excellent or good ($p < 0.001$). Despite these less favorable perceptions, Sudanese caregivers demonstrated greater awareness of the importance of oral health, with 85.4% considering it extremely important compared with 65.7% of Egyptian caregivers ($p < 0.001$). Likewise, a substantially greater proportion of Sudanese caregivers recognized that oral health could adversely affect children's academic performance (94.8% vs. 68.8%, $p < 0.001$).

Marked differences were also observed regarding access to oral healthcare. Only 15.6% of Sudanese caregivers considered dental services in Egypt to be readily accessible compared with 43.8% of Egyptian caregivers ($p < 0.001$). Nevertheless, willingness to participate in community-based programs providing free or low-cost dental care was high in both groups and significantly greater among Sudanese caregivers (91.7% vs. 80.2%, $p = 0.022$).

Financial constraints represented the predominant barrier to regular dental attendance among Sudanese families, being reported by nearly three-quarters of caregivers compared with approximately one-third of Egyptian caregivers (72.9% vs. 31.3%, $p < 0.001$). Lack of awareness was also significantly more common among Sudanese caregivers (63.5% vs. 41.7%, $p = 0.002$), whereas fear of dental treatment was reported more frequently by Egyptian caregivers (30.2% vs. 17.7%, $p = 0.042$). Transportation difficulties and perceived lack of need for dental care did not differ significantly between groups (both $p > 0.05$). Collectively, these findings indicate that reduced utilization of preventive dental services among Sudanese refugee children is primarily attributable to financial and healthcare-access barriers rather than inadequate caregiver awareness or motivation.

Clinical oral health status

Clinical examination demonstrated comparable levels of dental caries experience between the two populations. No statistically significant differences were observed in the numbers of decayed, missing, or filled teeth, nor in the overall DMFT index (all $p > 0.05$). However, significant differences were identified in oral hygiene and gingival health. Egyptian children exhibited higher plaque index (median 1.56 vs. 1.43; $p = 0.002$) and gingival index (median 1.60 vs. 1.46; $p = 0.003$) values than Sudanese children (Table 6). Despite these findings, Sudanese refugee children consistently reported poorer oral symptoms and substantially worse oral health-related quality of life across multiple domains.

Factors independently associated with poorer oral health-related quality of life

Multivariable ordinal logistic regression analysis was performed to identify factors independently associated with poorer OHRQoL (Table 7). Lack of health insurance emerged as the strongest independent predictor of poorer OHRQoL (adjusted OR = 34.81; 95% CI: 13.99–86.60; $p < 0.001$). Refugee status remained statistically associated with the outcome after adjustment (adjusted OR = 0.39; 95% CI: 0.17–0.89; $p = 0.026$). However, this estimate should be interpreted cautiously because refugee status was highly correlated with health insurance coverage and other indicators of healthcare access. Consequently, the adjusted coefficient is likely influenced by the strong

relationship between these variables and should not be interpreted independently of access-related factors.

Child age, sex, caregiver educational level, household income, DMFT/dmft score, plaque index, and gingival index were not independently associated with poorer OHRQoL after adjustment (all $p > 0.05$).

The multivariable model indicates that structural barriers to healthcare access, particularly the absence of health insurance, were more strongly associated with poorer OHRQoL than clinical oral health measures, emphasizing the importance of social determinants in shaping oral health experiences among refugee children.

Discussion

The present study compared caregiver-reported oral health-related quality of life (OHRQoL), oral symptoms, dental visits, caregiver perceptions, perceived barriers to dental care, and clinical oral health status between Sudanese refugee children living in Egypt and Egyptian children from the host community. Although both groups exhibited a similarly high cumulative dental caries experience, Sudanese refugee children consistently demonstrated significantly poorer OHRQoL across functional, emotional, and social domains, together with a greater burden of oral symptoms, substantially lower utilization of preventive dental services, and markedly poorer access to oral healthcare. Importantly, multivariable analysis further demonstrated that lack of health insurance, rather than clinical oral disease severity, emerged as the strongest independent factor associated with poorer OHRQoL. These findings suggest that oral health inequalities among refugee children are driven not only by biological disease but also by broader socioeconomic and healthcare-access factors that amplify the everyday consequences of oral conditions.

One of the most important observations of the present study was the apparent discrepancy between objective clinical findings and caregiver-reported oral health-related quality of life. Despite comparable DMFT/dmft scores, Sudanese refugee children experienced significantly more oral pain, gingival bleeding, oral malodor, oral dryness, functional limitations, emotional distress, and adverse social impacts than Egyptian children. This finding indicates that conventional epidemiological indicators, particularly the DMFT score, incompletely reflect the lived experience of oral disease among vulnerable populations. While DMFT remains the international standard for assessing cumulative caries experience, it does not capture current pain, functional impairment, psychosocial well-being, healthcare accessibility, or the broader impact of oral conditions on children's daily lives. Consequently, children with similar clinical disease burden may experience markedly different levels of disability and quality-of-life impairment depending on their social environment, continuity of care, and access to timely dental services.

Integrating validated OHRQoL instruments alongside conventional epidemiological indices would therefore provide a more comprehensive assessment of treatment needs, facilitate more equitable allocation of healthcare resources, and support the development of person-centred oral health policies. Such an approach aligns with the increasing emphasis within dental public health on addressing oral health inequalities through upstream and socially responsive interventions rather than relying exclusively on downstream clinical care.

The broader pattern observed in the present study suggests that displacement-related disadvantage was expressed more clearly through oral symptoms, functional limitations, emotional distress, social disruption, and restricted access to preventive dental care than through cumulative caries experience alone. These findings reinforce the concept that childhood oral health extends beyond the presence or absence of dental disease and encompasses children's ability to eat, sleep, speak, learn, interact socially, and maintain psychological well-being. Therefore, the clinical oral health indicators and patient- or caregiver-reported outcome measures should be regarded as complementary rather than interchangeable components of oral health assessment, in order to capture the full burden of disease and to inform person-centred oral healthcare policies.^{23,28}

Studies conducted among Syrian refugee children in Jordan ²⁹, Lebanon ³⁰, Türkiye ³¹, Greece ³², and several European ¹³ host countries have consistently reported poorer oral health-related quality of life, greater unmet dental treatment needs, higher frequencies of oral pain, and reduced utilization of preventive dental services than those observed in host populations. Likewise, recent investigations among refugee and asylum-seeking populations have shown that oral health disparities are shaped not only by disease prevalence but also by the cumulative effects of forced migration, disrupted healthcare, financial insecurity, and limited access to preventive services ^{13,18,29}. These findings indicate that the burden of oral disease among displaced populations extends beyond clinical pathology and reflects broader social determinants of health that continue to influence health outcomes after resettlement.

The present study extends this evidence to Sudanese refugee children living in Egypt, a population that has received remarkably little attention in the dental public health literature despite the substantial humanitarian consequences of the recent conflict in Sudan. Unlike many previous investigations that focused primarily on clinical oral health status or treatment needs, the present study simultaneously evaluated caregiver-reported oral symptoms, dental visits, perceived barriers to care, clinical oral health, and multiple dimensions of oral health-related quality of life. This multidimensional approach provides a more comprehensive understanding of oral health among refugee children and demonstrates that the consequences of displacement encompass functional, emotional, and social well-being in addition to measurable clinical disease.

A particularly noteworthy finding was the substantially greater frequency of oral pain, pain during eating, gingival bleeding, oral malodor, and oral dryness among Sudanese refugee children. These findings agree with previous reports describing extensive untreated dental disease, gingival

inflammation, oral infection, and high unmet treatment needs among refugee children.^{17,29,33} Patel et al., 2026, further reported severe untreated caries among recently resettled refugee children, with approximately two-thirds presenting with extensive carious lesions and the majority exhibiting frank dentine involvement.³⁴

Previous studies have observed that caregiver-reported symptom severity does not always parallel objectively with measured disease severity, possibly because chronic discomfort becomes normalized within disadvantaged populations or because competing resettlement priorities reduce attention to oral health problems.^{34,35} The detailed symptom-specific questions used in the present study may therefore have identified dimensions of oral disease that are insufficiently captured by global measures of oral health.

Untreated oral disease can impair mastication, sleep, speech, nutrition, school participation, self-confidence, and peer relationships, thereby influencing multiple aspects of childhood development.^{17,33,36} The higher frequencies of embarrassment, reduced confidence, avoidance of smiling, bullying, and social withdrawal observed among Sudanese children further support the concept that the psychosocial consequences of oral disease may be amplified by displacement-related adversity, financial insecurity, uncertainty regarding healthcare access, and disruption of normal social support systems. Previous qualitative and mixed-methods studies among refugee populations have similarly described how unfamiliar healthcare systems, language barriers, previous negative healthcare experiences, and social exclusion contribute to prolonged oral suffering and reduced quality of life even when clinical disease levels are comparable.³⁷⁻³⁹

These findings suggest that oral health inequalities among refugee children should not be interpreted solely as differences in disease prevalence. Rather, they reflect the cumulative interaction of biological disease, interrupted preventive care, socioeconomic disadvantage, healthcare accessibility, and the broader psychosocial consequences of forced displacement. Consequently, evaluation of oral health in refugee populations requires a multidimensional framework that integrates clinical indicators with patient- and caregiver-reported outcomes to accurately characterize treatment needs and the everyday burden of oral disease.

The caregiver-related findings provide important insight into the mechanisms underlying the oral health inequalities observed between Sudanese refugee and Egyptian children. Sudanese caregivers were significantly more likely to perceive their children's oral health as poor and to recognize the adverse impact of oral conditions on school performance. They also demonstrated greater awareness of the importance of oral health and expressed a stronger willingness to participate in community-based programs providing free or low-cost dental care. These findings suggest that poorer oral health outcomes among refugee children are unlikely to be explained by inadequate caregiver motivation or limited appreciation of oral health. Rather, they indicate that caregivers remain highly engaged despite substantial structural barriers that restrict access to preventive and therapeutic dental services.

This interpretation is further supported by caregivers' perceptions of healthcare accessibility. Sudanese caregivers consistently reported markedly poorer access to dental services, while financial constraints and lack of awareness of available services emerged as the principal barriers to regular dental attendance. In contrast, fear of dental treatment was more frequently reported among Egyptian caregivers, whereas transportation difficulties and perceived lack of need for dental care did not differ significantly between the two groups. These findings suggest that the lower utilization of preventive dental services observed among Sudanese refugee children reflects limitations in healthcare accessibility rather than reduced demand for dental care.

Similar barriers have been consistently reported among refugee populations worldwide, where treatment costs, inadequate insurance coverage, administrative complexity, language barriers, unfamiliarity with healthcare systems, and fragmented models of care contribute to delayed dental attendance and greater unmet treatment needs.¹³⁻¹⁶

The multivariable ordinal logistic regression analysis further strengthened this interpretation. After adjustment for demographic, socioeconomic, and clinical variables, lack of health insurance emerged as the strongest independent factor associated with poorer oral health-related quality of life, whereas DMFT/dmft score, plaque index, and gingival index were not independently associated with OHRQoL. Although refugee status remained statistically associated with the outcome, its adjusted effect should be interpreted cautiously because refugee status and health insurance coverage were strongly correlated within the study population. These findings suggest that inequalities in oral health-related quality of life among Sudanese refugee children may be mediated largely through differences in healthcare accessibility and financial protection rather than displacement alone, and so, reinforce the growing recognition that reducing oral health inequalities requires interventions targeting the broader social determinants of health in addition to the treatment of existing oral disease.^{1,2}

The present findings are consistent with the World Health Organization's conceptual framework on the social determinants of oral health, which recognizes that financial protection, equitable access to healthcare services, and broader socioeconomic conditions are fundamental determinants of oral health outcomes.^{1,2}

Likewise, the Lancet Series on Oral Health, 2020, emphasized that persistent oral health inequalities are primarily driven by structural and social determinants of health and cannot be reduced through treatment-oriented approaches alone.⁴⁰

In addition, Sudanese children demonstrated substantially greater reliance on pain-driven dental visits and markedly lower utilization of routine preventive dental visits. Only 5.2% of Sudanese children attended regularly, compared with 17.7% of Egyptians, while pain-driven attendance was reported for 64.6% and 37.5%, respectively, suggesting that oral healthcare was predominantly accessed only after symptoms developed rather than through regular preventive care. This pattern

exemplifies the inverse care phenomenon, in which those with the greatest healthcare needs often have the least access to preventive and timely dental services, thereby reinforcing existing oral health inequalities and increasing dependence on emergency-oriented care.⁴¹

The markedly lower utilization of preventive dental care among Sudanese refugee families further emphasizes the importance of strengthening access to primary oral healthcare. Integration of oral health assessment into refugee registration programmes, school-based oral health initiatives, maternal and child health services, and community outreach programmes may facilitate earlier identification of unmet treatment needs while reducing dependence on emergency and pain-driven dental attendance^{38, 39}. Culturally appropriate oral health education, language-sensitive communication, and financial support mechanisms should also be considered essential components of comprehensive refugee oral health strategies³⁷.

At a broader level, the present findings align with the World Health Organization's emphasis on reducing oral health inequalities through universal health coverage and the integration of oral health into primary healthcare systems.⁴²

Current international frameworks advocate a shift from treatment-oriented models toward integrated, prevention-focused oral healthcare systems that address the underlying determinants of oral health inequalities. The World Health Organization's Global Oral Health Action Plan (2023–2030) and the World Health Assembly Resolution on Oral Health (WHA74.5) emphasize equitable access to essential oral healthcare, universal health coverage, financial protection, and integration of oral health within primary healthcare services.^{1,2} Similarly, contemporary oral epidemiology increasingly recognizes that population oral health is shaped by multilevel interactions between individual behaviours, socioeconomic conditions, healthcare systems, and wider social environments rather than by biological factors alone. Consequently, policies designed to improve oral health among refugee populations should extend beyond emergency treatment and include sustainable preventive strategies that reduce structural barriers to care.

The combination of poorer oral health-related quality of life, reduced preventive dental visits, limited health insurance coverage, and substantial financial barriers observed among Sudanese refugee children indicates that improving access to dental care should be considered a public health priority rather than solely a clinical objective.

The findings of the present study have important implications for oral health policy in countries hosting large refugee populations. From a practical perspective, the present findings support the implementation of culturally appropriate, school- and community-based oral health programmes specifically tailored for refugee children. Such programmes should combine routine oral health screening, preventive services, caregiver education, referral pathways, and affordable restorative care while strengthening collaboration between schools, public health authorities, humanitarian organizations, and dental providers. Because Sudanese caregivers in the present study

demonstrated high awareness of the importance of oral health and expressed strong willingness to participate in community-based programmes, future interventions should capitalize on this positive caregiver engagement rather than focusing exclusively on increasing knowledge.

Additionally, improving financial protection through expanded insurance coverage or subsidized dental services may be particularly effective, given that financial constraints emerged as the predominant barrier to regular dental visits and lack of health insurance was the strongest independent predictor of poorer OHRQoL.

Limitations

To our knowledge, the present study is among the first investigations evaluating oral health-related quality of life among Sudanese refugee children residing in Egypt following the recent humanitarian crisis. Nevertheless, several limitations should be acknowledged. First, the cross-sectional design precludes causal inference regarding the relationship between refugee status and oral health-related quality of life. Second, participants were recruited from a limited geographical area, which may restrict generalizability to Sudanese refugee populations residing elsewhere in Egypt or other host countries. Finally, although several important socioeconomic and clinical variables were incorporated into the multivariable analysis, unmeasured factors such as dietary practices, oral hygiene behaviours, duration of displacement, previous exposure to preventive dental care, psychological distress, and caregiver oral health literacy may also influence oral health-related quality of life and warrant further investigation.

Conclusion

Sudanese refugee children living in Egypt experienced substantially poorer caregiver-reported oral health-related quality of life than Egyptian children despite having a comparable cumulative dental caries experience. Refugee children reported a greater burden of oral symptoms, more pronounced functional, emotional, and social impacts, lower utilization of preventive dental services, and markedly greater barriers to accessing oral healthcare. Importantly, multivariable ordinal logistic regression demonstrated that lack of health insurance was the strongest independent factor associated with poorer oral health-related quality of life, suggesting that inequalities in healthcare accessibility and financial protection may contribute more substantially to children's everyday oral health experiences than clinical disease severity alone.

These findings demonstrate that conventional clinical indices, such as the DMFT/dmft index, do not fully capture the oral health burden experienced by vulnerable refugee populations and should

be complemented by validated patient- or caregiver-reported outcome measures. Improving oral health among refugee children therefore requires approaches that extend beyond the treatment of dental disease to address the broader social determinants of health through equitable access to preventive and restorative dental care, expanded financial protection, culturally appropriate community- and school-based oral health programmes, and policies that reduce structural barriers to healthcare. Such integrated strategies are essential for reducing oral health inequalities and improving the overall well-being and quality of life of displaced children.

'Declarations':

a. Ethics approval and consent to participate:

The study protocol was reviewed and approved by the Research Ethics Committee of Kafrelsheikh University (Approval No. KFSIRB200-599). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and all relevant institutional and ethical guidelines and regulations. Written informed consent was obtained from the parents or legal guardians of all participating children, and age-appropriate assent was obtained from children aged eight years or older. Participation was voluntary, confidentiality and anonymity were maintained throughout the study, and participants were informed of their right to withdraw from the study at any stage without consequence.

b. Consent for publication: NA

c. Availability of data and materials: The information presented in this research is accessible on request from the corresponding author.

d. Competing interests: None

e. Funding: None

f. Authors' contributions:

S S: Conceptualization of the work, collect data

S E: Design Methodology, wrote the draft

A E, T B: Collect, Curation and analysis of Data, resources

E E: Design Methodology, supervision

All authors reviewed the manuscript

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h. Authors' information (optional)

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