

## Risk Factors of Dental Caries: Consumption of Sugary Snacks Among Indonesian Adolescents

Lendrawati Lendrawati<sup>1</sup>, Sondang Pintauli<sup>2</sup>, Anton Rahardjo<sup>3</sup>, Adang Bachtiar<sup>4</sup>, Diah Ayu Maharani<sup>5</sup>

<sup>1</sup>Department of Preventive and Public Health Dentistry, Faculty of Dentistry, University of Sumatera Utara, Sumatera, Indonesia.

 0000-0003-1581-4800

<sup>2</sup>Department of Preventive and Public Health Dentistry, Faculty of Dentistry, University of Sumatera Utara, Sumatera, Indonesia.

 0000-0001-6599-2598

<sup>3</sup>Department of Preventive and Public Health Dentistry, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia.

 0000-0001-7836-9084

<sup>4</sup>Department of Public Health, Faculty of Public Health, Universitas Indonesia, Jawa Barat, Indonesia.  0000-0003-3321-9757

<sup>5</sup>Department of Preventive and Public Health Dentistry, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia.

 0000-0001-6713-786X

Author to whom correspondence should be addressed: Anton Rahardjo, Department of Preventive and Public Health Dentistry, Faculty of Dentistry, University of Indonesia, Jalan Salemba No. 4, Jakarta, Indonesia 10430. Phone: +62-816774416. E-mail: [anton\\_r@ui.ac.id](mailto:anton_r@ui.ac.id).

Academic Editors: Alessandro Leite Cavalcanti and Wilton Wilney Nascimento Padilha

Received: 31 October 2018 / Accepted: 29 January 2019 / Published: 07 February 2019

### Abstract

**Objective:** To determine the risk factors of caries among adolescents in Padang City, by assessing the frequency of sugary snack consumption. **Material and Methods:** A cross-sectional study was conducted on 150 randomly selected junior high school students using a self-administered questionnaire along with oral examinations. The questionnaire consisted of questions on socio-demographic characteristics, oral health behavior, and frequency of consumption of sugary foods. Data were analyzed using the Chi-square tests and multivariate analysis. **Results:** Dental caries was found in 61% of the total students and was more prevalent in males when compared with females. The mean DMFT score was  $1.3 \pm 1.4$ . Sugary snack consumption, attitude, and protective factors were significantly related to the occurrence of caries ( $p < 0.001$ ). The risk of dental caries in subjects with high amounts of sugary snack consumption was 5.67 times higher (OR=5.7; CI: 2.7-11.9) than those with low consumption. Subjects with low protective factors, high consumption of sugary foods and drinks, and bad attitude presented with a caries prevalence of 94%. **Conclusion:** The consumption of sugary foods was found to play an important role in the development of caries in the current study.

**Keywords:** Health Risk Behaviors; Sugars; Risk Factors; Diet, Cariogenic; Dental Caries.

## Introduction

The urgent need to provide a public health response to the threat of non-communicable diseases resulted in the formulation of a global strategy for effective prevention and control of diseases [1]. The World Health Organization (WHO) global action plan for the prevention and control of infectious diseases (2013–2030) focused on various methods to recognize the risks to oral and non-communicable diseases and to design risk factor approaches for the prevention of oral and dental disease and for the maintenance of good oral health [2,3]. Empowering behavior change is better than simply giving information to individuals, communities, and the population in general. Individuals should take greater responsibility for health care and maintain their health by adopting healthy behaviors [1].

Dental caries is a multi-factorial disease known to result from a chronic imbalance between multiple risk and protective factors. It remains a public health problem in several countries with increasing prevalence in some developing countries, including Indonesia. Dental caries is generally preventable by avoiding the risk factors associated with it and is expected to improve with appropriate public health programs [4]. Sugar is the most important dietary factor associated with the development of dental caries, one of the most common diseases in the world [5]. A significant relationship between sugar consumption and caries incidence rates has been reported despite the use of fluoridated drinking water and fluoride-containing toothpastes [6,7]. Approximately 90% of food sugar or starch allows bacteria in plaque to produce acids 20 min after consumption, leading to loss of minerals in the enamel, and resulting in caries [6,8]. Enamel erosion caused by acids in carbonated beverages is thought to be worse than that produced by bacteria from sugar and sweet drinks [5,9].

The WHO and Food and Drug Interactions had initially recommended that sugar consumption should be less than 10% of the total energy intake per day; however, they currently recommend a reduction of less than 5% of the total energy intake per day, which is equivalent to approximately 25 grams (about six teaspoons) of sugar per day for adults [10]. The burden of dental caries in adults is much greater than that in children; therefore, a sugar consumption of 2%-3% of the total energy intake has been suggested for adults along with optimal fluoride use. Studies have shown that caries does not occur if sugar consumption is very low [11,12]. Indonesia's per capita sugar consumption has increased from 11.24 kg per capita in 2014 to 11.32 kg per capita in 2015, especially in households and home industries, due to increase in population and economic growth [13].

The period of adolescence is characterized by a significant increase in caries activity due to several factors, such as imperfect tooth enamel maturation, increase in total susceptible tooth surface area, environmental factors (such as diet), independent behaviors, and low priority for oral hygiene. In addition, enamel calcification at the time of eruption is incomplete, making the teeth susceptible to caries development, especially during the first two years after tooth eruption [14,15]. The transition from childhood to adolescence is the most dynamic period in human development, involving physical,

emotional, intellectual, and social changes. Therefore, it is essential as the best foundation for health independence and shapes adolescents' future as healthy adults [16,17].

A study conducted among schoolchildren in Uganda utilized a food frequency questionnaire to categorize individuals by the amount of sugar consumption (low and high) [18]. They reported that eight items of sugar-containing foods were not sufficient to estimate the absolute sugar intake, but could distinguish between individuals with high and low sugar consumption; therefore, the questionnaire can be used to identify the risk of caries in children [18]. The WHO has recommended the use of a structured questionnaire for data collection on oral health and risk factors among adults and children or adolescents [19]. The questionnaire has been simplified and tested in various countries around the world. It includes core questions that are considered essential in oral health, and the questions and answers can be tailored to the needs of the community. The questionnaire on the consumption of foods containing sugar is found in the Oral Health Questionnaire for Children [19]. The present study aimed to identify the risk factors of dental caries among adolescents (junior high school students) in Padang by assessing the frequency of sugary snack consumption and dental caries incidence using a questionnaire developed by the WHO.

## **Material and Methods**

### **Study Design and Sample**

This cross-sectional study was conducted on 150 junior high school students (males, 64; females, 86; age, 12-15 years) who were randomly selected from the Padang Municipality, West Sumatra province, Indonesia. The schools were spread over eleven sub-districts and selected by using the cluster sampling method. The self-administrated questionnaires were provided to the students and completed by them after providing them with explanations and ensuring that they had understood the questions.

### **Data Collection**

The questionnaire consisted of socio-demographic, protective factor, and attitude factor items. Socio-demographic data included questions regarding age, sex, and caries status of the participant, and level of education of parents. Protective factors consisted of the following five items: last visit to the dentist, tooth brushing habit after breakfast, tooth brushing habit before sleep, use of toothpaste, and consumption of fruits and vegetables every day. The risk factors of caries were evaluated using the eight-item self-administered questionnaire for frequency of consumption of sugary foods and drinks (biscuits, chocolates, ice cream/stick, candy, jelly/dessert, soft drinks, milk containing sugar, and tea/coffee with sugar) with a Likert response format (0=never, 1=seldom, 2=sometimes, 3=often, 4=very often, and 5=always) [17].

The attitude factor consisted of the following seven items: pain indicates the presence of a cavity; brown discoloration on tooth surface is a sign of damage; dental cavities should be filled; sweet drinks and soft drinks cause tooth damage; regular tooth brushing prevents cavities; after

breakfast is the best time for brushing teeth; and before bed is the best time for brushing teeth at night. The questionnaire was answered with a “yes” or “no”. Dental caries status was examined by two calibrated examiners (Kappa = 0.76) who were not involved in the study.

### Data Analysis

All data were recorded and analyzed using IBM SPSS Statistics for Windows Software, version 20 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to calculate the absolute and relative frequencies, mean and standard deviation. The Chi-square test and Odds Ratio (OR) were applied, with  $p < 0.05$ . Multivariate analysis was conducted using logistic regression to evaluate the influence of independent variables on the dependent variable in order to ascertain the factors responsible for dental caries.

### Ethical Aspects

Ethical approval was obtained from the Health Research Ethical Committee, Faculty of Medicine, University of Sumatera Utara.

### Results

The demographic characteristics of the participants are shown in Table 1. The mean DMFT was 1.3 ( $\pm 1.4$ ; minimum 0 and maximum 7). Fifty-nine students (40%) were caries-free (DMFT=0). The majority of the students presented with enamel caries (D1=24%; D2=17%; D3=11%), while one student (0.7%) had deep caries (D7). The prevalence of caries was higher in males than in females, 63% and 60% respectively (Table 1). The variables that affected the occurrence of caries were protective factors, risk factors, and attitude.

**Table 1. Distribution of participants according to demographic characteristics and caries status.**

Variables	Gender				Total	
	Boys		Girls		N	%
	N	%	N	%	N	%
Age (Years)						
12-13	34	53.1	37	43.0	71	47.3
14-15	30	46.9	49	57.0	79	52.7
Father's Education						
Low	26	40.6	37	43.0	63	42.0
High	38	59.4	49	57.0	87	58.0
Mother's Education						
Low	25	39.1	43	50.0	68	45.3
High	39	60.9	43	50.0	82	54.7
Caries Status						
DMF-T = 0	24	37.5	35	40.7	59	39.3
DMF-T > 0	40	62.5	51	59.3	91	60.7

A total of 52% of the students have a bad protection and occurrence of caries (61%). The questionnaire consisted of questions evaluating the performance of activities undertaken by the

students to maintain oral and dental hygiene. The protective factors were found to be active in the majority of the students in this study; visit to the dentist for dental treatment was the least represented among the students (n=71, 47%). The protective factors were more strongly manifested by the females when compared to the males, wherein females were found to visit the dentist more often (59%), brush their teeth more diligently after breakfast and before bed (59%), and consume more fruits and vegetables (66%). The most frequently consumed sugary food was ice cream/ice sticks (once a week; 88%), which was more prevalent among the females. Biscuits were consumed once a day by 39% of the females, while chocolates were eaten several times a month by 60% of the females in the current study. Soft drinks were consumed by 62% of the females several times a month.

The results of the assessment of the attitude factors in this study showed that some students disagreed that the best time to brush their teeth in the morning was after breakfast (31%), and that cavities due to dental caries should be filled immediately (27%). A total of 111 students (74%) demonstrated the right attitude toward dental health and were free from caries, whereas students with poor dental attitude experienced poor dental health and caries (85%). The strengths of the relationships between the independent variables and the dependent variable are shown in Table 2.

**Table 2. Significant associations showing odds ratio (OR) for dental caries occurrence.**

Risk Factor	B	Wald	p-value	OR	95% CI	
					Lower	Upper
Protective Factor	0.94	6.07	0.01	2.55	1.21	5.38
Risk Factor (FFQ)	1.46	13.19	0.00	4.29	1.96	9.42
Attitude	1.27	5.94	0.02	3.55	1.28	9.84

FFQ: Food Frequency Questionnaire; CI: Confidence Interval.

## Discussion

High consumption of sugar found in food and beverages is the main risk factor for caries and is the chief factor to be considered for the prevention, control, and treatment of caries [20]. Sugar produces a substrate for the growth of cariogenic bacteria, which produce acid and cause demineralization of the tooth enamel. The treatment strategies employed for caries control have not paid attention to this fundamental process thus far, which has resulted in the spread of caries as a multi-factorial disease that affects numerous people, making it a social burden due to the costs involved in treating the condition. One reason for the failure in caries control is the ignoring of the fundamental points that result in the progression of the disease in both children and adults. Dental caries is seen as a chronic disease that develops over a lifetime [6,8].

Strategies and approaches for the prevention of dental and oral diseases can be conducted by health promotion. Adolescent groups are considered an essential target for health promotion activities because the behaviors that are formed during adolescence can persist in adult life [20]. One of the critical approaches to understanding positive youth development has been to focus on the Five C's, which consisted of competence, confidence, connection, character, and caring. Teens who have

understood the Five C's will be on a path of development that results in the development of the sixth C, which is, contributing to self, family, and society [21]. The purpose of youth development is consistent with primary prevention. Primary prevention aims to reduce the incidence or number of new cases. Youth development exceeds prevention but for the development of health promotion and not just avoiding problems. Promotion of strength, resilience, and health in the community is defined as primary prevention for young people [13,7].

It is advice that individuals should reduce the frequency of consumption of foods containing sugar to up to four times a day, and limit the consumption of free sugar [22]. In countries where fluoride-containing toothpastes are available, people should brush their teeth twice a day; furthermore, it is advisable to limit the intake of free sugars to 10% or 5% of the total energy intake as part of a balanced diet [22]. Previous research showed that the ratio of dental caries increase between the ages of 6 and 18 years was 20% and 66% higher in high-sugar consumer groups when compared with low-sugar consumers [23]. The higher the consumption of sugar throughout life's journey, the higher the increase of dental caries [23].

WHO recommendations should be followed by national nutrition-related policies to reduce the intake of free sugars and to maintain dental and general health [22]. The American Heart Association recommends no more than three teaspoons of sugar (or 12 g) for children each day [24]. There is a need for home-based interventions that reduce added sugar intake to help prevent tooth decay as well as other systemic diseases linked to sugar, such as obesity, diabetes, hypertension, and cardiovascular disease [25]. Community-centered educational interventions could also be implemented within stores, homes, and clinical settings [26]. Preventive efforts should target the deleterious effects of added sugars by providing viable alternatives to sugar-sweetened beverages, making it easier for individuals to access fluorides and other types of preventive care that help to control tooth decay [25].

The protective factors that are found to effect a decrease in the risk of caries development are not strongly observed and are active in a very small number of children [27]. The risk factors found to be active in the group proved to be much more powerful [28]. The occurrence of risk factors has been proven in children. These factors represent a serious risk, provoking the development of caries. The combined action of the two types of factors tips the balance toward development of the caries process. The intermediate intake of carbohydrates and sweetened beverages along with inadequate oral hygiene are the strongest risk factors for children [27]. The chances of developing caries can be avoided to a large extent by avoiding sugary snacks and improving both attitude and protective factors. Therefore, it is advisable to reduce the consumption sugary snack and to provide dental health education, especially during adolescence, a period that represents major personal changes in an individual's life.

## Conclusion

The consumption of sugary foods is significantly associated with the occurrence of dental caries. Sugary snacks, attitude factors, and protective factors were found to influence the occurrence

of dental caries. Adolescence is a potential period of personal changes and action in the society; therefore, it is important to emphasize the positive effects of caries prevention during this period.

**Financial Support:** None.

**Conflict of Interest:** The authors declare no conflicts of interest.

## References

- [1] World Health Organization. Regional Committee for Europe. Behaviour change strategies and health: The role of health systems. Georgia: WHO, 2008.
- [2] Kwan SY, Petersen PE, Pine CM, Borutta A. Health promoting schools: An opportunity for oral health promotion. *Bull World Health Organ* 2005; 83(9):667-85.
- [3] Fukai K, Ogawa H, Hescot P. Oral health for healthy longevity in an ageing society: Maintaining momentum and moving forward. *Int Dent J* 2017; 67(S2):3-6. <https://doi.org/10.1111/idj.12347>
- [4] Fejerskov O, Kidd E. *Dental Caries: The Disease and its Clinical Management*. 2<sup>nd</sup>. ed. Oxford: Blackwell Munksgraad, 2008.
- [5] Sheiham A, James WP. A reappraisal of the quantitative relationship between sugar intake and dental caries: The need for new criteria for developing goals for sugar intake. *BMC Public Health* 2014; 14:863. <https://doi.org/10.1186/1471-2458-14-863>
- [6] Sheiham A, James WP. Diet and dental caries: The pivotal role of free sugars reemphasized. *J Dent Res* 2015; 94(10):1341-7. <https://doi.org/10.1177/0022034515590377>
- [7] Sheiham A, James WP. A new understanding of the relationship between sugars, dental caries and fluoride use: Implications for limits on sugars consumption. *Public Health Nutr* 2014; 17(10):2176-84. <https://doi.org/10.1017/S136898001400113X>
- [8] Quadri FA, Hendriyani H, Pramono A, Jafer M. Knowledge, attitudes and practices of sweet food and beverage consumption and its association with dental caries among schoolchildren in Jazan, Saudi Arabia. *East Mediterr Health J* 2015; 21(6):403-11.
- [9] Cheng R, Yang H, Shao M, Hu T, Zhou X. Dental erosion and severe tooth decay related to soft drinks: A case report and literature review. *J Zhejiang Univ Sci B* 2009; 10(5):395-9. <https://doi.org/10.1631/jzus.B0820245>
- [10] World Health Organization. *Guideline: Sugar Intake for Adults and Children*. Geneva: World Health Organization; 2015. Available at: [https://apps.who.int/iris/bitstream/handle/10665/149782/9789241549028\\_eng.pdf;jsessionid=0C598ECA933872BDA322D4A53E486401?sequence=1](https://apps.who.int/iris/bitstream/handle/10665/149782/9789241549028_eng.pdf;jsessionid=0C598ECA933872BDA322D4A53E486401?sequence=1). [Accessed on August 28, 2018]
- [11] Moynihan PJ, Kelly SAM. Effect on caries of restricting sugars intake: Systematic review to inform WHO guidelines. *J Dent Res* 2014; 93(1):8-18. <https://doi.org/10.1177/0022034513508954>
- [12] Mann J, Fleck F. The science behind the sweetness in our diets. *Bull World Health Organ* 2014; 92(11):780-1. <https://doi.org/10.2471/BLT.14.031114>
- [13] USDA Foreign Agricultural Service. *Indonesia Sugar Annual Report 2017*. Global Agricultural Information Network, 2017.
- [14] Clinical Affairs Committee, American Academy of Pediatric Dentistry. *Guideline on Adolescent Oral Health Care*. *Pediatr Dent* 2015; 37(5):49-56.
- [15] Lacruz RS, Habelitz S, Wright JT, Paine ML. Dental enamel formation and implications for oral health and disease. *Physiol Rev* 2017; 97(3):939-93. <https://doi.org/10.1152/physrev.00030.2016>
- [16] Patton GC, Sawyer SM, Santelli JS, Ross DA, Afifi R, B Allen NB, et al. Our future: A Lancet commission on adolescent health and wellbeing. *Lancet* 2016; 387(10036):2423-78. [https://doi.org/10.1016/S0140-6736\(16\)00579-1](https://doi.org/10.1016/S0140-6736(16)00579-1)
- [17] World Health Organization. *Meeting Report: Nurturing Human Capital along the Life Course: Investing in Early Child Development*. Geneva: WHO, 2013. 28p.
- [18] Kiwanuka SN, Åström AN, Trovik TA. Sugar snack consumption in Ugandan schoolchildren: Validity and reliability of a food frequency questionnaire. *Community Dent Oral Epidemiol* 2006; 34(5):372-80. <https://doi.org/10.1111/j.1600-0528.2006.00287.x>

- [19] World Health Organization. Oral Health Survey: Basic Methods. 5<sup>th</sup>. ed. Geneva: World Health Organization, 2013.
- [20] Majewski RF. Dental caries in adolescents associated with caffeinated carbonated beverages. *Pediatr Dent* 2001; 23(3):198-203.
- [21] Ferber T, Gaines E, Goodman C. Positive Youth Development: State Strategies. Research and Policy Report. National Conference of State Legislatures, 2005. 13p.
- [22] Moynihan P. Sugars and dental caries: Evidence for setting a recommended threshold for intake. *Adv Nutr* 2016; 7(1):149-56. <https://doi.org/10.3945/an.115.009365>
- [23] Peres MA, Sheiham A, Liu P, Demarco FF, Silva AE, Assunção MC, et al. Sugar consumption and changes in dental caries from childhood to adolescence. *J Dent Res* 2016; 95(4):388-94. <https://doi.org/10.1177/0022034515625907>
- [24] Johnson RK, Appel LJ, Brands M, Howard BV, Lefevre M, Lustig RH, et al. Dietary sugars intake and cardiovascular health: A scientific statement from the American Heart Association. *Circulation* 2009; 120(11):1011-20. <https://doi.org/10.1161/CIRCULATIONAHA.109.192627>
- [25] Chi DL, Hopkins S, O'Brien D, Mancl L, Orr E, Lenaker D. Association between added sugar intake and dental caries in Yup'ik children using a novel hair biomarker. *BMC Oral Health* 2015; 15:121. <https://doi.org/10.1186/s12903-015-0101-z>
- [26] Avery A, Bostock L, McCullough F. A systematic review investigating interventions that can help reduce consumption of sugar-sweetened beverages in children leading to changes in body fatness. *J Hum Nutr Diet* 2015; 28(S1):52-64. <https://doi.org/10.1111/jhn.12267>
- [27] Peneva M. Dental caries – disturbed balance of the risk factors. *J IMAB* 2007; 13(2):61-3.
- [28] Featherstone JD. Caries prevention and reversal based on the caries balance. *Pediatr Dent* 2006; 28(2):128-32.