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Risk factors for dental caries: A case study in peatlands and non-peatlands of West Kalimantan, Indonesia

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ABSTRACT

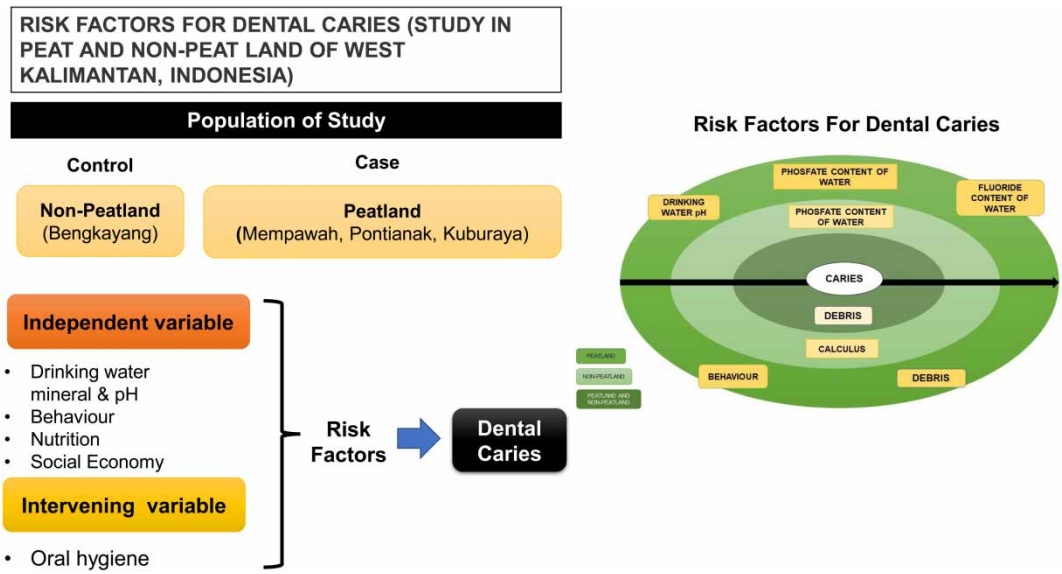
The prevalence of dental caries in peatlands and non-peatlands in West Kalimantan require preventive acts based on its natural conditions and the behavior of local communities. The objective was to analyse risk factors for dental caries in communities living in peatlands and non-peatlands in West Kalimantan. The research is a causal comparative study with cross-sectional approach. The samples were chosen by purposive sampling technique among adolescents aged 17–27 years, who were domiciled in Pontianak City (peatland) and Bengkayang (non-peatland) all their lives. The results showed that dental caries is significantly correlated with debris in peatlands ($rs = 0.289$). On non-peatlands, dental caries is correlated with drinking water phosphate ($rs = 0.313$) and calculus ($rs = 0.034$). In West Kalimantan, dental caries is significantly correlated with drinking water minerals (fluoride $rs = -0.243$; phosphate rs = 0.260), drinking water pH ($rs = 0.235$), behavior ($rs = -0.327$), and debris ($rs = 0.240$). The risk factors for dental caries in peatlands and non-peatlands in West Kalimantan are pH and drinking water minerals (fluoride and calcium), debris, calculus, and behavior.

Key words: dental caries, drinking water sources, peatland

HIGHLIGHTS

- The formation of caries is influenced by the surrounding environmental conditions.
- There are 49.55% of peatland residents in West Kalimantan who suffer from caries.
- Caries in peatlands is caused by low pH and a lack of fluoride and calcium in drinking water.
- The risk factor for dental caries in peatlands is debris, while in non-peatlands, the risk factors are calculus and water phosphate.

GRAPHICAL ABSTRACT



INTRODUCTION

Peatlands lie on swamp environments that are always flooded and the soil here develops from piles of organic material (Lestariningsih *et al*. 2018). Indonesia has a lot of peatlands, one of which is West Kalimantan province, which has peatlands covering an area of 1.7 million ha (Wahyunto & Subagjo 2004). One of the characteristics of peatlands is that the groundwater has a very low pH ranging from 3.98 to 4.25 (Astiani *et al.* 2018), brown color, and high iron levels ranging from 2 to 5 mg/L (Figure 1) (A'idah *et al*. 2018). This high content of heavy metals makes peat water inappropiate to be used for community needs (Naswir & Lestari 2014; Said *et al.* 2019; Ali *et al.* 2021). The communities in West Kalimantan use rainwater as their source of drinking water, which is collected in certain containers, but rainwater is also not good for health because it contains high levels of lead (Pb) (Payus & Meng 2015; Khayan *et al.* 2017).

Figure 1 | The appearance of peatland ground water. Peatland has unique characteristics that make it unsuitable to be used as a daily source of drinking water. It has a very low pH, brown color, and a high level of iron.

Dental caries is influenced by the surrounding environment as a disposition factor which includes genetic and biological factors, social environment, physical environment, health behavior, and dental and medical care (WHO 2019). Previous research shows the important role of minerals in the dental caries process. Calcium, phosphate, and magnesium from food are correlated with children's dental caries (Lin *et al.* 2014). Water minerals that have a strong influence on dental caries are fluoride and calcium (Arvin *et al*. 2018; Sejdini *et al.* 2018; Hartami *et al*. 2019; Yani *et al.* 2019), followed by phosphate (Hartami *et al.* 2019) and magnesium (Sejdini *et al.* 2018). In addition, salivary minerals that influence the enamel mineralization process are fluoride and calcium (Velásquez *et al.* 2019).

Dental caries is a dynamic disease that can occur throughout life, both in primary and permanent teeth (Pitts *et al.* 2017). The results of the 2018 Riskesdas showed that 49.55% of the population of West Kalimantan province suffers from dental caries; on average, they have five carious teeth and 95.37% of people just let dental caries occur without taking treatment (Ministry of Health of the Republic of Indonesia 2018). Dental caries causes impacts such as pain, reduced chewing function, bad breath, poor facial appearance, and reduced chances of getting a job. Dental caries also contributes to decreasing the quality of health, damaging children's well-being (Chaffee *et al.* 2017), and reducing the quality of children's lives (Karamoy 2017).

The prevalence cases of dental caries in the peatlands and non-peatlands of West Kalimantan require preventive acts according to their natural conditions and the behavior of local communities. So, it is essential to find the risk factors of dental caries in communities living in the peatlands and non-peatlands of West Kalimantan.

METHOD

This research is a causal comparative study with a cross-sectional approach. It was conducted at the Pontianak Health Polytechnic from April to July 2022. The population in this study were first-year students of the Pontianak Health Polytechnic aged 17–27 years. The sampling method is purposive sampling. Inclusion criteria are indigenous people from peat areas (Pontianak, Mempawah, and Kubu Raya) and non-peat areas (Bengkayang district), as well as domiciles in the research area for their whole lives. The exclusion criteria were those not suffering from any systemic disease or infection during the study. The samples obtained were from 48 peatland respondents (Pontianak) and 48 non-peatland respondents (Pontianak).

Respondents brought 250 mL of drinking water in sterile plastic bottles. Water was obtained from drinking water sources they usually consume. Drinking water sample parameters are pH, which was analyzed by using the HANNA HI 98103 Checker pH Tester; fluoride by Fluoride Low Range Tool (HI729); calcium by Reff test kit Calcium Pro; and phosphate by Salifert phosphate test kit.

Behavioral data were collected through interviews and translated into the Oral Hygiene Behavior (OHB) index (Suryanti *et al.* 2019). Socio-economic variables are sought by calculating the number of family members who live together; parents' education level which was obtained by calculating the number of years of formal schooling they have had; and economics was obtained by calculating their monthly income.

The data obtained from the examination were dental caries by calculating the number of dental caries in the mouth; oral hygiene by calculating the debris index (DI); and calculus index (CI) (Fitri *et al*. 2023). The nutritional status was measured by body height (cm) and body weight (kg).

DATA ANALYSIS

Normality test was done using the Kolmogorov–Smirnov test, Mann–Whitney mean difference test, and Spearman correlation using SPSS v.27 software (IBM SPSS, Armonk, NY: IBM Corp) with p-value = 0.05; CI 95%; df 47).

ETHICAL POLICY

Participant consent was obtained as written informed consent and the research protocol was approved by the Human Participants Protection Committee, Health Research Ethics Committee (HREC) of Pontianak Health Polytechnic, Indonesia. The HREC states that this research protocol meets the ethical principles outlined in the 2008 Declaration of Helsinki. The ethical approval is stated in No. 65/KEPK-PK. PKP/IV/2022, April 11, 2022.

RESULT

The research showed that peat soil respondents had an average of five carious teeth, and non-peat soil respondents had an average of four carious teeth. Drinking water in peatland respondents has a low average mineral content (water fluoride 0.06 mg/L, phosphate 0.03 mg/L, calcium 15.21 mg/L) than non-peat water mineral content (fluoride 0.17 mg/L, phosphate and 0.155 mg/L, calcium 22.94 mg/L). The average height and weight of respondents are 158 cm and 56 kg, respectively, almost similar to the non-peatland respondents (average height 159 cm and body weight 55 kg). The behavior of the dental hygiene indicator was higher among the peat respondents than the non-peat respondents (Table 1).

Peatlands and non-peatlands have significant average differences in drinking water minerals (fluoride sig. 0.003; phosphate sig. 0.000; father's education sig. 0.044) and behavior of dental hygiene (sig. 0.043) (Table 1).

West Kalimantan respondents had an average of 4–5 carious teeth, normal drinking water pH (6.89), low drinking water minerals (water fluoride 0.09 mg/L; phosphate 0.14 mg/L; calcium 19.07 mg/L), and adequate nutrition (TB 159.93 and BB 55.93). The average number of family members in one house is five people, with almost the same education level of parents, ranging by 10–11 years of school (high school level). The average family income is 4.2 million rupiahs a month and the behavior of dental hygiene is moderate (range) (Table 2).

This research variable has an abnormal data distribution for further statistical analysis using a non-parametric correlation test.

In peatlands, the risk factors for dental caries are significantly correlated (p-value 0.05) with debris only ($rs = 0.289$). Meanwhile, water minerals (phosphate $rs = 0.313$) and calculus ($rs = 0.034$) were significantly correlated with dental caries in the non-peatland community. In West Kalimantan, dental caries is significantly correlated (p-value 0.05) with drinking water minerals (fluoride $rs = -0.243$; phosphate rs 0.260), drinking water pH ($rs = 0.235$), behavior ($rs = -0.327$), and debris ($rs = 0.240$). Dental caries is not correlated with drinking water calcium, maternal education, height and weight, number of family members, and family economy (Table 3).

DISCUSSION

Since the past, peatland communities have had groundwater that cannot be consumed, instead, they used rainwater as a drinking water source. In line with the growth of its economy, refillable water has become popular for public consumption (Komarulzaman 2017). Drinking water in peatland respondents has a low mineral content (water fluoride 0.06 mg/L, phosphate 0.03 mg/L, calcium 15.21 mg/L) compared to non-peat respondents. Peatland respondents had an average of five carious teeth, and non-peatland respondents had an average of four carious teeth. In general, in West Kalimantan, dental caries is significantly negatively correlated with fluoride, drinking water pH, and behavior. The higher the behavioral value, pH, and fluoride of drinking water, the lower the incidence of dental caries. Dental caries is positively correlated

Table 1 | Average values of research variables based on the location

			Peatland		Non-peatland		Mann–Whitney	
	Variable	Sub-variable	Mean ($\bar{x}$)	Std. dev	Mean ($\bar{x}$)	Std. dev	Mann–Whitney U	p-Value
Dependent variable		Decay	4.48	2.76	3.54	2.72	914.50	0.08
Independent variable	**Drinking water**	pH	6.97	0.69	6.82	0.48	945.00	0.129
		Fluoride	0.06	0.10	0.13	0.17	752.00	0.003
		Phosphate	0.03	0.04	0.28	0.18	164.50	0.000
		Calcium	15.21	8.99	22.94	30.48	1,059.00	0.483
	Nutritional status	Height	158.98	7.11	159.85	6.88	1,039.00	0.406
		Weight	56.04	11.99	55.81	11.29	1,130.00	0.872
	Social economy	Number of family members	4.77	1.26	4.42	1.15	973.00	0.173
		Fathers' education level	10.15	4.26	11.58	3.47	883.50	0.044
		Mothers' education level	10.67	4.20	10.92	3.66	1,067.50	0.527
		Economy	43.38	19.33	41.25	17.77	1,092.00	0.616
	Behavior	Behavior	11.42	2.09	12.25	1.98	879.50	0.043
	Dental hygiene	Debris	0.90	0.45	1.07	1.44	1,145.50	0.962
		Calculus	0.63	0.56	0.99	1.36	960.00	0.156

Table 2 | Normality test and average values of dental caries risk factors in West Kalimantan

	Variable	Sub-variable	Peatland Mean ($\bar{x}$)	Non-peatland Std. dev	95% Confidence interval of the difference		One-sample Kolmogorov–Smirnov test
					Lower	Upper	*p*-Value
Dependent variable		Decay (Dental caries)	4.01	2.77	−0.17	2.05	0.04
Independent variable	**Drinking water**	pH	6.89	0.60	−0.10	0.39	0.00
		Fluoride	0.09	0.14	−0.12	−0.01	0.00
		Phosphate	0.15	0.18	−0.30	−0.19	0.00
		Calcium	19.07	22.69	−16.92	1.46	0.00
	Nutritional status	Height	159.42	6.97	−3.71	1.96	0.00
		Weight	55.93	11.59	−4.49	4.95	0.00
	Social economy	Number of family members	4.59	1.21	−0.13	0.84	0.00
		Fathers' education level	10.86	3.93	−3.01	0.14	0.00
		Mothers' education level	10.79	3.92	−1.85	1.35	0.00
		Economy	42.31	18.50	−5.40	9.65	0.00
	Behavior	Behavior	11.83	2.07	−1.66	−0.01	0.00
	Dental hygiene	Debris	0.99	1.06	−0.60	0.26	0.00
		Calculus	0.81	1.05	−0.78	0.06	0.00

Table 3 | Relationship between dental caries risk factors and the rate of dental caries in peat and non-peatlands in West Kalimantan

			Spearman's ρ					
	Variable	Sub-variable	Peatland *rs*	*p*-value 0.05 *Sig*	Non-peatland *rs*	*p*-value 0.05 *Sig*	Combination of West Kalimantan *rs*	*p*-value 0.05 *Sig*
Dental caries	**Mineral of drinking water**	Fluoride	− 0.207	0.158	− 0.087	0.556	− 0.243*	0.017
		Phosphate	− 0.200	0.173	.313*	0.031	0.260*	0.010
		Calcium	− 0.019	0.899	0.167	0.256	0.080	0.439
		pH	− 0.045	0.764	− 0.139	0.347	− 0.235*	0.021
	Social economy	Fathers' education level	− 0.097	0.512	− 0.001	0.993	− 0.087	0.400
		Mothers' education level	− 0.117	0.430	0.089	0.546	− 0.062	0.551
		Number of family members	− 0.032	0.832	− 0.180	0.220	− 0.079	0.443
		Economy	0.240	0.101	0.116	0.431	0.173	0.091
	Behavior	Behavior	− 0.281	0.053	− 0.234	0.109	− 0.327**	0.001
	Nutritional status	Height	0.013	0.931	− 0.248	0.089	− 0.128	0.215
		Weight	0.082	0.579	− 0.081	0.582	0.004	0.972
	Dental hygiene	Debris	0.289*	0.046	0.224	0.127	0.240*	0.018
		Calculus	− 0.031	0.836	0.341*	0.018	0.160	0.120

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

with phosphate, pH of drinking water, and debris. Peatlands have all sources of drinking water that contain very few minerals, especially fluoride, causing teeth to be easily attacked by dental caries, so the biggest risk factor for dental caries besides fluoride is debris. In non-peatlands, the mineral content of water is slightly higher, but still below the optimal limit, so the risk of dental caries is drinking water phosphate and calculus. Calculus is debris that has calcified and hardened. Calculus is a medium for plaque and debris to grow.

The environmental conditions in which people live could affect their health. The availability of clean water is one of the natural environmental factors that influences people's health (Northridge *et al.* 2003). Dental caries is influenced by the mineral content of water, which are fluoride and phosphate. Drinking water conditions that have fluoride levels below the optimal concentration (0.5 = 1.5 mg/L) are risk factors for dental caries (Selwitz *et al.* 2007). This risk determines whether or not a person or community is easily attacked by dental caries, and it can vary from time to time (Selwitz *et al.* 2007).

Water with fluoride is good if the fluoride content is >1 mg/L and water with calcium is good if the calcium content is >150 mg/L (Quattrini *et al.* 2016). This mineral intake can be obtained from food and drinks consumed every day (Northridge *et al.* 2003) and correlates with the concentration of calcium and phosphate in saliva (Dawood & El-Samarrai 2018). Saliva plays a role in facilitating ion transport (Sejdini *et al.* 2018). There is a direct correlation between the calcium, magnesium, and fluoride content of water and dentin samples (Razvan 2020). Low fluoride levels affect the strength of teeth to withstand the demineralization process caused by the chemical process between bacteria and sucrose (Puspa Dewi *et al.* 2019). Fluoride has three mechanisms for dental caries control, namely increasing remineralization, inhibiting demineralization, inhibiting glycolysis in dental caries bacteria (Ahmad 2018), increasing remineralization with calcium and phosphate, and being antimicrobial (O'Mullane *et al.* 2016). During the demineralization process, calcium is released before phosphate ions, and calcium will have optimal potential if combined with phosphate (Lin *et al.* 2014).

The higher the debris, the higher the risk of dental caries. The demineralization process occurs as long as bacteria and food debris are on the surface of the teeth. Dental caries is caused by an ecological imbalance between dental minerals and oral biofilm. The demineralization process in teeth occurs at a low pH when the oral environment is not saturated with mineral ions compared to the mineral content of the teeth. Enamel crystals, consisting of carbonated apatite, are dissolved by organic acids (lactic and acetic) produced by the cellular action of plaque bacteria in the presence of dietary carbohydrates (Sejdini *et al.* 2018). Food waste (debris) is the main factor causing dental caries which must be kept to a minimum level by implementing good behavior in maintaining the cleanliness of the tooth surface (Wasfi 2018). Debris is related to food waste containing carbohydrates and sugar which are substrates for the growth of bacteria (Rathee & Sapra 2020). Diet (Fiorillo 2019), eating habits (Shaohong & Linmei 2020), increased intake of refined carbohydrates and refined sugar (DiNicolantonio & O'Keefe 2018), night feedings, and excessive sugar intake (Qin *et al.* 2008) are associated with dental caries.

In this study, behavior is closely related to dental caries. The entire surface of the tooth has the potential to become a place for plaque to grow along with bacteria that cause dental caries. The frequency of brushing teeth, daily gargling habits, and oral hygiene status are related to dental caries (Kyaw Myint *et al.* 2020). Good dental hygiene behavior can reduce the demineralization process by producing a clean tooth surface, so that food residue and *Streptococcus mutans* do not produce acids that could harm your teeth.

CONCLUSION

The risk factor for dental caries in peatlands is debris. The risk factors for dental caries in non-peatland are calculus and water phosphate. In general, the risk factors for dental caries in peatlands and non-peatlands in West Kalimantan are pH and drinking water minerals (fluoride and calcium), debris, calculus, and behavior.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

REFERENCES

Ahmad, I. 2018 Mekanisme fluor sebagai kontrol karies pada gigi anak (The mechanism of fluorine as control of caries in children's teeth). *Dep Pedodonsia FKG UNPAD* **1** (1), 63–69.

A'idah, E., Destiarti, L. & Idiawati, N. 2018 Penentuan karakteristik air gambut di Kota Pontianak dan Kabupaten Kuburaya (Determining the characteristics of peat water in Pontianak City and Kuburaya Regency). *Jurnal Kimia Khatulistiwa* **7** (3), 91–96.

Ali, F., Lestari, D. L. & Putri, M. D. 2021 Peat water treatment as an alternative for raw water in peatlands area. *IOP Conference Series: Materials Science and Engineering* **1144** (1), 012052. https://doi.org/10.1088/1757-899X/1144/1/012052.

Arvin, E., Bardow, A. & Spliid, H. 2018 Caries affected by calcium and fluoride in drinking water and family income. *Journal of Water and Health* **16** (1), 49–56. https://doi.org/10.2166/wh.2017.139.

Astiani, D., Burhanuddin, B., Gusmayanti, E., Widiastuti, T. & Taherzadeh, M. J. 2018 Enhancing water levels of degraded, bare, tropical peatland in West Kalimantan, Indonesia: Impacts on CO_2 emission from soil respiration. *Biodiversitas Journal of Biological Diversity* **19** (2), 472–477. https://doi.org/10.13057/biodiv/d190221.

Chaffee, B. W., Rodrigues, P. H., Kramer, P. F., Vítolo, M. R. & Feldens, C. A. 2017 Oral health-related quality-of-life scores differ by socioeconomic status and caries experience. *Community Dentistry and Oral Epidemiology* **5** (7), 1–45 (3), 216–224. https://doi.org/10.1111/cdoe.12279.

Dawood, I. M. & El-Samarrai, S. K. 2018 Saliva and oral health. *International Journal of Advanced Research in Biological Sciences (IJARBS)* **5** (7), 1–45. https://doi.org/10.22192/ijarbs.2018.05.07.001.

DiNicolantonio, J. J. & O'Keefe, J. H. 2018 The introduction of refined carbohydrates in the Alaskan Inland Inuit diet may have led to an increase in dental caries, hypertension and atherosclerosis. *Open Heart* **5** (2), e000776. https://doi.org/10.1136/openhrt-2018-000776.

Fiorillo, L. 2019 Oral Health: The first step to well-being. *Medicina* **55** (10), 676. https://doi.org/10.3390/medicina55100676.

Fitri, H., Kasuma, N., Fajrin, F. N., Sovira, G. D. J., Aulia, R. K. & Huriyah, H. 2023 Description of the Simplified Oral Hygiene Index (Ohi-S) in Stunting Children. *Journal of International Dental and Medical Research.* **16** (2), 656–660.

Hartami, E., Irmawati, I. & Herawati, H. 2019 Perbedaan kadar kalsium dan fosfor gigi sulung pada anak dengan def-t rendah dan tinggi (Differences in primary teeth calcium and phosphorus levels in children with low and high DEF-T). *E-Prodenta Journal of Dentistry* **3** (2), 232–239. https://doi.org/10.21776/ub.eprodenta.2019.003.02.2.

Indonesia Ministry of Health 2018 *Laporan Provinsi Kalimantan Barat Riskedas 2018 (West Kalimantan Province Health Report 2018)*. In: National Health Report 2018. Indonesia.

Karamoy, Y. 2017 Hubungan Penyakit Gigi dan Mulut deangan Kualitas Hidup Anak di Kecamatan Talawan Kabupaten Minahasa Utara (The relationship between dental and oral diseases and the quality of life of children in Talawan District, North Minahasa Regency). *Jurnal Kesehatan Masyarakat Andalas* **11**, 1115–1119.

Khayan, K., Husodo, H., Sudarmadji, S. & Sugandawaty, S. 2017 Usate of filter tube to reduce Pb, turbidity and increase pH of rain water flowing through zinc rooftop house. *Jurnal Kesehatan 75 Masyarakat* **13** (1), 41–49.

Komarulzaman, A., de Jong, E. & Smits, J. 2017 The switch to refillable bottled water in Indonesia: A serious health risk. *Journal of Water and Health* **15** (6), 1004–1014.

Kyaw Myint, Z. C., Zaitsu, T., Oshiro, A., Ueno, M., Soe, K. K. & Kawaguchi, Y. 2020 Risk indicators of dental caries and gingivitis among 10 – 11-year-old students in Yangon, Myanmar. *International Dental Journal* **70** (3), 167–175. https://doi.org/10.1111/idj.12537.

Lestariningsih, N., Handayani, F. & Salasiah, S. 2018 Karakteristik Tanah Gambut dan Keanekaragaman Tumbuhan Tinggi di Taman Nasional Sebangau Kalimantan Tengah (Peat soil characteristics and high plant diversity in Sebangau National Park, Central Kalimantan). *Biosfer : Jurnal Tadris Biologi* **9** (1), 114. https://doi.org/10.24042/biosf.v9i1.2893.

Lin, H.-S., Lin, J.-R., Hu, S.-W., Kuo, H.-C. & Yang, Y.-H. 2014 Association of dietary calcium, phosphorus, and magnesium intake with caries status among school children. *The Kaohsiung Journal of Medical Sciences* **30** (4), 206–212. https://doi.org/10.1016/j.kjms.2013.12.002.

Naswir, M. & Lestari, I. 2014 Characterization active carbon and clum shell in reducing pH, color, COD, Fe and organic matter on peat water. *International Journal of Innovative Research in Advanced Engineering (IJIRAE)* **1** (11), 137–146.

Northridge, M. E., Sclar, E. D. & Biswas, P. 2003 Sorting out the connections between the built environment and health: A conceptual framework for navigating pathways and planning healthy cities. *Journal of Urban Health : Bulletin of the New York Academy of Medicine* **80** (4), 556–568. https://doi.org/10.1093/jurban/jtg064.

O'Mullane, D. M., Baez, R. J., Jones, S., Lennon, M. A., Petersen, P. E., Rugg-Gunn, A. J., Whelton, H. & Whitford, G. M. 2016 Fluoride and oral health. *Community Dental Health* **33** (2), 69–99. https://doi.org/10.1922/CDH_3707O'Mullane31.

Payus, C. & Meng, K. J. 2015 Consumption of rainwater harvesting in terms of water quality'. *International Journal of GEOMATE* **9** (2), 1515–1522. https://doi.org/10.21660/2015.18.95782.

Pitts, N., Zero, D., Marsh, P., Ekstrand, K., Weintraub, J., Ramos-Gomez, F., Tagami, J., Twetman, S., Tsakos, G. & Ismail, A. 2017 Dental caries. *Nature Reviews Disease Primers* **3**, 17030. https://doi.org/10.1038/nrdp.2017.30.

Puspa Dewi, S. R., Safitri, Y., Lany, L. E. & Dwi, R. S. 2019 *Gambaran kadar fluorida dalam air minum dan skor DMF-T anak 12 tahun di Sungai Pedado Palembang* (Description of fluoride levels in drinking water and DMF-T Scores for children 12 years old at the Pedado River, Palembang.). *Jurnal Riset Kesehatan* **8** (1), 68. https://doi.org/10.31983/jrk.v8i1.4089.

Qin, M., Li, J., Zhang, S. & Ma, W. 2008 Risk factors for severe early childhood caries in children younger than 4 years old in Beijing, China. *Pediatric Dentistry* **30** (6), 507–5132008.

Quattrini, S., Pampaloni, B. & Brandi, M. L. 2016 Natural mineral waters: Chemical characteristics and health effects. *Clinical Cases in Mineral and Bone Metabolism* **13** (3), 173–180. https://doi.org/10.11138/ccmbm/2016.13.3.173.

Rathee, M. & Sapra, A. 2020 *Dental Caries – StatPearls – NCBI Bookshelf*, pp. 1–7. Available from: https://www.ncbi.nlm.nih.gov/books/NBK551699/ (accessed 17 June 2023).

Razvan, C. 2020 The correlation between the mineral drinking water composition and the relevance of dentine in health – A pilot study. *Pakistan Journal of Medical Sciences* **36** (3). https://doi.org/10.12669/pjms.36.3.1820.

Said, Y. M., Achnopa, Y., Zahar, W. & Wibowo, Y. G. 2019 *Karakteristik fisika dan kimia air gambut Kabupaten Tanjung Jabung Barat, Provinsi Jambi* (Physical and chemical characteristics of peat water, West Tanjung Jabung Regency, Jambi Province). *Jurnal Sains Dan Teknologi Lingkungan* **11** (2 (Juni)), 132–142.

Sejdini, M., Meqa, K., Berisha, N., Çitaku, E., Aliu, N., Krasniqi, S. & Salihu, S. 2018 The effect of Ca and Mg concentrations and quantity and their correlation with caries intensity in school-age children. *International Journal of Dentistry* **2018**. https://doi.org/10.1155/2018/2759040.

Selwitz, R. H., Ismail, A. I. & Pitts, N. B. 2007 Dental caries. *The Lancet* **369** (9555), 51–59. https://doi.org/10.1016/S0140-6736(07)60031-2.

Shaohong, H. & Linmei, W. U. 2020 The prevalence of dental caries in urban areas is lower than that in rural areas – analysis of changes in the epidemiological characteristics of caries in urban and rural areas. *Journal of Prevention and Treatment for Stomatological Diseases* **28** (5), 273–278.

Suryanti, N., Bahar, A., Rahardjo, A., Seniati, A. N. L. & Maharani, D. A. 2019 Validity and reliability of the Indonesian version of oral hygiene behavior index questionnaire: A cross sectional study among young adolescents in junior high school in Bandung, Indonesia. *Journal of International Dental and Medical Research* **12** (2), 633–639.

Velásquez, N., Pérez-Ybarra, L., Urdaneta, C. J. & Pérez-Domínguez, M. 2019 *Asociación de sialometría, fosfato y calcio en saliva total bajo estímulo y en líquido crevicular gingival con caries dental en escolares* (Association of sialometry, phosphate and calcium in total saliva under stimulation and in gingival crevicular fluid with dental caries in schoolchildren). *Biomédica* **39** (1), 157–169. https://doi.org/10.7705/biomedica.v39i1.4069.

Wahyunto, S. R. & Subagjo, H. 2004 *Peta Sebaran Gambut, Luas dan Kandungan Karbon di Kalimantan 2000*-2002 (Map of Peatland Distribution Area and Carbon Content in Kalimantan 2000-2002). *Wetlands International – Indonesia Programme & Wildlife Habitat Canada (WHC)*, *Laporan ini dWetlands International – Indonesia Programme Jalan A.Yani No.53 Bogor P.O.Box 254/Boo 16002 Jawa Barat*, 1–52. Available from: http://wetlands.or.id/PDF/buku/Atlas Sebaran Gambut Kalimantan.pdf (accessed 17 June 2023).

Wasfi, R. 2018 Probiotic *Lactobacillus sp.* inhibit growth, biofilm formation and gene expression of caries-inducing *Streptococcus mutans*. *Journal of Cellular and Molecular Medicine* **22**, 1972–1983. https://pubmed.ncbi.nlm.nih.gov/29316223/.

WHO 2019 *Ending Childhood Dental Caries: WHO Implementation Manual*. World Health Organization, Geneva; 2019. Licence: CC BY-NC-SA 3.0IGO.

Yani, R. W. E., Palupi, R., Bramantoro, T. & Setijanto, D. 2019 Analysis of calcium levels in groundwater and dental caries in the coastal population of an archipelago country. *Open Access Macedonian Journal of Medical Sciences* **7** (1), 134–138. https://doi.org/10.3889/oamjms.2019.013.

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