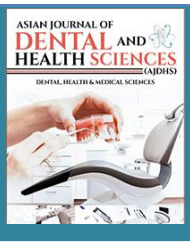

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Oral Health Literacy Level and Biofilm Maturation as Risk Indicators for Dental Caries and Gingivitis: A Cross-Sectional Study

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Abstract

Background. In Indonesia, dental and oral disorders are prevalent, with dental caries and gingivitis being the most common types of tooth decay in elementary school children. Gingivitis affects 90% of the world's population, with 80% of those affected being children under 12. Oral health literacy, which includes reading, writing, arithmetic, speaking, listening, and making sound decisions, is crucial for preventing oral diseases.

Methods. A study involving 82 primary school students. The study used a modified OHL-AQ questionnaire and the GC triPlaque ID Gel™ (TPID) technique to assess biofilm maturation

Results. The results showed a significant link between oral health literacy and biofilm maturation, suggesting that inadequate oral health literacy increases the risk of dental caries. **Conclusions.** Inadequate oral health literacy increases biofilm maturationand the risk of dental caries.

Keywords: Health literacy, Biofilm, Dental Caries, Gingivitis, Cross-Sectional Study

INTRODUCTION

Oral health plays an important role in supporting individual health. Problems with teeth and mouth in Indonesia reached 57.6%, while in the Special Region of Yogyakarta Province showed a higher percentage than the average in Indonesia, which was 65.6%.[1] There are several types of dental and oral diseases, but dental caries is a dental and oral disease that many children suffer from. Dental caries is a dental tissue disease characterized by tissue damage,starting from the tooth surface, namely from enamel, dentin, and extending towards the pulp. Dental caries is one of the most common forms of tooth decay experienced by school-age children, which can interfere with the growth and development process.[2]

The problem of dental caries in children, if not treated, will get worse, making children experience loss of chewing power and disrupting digestion.[3] In addition, dental caries can also cause dental pain, it reduces the frequency of children's attendance to school, disrupts learning concentration, affects appetite and food intake, it can affect nutritional status and ultimately result in impaired physical growth of children. This will affect the nutritional status and health of children.[4]

Apart from dental caries, the oral cavity disease that many people suffer from is gingivitis. The World Health Organization survey results show that 90% of the world's population suffers from gingivitis and 80% of them are children under 12 years of age. Gingivitis is the initial stage of periodontal disease in the form of inflammation of the gingiva caused by poor oral hygiene resulting in the accumulation of biofilm along the gingival margin.[5] Research conducted by Karim, et al, showed a high incidence of gingivitis in children aged 9-12 years, namely 63.83% had mild inflammation and 27.66% had moderate inflammation.[6] Lossu, et al state that gingival tissue that experiences inflammation is called gingivitis.[7] One of the causes of gingivitis is biofilm that sticks to the teeth. Untreated gingivitis will continue and cause damage to the supporting tissues of the teeth (periodontitis), the teeth become loose and must be removed.

Biofilm is a collection of microorganism cells that are irreversibly attached to a surface and encased in a matrix of Extracellular Polymeric Substances (EPS) that it produces itself, and shows a change in phenotype.[8,9]

Biofilms that are still young (immature) and in the oral cavity, are a normal condition, considering that biofilms are formed continuously. Mature biofilms can cause

diseases in the oral cavity such as dental caries and gingivitis, because they are dominated by cariogenic bacteria and periodontic bacteria.[10] Based on research by Seneviratne, et al., biofilm matures in vitro after 24-72 hours, while in vivo after 72 hours.[11]

Biofilm accumulation can be prevented by good oral health self-care behavior. One of the factors that influence oral health self-care behavior is health literacy, whichis the level of a person's capacity to obtain, process and understand basic health information and services needed to make appropriate health decision.[12] Oral health literacy is a general term that includes the skills of reading, writing, counting, speaking, listening, and making appropriatedecisions, especially in every action related to oral health.[13] A person who has low oral health literacy has a high risk of oral disease and matters related to oral disease.[14]

Elementary school children are a critical period for the occurrence of oral diseases, because at this age the ability to prevent biofilm accumulation, as a causative factor in the occurrence of oral diseases is not yet adequate. The purpose of this study was to investigate the level of oral health literacy of elementary school students and biofilm maturation as a risk indicator for dental caries and gingivitis.

MATERIALS AND METHODS

This study was an analytic observational study with a cross-sectional design. The sampling technique used was purposive sampling, the number of samples in this study were 82 respondents. The research location was at the elementary school (SD Negeri) Kadipiro 1 Yogyakarta, Indonesia. The data collection method in this study used a modified OHL-AQ questionnaire, to obtain oral health literacy data, and biofilm maturation examination using GC triPlaque ID Gel™ (TPID) to determine the risk of dental caries and gingivitis. Data analysis used a non-parametric statistical test, namely the Kendall-tau test.

RESULTS AND DISCUSSION

Result:

A. Respondent Characteristics

The characteristics of respondents in this study can be seen in Figure 1.

Based on Figure 1, it is known that most of the respondents 42 (51.2%) weremale and aged 11 years old 41 (50.0%).

B. Oral Health Literacy Level of Elementary School Students

Oral Health literacy level of elementary school student can be seen at Figure 2

Based on Figure 2, it is known that out of 82 respondents 47 (57.3%) respondents with a marginal level of oral health literacy.

C. Biofilm Maturation in Elementary School Students

This Research about biofilm maturation in elementary School Student can be seen at Figure 3.

Based on Figure 3, out of 82 respondents, 42 (51.2%) respondents were found with mature biofilm maturation. This indicates the risk of gingivitis.

D. The Association between Oral Health Literacy Level and Biofilm Maturation

The Association between Oral Health Literacy Level and Biofilm Maturation can be seen at Tabel 1.

Based on Table 1, it is known that respondents with inadequate oral health literacy, 13 (76.5%) had very mature biofilms. The results of the Kendall tau-b test obtained a p-value of 0.002 <0.05 means that there is a correlation between the level of oral health literacy and biofilm maturation in elementary school children. Based on this, it is known that inadequate oral health literacy will increase the level of biofilm maturation.

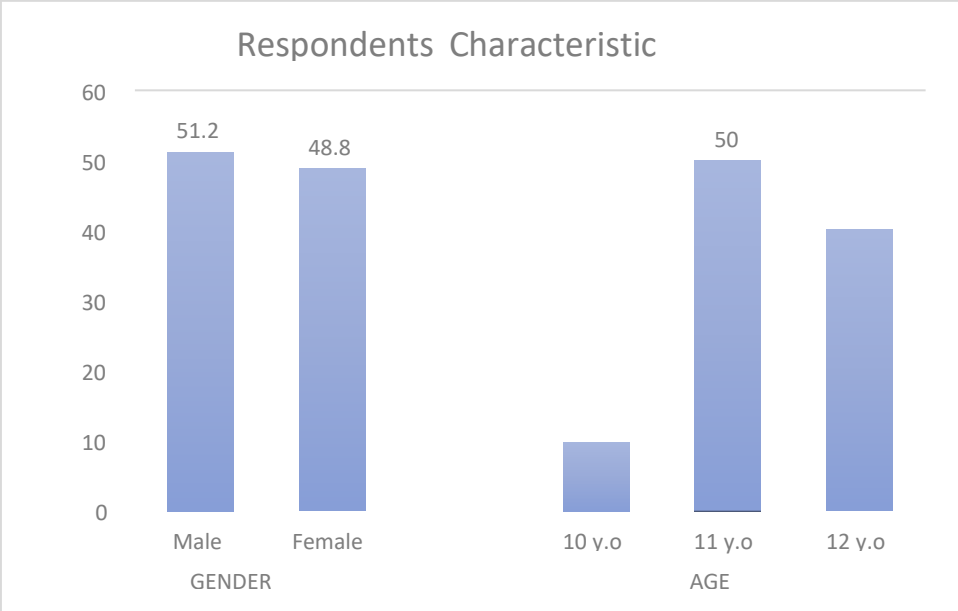

Figure 1: Characteristics of Respondents Based on Gender and Age

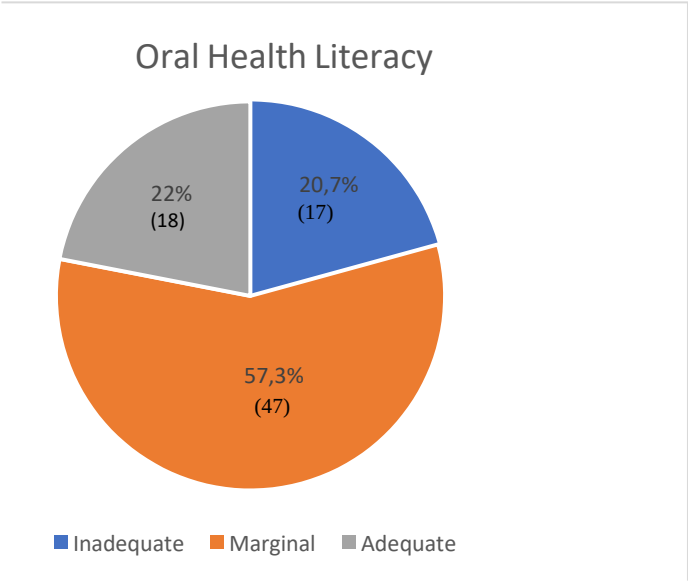

Figure 2: Oral Health Literacy Level of Elementary School Students

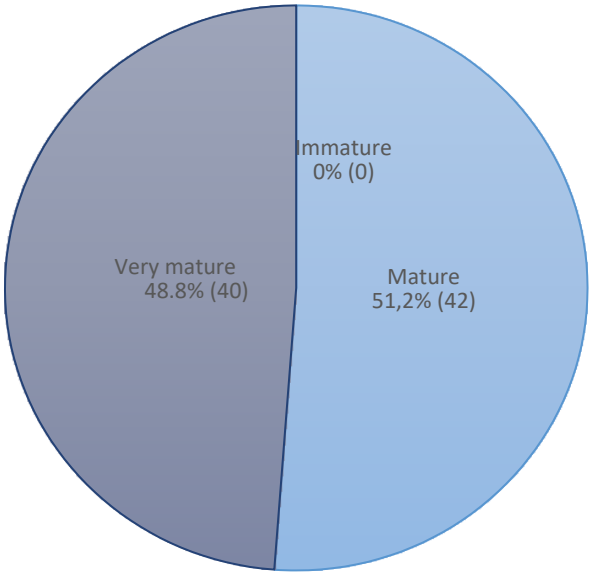

Figure 3: Distribution of Biofilm Maturation in Elementary School Students

Tabel 1: The Association between Oral Health Literacy and Biofilm Maturation

Oral HealthLiteracy	Biofilm Maturation								TOTAL		P VALUE
N	No Biofilm		Immature		Mature		Very Mature		SUM		
	N	%	N	%	N	%	N	%	N	%	
Inadequate	0	0	0	0	4	23.5	13	76.51	17		
Marginal	0	0	0	0	25	53.2	22	46.84	47	100	
Adequate	0	0	0	0	13	72.2	5	27.81	18		
Sum	0	0	0	0	42	52.1	40	48.88	82		0,002

DISCUSSION

Oral health literacy is defined as an individual who has the capacity to obtain, process or interpret and understand basic health information and servicesneeded to make informed health decisions in a way that improves health. Oral health literacy has an impact on a person's behavior, this is because the higher the oral health literacy, the better the person's knowledge.Oral health literacy assumes a person's ability to find, understand, and use oral health information is important to be able to access and benefit from oral health care services.[15]

Individuals with inadequate oral health literacy are at higher risk for oral diseases and disease-related problems. Lower reading skills have been associated with problems using preventive services, delayed diagnosis of medical conditions, poor adherence to medical instructions, poor self- management skills, increased risk of death, poor health outcomes, and higher health care costs. Age affects a person's absorption and mindset, the older the age, the more developed the absorption and mindset, therefore the knowledge will be better.[14]

Oral health literacy is one of the important factors that influence an individual's understanding of oral health care, as well as the individual's ability to make decisions regarding health promotion, disease prevention, and utilization of oral health care. Oral health literacy is a basic or primary care medium for everyone so it is considered an effective part of the health care system.[12]

The very mature category was found in 40 (48.8%) respondents, which is a risk for dental caries. This shows that the oral health self-care ability of elementary school students is still lacking, therefore the biofilm that forms become mature.

Biofilm that is still young (immature) and is in the oral cavity, is a normal condition, considering that biofilm is formed continuously. Mature biofilms can cause diseases in the oral cavity such as dental caries and gingivitis, because they are dominated by cariogenic bacteria and periodontic bacteria.[10] Based on research by Seneviratne, et al., biofilm matures in vitro after 24-72 hours, while in vivo after 72 hours.[11]

Approximately 65% of human infections result from biofilm formation. Biofilms have unique characteristics compared to microorganisms in the form of planktonic cells, usually more resistant. [16] Biofilm formation consists of 4 steps, namely bacterial attachment to the surface

(initial phase), proliferation and formation of extracellular matrix (intermediate phase), increase of extracellular matrix material to form a 3- dimensional biofilm structure (maturation phase) and after entering the maturation phase, some planktonic cells detach and attach to the surface to form a new biofilmcycle.[9]

According to research conducted by Flemming and Wuertz in 2019, biofilm maturation involves complex interactions between microorganisms, substrate surfaces, and the surrounding environment. The biofilm maturation process involves a number of complex stages, starting from the attachment of microorganisms on the surface to the formation of a mature and complex biofilm structure.[23]

Once the initial attachment occurs, the microorganisms begin to produce an extracellular matrix that protects and sustains the biofilm structure. This extracellular matrix production is a key stage in biofilm maturation that enables the formation of strong and durable structures (Bridier et al. 2019).[22] At advanced stagesof maturation, biofilms can become highly resistant to external perturbations, including physical stress, temperature changes, and antimicrobial therapy (Stewart and Franklin, 2020).

Oral health literacy plays an important role in maintaining optimal oral hygiene and preventing various dental conditions. One important aspect of oral health is the formation and maturation of dental biofilms. This discussion explores the correlation between oral health literacy and biofilm maturation, especially theimpact of individual knowledge and practices on oral health outcomes.

Oral health literacy encompasses an individual's ability to acquire, process and understand basic oral health information to make informed decisions regarding their oral care. Limited oral health knowledge has been associated with poor oral hygiene practices, increased risk of dental disease, and delayed treatment-seeking behavior (Jones et al., 2013).[22] Understanding the basic principles of oral health, including the importance of regular brushing, flossing, and professional dental check-ups, is essential to prevent the accumulation and maturation of dental biofilms.

The presence of highly mature biofilms indicates that oral health self-care behavior in elementary school children is still lacking. This self-care behavior is influenced by oral health literacy. The better the oral health literacy, the better the understanding of elementary school students in maintaining oral hygiene, thereforethe biofilm that forms do not become mature. This statement is in accordance with the opinion of Divaris, et al. (2013), which states that the interaction between oral health literacy and biofilm maturation is evident in individual oral care practices.[21] Individuals with higher levels of oral health literacy tend to perform effective oral hygiene behaviors, thus disrupting the early stages of biofilm formation. Conversely, individuals with limited oral health knowledge may neglect proper oral care, thus providing a conducive environment for biofilm maturation and subsequent oral health problems.

Mature biofilm is an indicator for gingivitis. In this study, 51.2% of elementary school students were found to be at risk of gingivitis. Poor oral health literacy is a significant risk indicator for poor oral health. Oral health literacy consistently emerged as a predictor of oral hygiene and gingival health status among respondents implying that low levels of oral health literacy directly affect oral health status including gingival index (Baskaradoss, 2018).[22] This study is in line with research conducted by Ineg benosun & Azodo, (2020) which shows there is a relationship between oral health literacy and gingival health status with a p-valueof 0.000. Respondents who have low health literacy have a risk of 7.054 times to experience gum inflammation (gingivitis).[21]

Addressing oral health literacy is a key component in preventing biofilm maturation and its associated consequences. Public health initiatives and educational programs should focus on improving oral health literacy to empower individuals to make decisions regarding their oral care. Simple and clear communication about the impact of daily oral hygiene practices on biofilm formation can contribute significantly to improved oral health outcomes (Guzman- Armstrong et al., 2016).[21]

CONCLUSION

According to this study, oral health literacy level is associated with biofilm maturation in elementary school students. Inadequate oral health literacy increases biofilm maturation and dental caries risk.

Ethical Approval: The study was approved by the DP.04.03/e- KEPK.1/130/2023 Committee.

Author Contributions:

Herastuti Sulistyani: Conceptualization, study design, methodology, writing—original draft, and supervision.

Quroti A'yun: Data collection, analysis, and writing—review & editing.

Dewi Risnawati: Data curation, statistical analysis, and visualization.

Diani Sulistiawati: Funding acquisition, resources, and final manuscript approval.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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REFERENCES

1. Kemenkes RI, Hasil Riset Kesehatan Dasar Tahun 2018, Kementrian Kesehatan RI, 2019; 53(9), 1689-1699.

2. Afrinis, N., Indrawati dan Farizah, N, Analisa Faktor yang Berhubungan dengan Kejadian karies Gigi Anak Usia Dini, Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, 2021;5(1) https://doi.org/10.31004/obsesi.v5i1.668

3. Widayati, N., Faktor Yang Berhubungan Dengan Karies Gigi Pada Anak Usia 4-6 Tahun (Studi Di Tk Ra Bustanussholihin Desa Balun Kecamatan Turi, Jurnal Berkala Epidemiologi, 2014; 2:197.

4.Fatimatuzzahro, N., Prasetya, R. C., & Amilia, W., Gambaran Perilaku Kesehatan Gigi Anak Sekolah Dasar di Desa Bangalsari Kabupaten Bantaeng, Jurnal IKESMA, 2016; 12(2):85.

5. Pontoluli, Z.G, Khoman, J.A, Wowor, V.N.S., Kebersihan Gigi Mulut dan Kejadian Gingivitis pada Anak Sekolah Dasar, e-Gigi, 2021; 9(1):21-28. https://doi.org/10.35790/eg.9.1.2021.32366

6. Karim CAA, Gunawan P, Wicaksono D., Gambaran status gingiva pada anak usia sekolah dasar di SD GMIM Tonsea Lama. e-GiGi, 2013;1(2):9. https://doi.org/10.35790/eg.1.2.2013.3227

7. Lossu, F. M., Pangemanan, D. H. C., & Wowor, V. N. S., Hubungan Pengetahuan Kesehatan Gigi Dan Mulut Dengan Indeks Gingiva Siswa Sd Katolik 03 Frater Don Bosco Manado, E-GIGI, 2015; 3(2). https://doi.org/10.35790/eg.3.2.2015.10489

8. Gunardi, W. D., Peranan Biofilm dalam Kaitannya dengan Penyakit Infeksi, Jurnal Kedokteran Meditek, 2007; 15 (39A).

9. Wibawa, T, Candida albicans biofilm: formation and antifungal agents resistance, J Med Sci, 2012; 44(2)

10. Tugeman, H., Rahman, N.A, Yusoff, A dan Daud, MKM, Oral Health Knowledge, Practice and Dental Plaque Maturity Status of Hearing-Impaired Children, Sains Malaysiana, 2016; 45(5):761-768

11. Seneviratne, C.J., Zhang, C.F. & Samaranayake, L.P., Dental plaque biofilm in oral health and disease. The Chinese Journal of Dental Research, 2011; 14(2):87-94.

12. Baskaradoss, J. K., Relationship between oral health literacy and oral health status. BMC Oral Health, 2018; 18(1):1-6. https://doi.org/10.1186/s12903-018-0640-1 PMid:30355347 PMCid:PMC6201552

13. Sistani, N M. M., Montazeri, A., Yazdani, R., & Murtomaa, H., New oral health literacy instrument for public health: development and pilot testing, Journal of Investigative and Clinical Dentistry, 2014; 5(4):313-321. https://doi.org/10.1111/jicd.12042 PMid:23559571

14. Batista MJ, Lawrence HP, Sousa M. Oral health literacy and oral health outcomes in an adult population in Brazil. BMC Public Health, 2017;18(1):60. https://doi.org/10.1186/s12889-017-4443-0 PMid:28747157 PMCid:PMC5530456

15. Robinson, L.A., Oral Health Literacy. J Calif Dent Assoc, 2012; 40(4): 312-314. PMid:22679670 https://doi.org/10.1080/19424396.2012.12220899

16. Weerasekera, M. M. Wijesinghe, G.K., Jayarathna, T.A., Gunasekara, C.P., Fernando, N., Kottegoda, N., Samarayanake, L.P., Culture media profoundly affect Candida Albicans and Candida tropicalis growth, adhesion and biofilm development, Memorias do Instituto Oswaldo Cruz. Fundacao Oswaldo Cruz, 2016; 111(11):697-702. https://doi.org/10.1590/0074-02760160294 PMid:27706381 PMCid:PMC5125054

17. Bridier, A., Briandet, R., Thomas, V., & Dubois-Brissonnet, F., Resistance of bacterial biofilms to disinfectants: a review. Biofouling, 2019; 27(9):1017-1032 PMid:22011093 https://doi.org/10.1080/08927014.2011.626899

18. Stewart, P. S., & Franklin, M. J., Physiological heterogeneity in biofilms. Nature Reviews Microbiology, 2020; 18(1):56-67.

19. Jones K, Parker E, Mills H, Brennan D, Jamieson LM, Development and psychometric validation of a Health Literacy in Dentistry scale (HeLD). Community Dent Health, 2013; 30(3):133-140.

20.Divaris K, Lee JY, Baker AD, Vann WF., Caregivers' oral health literacy and their young children's oral health-related outcomes. Pediatrics, 2013; 132(5):e1274-e1281.

21. Inegbenosum, H., & Azodo, C.C., Association between oral health literacy, gingival health and oral hygiene among dental patients. Nig J Dent Res, 2020, 5(1):7-13.

22. Guzman-Armstrong S, Warren R, Cunningham-Ford MA, Sinclair C., Effective communication and oral health literacy: A guide for oral health professionals. NSW Public Health Bull, 2016; 27(4):153-157