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Original Research Article

Dental Care for Hearing Impaired Children in Sudan: Assessing Caregivers' Knowledge, Attitudes, Practices, and Children's Oral Health Status

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Abstract: ***Aim***: This study aimed to assess the oral health status of hearing-impaired children and evaluate the knowledge, attitudes, and practices of their caregivers in Khartoum State, Sudan. ***Methods***: A descriptive cross-sectional study was conducted among 202 hearing-impaired children aged 6-16 years from three branches of Al-Amal schools. Data were collected using a pre-tested, self-administered questionnaire completed by caregivers, assessing their knowledge, attitudes, and practices regarding oral health. Clinical examinations were conducted to evaluate the children's oral health status using the DMFT/dmft indices, the Community Periodontal Index of Treatment Needs (CPITN), and the Simplified Oral Hygiene Index (S-OHI). Data were analyzed using SPSS version 24, with chi-square tests, ANOVA, t-tests, and Pearson correlation applied, setting the significance level at $P \leq 0.05$. ***Results***: The prevalence of dental caries was 81.3%, with an average DMFT score of 0.0962 and a dmft score of 0.0632. Most participants (60.1%) had fair oral hygiene, while periodontal health assessments using CPITN revealed significant treatment needs. The study found that 83.7% of caregivers had a moderate level of knowledge, but many held misconceptions, particularly regarding fluoride use, with 75% incorrectly believing that fluoride prevents periodontal diseases. Dietary habits such as frequent sweet consumption without proper oral hygiene were identified as major contributors to poor oral health outcomes. Statistical analysis revealed a moderate positive correlation between student class and DMFT scores ($r = 0.372$), and a negative correlation between class and dmft scores ($r = -0.351$). ***Conclusion***: The findings underscore the urgent need for targeted oral health interventions among hearing-impaired children, focusing on caregiver education, improved oral hygiene practices, and better access to dental care services. Addressing the misconceptions about fluoride and reinforcing proper dietary habits are essential for better oral health outcomes for this vulnerable group.

Keywords: Hearing Impairment, Dental Caries, Periodontal Diseases, Caregiver Knowledge, DMFT Index, Oral Health, CPITN, Oral Hygiene, Children with Disabilities, Sudan.

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INTRODUCTION

Hearing loss, according to the World Health Organization (WHO), is defined as a loss of more than 35 decibels (dB) in the better hearing ear. This condition affects around 432 million people worldwide, including 34 million children [1]. In sub-Saharan Africa, the prevalence of hearing impairment is significantly higher at 6 per 1,000 live births compared to 1 per 1,000 in developed countries [2]. Hearing impairment can result from hereditary factors, birth complications like prematurity or neonatal jaundice, and infections such as measles, rubella, and meningitis [1]. These impairments vary in degree and often present challenges in communication, education, and health care [3].

Oral health is essential for overall well-being, but children with disabilities, especially those with

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hearing impairments, face a higher risk of poor oral health. Factors such as communication barriers, limited awareness of oral hygiene practices, socioeconomic challenges, and caregiver neglect contribute to the difficulties these children encounter [4]. Research consistently indicates that children with disabilities have higher rates of dental caries and periodontal diseases compared to their non-disabled peers [5]. This disparity is due to difficulties in mastering proper oral hygiene practices, reliance on caregivers for dental care, and a lack of specialized healthcare services [6]. Dental caries is the most common and often overlooked oral health issue among children with disabilities, including those with hearing impairments. Research shows a significant variation in the prevalence of dental caries among hearing-impaired children, ranging from 35.32% in India [7] to 82.2% in Saudi Arabia [8]. Periodontal diseases are also common among this population due to poor oral hygiene and limited access to dental services [9]. These conditions significantly impact the quality of life of children, contributing to pain, discomfort, and difficulties in daily functioning [7].

Given these challenges, this study aims to assess the oral health status of hearing-impaired children in Khartoum State and evaluate the knowledge, attitudes, and practices of their caregivers. The study's outcomes will help in identifying gaps in caregivers' understanding of oral hygiene, the specific dental care needs of hearing-impaired children, and the challenges they face in accessing proper dental care. This information is crucial for developing targeted health interventions, promoting awareness, and ensuring that oral health services are better tailored to the needs of children with hearing impairments. Ultimately, the findings will provide a foundation for improving oral health outcomes in this vulnerable population and inform future policy and educational initiatives.

MATERIALS AND METHODS

A descriptive cross-sectional survey was conducted to assess the oral health status and treatment needs of hearing-impaired children attending three branches of Al Amal primary schools for hearing impaired children in Khartoum state. The study also assessed the knowledge, attitude, and oral health practices of their caregivers.

A pre-tested, self-administered questionnaire was used to assess the knowledge, attitude, and practice of dental care among caregivers. This questionnaire included sociodemographic data about the caregivers and another seventeen questions focused on their knowledge of oral disease prevention, perception toward oral care practice approaches, tools used for prevention, and their children's dietary habits.

Caregivers' knowledge was assessed using a validated questionnaire, with one point awarded for each correct response. Total scores were categorized as low (≤33rd percentile), moderate (34th-66th percentile), or high (≥67th percentile). This scoring system aligns with methods used in similar studies on caregivers of children with disabilities [10]. The oral health status examination was conducted by two examiners to ensure inter-examiner reliability. School teachers assisted in facilitating communication with the children. The examination was conducted using a plane mouth mirror and CPI probe where necessary in accordance with WHO criteria for diagnosis of dental caries. All instruments were sterilized before use, following the Type 3 examination procedure.

Clinical examinations were conducted at the institute's medical room or classroom. A specially designed form was used to record dentition status and treatment needs along with DMFT and dmft. Periodontal health status was assessed using CPITN and oral hygiene was evaluated with the Simplified Oral Hygiene Index (S-OHI).

The data collected from clinical examinations and caregiver questionnaires were analyzed using Statistical Package for the Social Sciences (SPSS) version 24. Descriptive statistics, including frequencies, means, and percentages, were used to summarize the demographic data, oral health status (DMFT/dmft and CPITN indices), and the knowledge, attitudes, and practices of caregivers.

For inferential statistics, several tests were employed to evaluate relationships between variables. All statistical tests were conducted with a significance level set at $P \leq 0.05$, and the results provided valuable insights into the factors influencing oral health outcomes among hearing-impaired children.

RESULTS

The study evaluated 202 hearing-impaired children, with a gender distribution of 54.5% males and 45.5% females. The assessment covered the children's oral health status and the knowledge, attitudes, and practices of their caregivers.

Caregivers Knowledge & Attitude

Regarding periodontal diseases, 94.1% of the caregivers believed they could be prevented through proper oral cleaning. Additionally, 81.6% viewed reducing sugar consumption as a preventive measure, while 75.1% supported the use of fluoride. Regular dental visits were deemed beneficial by 82.6% of participants. Concerning fluoride's benefits, 92.4% believed it could strengthen teeth, 85.5% thought it could whiten teeth, and 81.2% felt it could make teeth brighter (Table 1).

Caregivers' understanding of oral health was assessed, with 83.7% of caregivers displaying a moderate level of knowledge and 13.4% exhibiting a high level of knowledge (Figure 1). However,

misconceptions regarding fluoride were prevalent. For example, 75% of caregivers believed that fluoride could prevent periodontal diseases, a misunderstanding that reflects a lack of adequate oral health education.

Regarding daily oral care, 52.5% of children brushed their teeth twice daily, and 60.2% did so in the morning and evening. However, 87% of children did not use dental floss, and 73% did not use mouthwash, indicating insufficient oral hygiene practices.

Dietary Habits

The results also revealed dietary habits, with 50.2% of children consuming sweets frequently throughout the day and 60.4% not practicing oral hygiene after sweet consumption (Figure 2). Such practices contribute to the high prevalence of dental caries. In contrast, only 29% of participants consumed fruits after meals, and 23.9% did not consume milk or milk derivatives at all.

Level of Dental Caries

The average DMFT (Decayed, Missing, and Filled Teeth for permanent teeth) score was 0.0962±SD, and the average dmft score (for primary teeth) was 0.0632±SD (Table 2). The prevalence of dental caries was notably high, with 81.3% of the children affected (Figure 4). These findings indicate a significant burden of untreated caries among both primary and permanent dentitions.

In terms of oral hygiene, the Simplified Oral Hygiene Index (S-OHI) results showed that 60.1% of the participants had fair oral hygiene, while 21.3% had good hygiene, and 18.5% exhibited poor oral hygiene (Figure 3). The results emphasize that although some children maintain an acceptable level of hygiene, a large proportion fail to meet adequate oral health standards, likely contributing to the high rate of dental caries observed.

Periodontal Health Status

The Community Periodontal Index of Treatment Needs (CPITN) scores further highlighted the presence of periodontal health issues. The mean CPITN scores were as follows: CPITN16 (1.04±SD), CPITN11 (0.56±SD), CPITN26 (1.02±SD), CPITN46 (0.99±SD), CPITN31 (0.73±SD), and CPITN36 (0.99±SD). These scores suggest that a considerable number of children had periodontal treatment needs, with the highest needs identified in the upper right first molar region (CPITN16).

The second class exhibited the highest prevalence of poor oral hygiene, while the fifth class had the highest prevalence of good oral hygiene. All other classes displayed relatively high levels of poor oral hygiene (Figure 5).

The study found significant differences in DMFT and dmft scores across different student classes. For DMFT; the analysis revealed significant differences between class levels (Table 3), with an F-statistic of 48.57 and a p-value of 0.00000162 (or 0.000162%), indicating that older students tend to have more decay in permanent teeth. Similarly; for dmft, significant differences were observed (F-statistic = 23.65, p-value = 0.0000441, or 0.00441%), suggesting that younger students exhibit higher decay rates in primary teeth.

Additionally, a significant correlation was found between CPITN and S-OHI scores (Figure 6**)**, indicating that poorer oral hygiene is associated with greater periodontal treatment needs. The analysis showed that as oral hygiene deteriorates, the need for periodontal treatment increases, highlighting the importance of proper oral care.

There is significant relationships between CPITN16, CPITN11 and gender (0.042, 0.019 respectively) (Table 4). Moreover, while no significant association was found between brushing frequency and the prevalence of dental caries (P = 0.983), a significant relationship was observed between caregivers' knowledge and DMFT scores (P = 0.030), suggesting that higher caregiver knowledge was linked to better oral health outcomes (Table 5).

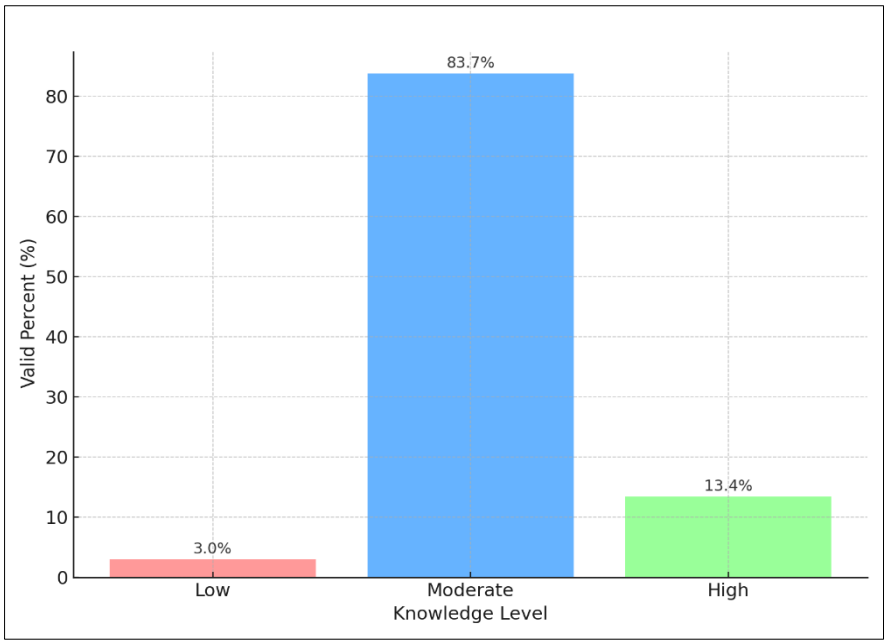

Figure 1: Level of knowledge of caregivers (Parents) about oral health

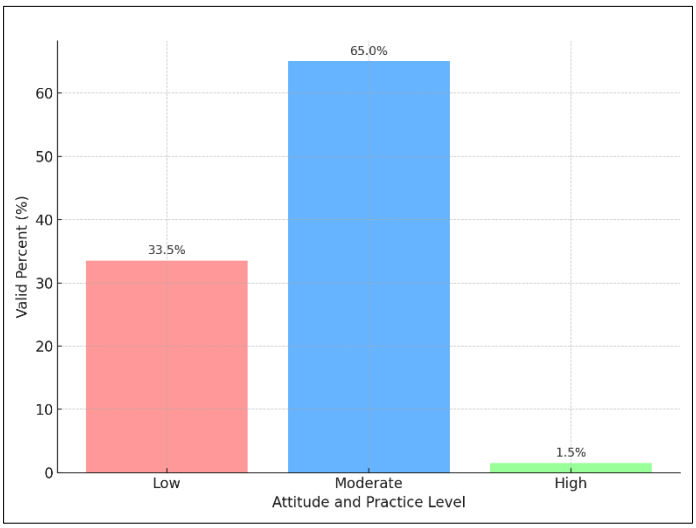

Figure 2: Level of attitude and practice towards dietary sweets by parents

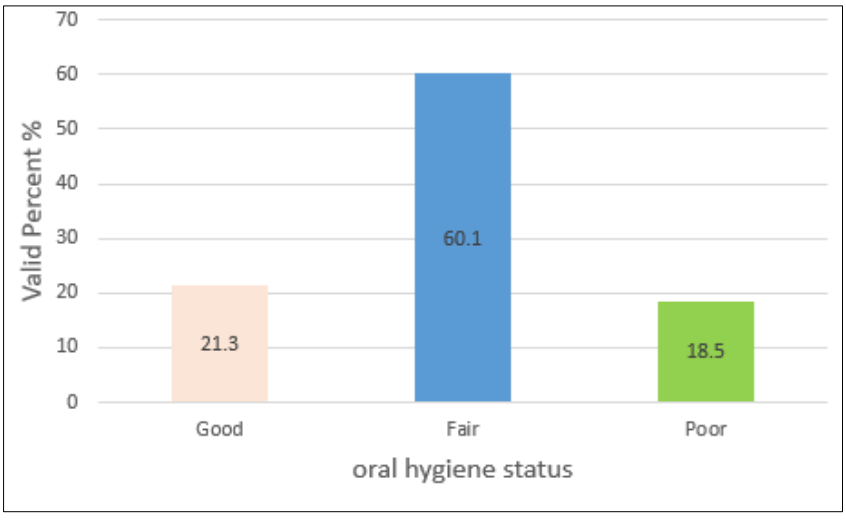

Figure 3: Oral hygiene status

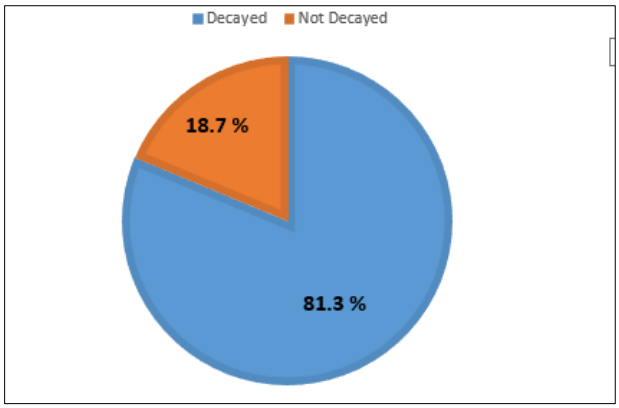

Figure 4: The prevalence of dental caries

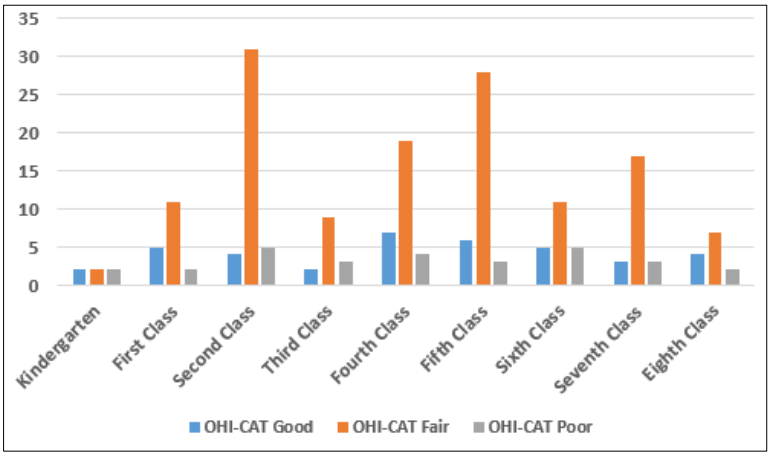

Figure 5: The association between oral hygiene and students' class

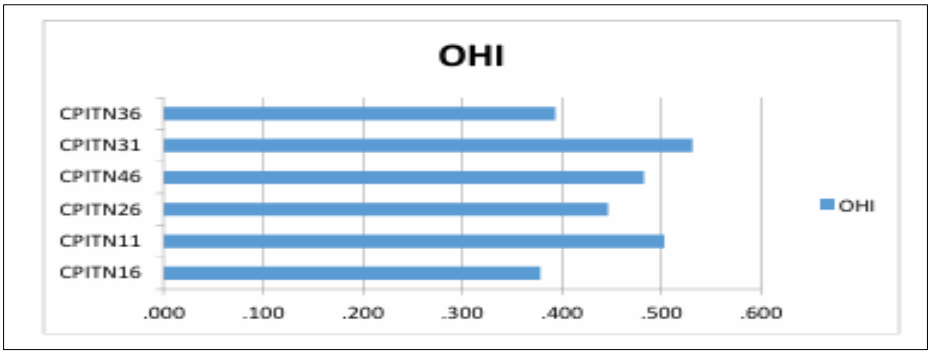

Figure 6: The correlation between CPITN and OHI

Table 1: Knowledge of caregivers about the prevention of dental caries, periodontal diseases and the use of fluoride

	Yes	No	Total
Prevention of dental caries through good cleaning of oral cavity	200 (99.0%)	2 (1.0%)	202(100%)
Prevention of dental caries through decrease amount of sweet	179(88.6%)	23(11.4%)	202(100%)
Prevention of dental caries through use of fluoride	171(84.7%)	31(15.3%)	202(100%)
Prevention of dental caries through regular dental visit	172(85.2%)	30(14.8%)	202(100%)
Prevention of periodontal diseases through good cleaning of oral cavity	190(94.1%)	12(5.9%)	202(100%)
Prevention of periodontal diseases through decrease amount of sweet	164(81.6%)	38(18.4%)	202(100%)
Prevention of periodontal diseases through use of fluoride	151(75.1%)	51(24.9%)	202(100%)
Prevention of periodontal diseases by regular dental visit	166(82.6%)	36(17.4%)	202(100%)
Fluoride make tooth stronger	173(92.4%)	16(7.6%)	189(93.5%)
Fluoride make tooth white	160(85.5%)	29(24.5%)	189(93.5%)
Fluoride make tooth bright	152(81.2%)	37(18.8%)	189(93.5%)
Don't know	13	0	13(6.5%)

Table 2: The mean DMFT/dmft/CPITN

	Mean	Std. Deviation	Minimum	Maximum
DMFT	0.0962	0.10304	0.00	0.43
Dmft	0.0632	0.11297	0.00	0.75
CPITN16	1.0448	0.91268	0.00	10.00
CPITN11	0.5622	0.60610	0.00	2.00
CPITN26	1.0199	0.68528	0.00	4.00
CPITN46	0.9900	0.62442	0.00	3.00
CPITN31	0.7313	0.66141	0.00	3.00
CPITN36	0.9950	0.67452	0.00	4.00

Table 3: The association between DMFT/dmft scores and students class

Students class	Mean DMFT scores for permanent dentition	Mean dmft scores for primary dentition	Anova test scores
1st class	0.02	0.07	DMFT (Permanent Teeth): F-statistic = 48.57, p-value = 0.00000162 (0.000162%) dmft (Deciduous Teeth): F-statistic = 23.65, p-value = 0.0000441 (0.00441%)
2nd class	0.03	0.06	
3rd class	0.07	0.03	
4th class	0.08	0.03	
5th class	0.10	0.018	
6th class	0.11	0.013	
7th class	0.15	0.001	
8th class	0.16	0.004	

Table 4: The association between CPITN, DMFT, dmft and gender

	Mean ±SD	gender	Number	Mean ± SD	P value
CPITN16	1.0448±SD	Male	109	1.1651 ± 1.06	0.042
		Female	91	0.9011 ± 0.66	
CPITN11	0.5622±SD	Male	109	0.6514 ± 0.59	0.019
		Female	91	0.4505 ± 0.60	
CPITN26	1.0199±SD	Male	109	1.0459 ± 0.59	0.561
		Female	91	0.9890 ± 0.78	
CPITN46	0.9900±SD	Male	109	1.0642 ± 0.62	0.066
		Female	91	0.9011 ± 0.61	
CPITN31	0.7313±SD	Male	109	0.8073 ± 0.68	0.071
		Female	91	0.6374 ± 0.62	
CPITN36	0.9950±SD	Male	109	1.0642 ± 0.67	0.113
		Female	91	0.9121 ± 0.67	
DMFT	0.0962±SD	Male	110	0.0867 ± 0.10	0.147
		Female	91	0.1079 ± 0.10	
dmft1	0.0632±SD	Male	109	0.0578 ± 0.09	0.520
		Female	91	0.0681 ± 0.13	

Table 5: Comparison of Caregivers Knowledge Levels with DMFT Scores

Caregiver Knowledge Level	Number of Caregivers	Mean DMFT±SD	P-value
Low	6	0.254 ± 0.085	0.030
Moderate	169	0.091 ± 0.067	
High	27	0.053 ± 0.062	

DISCUSSION

This study aimed to assess the oral health status of hearing-impaired children and evaluate the knowledge, attitudes, and practices of their caregivers in Khartoum State. The findings provide critical insights into the oral health challenges faced by this vulnerable population and their caregivers, with significant implications for health interventions and policy improvements.

Prevalence of Dental Caries

The prevalence of dental caries in our study was found to be 81.3%, which is alarmingly high compared to other global studies. For instance, in India, dental caries prevalence among hearing-impaired children was reported as 35.32% and 56% in different studies [11]. Similarly, lower rates were observed in Ethiopia (38.9%) [12], Brazil (42.9%) [13], and Rwanda (42.4%) [14]. However, the findings in our study are more comparable to those from Saudi Arabia, where the prevalence was

reported as 82.2% [8]. This high prevalence could be attributed to the lack of proper oral hygiene practices, poor access to dental care, poor dietary habits, and inadequate oral health education among caregivers.

The high DMFT and dmft scores observed (0.0962 and 0.0632, respectively) further emphasize the widespread problem of untreated dental caries. These figures highlight the need for urgent dental care interventions, especially in children with hearing impairments, who face additional challenges in accessing appropriate oral health services due to communication barriers [15, 16].

Periodontal Health and Oral Hygiene

Our findings on periodontal health, assessed using CPITN scores, showed that most children had some level of periodontal disease, indicating a significant need for both preventive and curative care. The mean CPITN scores align with studies showing that children with hearing impairments often exhibit poor periodontal health due to challenges in maintaining oral hygiene [4-6]. The correlation observed between CPITN and S-OHI scores suggests that poor oral hygiene is a key factor contributing to periodontal issues. Comparatively, similar studies have reported varying degrees of periodontal health issues among children with disabilities. For example, research conducted in Thailand found significant periodontal treatment needs among children with disabilities, including those with hearing impairments [17]. In our study, the high prevalence of periodontal issues reflects the broader lack of awareness and proper hygiene practices among caregivers, further justifying the need for targeted interventions aimed at improving oral hygiene in this population.

Caregivers' Knowledge, Attitudes, and Practices

The caregivers in our study exhibited a moderate level of knowledge regarding oral health, with 83.7% demonstrating adequate understanding. However, significant misconceptions were prevalent, particularly regarding fluoride use. Around 75% of caregivers incorrectly believed that fluoride prevents periodontal diseases, while a high percentage associated fluoride with whitening and brightening teeth. These misconceptions have been observed in other studies as well, such as in Nigeria, where caregivers of disabled children similarly exhibited gaps in oral health knowledge [2].

Despite the moderate level of knowledge, the caregivers' attitudes and practices did not always align with best practices for oral hygiene. For example, while 52.5% of children brushed their teeth twice daily, most did not use dental floss or mouthwash, highlighting gaps in the application of knowledge to daily practices. This reflects findings from other studies that show caregivers' knowledge does not always translate into effective oral hygiene behaviors among children [12]. These gaps can be attributed to a lack of accessible oral health education programs and socioeconomic barriers that limit the availability of dental care products.

Dietary Habits and Their Impact on Oral Health

The dietary habits observed in this study further contribute to the high prevalence of dental caries. Half of the participants (50.2%) frequently consumed sweets, and 60.4% did not practice oral hygiene after sweet consumption. Poor dietary habits have been identified as a significant risk factor for dental caries in numerous studies. For example, a study in Ethiopia found that frequent sugar consumption was a major contributor to caries development in children with disabilities [14]. In our study, the lack of proper oral hygiene following sweet consumption exacerbates the risk of dental caries, further justifying the need for educational programs that emphasize the importance of dietary habits in maintaining oral health.

Comparison with Global Literature and Justification

The results of this study align with global findings that children with disabilities, particularly those with hearing impairments, are at a higher risk of oral health issues due to various barriers, including communication challenges and a reliance on caregivers for oral hygiene [6-9]. The high prevalence of dental caries and periodontal diseases, combined with inadequate caregiver knowledge and practices, mirrors findings from other regions, indicating that this is a widespread issue that requires attention [8].

One justification for the high rates of oral health issues observed in our study is the limited access to specialized dental care in Sudan. Similar to findings in other low-resource settings, access to dental services for children with disabilities is often restricted by socioeconomic factors and a lack of trained dental professionals who can effectively communicate with and treat hearing-impaired children [7-9]. Additionally, cultural beliefs and misconceptions about oral health, particularly regarding the role of fluoride, further contribute to the poor oral health outcomes observed [11].

Implications and Recommendations

The findings of this study highlight the urgent need for targeted oral health interventions in hearing-impaired children. Programs that focus on improving caregivers' knowledge, addressing misconceptions about fluoride, and promoting better oral hygiene practices are essential. Furthermore, increasing access to specialized dental services that cater to children with disabilities is crucial in reducing the prevalence of dental caries and periodontal diseases.

Future studies should explore strategies for improving communication between healthcare providers and hearing-impaired children, as well as the effectiveness of school-based oral health programs in addressing the unique needs of this population like the

school oral health program that was established by the ministry of health at Khartoum state. By implementing these measures, we can significantly improve the oral health and overall quality of life for hearing-impaired children in Khartoum State and beyond.

Declarations

Abbreviations

CPITN – Community Periodontal Index of Treatment Needs
DMFT – Decayed, Missing, and Filled Teeth (permanent teeth)
dmft – decayed, missing, and filled teeth (primary teeth)
S-OHI – Simplified Oral Hygiene Index
SPSS – Statistical Package for the Social Sciences
WHO – World Health Organization
dB – Decibels
OHI – Oral Hygiene Index

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Ethics and Research Committee of the College of Oral and Dental Medicine – Karary University, Sudan. This study was conducted in full accordance with the ethical principles of the Declaration of Helsinki.

Written informed consent was obtained from all participants' legal guardians before data collection. Parents and caregivers were informed about the research objectives, procedures, and their rights to withdraw at any time without consequences. The guardians also provided consent for clinical examination of their children.

Purpose of the Study

The study aims to understand the challenges faced by caregivers of hearing-impaired children and explore potential solutions to improve their oral health and also to assess the oral health status of your child.

What Your Participation Involves

If you agree to participate:

- You will be required to complete a questionnaire about your knowledge, attitudes, and practices regarding oral health care for hearing-impaired children.
- Data collected will be kept confidential and used solely for research purposes.
- Giving permission to conduct oral health examination for your child, using dental examination sets by our dentists researchers.

Potential Benefits

- The findings from this study may lead to improved oral health care guidelines and practices for hearing-impaired children. And providing feed back regarding the oral health status of your child.
- Children with oral health detected problems will receive free dental care at Karary University Dental clinics if you are willing to.

Risks and Confidentiality

- There are no anticipated risks associated with participation.
- All information will remain confidential and anonymized.

Consent Declaration

I have read and understood the information above. By signing below, I agree to participate in this study voluntarily by answering the questionnaire and to allow clinical examination for my child.

Participant Name	Signature	Date

Consent for Publication

Written informed consent for the publication of relevant anonymized clinical findings and data was obtained from the parents or legal guardians of all child participants prior to inclusion in the study. No identifiable images or personal information were included in this publication.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available in the link: (https://drive.google.com/file/d/1dH508F45P6ViqSKB0PqQc78r19gkAMyu/view?usp=drivesdk)
With the English language version of the questionnaire that was developed for this study (https://drive.google.com/file/d/1iAYc7aVU7JhE8nf9Tr2SNQ6-DmFoLCqH/view?usp=drivesdk)

Competing Interests: The authors decelerate that they have no competing interests.

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Clinical Trial Number: Not Applicable

Authors' Contributions

A.I Concepted, designed the Work, also; Interpreted the data and revised the work. M S. A, M EA and A.F have acquitted, analyzed the data and drafted the work. M.M have analyzed the data and drafted the work. H.M has revised the whole work. E M has participated in work drafting.

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