

# Oral Health Status of Hearing-Impaired Students Attending Special Need Schools in Amhara Region, Ethiopia: A Cross-Sectional Study

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**Background:** Oral health care is the most common unmet need among individuals with a disability. Individuals with a disability may have compromised oral health needs due to neglect from parents, socioeconomic problems, and communication barriers. In Ethiopia, there is a lack of data on oral health status of the hearing-impaired population. Therefore, this study aimed to assess the oral health status of hearing-impaired students in the Amhara region, Ethiopia.

**Methods:** A cross-sectional study was conducted from November 2020 to April 2021 on hearing-impaired students in Amhara region, Ethiopia. Data were collected using a pretested interview administered questionnaire and clinical examination. Oral cavity was evaluated using the simplified oral hygiene index, decayed, missed and filled teeth, and community periodontal index. Data analysis was done using SPSS 26.0, and logistic regression analysis was done to identify the risk factors of dental caries and periodontal disease.

**Results:** A total of 149 hearing impaired students with an age range of 7–30 years were involved in the study. The prevalence of periodontal disease and dental caries was 22.8% (95% CI: 16.8, 30.4) and 38.9% (95% CI: 32.2, 46.9), respectively. Being grade 1–4 student (AOR = 3.94, 95% CI: 1.16, 13.38), lack of formal education (AOR = 4.98, 95% CI: 1.00, 24.65), dental caries (AOR = 2.51, 95% CI: 1.08, 5.08) and bleeding on probing (AOR = 9.98, 95% CI: 3.69, 26.64) were statistically significant with periodontal disease. Grade level, parents' support during brushing, oral health status, and medication intake were independent factors for dental caries.

**Conclusion:** In the present study, a significant number of hearing-impaired students had periodontal disease and dental caries. School oral health programs and caregivers assisted oral hygiene practices are essential to combat oral health problems in hearing-impaired students. Moreover, a nationwide prospective study with a large sample size will be required to reflect the oral health status of hearing-impaired individuals in the country.

**Keywords:** oral health status, hearing impairment, dental caries, periodontal disease, DMFT

## Background

In the world, more than 360 million population live with hearing impairment, and 9% of them are under 15 years. In sub-Saharan Africa 6 per 1000, live births were hearing impaired, which was high compared with one per 1000 in developed countries.<sup>1,2</sup> Hearing impairment was quite common in South Asia, Asia Pacific, and sub-Saharan Africa.<sup>3</sup> In Ethiopia, it is estimated that 71.2% of the population with disability were hearing-impaired individuals.<sup>1</sup> A survey in North West Ethiopia showed that 8.3% of the study participants had a hearing impairment.<sup>4</sup>

Oral health care is the most common unmet need among individuals with disabilities. Health care access was continued to be a challenge for individuals with special needs in the 21st century.<sup>5</sup> Individuals with disabilities may have a compromised oral health need due to neglect from parents, socioeconomic problems, and communication barriers.<sup>6</sup> The high prevalence of oral health problems in individuals with a disability has been attributed to poor oral hygiene practice, lack of awareness about oral hygiene, diet, physical limitations, professional's attitude, and lack of access to oral health care.<sup>7</sup>

Hearing impairment is a disability that can limit one's ability to acquire information and have a negative impact on one's personal health.<sup>8</sup> The severity and magnitude of dental problems in the hearing impaired population are worse and have more untreated dental conditions than the general people.<sup>9</sup> The oral hygiene status of children and young adults with hearing disabilities was significantly associated with age, economic status and educational level of parents, especially maternal education.<sup>10</sup> In India, 65% of special need school students had dental caries with a mean level of caries prevalence (DMFT) of  $1.6 \pm 1.3$ .<sup>11</sup> Azfar et al, in Pakistan, reported that 51% of disabled students had dental caries with a mean DMFT score of  $2.08 (\pm 2.97)$ , and 48.1% of them had good oral hygiene status (48.1%).<sup>12</sup>

Oral health has a strong psychological, biological, and social consequences as it affects the communication, aesthetics, and quality of life of the affected individuals.<sup>13</sup> Hearing impaired people had difficulty communicating with health care professionals, and as a result of the communication gap, most dental and medical professionals ignored those patients with hearing impairment.<sup>14</sup> Assessing the oral health status of hearing-impaired students may reduce future treatment needs, reduce treatment cost and plan preventive and curative measures.<sup>14,15</sup> Besides, it is also important for resource planning and designing community service for disabled populations based on their needs.

In Ethiopia, some studies were carried out on the oral health status of school children.<sup>16-19</sup> However, there is no evidence of the oral health status of the hearing-impaired population in the country. Hence, this study aimed to assess the oral health status of hearing-impaired students attending special need schools in Amhara region, Ethiopia.

## Methods

### Study Area and Period

This study was conducted on eight special need schools (Gondar, Bahir Dar, Dessie, and Debre Markos, two from each) in Amhara regional state, Ethiopia. The list of students was taken from their roster. The study was carried out over six months, from November 2020 to April 2021.

### Study Design

School-based cross-sectional study was employed among hearing-impaired school students in Amhara region, Ethiopia.

### Inclusion and Exclusion Criteria

Source and study populations: All hearing-impaired individuals in Amhara regional state were the source population for this study, while hearing-impaired students that attend special need schools were the study population.

Exclusion criteria: Study participants with dental/medical emergency, uncooperative, and who were absent from school during the data collection period were excluded from the study.

### Sample Size Determination and Sampling Techniques

The sample size was determined using a single population proportion formula for another study published to BMC oral health journal entitled "Dental health problems and treatment-seeking behavior among special need school students in Amhara Region",<sup>20</sup> where the following assumptions were considered: P (50% proportion of dental health problem among special need student), d (Margin of error: 5%),  $Z_{\alpha/2}$  (the value of the standard normal curve score corresponding to the given confidence interval = 1.96) corresponding to 95% confidence level, and 15% non-response rate. In this study, we have included all (149) hearing-impaired special needs students.

## Operational Definition

Dental caries: A participant was considered to have a dental caries if he/she had decayed, teeth, missed teeth due to dental caries, and restored teeth in both primary and permanent dentitions.

Hearing Impairment: The term hearing impairment refers to students who had both complete and partial hearing problem and attend special need schools in the study area.

Periodontal disease: Periodontal diseases are infections and inflammation of the gum and bone that surround and support the teeth. In the present study, a student is considered to have periodontal disease if and only if the participant had a periodontal pocket depth of greater than 3 mm.

Oral health status: The oral hygiene of the students was evaluated using the simplified oral hygiene index.<sup>21</sup>

## Study Variables

The dependent variables in this study were dental caries, periodontal disease, and oral health status. Whereas socio-demographic characteristics, tooth brushing habits, and dietary habits were independent variables.

## Data Collection Tools and Techniques

The data collection tool had two parts. The first part includes a structured questionnaire that targets to record the sociodemographic, tooth brushing habits and dietary habits. The second part includes an intra-oral examination.

### Questionnaire Administered Interview

A structured pretested interview administered questionnaire was used to collect data on sociodemographic, oral health behavior, medical condition, duration of hearing impairment, and oral habits (pen/pencil/finger sucking and mouth breathing pattern). The questionnaire was adopted from the WHO Oral Health Survey tool<sup>14</sup> and different kinds of the literature.<sup>22,23</sup> The tool was prepared in English and translated into the local language-Amharic. It was then translated back into English by two non-dental professionals, and the translated and original questionnaire was assessed if they achieve conceptual and semantic equivalence, and they did not require any further amendment. Special need experts that knew sign language were involved in communicating the information between the students and dental professionals.

### Intra-Oral Examination

The oral cavity of the study participants was evaluated using a community periodontal index (CPI) probe, mouth mirror, and dental explorers as WHO criteria to diagnose periodontal disease and dental caries. Four examiners, who were calibrated before the actual study to reduce inter-examiner variation, were involved in the intra-oral examination process. Moreover, 2 special need experts were involved in the process. The data recorded were DMFT index (decayed, missed, and filled teeth), oral hygiene status (based on simplified oral hygiene index, OHI-S),<sup>21</sup> and periodontal status using the community periodontal index (CPI). The OHI-S was recorded on six surfaces of index teeth (buccal surface of 11, 16, 26, and 31) and lingual surface of 36 and 46. For under 18 years of age children, a guideline that was developed by the British Society of Periodontology and the British Society of Pediatric Dentistry “Guidelines for Periodontal Screening and Management of Children and Adolescents Under 18 Years of Age” was used.<sup>24</sup> Students with a dental emergency were referred to the nearby dental care centers for treatment. The intra-oral examination was done at the schools using normal light/daylight, tongue depressor, mouth mirror, periodontal probe, and dental explorers. A pilot test was done on 15 hearing impaired students at Injibara in October 2020. Cohen kappa coefficient was then calculated for inter-examiner reliability, and ranged from 0.88–0.95, indicating good and almost perfect results. To avoid cross-infection of COVID-19, maximum preventive methods and strategies were implemented. A five-day training was given for the data collectors. Moreover, there was daily onsite supervision to check the completeness of the questionnaire.

## Data Analysis

The statistical package for social science, version 26.0 (IBM Corp., Armonk, NY, USA), was used for the statistical analysis. Descriptive data of frequency, percentage, mean, and SD were calculated and presented in terms of tables. A bivariable and multivariable logistic regression model was used to identify the factors associated with dental caries and

periodontal disease among hearing-impaired students in the Amhara region. Study variables with  $P < 0.05$  at a 95% confidence interval were considered statistically significant.

## Ethical Consideration

The ethical clearance was obtained from the University of Gondar Institutional Review Board (Ref. No: V/P/RCS/05/541/2020). Furthermore, permission was requested and obtained from each town's education Bureau and special need schools. Written informed consent was obtained from parents or legal guardians, and assent from the students themselves was obtained before the study. The study was done in accordance with the declaration of Helsinki (Code of Ethics of the World Medical Association).

## Results

### Demographic Characteristics

A total of 149 hearing impaired students of 7–30 years and a mean age of 15.51 (SD  $\pm 3.904$ ) were involved in the study. The majority of the study participants were females (57%) and 13–18 years old (65.8%). Almost half of the students were grade 5 to grade 8 (48.3%). Most of the study participants (84.6%) had a family monthly income of  $\leq 2500$  Ethiopian Birr (Table 1).

### Oral Health Behaviors of the Study Participants

One hundred forty-two students (95.3%) had a habit of sugary food intake, of this 30.2% took twice, or more per day. More than 3/4th (80.5%) of the participants had tooth brushing habits. Of this, only 7.4% of them brushed their teeth twice a day, and 20.1% of the study participants had parental support during tooth brushing. Tooth stick was the commonly (45.0%) used tooth-brushing material. About 17 (11.4%) students had other medical comorbidities in addition to their hearing disability. Regarding the oral habits of the study participants, 36.2% were mouth breathers and 17.4% had sucking habits (finger, pen, pencil, etc.) (Table 2).

### Oral Health Status

The oral health status of the participants was evaluated using the simplified oral hygiene index, and was 36.2%, 32.2%, and 31.5% for Good, Fair, and poor oral hygiene, respectively.

### Prevalence of Periodontal Disease

The prevalence of periodontal disease among hearing-impaired students in the Amhara regional state was 22.8% (95% CI: 16.8, 30.4). Nearly one-third (29.2%) of students above the age of 18 years had periodontal disease. High prevalence was reported among 18 and above years (29.2%), grade 9–12 students (35.0%), and students with poor oral health status (59.6%), class-II malocclusion (45.5%), participants who had no family support during tooth brushing (25.0%), and dental caries (32.8%). Moreover, 43.6% (95% CI: 35.6, 51.2) of the study participants had bleeding on probing (BOP). Twelve (27.9%) students with malocclusion had periodontal disease (Table 3).

### Prevalence of Dental Caries

The prevalence of dental caries among hearing-impaired school students in the region was 38.9% (32.2, 46.9). Forty-one (41.8%) of students aged 13 to 18 years had dental caries, and 64.7% of students with comorbidities had dental caries. Moreover, the prevalence was high in students with class-II malocclusion (50.0%), periodontal disease (55.9%), and sucking habit (53.8%). About 60% of students with family support during their oral hygiene practice had dental caries. Students with a history of medication intake had a higher prevalence of dental caries than those who were not on medication (78.6% vs 34.8%) (Table 4).

**Table 1** Sociodemographic Characteristics of Hearing-Impaired Students Attending Special Need Schools in the Amhara Region, Ethiopia

Variables		Frequency (n)	Percentage (%)
Sex	Male	64	43.0
	Female	85	57.0
Age	7–12 years	27	18.1
	13–18 years	98	65.8
	>18 years	24	16.1
Religion	Orthodox	107	71.8
	Catholic	10	6.7
	Muslim	29	19.5
	Protestant	3	2.0
Location of the participants	Gondar	39	26.2
	Bahir Dar	39	26.2
	Debre Markos	27	18.1
	Dessie	44	29.5
Grade level	1–4	57	38.3
	5–8	72	48.3
	9–12	20	13.4
Mothers educational status	No formal education	126	89.4
	Primary	6	4.3
	Secondary and above	9	6.4
Fathers educational status	No formal education	116	82.9
	Primary	7	5.0
	Secondary and above	17	12.1
Family monthly income	< 2500 Ethiopian birr	115	84.6
	≥2500 Ethiopian Birr	21	15.4

### The Decayed Missed and Filled Teeth (DMFT/dmfts)

The mean DMFT score was  $1.15 \pm 1.654$ . Decay was the highest component of the mean DMFT, with a mean value of  $0.77 \pm 1.258$ . There was no filled tooth among the study participants. The mean DMFT was  $1.54 \pm 1.911$  for those above 18 years and  $1.90 \pm 1.917$  for those grades 9–12 students. The mean dmft in the primary dentition was  $0.11 \pm 0.564$  (Table 5).

### Factors Associated with Periodontal Disease

As shown in Table 6, variables with a p-value of  $<0.25$  in bivariate logistic regression model such as: age, sex, grade level, sugary food intake, mouth breathing, parents support during tooth brushing, oral health status, paternal educational status, class-II malocclusion, bleeding on probing, medication intake and dental caries were entered into the multivariate

**Table 2** Oral Health Behavior of Hearing-Impaired Students Attending Special Need Schools in Amhara Region, Ethiopia, 2020/21 (n = 149)

Variables		Frequency	Percentage
Sugary food intake	Yes	142	95.3
	No	7	4.7
Frequency of sugary food intake	Some times	63	42.3
	Once a day	34	22.8
	Twice a day	38	25.5
	Three and more times a day	7	4.7
Type of sugary food intake	Milk with sugar	63	42.3
	Juice	46	30.9
	Chewing gum	70	47.0
	Soft drinks	57	38.3
	Deserts	70	47.0
	Candy	85	57.0
Tooth brushing	Yes	120	80.5
	No	29	19.5
Frequency of tooth brushing	Some times	53	35.6
	2-3 times per week	9	6.0
	Once a day	47	31.5
	Twice a day	11	7.4
Tooth brushing materials	Toothbrush	51	34.2
	Tooth stick*	67	45.0
	Charcoal	1	0.7
	Other	1	0.7
Parents support during tooth brushing	Yes	30	20.1
	No	119	79.9
Time of tooth brushing	Before bed	15	10.1
	Before breakfast	81	54.4
	After breakfast and before bed	19	12.8
	At school	1	0.7
Brushing after meal	Never	27	18.1
	Some times	82	55.0
	Always	7	4.7

(Continued)

**Table 2** (Continued).

Variables		Frequency	Percentage
Changing toothbrush	Monthly	14	9.4
	Every three months	23	15.4
	Every six months	24	16.1
	Yearly	24	16.1
Mouth breathing*	Yes	54	36.2
	No	95	63.8
Sucking habit	Yes	26	17.4
	No	123	82.6
Comorbidity	Yes	17	11.4
	No	132	88.6
Medication	Yes	14	9.4
	No	135	90.6

**Notes:** \*The breathing pattern is assessed using the butterfly test. \*Tooth Stick: a traditional tooth brushing material that is prepared from Stick.

logistic regression model. In the multivariable logistic regression analysis, grade level, fathers' educational status, dental caries, and bleeding on probing were statistically significant factors for periodontal disease.

Hearing-impaired students attending grades 1–4 (AOR = 3.94 (95% CI; 1.159, 13.379)) were 3.94 times more likely to have periodontal disease than students attending grades 5–8 and 9–12. Students that had illiterate fathers were 4.98 times more likely to have periodontal disease (AOR = 4.98, 95% CI; 1.00, 24.65). Students with dental caries were 2.51 times more likely to have periodontal disease than students who do not have dental caries (AOR = 2.51, 95% CI: 1.08, 5.08). Special needs school students with bleeding on probing were 9.89 times more likely to have periodontal disease than normal students were (AOR = 9.89, 95% CI; 3.69, 26.64) (Table 6).

## Factors Associated with Dental Caries

In the bivariate logistic regression model, grade level, parents' support during tooth brushing, comorbidity, oral health status, class-II malocclusion, sucking habits, periodontal disease, and medication intake had a p-value of <0.25. These variables were entered into the multivariable logistic regression model, and grade level, parents' support during tooth brushing, oral health status, and medication intake were significantly associated with dental caries.

Grade 9–12 students (AOR = 4.45 (95% CI: 1.10, 21.28)) were 4.45 times more likely to have dental caries than students attending grade 1–4 and grade 5–8. Students who had no family support during tooth brushing were 5.10 times more likely to have dental caries than those who had family support during their oral hygiene practice (AOR = 5.10, 95% CI: 1.89, 13.76). Students with poor oral health status were 8.07 times more likely to have dental caries compared to good oral health status students (AOR = 8.07 (95% CI; 2.49, 26.18)). Moreover, students who were on medication were 9.26 times more likely to have dental caries than students who did not take medications for systemic disease (AOR = 9.26; 95% CI: 2.17, 39.45) (Table 7).

## Discussion

In this study, the prevalence of periodontal disease was 22.8% (95% CI: 16.8, 30.4). The study found a significant association between grade level, fathers' educational status, dental caries, and bleeding on probing with periodontal disease. About 38.9% (95% CI; 32.2, 46.9) of the study participants had dental caries, and grade level, parents support

**Table 3** Prevalence of Periodontal Disease Among Hearing-Impaired School Students in Amhara Regional State, Ethiopia, 2020/21

Variables		Periodontal Disease		P-value (Chi-Square)
		Yes	No	
Age	7–12 years	1 (3.7%)	26 (96.3%)	0.031
	13–18 years	26 (26.5%)	72 (73.5%)	
	Above 18 years	7 (29.2%)	17 (70.8%)	
Sex	Male	18 (28.1%)	46 (71.9%)	0.180
	Females	16 (18.8%)	69 (81.2%)	
Location	Gondar	11 (28.2%)	28 (71.8%)	0.576
	Bahir Dar	9 (23.1%)	30 (76.9%)	
	Debre Markos	7 (25.9%)	20 (74.1%)	
	Dessie	7 (15.9%)	37 (84.1%)	
Grade level	1–4	7 (12.3%)	50 (87.7%)	0.043
	5–8	20 (27.8%)	52 (72.2%)	
	9–12	7 (35.0%)	13 (65.0%)	
Religion	Orthodox	25 (23.4%)	82 (76.6%)	0.955
	Catholic	2 (20.0%)	8 (80.0%)	
	Muslim	6 (20.7%)	23 (79.3%)	
	Protestant	1 (33.3%)	2 (66.7%)	
Sugary food intake	Yes	31 (21.8%)	111 (78.2%)	0.196
	No	3 (42.9%)	4 (57.1%)	
Tooth brushing	Yes	27 (22.5%)	93 (77.5%)	0.850
	No	7 (24.1%)	22 (75.9%)	
Frequency of tooth brushing	Some times	13 (24.5%)	40 (75.5%)	0.963
	2–3 times per week	2 (22.2%)	7 (77.8%)	
	Once a day	9 (19.1%)	38 (80.9%)	
	Twice a day	3 (27.3%)	8 (72.7%)	
Parents support during tooth brushing	Yes	4 (13.3%)	26 (86.7%)	0.183
	No	22 (25.0%)	66 (75.0%)	
Mouth breathing	Yes	6 (11.1%)	48 (88.9%)	0.010
	No	28 (29.5%)	67 (70.5%)	
Comorbidity	Yes	3 (17.6%)	14 (82.4%)	0.589
	No	31 (23.5%)	101 (76.5%)	
Medication	Yes	3 (21.4%)	11 (78.6%)	0.896
	No	31 (23.0%)	104 (77.0%)	

(Continued)



**Table 3** (Continued).

Variables		Periodontal Disease		P-value (Chi-Square)
		Yes	No	
Oral health status	Good	0 (0.0%)	54 (100.0%)	<0.001
	Fair	6 (12.5%)	42 (87.5%)	
	Poor	28 (59.6%)	19 (40.4%)	
Mothers educational status	No formal education	30 (23.8%)	96 (76.2%)	0.981
	Primary education	1 (16.7%)	5 (83.3%)	
	High school and above	2 (22.2%)	7 (77.8%)	
Fathers educational status	No formal education	23 (19.8%)	93 (80.2%)	0.327
	Primary education	2 (28.6%)	5 (71.4%)	
	High school and above	6 (35.3%)	11 (64.7%)	
Class-I occlusion	Yes	22 (20.8%)	84 (79.2%)	0.346
	No	12 (27.9%)	31 (72.1%)	
Class-II malocclusion	Yes	10 (45.5%)	12 (54.5%)	0.006
	No	24 (18.9%)	103 (81.1%)	
Bleeding on probing	Yes	28 (43.1%)	37 (56.9%)	<0.001
	No	6 (7.1%)	78 (92.9%)	
Dental caries	Yes	19 (32.8%)	39 (67.2%)	0.018
	No	15 (16.5%)	76 (83.5%)	
Malocclusion	Yes	12 (27.9%)	31 (72.1%)	0.346
	No	22 (20.8%)	84 (79.2%)	

during tooth brushing, oral health status, and medication intake were independent factors for dental caries among hearing-impaired students.

When compared with the present study, a low prevalence (7%) of periodontal disease (pocket depth of >3 mm) was reported in India in 2013 among the special needs school students.<sup>25</sup> Likewise, Ameer and collaborators found a low prevalence (9.1%) of periodontal disease among hearing-impaired individuals.<sup>26</sup> A high prevalence of periodontal disease might be due to an individual's low awareness about oral hygiene, communication problem, and lack of oral health care.<sup>26,27</sup> Presumably, it may also be due to financial problems to purchase tooth brushing materials as most of the participants were from a low monthly income family and lack of parents' support during tooth brushing.

The current study found that 7.4% of the hearing-impaired students brushed their teeth at least twice a day. A high frequency was reported in Pakistan where 28.3% of hearing-impaired children brushed their teeth twice a day.<sup>12</sup> Interestingly, Rajabloo et al recently reported that half of (49.2%) of hearing-impaired special need schools in Iran had a habit of brushing their teeth once daily.<sup>28</sup> The low oral hygiene practice in our study subjects might be due to socio-economic problems and/or lack of oral health awareness in our study participants. Our study also found that students who did not have family support while brushing their teeth were 5.1 times more likely to have dental caries than those who did have family support in their daily oral hygiene practice. A study done in India found that supervised oral hygiene

**Table 4** Factors Associated with Dental Caries Among Hearing-Impaired Students in Special Need Schools in Amhara Region, Ethiopia, 2020/21

Variables		Dental Caries		p-value (Chi-Square)
		Yes	No	
Age	7–12 years	8 (29.6%)	19 (70.4%)	0.509
	13–18 years	41 (41.8%)	57 (58.2%)	
	Above 18 years	9 (37.5%)	15 (62.5%)	
Sex	Male	24 (37.5%)	40 (62.5%)	0.757
	Females	34 (40.0%)	34 (60.0%)	
Grade level	1–4	21 (36.8%)	36 (63.2%)	0.112
	5–8	25 (34.7%)	47 (65.3%)	
	9–12	12 (60.0%)	8 (40.0%)	
Religion	Orthodox	39 (36.4%)	68 (63.6%)	0.709
	Catholic	4 (40.0%)	6 (60.0%)	
	Muslim	14 (48.3%)	15 (51.7%)	
	Protestant	1 (33.3%)	2 (66.7%)	
Sugary food intake	Yes	56 (39.4%)	86 (60.6%)	0.565
	No	2 (71.4%)	5 (28.6%)	
Tooth brushing	Yes	47 (39.2%)	73 (60.8%)	0.903
	No	11 (37.9%)	18 (62.1%)	
Frequency of tooth brushing	Some times	18 (34.0%)	35 (66.0%)	0.749
	2–3 times per week	3 (33.3%)	6 (66.7%)	
	Once a day	22 (46.8%)	25 (53.2%)	
	Twice a day	4 (36.4%)	7 (63.6%)	
Parents support during tooth brushing	Yes	18 (60.0%)	12 (40.0%)	0.006
	No	28 (31.8%)	60 (68.2%)	
Mouth breathing	Yes	22 (40.7%)	32 (59.3%)	0.732
	No	36 (37.9%)	59 (62.1%)	
Comorbidity	Yes	11 (64.7%)	6 (35.3%)	0.021
	No	47 (35.6%)	85 (64.4%)	
Medication	Yes	11 (78.6%)	3 (21.4%)	0.001
	No	47 (34.8%)	88 (65.2%)	
Oral health status	Good	14 (25.9%)	40 (74.1%)	0.000
	Fair	15 (31.3%)	33 (68.8%)	
	Poor	29 (61.7%)	18 (38.3%)	

(Continued)

**Table 4** (Continued).

Variables		Dental Caries		p-value (Chi-Square)
		Yes	No	
Mothers educational status	No formal education	29 (40.3%)	43 (59.7%)	0.304
	Read and Write	22 (40.7%)	32 (59.3%)	
	Formal education	3 (20.0%)	12 (80.0%)	
Fathers educational status	No formal education	24 (37.5%)	40 (62.5%)	0.838
	Read and Write	21 (40.4%)	31 (59.6%)	
	Formal education	8 (33.3%)	16 (66.7%)	
Class-2 malocclusion	Yes	11 (50.0%)	11 (50.0%)	0.249
	No	47 (37.0%)	80 (63.0%)	
Bleeding on probing	Yes	36 (55.4%)	29 (44.6%)	0.000
	No	22 (26.2%)	62 (73.8%)	
Sucking habits	Yes	14 (53.8%)	12 (46.2%)	0.086
	No	44 (35.8%)	79 (64.2%)	
Periodontal disease	Ye	19 (55.9%)	15 (44.1%)	0.021
	No	39 (33.9%)	76 (66.1%)	

practice resulted in a marked improvement in oral hygiene and reduced the incidence and severity of oral health problems in hearing-impaired individuals.<sup>29</sup>

Individuals with disabilities have a higher prevalence of dental caries than the non-disabled population.<sup>30,31</sup> The current study found that 38.9% (95% CI: 32.2, 46.9) of the hearing-impaired students had dental caries. Similar results were reported in Brazil<sup>32</sup> (42.9%), India (35.32%),<sup>33</sup> and Rwanda (42.4%).<sup>34</sup> A slightly higher prevalence of dental caries was documented in hearing-impaired children in India (56%),<sup>35</sup> Thailand (53.6%),<sup>36</sup> and China (55.9%).<sup>37</sup> Azfar et al reported that over half (51%) of hearing and speech-impaired children in Pakistan had dental caries.<sup>12</sup> Moreover, a much higher rate of dental caries was reported among hearing-impaired college students in Thailand (82.5%)<sup>36</sup> and Saudi Arabia (82.2%).<sup>38</sup> The difference might be due to socioeconomic variation between the study participants, and the difference in public welfare for the disabled population among countries.<sup>39</sup>

Our study found that 31.5% of hearing-impaired students had poor oral hygiene status. A slightly higher prevalence (40%) of poor oral health status was reported in Iraq among deaf persons.<sup>40</sup> A low prevalence of poor oral health status among hearing-impaired children in Nigeria (22.2%)<sup>41</sup> and Pakistan (5.7%).<sup>12</sup> Moreover, the current study found a significant association between poor oral hygiene status and dental caries. Recently, Vichayanrat et al reported that hearing-impaired college students in Thailand with poor oral hygiene status were 3.26 times more likely to have dental caries (OR 3.26; 95% CI: 1.64–6.45) than those with good oral hygiene status.<sup>36</sup> Likewise, a cross-sectional study among 226 randomly selected children living with disabilities in Rwanda found that participants with good oral hygiene had low dental caries than those with poor oral hygiene status (AOR = 0.296, CI: 0.159; 0.550).<sup>34</sup> The high risk of dental caries in students with poor oral hygiene status might be due to the accumulation of dental plaque, which contains cariogenic bacteria that are involved in the initiation and progression of dental caries. Moreover, limitation in hearing might be contributed to limited understanding, and fear of communicating their oral health needs and procedures.<sup>42</sup>

In the present study, the mean DMFT score among the hearing-impaired school students was  $1.15 \pm 1.654$ . In addition, the mean dmft in the primary dentition was  $0.11 \pm 0.564$ . A slightly higher result was reported in India where

**Table 5** DMFT/dmft Index of Hearing-Impaired Students Attending Special Need Schools in Amhara Region, Ethiopia, 2020/21

Variables		Mean DMFT (Permanent Dentition)	Mean dmft (Primary Dentition)
Age	7–12 years	0.74±1.831	0.63±1.214
	13–18 years	1.16±1.524	0.00±0.000
	Above 18 years	1.54±1.911	0.00±0.000
Sex	Male	1.05±1.474	0.14±0.639
	Females	1.22±1.782	0.09±.503
Grade level	Grade 1–4	1.26±1.996	0.30±0.886
	Grade 5–8	0.85±1.146	0.00±0.000
	Grade 9–12	1.90±1.917	0.00±0.000

the mean DMFT score was 1.77 in hearing impaired and blind young adults.<sup>25</sup> Tahani and Heidary in Iran documented a mean DMFT score of  $3.8 \pm 4.4$  for 4–12 school students.<sup>43</sup> However, a lower result was reported among institutionalized hearing impaired children in India ( $0.37 \pm 0.88$ ).<sup>44</sup> The difference might be due to the difference in lifestyle and oral hygiene practice between the studies. Our findings show that decay is a major component of the mean DMFT with a mean value of  $0.77 \pm 1.258$ , and there is no filled tooth. This showed oral health care service is still a challenge for the hearing-impaired students in the study area.

Moreover, the present study found that sex, age, residence, sugary food intake, and tooth brushing habit did not have a statistically significant association with dental caries. A similar finding was reported in Rwanda, where gender, residency, and toothpaste use have no significant association with dental caries among children with disabilities.<sup>34</sup> On the contrary, studies done in the USA,<sup>45</sup> Rwanda,<sup>34</sup> and Tanzania<sup>46</sup> found a statistically significant association between sugar intake and dental caries. This might be due to the difference in frequency of sugar-rich staff intake.

Our study found a statistically significant association between students' grade level, paternal educational status, dental caries, gingival bleeding on probing with periodontal disease. Subsequently, being grades 1 to 4 increased the prevalence of periodontal disease among hearing-impaired special need students by four-folds as compared with grade 9–12 students. This might be due to a low level of awareness about oral hygiene practice in lower-grade students.

In addition, parental educational status was significantly associated with periodontitis, in such a way that students whose fathers had no formal education were fivefold times more likely to have the periodontal disease compared with those who had formal education. On the contrary, grade 9–12 students were 4.45 times more likely to have dental caries than grade 1–4 students. The high prevalence of dental caries among grade 9–12 students could be attributed to the fact that the prevalence of dental caries increases with age,<sup>47</sup> and the long-term effect of the disability might compromise their oral health status.

In addition, students with occasional parental support during tooth brushing were 4.84 times more likely to have dental caries than those who had frequent support from their parents. A study done in North Showa, Ethiopia, reported that lack of parental support during tooth brushing was significantly associated with dental caries.<sup>48</sup> Besides, a cross-sectional study conducted on 415 preschool children and their caregivers from Curitiba, Brazil, reported a high prevalence of dental caries among special need children whose caregivers had a poor oral health knowledge (PR = 1.35; 95% CI: 1.01–1.79), and those with infrequent parental support during tooth brushing (PR = 1.48; 95% CI: 1.16–1.91).<sup>32</sup> Literature indicates that low parents' or caregivers' knowledge of oral health or poor attitude has been associated with frequent use of sweet foods, bottle feeding during the night, and failure to brush their children due to negligence and frustration.<sup>49,50</sup>

**Table 6** Factors Associated with the Periodontal Disease Among Special Need Students in Amhara Region, Ethiopia, 2021 (n = 149)

Independent Variables		COR (95% CI)	AOR (95% CI)	P-value
Age	7–12 years	10.71 (1.21,94.96)	5.02 (0.47,53.80)	0.183
	13–18 years	1.14 (0.43,3.06)	0.87 (0.28,2.69)	0.815
	Above 18 years			
Sex	Male	0.59 (0.27, 1.28)	0.515 (0.227,1.172)	0.230
	Female			
Grade level	1–4	3.85 (1.14, 12.93)	3.94 (1.16, 13.38)	0.001
	5–8	1.40 (0.49, 4.02)	1.39 (0.48, 4.02)	0.586
	9–12			
Sugary food intake	Yes	2.69 (0.57, 12.64)	2.99 (0.59, 14.97)	0.184
	No			
Parents support during tooth brushing	Never	0.60 (0.07, 5.42)	1.63 (0.14, 18.64)	0.694
	Sometimes	1.40 (0.12, 16.46)	1.92 (0.15, 24.41)	0.615
	Always			
Comorbidity	Yes	2.02 (0.89, 4.56)	1.19 (0.07, 19.77)	0.905
	No			
Fathers educational status	No formal education	3.06 (1.01, 9.21)	4.98 (1.00, 24.63)	0.049
	Read and Write	1.36 (0.48, 3.87)	2.78 (0.60, 12.89)	0.190
	Formal education			
Class-2 malocclusion	Yes	0.28 (0.11, 0.72)	0.41 (0.14, 1.24)	0.116
	No			
Dental caries	Ye	2.47 (1.13, 5.38)	2.51 (1.08, 5.08)	0.032
	No			
Medication	Yes	1.09 (0.29, 4.17)	0.66 (0.04, 11.50)	0.772
	No			
Mouth breather	Yes	3.34 (1.29, 8.70)	2.21 (0.69, 7.09)	0.183
	No			
Bleeding on probing	Yes	0.10 (0.04, 0.27)	9.892 (3.687, 26.537)	<0.001
	No			
Years lived with disability	0.89	0.89 (0.80, 0.99)	0.96 (0.85, 1.08)	0.465

**Abbreviations:** COR, crude odds ratio; AOD, adjusted odds ratio; CI, confidence interval.

## Strength and Limitation of the Study

This is the first study on the oral health status of hearing-impaired school students in Ethiopia. The investigators faced some challenges during data collection. The first challenge was the COVID-19 pandemic. Due to this pandemic, some hearing-impaired students withdraw from their education due to a lack of support from their friends and the community,

**Table 7** Factors Associated with Dental Caries Among Special Need Students in Amhara Region, Ethiopia, 2021 (n = 149)

Independent Variables		COR (95% CI)	AOR (95% CI)	P-value
Grade level	1–4	1	1	
	5–8	0.91 (0.44, 1.88)	1.29 (0.529, 3.15)	0.575
	9–12	2.57 (0.91, 7.30)	4.45 (1.10, 21.28)	0.037
Parents support during tooth brushing	Yes	1	1	
	No	3.21 (1.36, 7.57)	5.10 (1.89, 13.76)	0.001
		2.14 (0.41, 11.29)	3.72 (0.66, 20.84)	0.135
Comorbidity	Yes	3.32 (1.15, 9.54)	3.12 (0.89, 10.89)	0.075
	No	1	1	
Oral health status	Good	1	1	
	Fair	1.29 (0.55, 3.08)	1.31 (0.49, 3.46)	0.587
	Poor	4.60 (1.98, 10.73)	8.07 (2.49, 26.18)	0.001
Class-2 malocclusion	Yes	1.70 (0.69, 4.23)	0.83 (0.21, 3.31)	0.796
	No	1	1	
Sucking habits	Yes	2.09 (0.89, 4.91)	1.52 (0.54, 4.27)	0.424
	No	1	1	
Periodontal disease	Yes	2.47 (1.13, 5.38)	0.83 (0.29, 2.38)	0.726
	No	1	1	
Medication	Yes	6.87 (1.83, 25.82)	9.26 (2.17, 39.45)	0.003
	No	1	1	

**Abbreviations:** COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval.

as social distancing and face masking become mandatory. Due to the impairment, some of the students did not express their problems confidentially, and the nature of the self-reported oral health behavior has its limitation. Finally, due to the nature of the cross-sectional study, a conclusion about the causal relationship between the independent factors and the dependent factors cannot be drawn.

Despite these challenges, the current study, which was carried out extensively by multi-professionals, was successful in determining the prevalence of periodontal disease and dental caries among hearing-impaired students attending special need schools in the Amhara region, Ethiopia.

## Conclusion and Recommendation

In the present study, a significant amount of special needs school students had periodontal disease and dental caries. School oral health programs and caregivers assisted oral hygiene practice is essential to combat oral health problems in hearing-impaired students. Moreover, a nationwide prospective study with a large sample size will be required to reflect the oral health status of hearing-impaired individuals in the country.

## Abbreviations

DMFT, Decayed, Missed, and filled permanent teeth; dmft, decayed, missed, and filled primary teeth; SD, standard deviation; WHO, World Health Organization; COR, crude odds ratio; AOR, Adjusted odds ratio.

## Data Sharing Statement

All the data used for this study are available on request from the corresponding author (teferaden@gmail.com).

## Ethics Approval and Consent to Participate

Ethical approval was obtained from the University of Gondar, institutional review board (Ref. No: V/P/RCS/05/541/2020). All research participants, parents, and legal guardians were properly informed about the nature of the study and the benefits of taking part in it. Before the study began, parents/legal guardians and special need schools provided written approval. The study was done in accordance with the declaration of Helsinki (Code of Ethics of the World Medical Association).

## Consent for Publication

Consent for publication was obtained by all authors.

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## Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; gave final approval for the version to be published, and agreed to be accountable for all aspects of the work.

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## Disclosure

The authors report no conflicts of interest in this work.

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