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Research Report

A spatial mapping of children's toothache prevalence and its determinants

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ABSTRACT

Background: Toothache is the most common oral pain and has been confirmed as a public health problem. World Health Organization (WHO) stated that oral health problem impacts 90% of pre-adolescent, ranging from the feeling of distressing pain, nutritional intake disturbance, to the extent of school absence. Geospatial Information System (GIS) is a method to describe a data in a spatial geographic mapping, it can be a valuable tool to explore the relationships between health and its determinant factors, and also show the locations where the problem occurs. **Purpose:** To describe the geospatial mapping of toothache prevalence and its determinant behavioural factors among Indonesian children. **Methods:** It is a secondary data analysis of the 5th wave of Indonesian Family Life Survey (IFLS) data. The 7,010 respondents' data from children aged 5-15 years old were analysed and mapped using Quantum GIS. Geospatial data mapping was conducted by inserting toothache prevalence and its determinant factors to the geographical map. **Results:** Based on the mapping, there are a consistent pattern of the prevalence, in which South Sulawesi and South Kalimantan provinces have the very high number in toothache prevalence, bad sugar consumption behavior and bad toothbrushing behavior. **Conclusions:** This study showed the prevalence and distribution of toothache and its behavioural determinants among children age 5-15 years old in Indonesia, across provinces. Therefore, toothache among Indonesian children is an oral health problem that needs attention and intervention.

Keywords: Toothache prevalence; Indonesian Family Life Survey Data; Spatial analysis; Child health; Medicine

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INTRODUCTION

Toothache is the most common oral pain and has been confirmed as a public health problem.[1] World Health Organization (WHO) stated that oral health problem impacts 90% of pre-adolescent, ranging from the feeling of distressing pain, nutritional intake disturbance, to the extent of school absence.[2] Toothache is one of the symptoms of oral health problems, such as dental caries. Dental caries is a most common chronic oral disease in children resulting from the interaction of bacteria and sugary food in tooth enamel.[3] Dental caries is also the most prevalent oral health problem among children. Indonesian Basic Health Survey in 2018 reported that dental caries prevalences among five to nine and ten to fourteen years old children were 92.6% and 73.4% respectively.[4]

Most of the dental caries cases are related to oral health behaviors, such as frequent sweet food consumption and low awareness of maintaining dental hygiene.[5] A study conducted by Colak et al. (2013) showed that there is a relationship between dental caries and socioeconomical status, which state that dental caries is more common in children living in poverty, including children from ethnic and racial minorities, and children whose parents have low levels of education.[3] Gender and age factors also affect the toothache related to oral health.[6] Su et al (2018) showed that dental caries prevalence increase as the age increases, while female population has better oral health index than male.[6]

Studies concerning of toothache and its determinant factors have been done in some countries. Kakoei et al. (2013) studied the toothache prevalence and its contributing factors in Southeast Iran and found that 55.1% of the population suffer from toothache.[1] Bakar et al. (2020) also conducted a study of toothache prevalence in Indonesian children and its determining factors, and found that the prevalence have been rising from 2007 to 2014, from 10.66% and 15.55% respectively.[7] However, there is still limited study that using the geospatial mapping to describe

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the prevalence and determinant factors of toothache prevalence.

Geospatial Information System (GIS) is a method to describe a data in a spatial geographic mapping.[8] GIS is still rarely used in public health and dentistry. GIS can be a valuable tool to explore the relationships between health and its determinant factors, and also show the locations where the problem occurs.[9] The aim of this study is to describe the geospatial mapping of toothache prevalence and its determinant factors among Indonesian children.

MATERIALS AND METHODS

This study is a secondary data analysis of the 5th wave of the Indonesian Family Life Survey (IFLS) data conducted in 2014 - 2015, with subclass sample of children aged 5 to 15 years old. IFLS wave 5 is the latest survey from the sequence of IFLS longitudinal survey. The IFLS wave 5 study was obtained an ethical clearance from Gajah Mada University (UGM), Indonesia and the Institutional Review Board (IRB) at RAND Corp, USA. This particular study was approved by the Ethics Committee of Faculty of Dental Medicine, Airlangga University (No. 342/HRECC.FODM/VII/2020). The data included in this study contains toothache prevalence and the determinant factors i.e. sweet foods and beverages consumption, toothbrushing behavior, socioeconomic status, and the parents' education.

Children's age was divided into two groups i.e. five to nine years old and ten to fifteen years old. For toothbrushing behavior, the respondents were asked how many times they brush their teeth daily and then the answers can be categorized as 'brushing teeth less than twice daily or twice daily but infrequently' and 'brushing teeth twice daily or more'. The sugars consumption behavior was measured from the frequency of consumption of sweet food and beverages ranging from score 1-7, represents the frequency of consumption on a weekly basis. Food and beverages score are taken separately, so the score can up to be 14, in which 0-7 is categorized as 'good' and 8-14 as 'bad'. Parent's education is measured based on the father's formal education, where 0-6 years of education was categorized as 'elementary school' and 7-12 years of education or more was categorized as 'secondary school'. The data for socioeconomic status were self-reported by the parents (father) and have six continuous level, with each level representing a gradual increase. Level 1 indicated the lowest socioeconomic status, and level 6 was the highest. The socioeconomic status was then categorized into two categories i.e. low socioeconomic status (level 1-3) and high socioeconomic status (level 4-6). The determinant factors were shown by descriptive tabulation and then transferred into geospatial data.

The secondary data analysis was conducted using statistical package for social science (SPSS, IBM Corporation, Illinois, US) version 25 and Quantum GIS (QGIS) ver. 3.10 software. Mapping of geospatial data was conducted by inserting toothache prevalence and its determinant factors to the geographical map.

RESULTS

Table 1 showed the characteristics of the study participants, including the toothache prevalence and its determinant factors. The toothache prevalence in this study was 17.7%. Most of the respondents have good sugar consumption behavior (90.2%) and good toothbrushing behavior (80.5%). As for the socioeconomic status, 78.5% of the respondents are from family with low socioeconomic status.

Table 2 revealed that children aged five to nine years have higher toothache prevalence (20.1%) than 10-15 years old children (14.9%). The children with bad sugar consumption behavior and bad toothbrushing behavior had higher prevalence of toothache than their counterparts (21.0% vs 17.3% and 20.2% vs 17.1%, respectively). The family from lower socioeconomical status have slightly higher number of toothache prevalence (18.6% vs 16.1%),

Table 1. Characteristics of participants

Category	Frequency (n)	Percentage (%)
Toothache		
Yes	1,241	17.7%
No	5,769	82.3%
Age		
5-9 years old	3,731	53.2%
10-15 years old	3,279	46.8%
Gender		
Male	3,625	51.7%
Female	3,385	46.8%
Sugars consumption behavior		
Good	6,321	90.2%
Bad	689	9.8%
Toothbrushing behavior		
Good (2 times a day or more frequently)	5,641	80.5%
Bad (Less than 2 times a day or 2 times but not frequently)	1,369	19.5%
Family socioeconomic status		
Low socioeconomic status	5,503	78.5%
High socioeconomic status	1,507	21.5%
Parents Education		
Elementary school	2,375	33.9%
Secondary school or higher	4,635	66.1%

while parent's education level does not have a significant difference.

Geospatial mapping of toothache prevalence, bad sugar consumption behavior, and bad toothbrushing behavior among 5-15 years old Indonesian children using GIS. Geospatial mapping using the GIS was conducted in 13 IFLS main provinces, which were North Sumatera, West Sumatera, South Sumatera, Lampung, DKI Jakarta, West Java, Central Java, Yogyakarta, East Java, Bali, NTB, South Kalimantan, and South Sulawesi.

Table 3 revealed the distribution of toothache prevalence as well as the percentage of the population having bad sugar consumption behavior and bad toothbrushing behavior in each Indonesian province. There are three province that have the highest toothache prevalence, which are West Java (22.2%), South Kalimantan (21.2%) and South Sulawesi (20.3%). The bad sugar consumption behavior was defined as frequent consumption of sugar (8-14 times a week), and the highest percentage was from South Sulawesi (16%). Furthermore, the province with the highest percentage of bad toothbrushing behavior was West Sumatera (26.2%).

Geospatial maps were made based on the table 3, and presented in Figure 1 to 3. Based from Figure 1, the highest toothache prevalence is indicated with dark red color and can be seen in West Java, South Kalimantan, South Sulawesi, and DKI Jakarta. The lightest color, which indicated the lowest prevalence, is seen in South Sumatera, Lampung, and Yogyakarta. Figure 2 showed the bad sugar consumption behavior across Indonesian provinces. The highest prevalence was indicated with dark blue color i.e. Bali, NTB, South Kalimantan, South Sulawesi. Figure 3 showed the geospatial map of bad toothbrushing behavior. As the darkest color indicated, the highest number of bad toothbrushing behavior can be seen in NTB province, along with North Sumatera and West Sumatera. Most of province have moderate number, while the lowest can be seen in South Sumatera and Yogyakarta.

Table 2. Association of age, gender, sugar consumption behavior, toothbrushing behavior, family socioeconomic status, and parents' education with toothache prevalence

Category	Toothache	
	Yes (n[%])	No (n[%])
Age		
5-9 years old	751 (20.1%)	2,980 (79.9%)
10-15 years old	490 (14.9%)	2,789 (85.1%)
Gender		
Male	606 (16.7%)	3,019 (83.3%)
Female	635 (18.8%)	2,750 (81.2%)
Sugars consumption behavior		
Good	1,096 (17.3%)	5225 (82.7%)
Bad	145 (21.0%)	544 (79.0%)
Toothbrushing behavior		
Good (2 times a day or more frequently)	965 (17.1%)	4676 (82.9%)
Bad (Less than 2 times a day or 2 times but not frequently)	276 (20.2%)	1093 (79.8%)
Family socioeconomic status		
Low socioeconomic status	998 (18.1%)	4505 (81.9%)
High socioeconomic status	243 (16.1%)	1264 (83.9%)
Parents Education		
Elementary school	425 (17.9%)	1,950 (82.1%)
Secondary school or higher	816 (17.6%)	3,819 (82.4%)

Table 3. Distribution of toothache, bad sugar consumption behavior, and bad toothbrushing behavior in each Indonesian province included in the study

Province	Toothache	Bad sugar consumption behavior	Bad toothbrushing behavior
North Sumatera	16.5%	9.1%	25.9%
West Sumatera	18.2%	7.7%	26.2%
South Sumatera	15.3%	5.9%	12.9%
Lampung	15.3%	10.1%	14.4%
DKI Jakarta	18.6%	10.8%	15.9%
West Java	22.0%	8.3%	19.3%
Central Java	17.9%	6.7%	18.%
Yogyakarta	13.6%	7.5%	11.2%
East Java	16.0%	9.0%	17.2%
Bali	16.6%	14.9%	20.8%
South Kalimantan	21.2%	13.2%	21.5%
South Sulawesi	20.3%	16.0%	22.3%

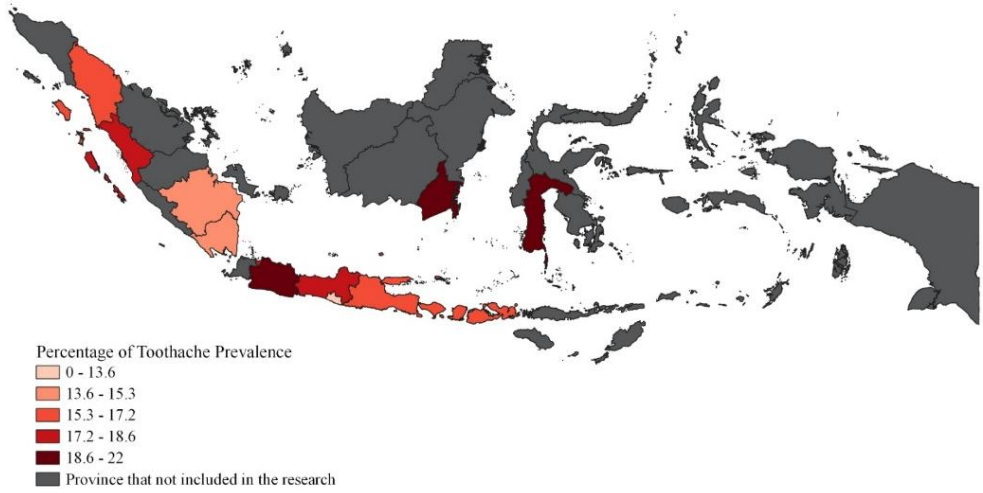

Figure 1. Geospatial Mapping of Toothache Prevalence among 5 to 15 years old. The darkest colour indicated the highest prevalence.

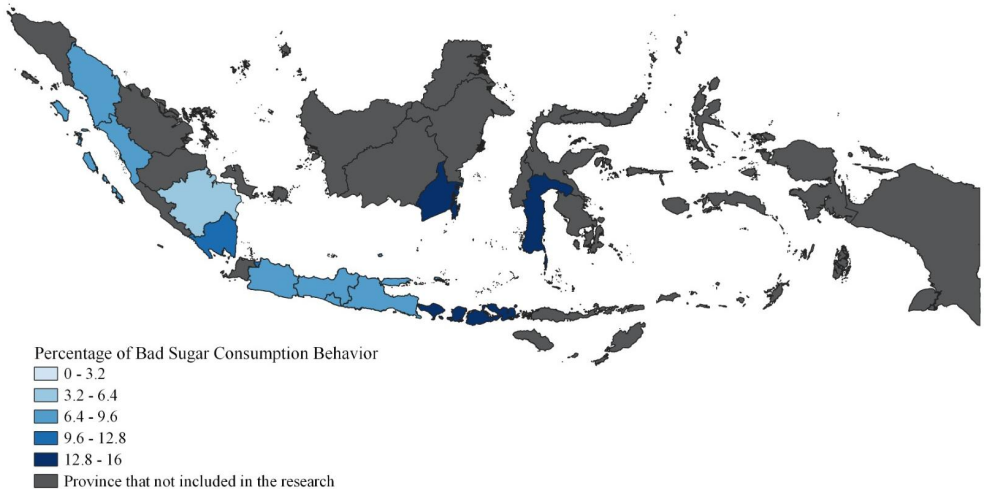

Figure 2. Geospatial Mapping of Bad Sugar Consumption Behavior among 5 to 15 years old. The darkest colour indicated the highest prevalence.

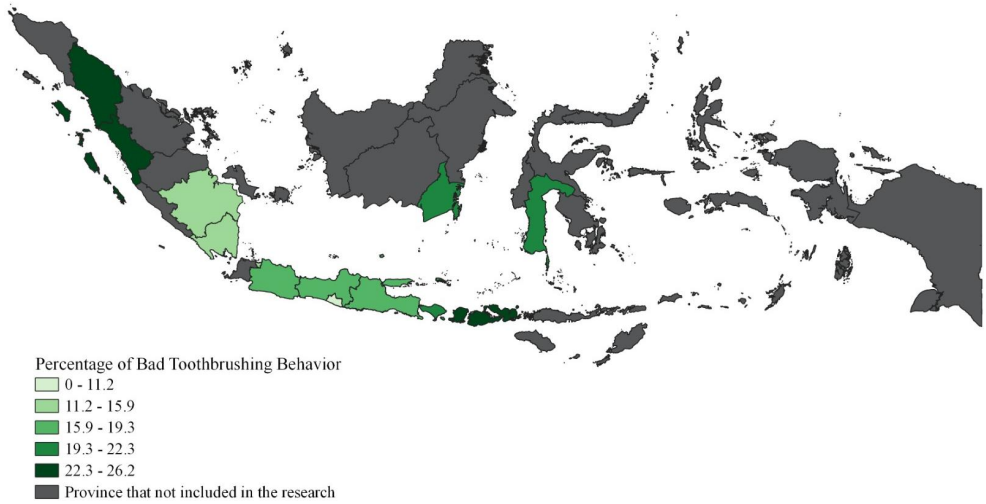

Figure 3. Geospatial Mapping of Bad Toothbrushing Behavior among 5 to 15 years old. The darkest colour indicated the highest prevalence.

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DISCUSSION

Toothache or dental pain has been confirmed as a public health problem and have a direct relationship with dental caries.[1,10] In this study, the data of toothache are taken from IFLS 5 based on the interview about toothache symptoms that felt by the respondents in the last 4 weeks. The respondents who have bad sugar consumption behavior (frequent sugar consumption, 8-14 times a week) shows a higher toothache prevalence compared to those who have good sugar consumption behavior. It is already known that sugar plays important role in pathophysiology of dental caries. Fermentable sugar is one of important variable in dynamics of carious lesion, together with other environmental conditions, bacteria, and host factors.[11] This is in line with the finding of a study conducted by Viswanath and Sabu (2014) that showed DMF-T in children increased with higher frequency of sugar intake.[12]

Respondent who brushes their teeth less than twice a day or twice a day but infrequently in this study have a higher prevalence of toothache. Viswanath and Sabu also reported in their study that teeth cleaning has a direct effect on dental caries, which was shown by the lower score in DMFT in children who brush their teeth frequently.[12] Our finding showed that toothache mostly suffered by female than male. This is in line with a study conducted by Kuhnen (2009) reporting that female have a higher prevalence of toothache.[13] Another study conducted by Pentapati (2020) also showed that toothache by male is reported marginally less than woman.[10] However, Kakoei stated that there is no difference of toothache prevalence between both of genders.[1] Hence, there is still debatable whether gender has a role in toothache.

Concerning the age, this study showed that toothache is more frequent in children age 5-9 years old. This result is in accordance with the study by Viswanath and Sabu (2014) that primary teeth have higher dental caries prevalence than permanent teeth and can be attributed to lower susceptibility of primary teeth to dental caries comparing to permanent teeth.[12] It can be contributed by lower mineral content in primary teeth so it become more susceptible. Children from lower socioeconomic status showed higher prevalence of toothache. This finding is consistent with some earlier studies.[1,7,13] Kuhnen stated that the difference in prevalence probably because family in higher socioeconomic status have a better access to healthcare and preventive treatment.[13] The result was also similar to children whose parents' education status is low. Kakoei et al. (2013) reported the same findings and stated that people with higher education take a better care of their oral health.[1] However, Bakar (2020) found that there is no direct correlation between parent's education with their children's oral health. The mother's education level has a significant association with sugar consumption and tooth brushing behavior, while the correlation with dental caries is mediated by the sugar consumption.[7]

The GIS mapping used color saturation to indicate the prevalence of toothache, the proportion of bad sugar consumption behavior, and bad toothbrushing behavior in each province. Based on the map, there are a consistent pattern of the prevalence, i.e. South Sulawesi and South Kalimantan have very high number in toothache prevalence, bad sugar consumption behavior, and bad toothbrushing behavior. As explained before, there is direct relationship between sugar consumption and toothbrushing, so it is understandable that the numbers have linear proportion. Moreover, basic health survey also noted that high number of population in South Sulawesi and South Kalimantan have never gotten dental treatment, 95.5% and 95.4% respectively. This result indicates that awareness of oral health is still low. There are some of factors that can affect the behavior, such as knowledge, attitudes, including socioeconomic and educational status.[14] The other factor that can attributed to the toothache and oral health in general is mineral content in the water. A study conducted by Said and Salamah (2017) showed that people who live with high level of iron (Fe) in river as drinking water in Mekar Sari village, South Kalimantan, also have high DMF-T index.[15]

In this study, the GIS mapping of the data results aim for identifying the prevalence and distribution of toothache in children age 5-15 in Indonesia. It can be used for decision maker in every province to make an intervention program to resolve the high prevalence of toothache. However, this study only regarding the individual determinant factors such as sugar consumption behavior and toothbrushing behavior, while there may be regional factors that can affect the prevalence of toothache in each province, such as mineral content in water. Moreover, the IFLS survey data used in this study only covered 13 provinces in Indonesia.

In conclusion the prevalence and distribution of toothache among children age 5-15 years old in Indonesia. It showed that toothache in children age five to nine years old are more common. The sugar consumption and toothbrush behavior also have correlation with toothache prevalence. The GIS mapping also highlighted the provinces that have high number of toothache prevalence, which are South Sulawesi and South Kalimantan. Based on the results, it can be concluded that toothache in children in Indonesia is a oral health problem that needs attention and intervention.

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