ORIGINAL ARTICLE

Comparison of dental caries status among visually impaired children based on risk factors: a cross-sectional study

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Received: 1 October 2024
Revised: 15 November 2024
Accepted: 20 March 2025
Published: 31 March 2025
DOI: 10.24198/pjd.vol37no1.58457

p-ISSN 1979-0201
e-ISSN 2549-6212

Citation:
Mayasari, Y.Darwita, RR, Setiawati, F. Novrina, H. Comparison of dental caries status among visually impaired children based on risk factors: a cross-sectional study. Padj J Dent, March.2025; 37(1): 9-17.

ABSTRACT

Introduction: According to the World Health Organization (WHO), over 2.2 billion people globally are affected by visual impairment, which significantly affects their dental and oral hygiene behaviors. Consequently, the prevalence of dental caries among visually impaired children remains high, primarily due to challenges in maintaining proper hygiene. This study aims to analyze differences in dental caries status among visually impaired children based on risk factors. **Method:** The study procedures were carried out using a cross-sectional design. The sample population comprised 94 students at the National Special School (SLB) A Pembina, who were selected using a purposive sampling method. Data collection was conducted in 2 stages. The first stage involved gathering information on risk factors through interviews regarding toothache experience, visits to the dentist, tooth brushing frequency, and fluoride toothpaste use. The second stage consisted of dental and oral examinations conducted by five trained investigators. **Results:** The overall prevalence of dental caries among visually impaired children was 42.6%, with a deft/DMFT index of 1.05/0.8. In addition, there were significant differences in dental caries status based on risk factors, such as toothache experience (p=0.001, ≤0.05, Pearson's Chi-square, 95% CI), visits to the dentist (p=0.000, ≤0.05, Pearson's Chi-square, 95% CI), tooth brushing frequency (p=0.000, ≤0.05, Pearson's Chi-square, 95% CI), and fluoride toothpaste use (p=0.000, ≤0.05, Pearson's Chi-square, 95% CI). **Conclusion:** Based on these results, the prevalence of dental caries among visually impaired children is relatively high. Caries experience is significantly associated with toothache experience, visits to the dentist, tooth brushing frequency, and fluoride toothpaste use.

KEYWORDS

Visually impaired, dental caries, risk factors

INTRODUCTION

The term "visually impaired" refers to individuals who experience significant disturbances in their sense of sight.[1–3] The International Classification of Diseases (ICD-11) categorizes visual impairment into six levels: near-to-normal vision (vision acuity ≥20/70), moderate visual impairment (20/ 200 ≤ vision acuity ≤20/70), severe visual impairment (20/400 ≤ vision acuity ≤ 20/200), extremely severe visual impairment (20/ 1,200 ≤ vision acuity ≤ 20/400), near blindness (vision acuity ≤ 20/ 1,200), and absolute blindness.[4]

In addition, visually impaired can be classified as total and low vision based on the severity of impairment.[5] Several studies have shown that visual impairment can be caused by congenital or physiological factors, developing with age.[6] Globally, there were 596 million people with vision impairment in 2020, of whom 43 million were blind. Ninety percent of these individuals reside in low- and middle-income countries (LMICs).[7] According to the World Health Organization (WHO), over 2.2 billion people worldwide have been visually impaired; among these, 36 million are visually impaired, and at least 1 billion, or nearly half of all cases, could

be prevented or remain untreated.[1] Data from the 2015 Indonesian Intercensal Population Survey (SUPAS) revealed that 8.56% of the population aged 10 years and above experienced functional impairment, with the largest percentage related to vision (6.36%).

Blindness and visual impairment are associated with higher mortality rates as well as reduced economic, educational, and employment opportunities. Additionally, vision impairment increases comorbidities, including cognitive impairment and fall risk in older adults, and significantly diminishes quality of life.[8,9]

In terms of oral health, studies suggest that visually impaired children have poorer oral health status compared to sighted children. Individuals with visual impairment are unable to visualize the plaque deposits on the tooth surface, hence leading to a poor understanding of the importance of oral hygiene, which results in the development of dental caries as well as inflammatory diseases of the periodontium and loss of tooth structure.[10,11] The detection and diagnosis of caries at the initial (non-cavitated) and moderate (enamel) levels of severity is fundamental to achieving and maintaining good oral health and preventing oral diseases.[4,12]

Several studies have reported that visually impaired individuals experience worse health and oral hygiene problems compared to those with normal vision.[13,14] John JR, et al. (2017) in Chennai City, Tamil Nadu, reported that moderate oral hygiene status and inadequate dental health knowledge regarding proper tooth brushing techniques were the major contributors to the increased prevalence of dental caries.[5] The oral hygiene challenges of children and adolescents with disabilities pose difficulties not only for the individuals themselves but also for their teachers, parents, and guardians. Children living in family homes brush their teeth with the help of their parents or relatives, while children living in dormitories are assisted by the teachers and caretakers employed there.[13,15]

Recent studies have demonstrated that blind children can maintain an acceptable level of oral hygiene when taught using special customized methods such as the multisensory approach, which has proven more effective than the unisensory mode.[16] This highlights the need for specific programs to prevent dental caries in this community by considering the risk factors related to dental caries. Therefore, this study aims to analyze differences in dental caries status among visually impaired children based on risk factors.

METHODS

This analytical study was conducted using a cross-sectional design on February 27, 2024, at the National Special School (SLB) A Pembina Lebak Bulus, South Jakarta. The sample population comprised 94 students of the National SLB A Pembina, Jakarta, who were selected using the purposive sampling method based on predetermined inclusion and exclusion criteria. The participants were between 6 and 17 years old. Inclusion criteria were: students of the National SLB A Pembina, willingness to participate, and parental consent. Exclusion criteria were: students who provided informed consent but did not complete all study stages. Oral examinations and questionnaires were administered after written informed consent was obtained from the parents.

This study was conducted in 2 stages. The first stage involved administering a questionnaire using an online form equipped with touch and sound vibration technology, which contained four questions related to risk factors. The second stage was dental and oral examinations using the WHO Annex examination form. The examiners were 5 trained investigators who conducted the agreement test. Prior to the survey, five trained dentists were calibrated in recording dental caries in 15 students aged 6 to 12 years in order to standardize the clinical criteria and minimize inter-examiner variability. The Cohen's kappa values of the 5 dentists

were 0.80, 0.82, 0.82, 0.90, and 0.90, with no evidence of systematic error ($p>0.5$, Wilcoxon test).

The World Health Organization (WHO) guidelines were adopted as the diagnostic criteria for dental caries, defining a carious tooth as a cavity into the surface of dentine.[17] All participants' teeth were examined using a ball-ended WHO probe. Dental caries were assessed using the DMFT index for the permanent dentition and the deft index for the primary dentition. The prevalence of dental caries was calculated by assigning code 0 to subjects with a DMFT/deft score of 0 (no dental caries) and code 1 to subjects with a score ≥ 1 (dental caries). In addition, questions related to general information, such as gender, mother's education level, and visual impairment status, were obtained from student health records.

Data were analyzed using a computer-based statistical application. Univariate tests were used to determine the frequency distribution and proportion of each dental caries risk variable, while bivariate tests (Chi-square test) were used to determine differences in dental caries status of respondents based on dental caries risk variables, with a significance limit of $p \leq 0.05$.[18]

RESULTS

This study included 94 students from the National SLB A Pembina, South Jakarta, with ages ranging from 6 to 17 years. Of these students, 56.4% were male, and the majority (72.3%) were classified as totally visually impaired. Most of the students' mothers (43.6%) had completed senior high school as their highest level of education (Table 1).

Table 1. Frequency Distribution Based on General Characteristic of Respondents (n=94).

Variable	N	%
Gender		
Male	53	56.4
Female	41	43.6
Visually Impaired Status		
Low vision	26	27.7
Total visually impaired	68	72.3
Mother's Last Education		
Elementary School	17	18.1
Junior High School	11	11.7
Senior High School	41	43.6
University (Diploma, Bachelor's, Master's, Doctorate)	25	26.6

Based on the dental and oral examination results, 40 students (42.6%) had dental caries, while 54 (57.4%) did not (Table 2).

Table 2. Prevalence of Dental Caries in Visually Impaired Students (n=94).

Variable	n	%
Dental Caries	40	42.6
Without Dental Caries	54	57.4
	94	100

In addition, the mean and standard deviation of the DMFT and deft scores were 0.8 ± 1.64 and 1.05 ± 2.567, respectively (Table 3).

Table 3. Mean and Standard Deviation of Dental Caries (n=94)

Variable	Mean	SD
DMFT index	0.8	1.64
deft index	1.05	2.567

The study on differences in dental caries status based on various risk factors found no significant associations between dental caries status and gender, age,

parents' last education, visually impaired status, perception of dental and gum conditions, toothache experience, tooth brushing frequency, tooth cleaning aids, fluoride toothpaste use, experience of dental and oral problems, sweet food and drink habits, tobacco use, oral hygiene status, or crowding of upper and lower jaw teeth ($p \geq 0.05$). However, significant differences were observed in dental caries status with respect to visits to the dentist and the need for immediate treatment ($p \leq 0.05$).

Table 4 presents data on differences in dental caries status among visually impaired children based on four risk factors. Regarding toothache experience, among children who had never experienced toothache, 15 (23.8%) had dental caries, while 48 (76.2%) did not. In contrast, among those who had experienced toothache, 16 (51.6%) suffered from dental caries, while 15 (48.4%) did not. A significant difference in dental caries status was observed based on toothache experience (p-value = 0.001). For visits to the dentist, among children who had never visited the dentist, 7 out of 32 children (21.9%) suffered from dental caries, while 25 (78.1%) did not. Among those who visited the dentist less than 6 months ago, 1 out of 8 children (12.5%) suffered from dental caries, while 7 (87.5%) did not. Meanwhile, among those who visited the dentist more than 1 year ago, 23 out of 54 children (42.6%) suffered from dental caries, while 31 (57.4%) did not. The differences in dental caries status based on dentist visits were also significant (p-value = 0.000). Concerning tooth brushing frequency, among children who brushed their teeth once a day, 7 out of 21 children (33.3%) had dental caries, while 14 (66.7%) did not. Among those who brushed their teeth twice a day, 23 out of 65 children (35.4%) had dental caries and 42 (64.6%) did not. In the group of children who brushed their teeth more than twice a day, 1 out of 8 children (12.5%) had dental caries and 7 (87.5%) did not. There was a significant difference between the group of children who had and did not have dental caries based on the risk factor of tooth brushing frequency (p-value=0.000). Finally, for fluoride toothpaste use, among children who were unsure whether their toothpaste contained fluoride, 1 out of 5 children (20%) had dental caries and 4 (80%) did not. Among those who used fluoride toothpaste, 30 of 89 children (33.7%) experienced dental caries, while 59 (66.3%) did not. There was a significant difference (p-value=0.000) between the group of children who had and did not have dental caries based on the risk factor of fluoride toothpaste use (Table 4).

Table 4. Comparison of Dental Caries Status Based on Risk Factors (n=94)

Variable	n	Dental Caries Status		p-value
		Dental caries n (%)	No dental caries n (%)	
Toothache Experience (in the past 12 months)				
Never	63	15 (23.8%)	48 (76.2%)	0.001*
Ever	31	16 (51.6%)	15(48.4%)	
Visits to the Dentist (in the past 12 months)				
Never	32	7 (21.9%)	25 (78.1%)	0.000*
Less than 6 months ago	8	1 (12.5%)	7 (87.5%)	
More than 1 year ago	54	23 (42.59%)	31 (57.4%)	
Tooth Brushing Frequency				
Once a day	21	7 (33.3%)	14 (66.7%)	0.000*
Twice a day	65	23 (35.4%)	42(64.6%)	
More than twice a day	8	1 (12.5)	7(87.5%)	
Fluoride Toothpaste Use				
No	5	1 (20%)	4 (80%)	0.000*
Yes	89	30(33.7%)	59 (66.3)	

*Significant, Chi-square test, $p \leq 0.05$, CI = 95%

DISCUSSION

This analytical cross-sectional study, conducted among 94 children at the National Special School (SLB) A Pembina, South Jakarta, aimed to determine differences in dental caries status among visually impaired children based on various risk factors. The socio-demographic data revealed that the majority of participants were male, had total visual impairment, and had mothers with a senior high school education (Table 1). The dental examinations indicated that while a larger portion of the children were without dental caries, a substantial 42.6% of the children did exhibit dental caries (Table 2). Previous research has indicated that overall caries experience in normal healthy children was found to be marginally higher than in visually impaired children namely 2.72 and 2.22, respectively; however, the oral hygiene status was found to be better in normal healthy children than in visually impaired children.[19]Various studies were conducted to assess the prevalence of dental caries in visually impaired children, including Mustafa et al. (2018) in Riyadh, who reported that the prevalence of dental caries in visually impaired children aged 6-15 years was 32.5%.[20] In addition, Liu L, et al. (2019) stated that 78.64% of visually impaired children in Northeast China experienced dental caries.[21] Visually impaired children are at greater risk of poor oral hygiene and have restricted access to oral care compared to normal healthy children. Blindness could limit such children from actively maintaining optimal oral hygiene, highlighting the need for targeted awareness campaigns, proper oral health guidance, and regular screenings to avoid complicated treatment needs for these children. Family awareness of the importance of oral health is a critical factor in improving the oral health of children with disabilities.[19]

Based on the calculation of the mean dental caries experience, the DMFT and deft indices obtained were 0.8 ± 1.64 and 1.05 ± 2.567, respectively (Table 3), and based on the WHO criteria, these results fell into the "very low" category. The DMFT (Decayed, Missing, Filled Teeth) index was used to assess oral health status in various populations, including visually impaired communities. Previous studies have shown varying results regarding the prevalence of dental caries among visually impaired individuals. In the study conducted in New Delhi, India, the prevalence of dental caries in visually impaired children and adults aged 6-25 years was 50.84% in the permanent dentition group.[22] Similarly, in Chennai, India, the prevalence of dental caries in permanent teeth among visually impaired children was reported as 40%.[23] Notably, the same study reported that hearing-impaired children had significantly higher deft (decayed, extracted, filled teeth) scores in primary teeth compared to visually impaired children. In conclusion, the DMFT index among visually impaired individuals varied across populations and age groups. Factors such as age, gender, and socioeconomic status could influence the prevalence and severity of dental caries in this community. These findings highlight the necessity for targeted oral health interventions and preventive measures aimed at improving the oral health status of visually impaired individuals.

The analysis of differences in dental caries status on various risk factors revealed significant differences between groups with and without dental caries (Table 4). Regarding toothache experience, there was a significant difference between the groups with and without dental caries. While limited literature directly addresses the relationship between toothache experience and dental caries status in visually impaired children, relevant insights can be gleaned from Sharififard et al. (2020), which examined oral health among visually impaired adolescents. This study found that dental caries (DMFT) was significantly associated with toothache (P = 0.003, OR = 3.70, 95% CI: 1.54–9.09) among visually impaired adolescents.[24] This suggested that experiencing toothache was associated with a higher likelihood of developing dental caries in this population. Furthermore, the study also showed that visually impaired adolescents were able to accurately assess their oral health status, despite being unable to visually examine their

teeth. This study noted that dental health perception was significantly associated with DMFT (P = 0.005, OR = 3.06, 95% CI: 1.40–6.67) and oral hygiene status (OHI-S) (P = 0.006, OR = 2.87, 95% CI: 1.35–6.12).[24] A relationship between toothache experience and dental caries status in visually impaired adolescents can be inferred from this study. The ability of this visually impaired group to see their oral health status accurately, even without visual cues, suggested that self-reported toothache could be an important indicator of dental caries in this population. However, further research focusing specifically on visually impaired children is needed to draw definitive conclusions regarding this relationship.

Regarding the risk factor of regular dental visits, a significant difference in dental caries prevalence was observed between groups with and without dental caries in visually impaired children (Table 4). Several studies have highlighted the importance of regular visits to the dentist in preventing and treating dental and oral health problems in this population. Additionally, the purpose of regular visits to the dentist is to control and detect early signs of dental caries. When visits to the dentist are not performed routinely, dental caries prevention cannot be carried out as early as possible. A preliminary study conducted in Jakarta, Indonesia, found that dental visits significantly influenced dental caries status in visually impaired children aged 6-12 years (p = 0.029, 95% CI). [25] This study emphasized that regular visits to the dentist and knowing the need for treatment are crucial factors in preventing dental caries. However, some reports showed gaps in access to dental care for visually impaired children. Studies in Gulbarga, India, revealed a lack of dental care in visually impaired children, with a dental caries prevalence of 49.3%.[22] Similarly, Zhou N et al. (2020) in Hong Kong stated that the most common barriers were that dental care was too expensive, children did not like dental care, children were uncooperative, children were too young to go to the dentist, children were afraid of the dentist, and parents were anxious when taking their children to the dentist.[26] In conclusion, regular dental visits play a vital role in reducing the risk of dental caries in visually impaired children. Nonetheless, continued efforts are necessary to improve access and quality of dental care for this population.

Differences in caries status were also found based on tooth brushing frequency (Table 4). Various studies have found a significant relationship between tooth brushing habits and oral health status, including dental caries, in visually impaired children. Reports on institutionalized visually impaired children aged 6-14 years showed that a specially designed oral health education program, including tooth brushing instructions, significantly improved their oral hygiene status and reduced dental caries (Shetty et al., 2013). Furthermore, a study reported that 70.2% of visually impaired children aged 7-11 years brushed their teeth daily, with a significant inverse correlation between daily brushing and the Simple Oral Hygiene Index (OHI-S).[2] This suggested that regular tooth brushing was associated with better oral hygiene in these children. In conclusion, although the specific relationship between tooth brushing frequency and dental caries status in visually impaired children was not explicitly stated in the presented study, evidence suggested that proper tooth brushing habits and oral health education could significantly improve oral hygiene and potentially reduce the risk of dental caries in this population.[22,23,27] However, more targeted reports are needed to determine a direct correlation between tooth brushing frequency and caries status in visually impaired children.

Differences in dental caries status were also observed based on fluoride toothpaste use (Table 4). The use of fluoride combined with proper tooth brushing techniques is widely regarded as the most prevalent method of maintaining oral hygiene.[28] Fluoride is a compound that decreases the solubility of dental enamel when incorporated into the hydroxyapatite crystal, thereby lowering its solubility and the critical pH for dissolution. Fluoride also exerts its anticariogenic action by being in solution and changing the saturation characteristics with respect to the tooth mineral in the biofilm fluid at the tooth surface and within the tooth mineral

by enhancing remineralization and decreasing demineralization and, when at a sufficient concentration, by inhibiting bacterial metabolism of carbohydrates.[29]

Although fluoride toothpaste improves overall oral hygiene and reduces cariogenic bacteria, it did not have a direct influence on caries in this population during the study period. The importance of fluoride toothpaste is further supported by studies in the general population.[30–32] For example, a report with a large sample size in China found that adolescents who used fluoride toothpaste twice daily had a lower chance of developing dental caries.[33] Furthermore, awareness of fluoride's benefits is strongly associated with better oral hygiene practices. In conclusion, although a direct influence on caries status was not immediately apparent, fluoride toothpaste use appeared to improve overall oral hygiene and reduce cariogenic bacteria in visually impaired children. This, combined with appropriate oral health education and regular dental care, could contribute to better long-term oral health outcomes for this population. Efforts to maintain oral health in visually impaired children can be made through the School Health Program (UKS), specifically the School Dental Health Program (UKGS). UKGS is one of the dental health service efforts in schools that provides promotive, preventive, and curative services, including annual dental and oral examinations.34–36 SLB is a UKS target that has not been optimally addressed. Most SLBs in Indonesia currently do not have adequate UKS health service facilities and infrastructure. The implementation of UKS in SLB is also far behind compared to the implementation of UKS in public schools. For example, at the National SLB A Pembina as the study location, UKS activities were interrupted during the pandemic. Studies such as those by Gerung AY, Wowor VNS, and Mintjelungan CN (2021) have demonstrated the positive impact of UKGS on improving dental and oral health behaviors among elementary school students.[34,35]

One key limitation of this study is that it only provides insight into the dental caries status of a relatively small visually impaired population. While our data provide baseline epidemiological aspects of dental caries status for visually impaired populations, it is recommended that future studies include larger samples and a control group of sighted children.

CONCLUSION

This study identifies four significant risk factors influencing dental caries in visually impaired children: toothache experience, dental visit frequency, tooth brushing habits, and fluoride toothpaste use. These findings demonstrate that these factors are significantly associated with the risk of dental caries in visually impaired children. The results could serve as the basis for targeted dental and oral disease prevention programs, specifically designed for visually impaired children.

Author Contributions: This research article is the result of collaborative work by several authors. M.Y and D.R.R conceptualized the study and developed the methodology. M.Y.,D.R., and S.F contributed to the validation and formal analysis of the data. M.Y. curated the data and wrote the original draft of the paper while D.R.R., S.F., and N.H. reviewed and edited it. S.F. also contributed to the visualization of the data. D.R.R., supervised the research project and was responsible for the project administration and funding acquisition. All authors have read and approved the final version of the manuscript

Funding: This research was funded by the PUTI grant, Universitas Indonesia (No.NKB-252/UN2.RST/HKP.05.00/2022).

Institutional Review Board Statement: The research was conducted in accordance with ethical principles and was approved by the Institutional Review Board of the Dental Study Ethics Commission (KEPKG) of the Faculty of Dentistry, University of Indonesia Number: 25/Ethical Approval/FKGUI/VI/2023.

Informed Consent Statement: Written informed consent was obtained from all study participants prior to their inclusion in the research. The purpose and procedures of the study were explained in detail to the participants, and they were given the opportunity to ask questions and clarify any doubts they may have had. Participants were informed that their participation was voluntary and that they

could withdraw from the study at any time without any consequences participating patients who can be identified (including by the patients themselves).

Data Availability Statement: The data that support the findings of this study are available upon request from the corresponding author. Restrictions apply to the availability of these data, which were used under license for this study and are not publicly available. However, data are available from the authors upon reasonable request and with the permission of the data provider.

Conflicts of Interest: The authors declare no conflicts of interest related to this study.

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