

Association of Age and Sex with Dental Caries among Elementary School Children in a Primary Health Care Setting in Semarang, Indonesia

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ABSTRACT

Dental caries remains an unresolved public health challenge in elementary school-aged children and may compromise nutritional health, educational attainment, and overall life quality. This study explored the influence of age and sex on the occurrence of dental caries among elementary school-aged children within the service area of Kedungmundu Primary Health Center, Semarang. A quantitative cross-sectional design was applied using secondary data obtained from routine dental health examinations involving 9,323 students. The entire study population was analyzed using a total sampling strategy, with univariate statistical procedures and Chi-square analysis applied to the data. The findings revealed that the prevalence of dental caries was comparable between boys and girls, with no statistically significant association observed between sex and caries occurrence ($p = 0.872$). Conversely, age demonstrated a significant relationship with dental caries, as younger children exhibited a higher prevalence compared to adolescents (PR = 0.536; 95% CI: 0.494–0.583; $p < 0.001$). These results indicate that age plays a more influential role than sex in determining dental caries occurrence among school-aged children. Strengthening early preventive and promotive oral health efforts targeting younger age groups is therefore essential to reduce the burden of dental caries in school settings.

Keywords: *dental caries, elementary school children, age, sex*

Abstrak (Bahasa Indonesia)

Karies gigi pada anak usia sekolah masih menjadi persoalan kesehatan masyarakat yang memerlukan perhatian serius karena berpotensi memengaruhi kondisi gizi, kemampuan akademik, dan kesejahteraan anak. Penelitian ini dilakukan untuk mengevaluasi hubungan faktor usia dan jenis kelamin dengan kejadian karies gigi pada anak sekolah dasar di wilayah kerja Puskesmas Kedungmundu, Kota Semarang. Penelitian menggunakan pendekatan kuantitatif dengan desain potong lintang berbasis data sekunder yang berasal dari hasil pemeriksaan kesehatan gigi sebanyak 9.323 siswa. Seluruh populasi penelitian dianalisis menggunakan metode total sampling, dengan pengujian data dilakukan melalui analisis deskriptif dan uji Chi-square. Hasil analisa menggambarkan bahwa jenis kelamin tidak berhubungan dengan kejadian karies gigi ($p = 0,872$). Sebaliknya, usia terbukti memiliki hubungan yang signifikan dengan kejadian karies, di mana kelompok anak usia lebih muda menunjukkan prevalensi karies yang lebih tinggi dibandingkan kelompok usia remaja (PR = 0,536; IK 95%: 0,494–0,583; $p < 0,001$). Temuan ini menegaskan bahwa usia merupakan determinan penting dalam kejadian karies gigi pada anak sekolah dasar, sehingga strategi promotif dan preventif kesehatan gigi perlu difokuskan sejak tahap usia dini.

Kata kunci: *karies gigi, anak SD, usia, jenis kelamin*

INTRODUCTION

Oral and dental health issues continue to pose a significant public health challenge globally, although their impact is often overlooked, particularly among school-aged children. Disorders of the teeth and oral cavity can affect individuals at all stages of life and involve both primary and permanent dentition. In 2025, the World Health Organization (WHO) estimated that nearly 2 billion people worldwide experienced dental caries in permanent teeth, while approximately 510 million children were affected by caries in primary teeth (WHO 2025a). Dental caries is recognized as a progressive condition affecting the hard tissues of the teeth, resulting from bacterial activity in dental plaque that converts fermentable carbohydrates into acids, ultimately causing enamel and dentin demineralization (Rathee & Sapra 2023). If not properly managed, dental caries may progress to more severe conditions, including pain, infection, impaired chewing ability, compromised nutritional status, and reduced learning capacity in children.

The distribution of oral disease burden varies substantially across regions. Countries in the African and Eastern Mediterranean regions have reported the

greatest increases in prevalence and disability-adjusted life years (DALYs) related to oral conditions, largely due to limited preventive measures and inadequate access to dental care services. In contrast, Europe has shown relatively stable trends and remains the only WHO region demonstrating a reduction in untreated dental caries in both primary and permanent teeth following age standardization (Bernabe et al. 2025). These regional differences underscore persistent challenges in caries prevention associated with behavioral patterns, environmental factors, and unequal access to oral health care. To address these challenges, WHO has introduced several global initiatives, including the Global Oral Health Action Plan and the Global Strategy on Oral Health, which prioritize preventive and promotive approaches, early oral health education, integration of oral health services into primary health care, and reinforcement of school-based oral health programs (WHO 2025b).

In the Indonesian context, dental caries remains a major public health concern. Findings from the Indonesian Health Survey (SKI) 2023 revealed that 56.9% of

individuals aged three years and above experienced oral and dental health problems within the previous year, while only 11.2% obtained professional dental treatment (Pemerintah Republik Indonesia 2025). This imbalance indicates a considerable unmet demand for oral health services, particularly among children who are in critical phases of dental development. At the provincial level, Central Java continues to report high levels of dental caries among children. Data from SKI 2023 show that the prevalence of damaged, decayed, or painful teeth reached 37.4% among children aged 3–4 years, increased to 49.9% in the 5–9-year age group, and remained substantial at 37.2% among those aged 10–14 years (Pemerintah Republik Indonesia 2025). These patterns suggest that dental caries often develops early in life and persists due to insufficient preventive and curative efforts.

Similar conditions are observed in Semarang City. In 2025, the Semarang City Health Office reported that dental caries constituted the most frequently reported oral health problem among school-aged children, accounting for 8,262 cases or 36.40% of all reported cases (Dinas Komunikasi dan Informatika Provinsi Jawa Tengah 2025). Elementary school children are particularly susceptible to dental caries due to behavioral

factors, including high consumption of sugary foods and beverages, inadequate toothbrushing practices, and limited utilization of dental health services.

Age has consistently been identified as a key factor influencing dental caries occurrence in children. Evidence suggests that younger children are more vulnerable to caries, particularly in primary teeth, due to thinner enamel, limited ability to perform oral self-care, and insufficient parental supervision (Moca et al. 2021). Conversely, caries prevalence may decline as children grow older and develop improved oral hygiene behaviors, greater awareness, and stronger permanent teeth. In addition to age, sex has also been examined as a potential determinant of dental caries. While some studies have reported higher prevalence among boys, often associated with poorer oral hygiene habits and higher sugar intake, other studies have found no statistically significant relationship between sex and caries occurrence (Suzana, Gustina & Rahutami 2024). These mixed findings highlight the importance of generating context-specific evidence, particularly in low- and middle-income countries.

Although previous studies have explored factors associated with dental caries, evidence focusing on the combined role of

age and sex among elementary school children in Indonesia remains limited, especially studies utilizing large-scale routine dental examination data from primary health care settings. A comprehensive understanding of these demographic factors is crucial for developing targeted, evidence-based oral health promotion and prevention strategies in schools and community health services. Therefore, this study aimed to examine the association between age and sex and the occurrence of dental caries among elementary school children in the working area of Kedungmundu Primary Health Center, Semarang, to support more effective and age-appropriate oral health interventions.

METHOD

This research adopted a quantitative methodology with a cross-sectional design. Secondary data were obtained from routine dental health examination records collected by Kedungmundu Primary Health Center in Semarang. The study population comprised all elementary school students within the health center's service area who participated in dental screening during the designated reporting period. From the available records, data from 9,323 students were eligible and

included in the analysis. A total sampling approach was implemented, ensuring that all records meeting the data completeness criteria were analyzed.

Dental caries status served as the outcome variable, while age and sex were treated as explanatory variables. Caries status was determined based on clinical examination findings recorded by trained health personnel and classified as either present or absent. Age was categorized into children and adolescents according to developmental stages, and sex was categorized as male or female. The data were extracted from standardized dental examination forms routinely applied in school-based oral health services and subsequently compiled in the health center's reporting database.

Prior to analysis, the dataset underwent systematic data cleaning, coding, and validation procedures to ensure accuracy and internal consistency. Descriptive analysis was conducted to summarize the distribution of dental caries across age and sex categories. Analytical assessment of associations between the independent variables and dental caries occurrence was performed using the Chi-square test. The magnitude of associations was reported as prevalence ratios (PR) with corresponding 95% confidence intervals, and statistical

significance was established at a p-value threshold of <0.05. All analyses were carried out using appropriate statistical software.

The study adhered to ethical standards for research involving human data. Ethical approval was granted by the appropriate institutional ethics committee, and authorization to access and utilize secondary data was obtained from Kedungmundu Primary Health Center. To protect participant privacy, all data were anonymized and analyzed without personal identifiers.

RESULTS AND DISCUSSION

Results

Table 1. Distribution of Dental Caries by Respondent Characteristics

No	Respondent Characteristics	Dental Caries Present		Dental Caries Absent	
		n	%	n	%
1.	Sex				
	Male	2,554	53.3	2,224	46.5
	Female	2,438	53.6	2,107	46.4
2.	Age Group				
	Children	3,146	60.3	2,068	39.7
	Adolescents	1,846	44.9	2,263	55.1

The analysis included data from 9,323 elementary school children who underwent routine dental health examinations in the

working area of Kedungmundu Primary Health Center. Overall, dental caries was highly prevalent among the study population. Based on sex distribution, 53.3% of boys and 53.6% of girls were identified as having dental caries, indicating a nearly equal proportion between male and female students. In terms of age groups, a higher proportion of dental caries was observed among children compared to adolescents, with 60.3% of children experiencing caries versus 44.9% among adolescents.

Table 2. Association between Sex and Age with Dental Caries Occurrence

Variable	Dental Caries Present		Dental Caries Absent		PR (95% CI)	p-value
	N	%	n	%		
Sex						
Male	2,554	53.3	2,224	46.5	0.992 (0.915–1.077)	0.872
	2,438	53.6	2,107	46.4		
Age Group						
Children	3,146	60.3	2,068	39.7	0.536 (0.494–0.583)	<0.001
	1,846	44.9	2,263	55.1		
Adolescents	1,846	44.9	2,263	55.1	Refere nce	
	3,146	60.3	2,068	39.7		

Bivariate analysis using the Chi-square test showed no statistically significant

association between sex and dental caries occurrence (PR = 0.992; 95% CI: 0.915–1.077; $p = 0.872$). This finding indicates that the likelihood of experiencing dental caries was similar for boys and girls. In contrast, age was significantly associated with dental caries occurrence. Children had a significantly higher prevalence of dental caries compared to adolescents (PR = 0.536; 95% CI: 0.494–0.583; $p < 0.001$), suggesting that younger age groups are more vulnerable to dental caries.

Discussion

The findings of this study demonstrate that age is significantly associated with dental caries among elementary school children, whereas sex does not show a meaningful relationship. The higher proportion of dental caries identified among younger children reinforces the view that early childhood represents a critical phase in oral health development. At younger ages, children are more vulnerable to dental caries due to the thinner enamel of primary teeth, limited capacity for independent oral hygiene practices, and a greater reliance on parental supervision (Abdullah 2018). Furthermore, frequent intake of sugary foods and beverages during early childhood may further elevate the risk of caries

development (Purnamasari, Hartini & Herawati 2017).

These results are in line with previous studies indicating that dental caries prevalence is generally higher in younger age groups and tends to decline as children grow older, coinciding with improved oral hygiene behaviors and the eruption of permanent teeth (Hoa et al. 2025). Studies by Goenka et al. also reported a reduction in caries prevalence from early childhood to adolescence, which was attributed to increased health awareness and better oral hygiene practices among older children (Sarawgi et al. 2018). Comparable findings were reported by Abuhaloob and Petersen, who emphasized the increased susceptibility of younger children to dental caries. The present study adds to this body of evidence by utilizing large-scale routine dental examination data obtained from a primary health care setting (Abuhaloob & Petersen 2021).

Conversely, the absence of a significant association between sex and dental caries occurrence observed in this study is consistent with several earlier investigations reporting similar caries prevalence among boys and girls (Suzana et al. 2024). Research conducted in Indonesia suggests that although behavioral differences between

male and female children may exist, these differences do not consistently result in substantial variation in caries prevalence (Kusuma & Taiyeb 2020). This indicates that modifiable factors such as dietary patterns, toothbrushing habits, and access to dental health services may have a greater influence on caries occurrence than biological sex alone.

From a public health standpoint, the high burden of dental caries identified in this study highlights persistent challenges in the implementation of effective oral health promotion and prevention strategies at the community level. Despite ongoing global and national initiatives aimed at integrating oral health services into primary health care and school-based programs, dental caries remains a prevalent problem among elementary school children, particularly in younger age groups. The findings underscore the importance of reinforcing early preventive measures, including regular dental screening, comprehensive oral health education, and active parental involvement, within both school health initiatives and primary health care services.

Overall, this study contributes valuable evidence by confirming that age, rather than sex, plays a central role in the occurrence of dental caries among elementary school

children. These results emphasize the necessity of implementing age-specific and data-driven oral health strategies to effectively reduce the burden of dental caries and promote optimal oral health development in children.

CONCLUSION

This study concludes that age is significantly associated with dental caries occurrence among elementary school children in the working area of Kedungmundu Primary Health Center, Semarang, whereas sex does not demonstrate a significant relationship. Younger children exhibited a higher prevalence of dental caries compared with adolescents, indicating increased susceptibility to oral health problems at earlier stages of development. These findings address the research objective by confirming that demographic factors, particularly age, play an important role in dental caries among school-aged children. The results highlight the importance of implementing early, age-appropriate preventive and promotive oral health interventions within school-based programs and primary health care services to reduce the burden of dental caries and improve long-term oral health outcomes for children.

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REFERENCE

- Abdullah, N., 2018, 'Hubungan Status Kesehatan Gigi dan Mulut Anak Sekolah dengan Pelaksanaan UKGS (Usaha Kesehatan Gigi Sekolah) di Sekolah Dasar dan Sederajat Se Kota Makassar', *Media Kesehatan Gigi*, 17(1).
- Abuhaloob, L. & Petersen, P.E., 2021, 'Oral Health Status and Oral Health Behaviour among 5- to 6-year-old Palestinian Schoolchildren – Towards Engagement of Parents and Schoolteachers for Oral Health through Schools', *Oral Health and Preventive Dentistry*.
- Bernabe, E., Marcenes, W., Abdulkader, R.S., Abreu, L.G., Afzal, S., Alhalaiqa, F.N., Al-Maweri, S., Alsharif, U., Anyasodor, A.E., Arora, A., Asgary, S., Ashraf, T., Balasubramanian, M., Banakar, M., Barrow, A., Bashiri, A., Belay, S.A., Belgaumi, U.I., Berhie, A.Y., Bhardwaj, P., Bhaskar, S., Bijani, A., Bouaoud, S., Cao, Y., Chaurasia, A., Chen, M.X., Chu, D.-T., Cruz-Martins, N., Dadras, O., Dai, X., Diaz, D., Du, M., Ekholuenetale, M., Ekundayo, T.C., Tantawi, M. El, Elhadi, M., Fagbamigbe, A.F., Farshidfar, N., Fatehizadeh, A., Fischer, F., Folleyan, M.O., Gaewkhiew, P., Gajdacs, M., Golechha, M., Gupta, B., Gupta, S., Hagins, H., Halboub, E.S., Hamidi, S., Hariyani, N., Hay, S.I., Heidari, M., Herrera-Serna, B.Y., Heyi, D.Z., Hostiuc, S., Humphrey, K.M., Ibitoye, S.E., Ilic, M.D., Isola, G., Kandaswamy, E., Kantar, R.S., Kaur, N., Kemmer, L., Khader, Y.S., Khateri, S., Kisa, A., Krishan, K., Kruger, E., Laloo, R., Li, A., Lim, S.S., Mestrovic, T., Mokdad, A.H., Moreira, R.S., Morrison, S.D., Murray, C.J.L., Natto, Z.S., Nayak, B.P., Nguyen, T., Nguyen, V.T., Omotayo, A.O., Padron-Monedero, A., Patel, J., Patil, S., Pawar, S., Petcu, I.-R., Qattee, I., Rahman, M., Ratan, Z.A., Riad, A., S, M., S N, C., Sabour, S., Saheb Sharif-Askari, F., Sahebkar, A., Sakshaug, J.W., Samy, A.M., Sarode, S.C., Sawhney, M., Schwendicke, F., Shaikh, M.A., Tadakamadla, S.K., Tesler, R., Thiyagarajan, A., Tovani-Palone, M.R., Umair, M., Unnikrishnan, B., Valadan Tahbaz, S., Varma, S.A., Vukovic, A.P., Wang, C., Wickramasinghe, N.D., Yadav, L., Yigit, A., Zare, I., Zhang, Z.-J. & Kassebaum, N.J., 2025, 'Trends in the global, regional, and national burden of oral conditions from 1990 to 2021: a systematic analysis for the Global Burden of Disease Study 2021', *The Lancet*, 405(10482), 897–910.
- Dinas Komunikasi dan Informatika Provinsi Jawa Tengah, 2025, *44.474 Anak di Kota Semarang Telah Ikuti CKG, Dinas Komunikasi dan Informatika Provinsi Jawa Tengah*.
- Failasufa, H., Fahrie, T.O. & Arimbi, A., 2021, 'Hubungan Pelaksanaan Usaha Kesehatan Gigi Sekolah terhadap Status Karies Gigi : Literature Review', *Indonesian Journal of Dentistry*, 1(2), 37.
- Hoa, L.T.T., Tue, P.X., Vinh, H.T., Duong, T.T.T. & Dung, L.T.K., 2025, 'Determinants of dental caries among primary schoolchildren in a mountainous region of Northern Vietnam', *Frontiers in Oral Health*, 6.
- Kusuma, A.P. & Taiyeb, A.M., 2020, 'Gambaran Kejadian Karies Gigi Pada Anak Kelas 2 Sekolah Dasar Negeri 20 Sungaiselan', *Media Kesehatan Politeknik Kesehatan Makassar*, 15(2), 238.

- Moca, A.E., Vaida, L.L., Negruțiu, B.M., Moca, R.T. & Todor, B.I., 2021, 'The Influence of Age on the Development of Dental Caries in Children. A Radiographic Study', *Journal of Clinical Medicine*, 10(8), 1702.
- Pemerintah Republik Indonesia, 2025, *Keputusan Menteri Kesehatan Republik Indonesia Nomor HK.01.07/Menkes/15/2025 Tentang Pedoman Nasional Pelayanan Klinis Tata Laksana Karies Gigi*.
- Purnamasari, N.L., Hartini, T.N.S. & Herawati, H., 2017, 'Perilaku Mengosok Gigi Kebiasaan Makan dan Minum Tinggi Sukrosa dengan Kejadian Karies Gigi pada Siswa Di MIN Jejeran', *JURNAL NUTRISIA*, 19(2).
- Rathee, M. & Sapra, A., 2023, *Dental Caries, National Library of Medicine*.
- Sarawgi, A., Nirwan, M., Dutta, S. & Goenka, P., 2018, 'Prevalence of Dental Caries in Children of Age 5 to 13 Years in District of Vaishali, Bihar, India', *International Journal of Clinical Pediatric Dentistry*, 11(5), 359–364.
- Suzana, A., Gustina, E. & Rahutami, S., 2024, 'Faktor – Faktor yang Mempengaruhi Kejadian Karies Gigi pada Anak Sekolah di SD Islamiyah Kecamatan Sekayu Tahun 2024', *Jurnal Akademika Baiturrahim Jambi*, 13(2), 417–426.
- WHO, 2025a, *Sugars and Dental Caries, World Health Organization*.
- WHO, 2025b, *Oral Health, World Health Organization*.