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DENTAL CARIES AND RISK OF STUNTING AMONG UNDER FIVE-YEAR CHILDREN AT KLABANG DISTRICT BONDOWOSO REGENCY INDONESIA: A NESTED CASE-CONTROL STUDY

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ABSTRACT

Teeth and oral cavity have an important role in nutritional intake. Pain and discomfort associated with untreated caries can decrease the ability to chew, resulting in inadequate nutritional intake and thus linear growth. Increased pro-inflammatory cytokines as the body's response to chronic infection to the consequences of untreated caries can affect bone growth during the prenatal and postnatal periods. This study aimed to investigate the effect of dental caries on the stunting occurrence in under five-year children who were registered in the birth cohort born from 2014-2015 at Klabang Public Health Center using a case-control nested in cohort study design. 42 stunting and 42 normal children were matched age and gender, obtained by purposive sampling from a total of 317 children. The distribution of respondents showed that more than half were male (66.7%), and have a high caries level 54,8%. The def-t index of case and control groups were 7.40±2.84 and 4.52 ± 2.04, respectively. The result of Mc Nemar test showed that dental caries were a risk factor for stunting (COR = 1.222; 95% CI=0.263-5.682; p=0.000). After being controlled with confounders in multivariable logistic regression analysis, high caries level was the most dominant risk factor for stunting (AOR = 5.4; 95% CI=1.95-14.95; p=0.001). It could be concluded that healthy teeth and mouth are important for general health. Dental procedures as the curative and rehabilitative efforts in Integrated Health Post for Child (Posyandu) are recommended to reduce the negative impact of dental caries in linear growth.

KEYWORDS: Under five-year children, dental caries, linear growth, stunting.

INTRODUCTION

Anthropometric measures are the most useful parameters for assessing health in early life and childhood. Anthropometric indexes can describe the risk of morbidity, mortality, cognitive and even behavioral status.[1–4] Height is considered a stable indicator because it represents an old health condition.[5] The inability of children to reach their potential height for a certain age is called stunting. Stunting is the most common measurement to identify chronic malnutrition in the form of linear growth failure.[6]

Stunting is a health problem in Indonesia, particularly in East Java Province. Bondowoso is one of the twelve regencies specifically for stunting intervention in East Java Province which has the third-highest prevalence of stunting under five at 38.3%. Klabang District is a district among the seven districts for special intervention locations, with the third-highest prevalence, amounting to 30.8%.[7] Various intervention efforts have not shown optimal results. Data for 2018 shows that the prevalence of stunting under five in Klabang District has increased again to 35.57% and is the highest prevalence among the seven districts of the intervention locus at Bondowoso Regency.[8]

Stunting is a multifactorial disease that can appear earlier during intrauterine life or childhood or can occur during a person's life as a result of poor nutrition.[9] Indirect factors, such as low maternal education and inadequate household income, have been identified as risk factors that can increase the risk of stunting in children under five years of age.[10,12] Meanwhile, a number of factors can directly contribute to stunting, such as iron micronutrient deficiency and inflammation.[13]

Pain and discomfort due to untreated dental caries,[14,15] causes a decrease in the child's ability to chew foods containing iron, which results in iron deficiency.[16] Iron deficiency leads to iron deficiency anemia, which has a negative impact on linear growth.[17,18] Untreated dental caries also result in an increase in pro-inflammatory cytokines as a form of the body's response to chronic infection.[19] Inflammatory activity due to untreated dental caries is also a component of almost the same pathogenesis in disease-related malnutrition,[20–22] which can affect bone growth during the prenatal and postnatal periods.[13,23–25] Although some accumulated evidence suggests that dental caries negatively affects children's linear growth,[14,26–29] but some studies still show inconsistencies in results.[30–32]

Based on dental health surveillance data for children under five at the Klabang Health Center, it is known that the dental caries experience index (def-t) is a high criteria,[33] from 5.17 in 2017 to 6.36 in 2018.[34,35] Dental caries and malnutrition are both multifactorial diseases that share the same risk factors, so reducing these factors can reduce the risk of both conditions.[31,36] To the best of our knowledge, there is no study using a case-control nested in cohort design, therefore this study was conducted with that design to investigate the effect of dental caries on the stunting occurrence in under five-year children at Klabang Public Health Center. This design was chosen because cases and controls maintained the same level of risk during the study time, which was selected from a pre-existent cohort.[37]

MATERIAL AND METHODS

Study Design

This is a nested case-control study that was conducted in August to September 2019 to investigate the association between dental caries and stunting occurrence in under five-year children who were registered in the birth cohort born from 2014-2015 at Klabang Public Health Center. The total number of births registered in Klabang Public Health Center during 2014-2015 was about 317 children.

Inclusion and Exclusion Criteria

We included all children were between 48-59 months of age who were had age-specific height of the NCHS/WHO from birth to the time of the study and complete dental record from the first dental check-up (at age 2 year) until one month prior to the time of the study. For fitting some covariates, as the stunting is multifactorial etiology, we also excluded the children with systemic disease and mental-intellectual disorder, low birth weight record, mother height <150m, ever hospitalized because of infection (e.g Acute Respiratory Infection or diarrhea), and not have complete vaccination.

Sample size and Sampling Technique

A sample size of 76 children (38 stunted respondents as cases and 38 controls with normal height) was required to obtain the medium effect size of the associations between variables. The type I of error and power of the test were set to 5 and 80%, respectively. However considering the possibility of missing data, the number of respondents was increased to 42 children for each group. Accordingly, 84 children aged 48-59 were selected by matching age and gender. The purposive sampling was conducted to select the required respondents. The population of the cases and controls were 78 and 239 children, respectively. After excluded the population of case, we obtained 54 cases that met the research requirements for case samples. We selected again 42 respondents to become a sample of 54 respondents by selecting 6 villages that had the highest incidence of stunting, namely Pandak, Karanganyar, Wonoboyo, Klabang, Karangsengon, Blimbing. For the control group, we chose controls that matched the case group based on matching age and sex in the 6 villages that had the highest incidence of stunting, so that we obtained 42 control samples, who lived around the sample of cases who had the same characteristics as the case group.

Variables and Data Collection

We retrospectively reviewed the dental record at the first dental check-up (at age 2 year) until one month prior to the time of the study to obtain data on dental caries as the independent variable. According to WHO criteria[33], caries were recorded when a lesion had detectable cavity and undermined enamel in a pit fissure, or a smooth surface. We calculated the number of decayed (cavitated), extracted (because of caries), and restored teeth (def-t) to record the dental caries experience of primary teeth. The def-t index simply dichotomized as low (def-t <5) and high (def-t ≥5) based on caries severity at 48-59 month children in the AAPD criteria.[38] The maternal education and family income as the potential confounders were obtained by interview. Maternal education was defined as the level of education that the respondent's mother has passed is seen from the highest level of education, dichotomized as low (<9 years of education) and high (≥9 years of education). Family income was defined as all income received by the family either in the form of money or services in the last 6 months is calculated in rupiah each month, dichotomized as insufficient (<UMK or <Rp. 1.801.406) and sufficient (≥UMK or ≥Rp. 1.801.406).

Statistical Methods

Data management and analyses were conducted using software (SPSS ver.16; IBM SPSS Inc.), with the statistical significance inferred for $p < 0.05$. Univariate analysis was conducted to calculate frequency distribution, means, and standard deviation of sample characteristic. Bivariate analysis were performed individually with each variables using *Mc Nemar* test. Odds Ratio (OR) and 95% Confidence Interval (CI) were calculate to ascertain the factor associated with stunting. The independent variables were combined in to a logistic regression model after controlling simultaneously for potential confounders.

RESULT

Demographic Characteristic of Respondent

This study enrolled 42 stunting children as case group and 42 normal children as control group. Demographic characteristics of the respondent and their family are presented in Table 1. The mean age of all respondents was 25.95±1.58 month (range 24-29) at first dental check-up and 52.81±3.37 month (range 47-58) at the time of reviewed dental record. More than half (33.3%) of them were boys. More than half of the case group (35.7%) had low maternal education, but more than half of the control group has high maternal education (27.4%). More than half of the case group (36.9%) had insufficient family income, but more than half of the control group has sufficient family income (28.6%).

Table 1: Demographic Characteristic of Respondent.

No.	Demographic Characteristic	Case n (%)	Control n (%)	Total n (%)
1.	Age Age at first dental check-up, month (mean±SD) Age at the time of reviewed dental record, month (mean±SD) Age at the time of study, month (mean±SD)	 25.95±1.58 52.81±3.37 53.10±3.37	 25.95±1.58 52.81±3.37 53.10±3.37	 - - -
2.	Sex Boy Girl	 28 (33.3%) 14 (16.7%)	 28 (33.3%) 14 (16.7%)	 56 (66.7%) 28 (33.3%)
3.	Maternal education Low (<9 years of education) High (≥9 years of education)	 30 (35.7%) 12 (14.3%)	 19 (22.6%) 23 (27.4%)	 49 (58.3%) 35 (41.7%)
4.	Family income Insufficient (<UMK) Sufficient (≥UMK)	 31 (36.9%) 11 (13.1%)	 18 (21.4%) 24 (28.6%)	 49 (58.3%) 35 (41.7%)

Clinical Characteristic of Respondent

The dental caries index as a clinical characteristic of children is shown in Table 2. The mean of decayed teeth (d-t) of the case and control groups were 6.76±2.80 and 4.19±1.95, respectively. The mean of extracted teeth (e-t) of case and control groups were 0.64±0.49 and 0.19±0.40, respectively. There were no filled teeth in the case group (0.00±0.00). The case group had very high categories of caries index (7.40±2.84), while the control group had high categories according to WHO criteria. More than half of the case group (38.1%) had high caries status, but more than half of the control group has low caries status (33.3%).

Table 2: Clinical Characteristic of Respondent.

No.	Clinical Characteristic	Case n (%)	Control n (%)	Total n (%)
1.	Dental caries index (def-t) d-decayed (mean±SD) e-extracted (mean±SD) f-filled (mean±SD) def-t (mean±SD)	 6.76±2.80 0.64±0.49 0.00±0.00 7.40±2.84	 4.19±1.95 0.19±0.40 0.14±0.48 4.52±2.04	 - - - -
2.	Dental caries status High caries (def-t ≥5) Low caries (def-t <5)	 32 (38.1%) 10 (11.9%)	 14 (16.7%) 28 (33.3%)	 46 (54.8%) 38 (45.2%)

Dental Caries as The Dominant Risk Factor on The Stunting Occurrence

The association between dental caries as the independent variable, thus the maternal education and the family income as the covariates to stunting occurrence are shown in Table 3. High dental caries is a risk factor for stunting occurrence of children under five-year (COR= 1.222; 95%CI= 0.263-5.682), meaning that high dental caries increases the risk of stunting by 1.222 fold. Low maternal education is also a risk factor for child stunting (COR= 2; 95%CI= 0.494-8.089), meaning that mothers with low levels of education increase the risk of stunting by 2 fold. Likewise, low maternal education also plays a role as a risk factor for child stunting (COR= 1.44; 95%CI= (0.349-5.948)), meaning that mothers with low levels of education increase the risk of stunting by 1.44 fold.

Table 3: Association between Dental Caries, Maternal Education and Family Income to Stunting Occurrence.

Variable		Control n (%)		Total	OR (95%CI)	p-value
Dental Caries Status	High caries (def-t ≥5)	11 (26.2%)	21 (50%)	32 (76.2%)	1.22 (0.263-5.682)	0.000*
	Low caries (def-t <5)	3 (7.1%)	7 (16.7%)	10 (23.8%)		
Maternal Education	Low(<9 years of education)	15 (35.7%)	15 (35.7%)	30 (71.4%	2 (0.494-8.089)	0.019*
	High (≥9 years of education)	4 (9.5%)	8 (19%)	12 (28.6%)		
Family Income	Insufficient (<UMK)	14 (33.3%)	17 (40.5%)	31 (73.8%)	1.44 (0.349-5.948)	0.007*
	Sufficient (≥UMK)	4 (9.5%)	7 (16.7%)	11 (26.2%)		

*Mc Nemar test (statistically significant)

The last analysis is multivariate analysis using logistic regression to determine the influence of the dental caries variable after being controlled with the interaction and confounder variables. The odds ratio for each variable and interaction variable are shown in Table 4. There is no interaction between dental caries and maternal education (p=0.073), also dental caries and family income (p=0.339), so that the interaction variable was not included in the next analysis.

Table 4: Interaction Variable Detection.

Variable	OR_{Crude}	95%CI		p-value
		Min.	Max.	
Dental caries	1.016	0.129	8.007	0.988
Maternal education	1.078	0.248	4.688	0.920
Family income	2.016	0.459	8.850	0.353
Dental caries*Maternal education	6.988	0.836	58.415	**0.073**
Dental caries*Family income	2.841	0.334	24.191	**0.339**

The odds ratio for each variable after the interaction variable excluded is presented in Table 5. After excluded the interaction variable, the odds ratio for dental caries, maternal education, and family income were 5.400, 3.006, and 3.483, respectively.

Table 5: Interaction Variable Exclusion.

Variable	OR_{Crude}	95%CI		p-value
		Min.	Max.	
Dental caries	**5.400**	1.950	14.954	0.001
Maternal education	**3.006**	1.069	8.451	0.037
Family income	**3.483**	1.236	9.814	0.018

The ΔOR for dental caries variable in the confounding effect detection is presented in Table 6. ΔOR on confounder detection were 7.26%, 12.37%, and 18.52%, respectively. A variable is a confounder if it gives ΔOR> 10%, so it can be concluded that mother's education and family income are confounders.

Table 6: Potential Confounder Detection.

Excluded Potential Confounder	OR_{Crude}	$OR_{Adjusted}$	ΔOR	ΔOR(%)	Confounding Effect
Dental Caries	5.400				
Maternal Education	5.400	5.792	0.073	7.26	confounding -
Family income	5.400	6.086	0.124	**12.37**	confounding +
Maternal education	5.400	6.400	0.185	**18.52**	confounding +
Family income					confounding +

The effect of dental caries on the stunting occurrence adjusted by confounder is presented in Table 7. Table 7 shows that the dental caries variable is the most dominant variable related to the occurrence of under-five stunting based on the OR value of the three variables. After adjusting for the variables of maternal education and family income, the OR value of the dental caries variable was 5.4, which was the greatest OR value compared to the OR of the other two variables.

Table 7: Effect of Dental Caries on The stunting Occurrence Adjusted by Confounder.

Stunting	B	$OR_{adjusted}$	95%CI		p-value
			Min.	Max.	
Dental caries	**1.686**	5.400	1.950	14.954	0.001
Family income	**1.248**	3.483	1.236	9.814	0.018
Maternal education	**1.101**	3.006	1.069	8.451	0.037
Constant	**-2.308**	0.99			0.000

DISCUSSION

Demographic Characteristic of Respondent

The results of this study reveal that toddlers with a mean age of 53.1 months (age group 48 - 59 months) are a group that is prone to stunting. This finding is in accordance with the results of Indonesia Basic Health Surveillance in 2013 and 2018 [39,40] and research in Maluku.[41] The age of 48-59 months is the initial age of increasing physical activity in children. Children start preschool and socialize with their environment so that the need for nutrients also increases. Malnutrition is prone to occur at this age if the need for nutrients is not fulfilled.[42] High physical activity in boys is often not accompanied by adequate nutritional intake. Lack of food intake results in a surge in GH and insulin, resulting in an increase in lipolysis or a reduction in white fat reserves, and a decrease in leptin levels. Hypoleptinemia causes production and work constraints of chondrocyte growth factor so that the conversion of T4 to active T3 is disrupted which results in impaired chondrocyte maturation.[21]

The results of this study also describe that the proportion of the incidence of stunting is more common in boys than girls, with a mean ratio of 2: 1. The results of this study support the same findings in Libya,[43] China,[44] Ethiopia [45], and Maluku Province.[41] Boys tend to be more physically active so they spend more energy for activities but not for growth.[46] A negative energy balance for a long time causes plasma insulin to decrease so that it can reduce the synthesis of Liver Insulin Growth Factor (IGF-1), affect the performance of IGF binding protein-1, thyroid hormone, and other systemic factors involved in Fibroblast Growth Factor (FGF- 21) linear growth.[47]

The results of this study illustrate that mothers with lower education and insufficient family income in the case group are higher than in the control group. The description of the level of maternal education in this study is consistent with the results of data analysis from the Indonesian Family Life Survey (IFLS) from 1997 to 2007.[48] The finding in this study also similar to the result of the previous study conducted in a rural area setting.[11,49] This is supported by the results of research which states that the work and income of parents as farmers are at risk of child stunting.[50] Research in Uganda stated that differences in services between regions, especially in rural and urban areas, resulted in children living in urban areas having a better chance of attending school than children living in rural areas.[51]

Clinical Characteristic of Respondent

This study reported that the def-t index of children under five in the case group was higher than the control group, with a ratio of 7.40 ± 2.84 and 4.52 ± 2.04. It can be seen that the mean decayed score of each group is the largest component in the overall def-t index. The deft index in this study was not much different from the cross sectional study in Kenya,[32] which states that the mean enrollment index for children aged 3 - 5 years is 7.5 ± 1.9. Meanwhile, a study in india revealed that the def-t index was higher at 8.9.[52] This difference is thought to be due to dietary variations between different populations.[52]

The results of this study indicate that high caries status is more common in the case group than in the control group. This study also revealed that none of the children under five in the case group had their teeth filled (f-t = 0). The data illustrate that most children who have dental caries are not treated. The same thing was also found in research in South Africa which stated that 92.3% of the def-t component was a component of decayed teeth.[53] The belief that the primary teeth will be replaced by permanent teeth has resulted in the low awareness of caring for the primary teeth. Parents, especially mothers, do not perform dental caries treatment in children unless there are complaints of pain and discomfort. This is related to other financial resources that must be suppressed and allocated for dental care.[54–56]

Dental Caries as The Dominant Risk Factor on The Stunting Occurrence

The results of this study also proved that dental caries played a role as a risk factor that increased the risk of stunting by 1.22 times in children under five (COR = 1.222; 95% CI: 0.263–5.682; p= 0.000). This finding strengthens the study that reported a significant relationship between caries prevalence and stunting (p

<0.05) in 126 children aged 3-5 years using a case-control design.[26] Longitudinal studies have also shown that dental caries in children aged 61 months results in the weight gain and height of children more slowly than in the previous year.[27]

The plausible mechanism that can explain this phenomena is pain and discomfort in children results in decreased ability of children to eat, including chewing foods that contain iron.[16] A study in India on 60 children aged 2-6 years stated that the proportion of iron deficiency anemia in Early Childhood Caries (ECC) 15 was 86.7% compared to the mild ECC group (13.3%).[57] Iron deficiency can reduce the body's immune ability, so that infectious diseases can easily enter the body. Iron deficiency anemia and prolonged infectious disease have a negative effect on linear growth in infants, children and adolescents.[18] Iron plays a role in circulating oxygen to all body tissues so that reduced oxygenation to bone tissue results in bones not growing optimally.[17]
Another study in Brazil also suggests that Early Chilhood Caries (SECC) at preschool age has an impact on decreasing vitamin D status, calcium and serum albumin levels as well as an increase in PTH levels and the chance of malnutrition compared to caries-free children.[58] Vitamin D, calcium and phosphorus are micronutrients that are very important in children's linear growth.[59] Lack of calcium deposits in the bones in children can cause stunted growth.[60]

Recent studies have also reported that children with untreated ECC have high levels of pro-inflammatory cytokines, which increase with the severity of ECC.[61] This increase in pro-inflammatory cytokines is a series of inflammatory complex activities in response to the body's chronic infection such as pulpitis or abscess, which is a continuation of the untreated dental caries process.[19] The activity of the inflammatory complex which seen in untreated ECC is a component of the pathogenesis found in malnutrition associated with disease.[20–22] Increased pro-inflammatory cytokines can regulate the role of Type 1 Insulin-like Growth Factor (IGF-1) in mediating the growth-promoting effects of Growth Hormone (GH) on bone growth at prenatal and postnatal stages,[23]–[25] resulting in a decrease in cartilage tissue which results in the formation of the epiphyseal plate of long bones causing delayed endochondral ossification.[62,63]

After adjusting for confounding variables for maternal education and family income, the OR value of the dental caries variable was 5.4 (95% CI= 1.95-14.954; p= 0.001). Thus it can be interpreted that under five-year children with high caries status at the same family income and maternal education conditions can experience an increased risk of stunting, which was 1.2-fold to 5.4 times higher than children with low dental caries. This study is in accordance with a cross-sectional study in Saudi Arabia,[14] which states that a deficit in height for age scores that remains significantly associated with high caries rates (dmft= ≥7), after controlling for age, gender, education level of parents, and number of teeth. A longitudinal study in China stated that an increase in the dmft index was still significantly associated with a height for age score after controlling for dietary habits and family income (regression coefficient = -0.02; 95% CI = 0.04-0.01; p = <0.001) . The relationship between dental caries and the height for age scores is also distorted by other factors that have a risk for child growth.[29]

The results of this study also found that low family income and mothers with low education were the confounders of the relationship between dental caries and the incidence of under-five stunting. This is consistent with the findings that families with high incomes and high maternal education will support better child development through the provision of developmental stimulation tools such as children's toys, books for children, and activities that support child development.[10] Families with high income and high education will provide positive activities for their children, for example by including their children in play groups or preschool or the like. On the other hand, families with low income and low education tend to let watch TV longer than have to participate in tutoring.[64]

The potential impact of dental caries on linear growth disorders observed in this study is in line with other studies that highlight the need to prioritize oral health.[29,65] Not only for pain relief and restoration of functional teeth but also to avoid negative impacts on children's growth and general well-being.[29] Dental caries and malnutrition are both multifactorial diseases with unique risk factors and share the same risk factors, so reducing these factors can reduce the risk of both conditions. Both can adversely affect children at their current stage of life and have adverse outcomes for their health, education and future economic potential .[31,36]

CONCLUSION

Dental caries was associated with an increased risk of stunting among under five-year Children. However, our study have limitation in stunting diagnosis manually by anthropometric, it is also suggested to add an X-rays examination as a measurement validity confirmation. More in longitudinal study are warranted to validate our findings and to better understand the mechanisms behind this potential association. It is suggested to conduct future research with larger number of samples and different area.

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REFERENCES

1. Evazpoor A, Edalati A, Hyppönen E, Fararouei M, Parisai Z. Deaths of children aged under 5 years and related factors in the Islamic Republic of Iran: a population- based case–control study. East Mediterr Health J, 2016; 22(6): 368-374.
2. Fararouei M, Brown IJ, Akbartabar Toori M, Estakhrian Haghighi R, Jafari J. Happiness and health behaviour in Iranian adolescent girls. J Adolesc, 2013;36(6): 1187-1192.
3. Fararouei M, Robertson C, Whittaker J. Maternal Hb during pregnancy and offspring's educational achievement: a prospective cohort study over 30 years. Br J Nutr, 2010; 104(9): 1363-1368.
4. Hoddinott J, Behrman JR, Maluccio JA. Adult consequences of growth failure in early childhood. Am J Clin Nutr. 2013; 98(5): 1170-1178.
5. Rogol AD, Hayden GF. Etiologies and Early Diagnosis of Short Stature and Growth Failure in Children and Adolescents. J Pediatr, 2014; 164(5):1-20.
6. Reinhardt K, Fanzo J. Addressing Chronic Malnutrition through Multi-Sectoral, Sustainable Approaches: A Review of the Causes and Consequences. Front Nutr, 2014; 1(13): 1-11.
7. Indonesia National Team For The Acceleration Of Poverty Reduction. 100 Kabupaten/Kota Prioritas Untuk Intervensi Anak Kerdil (Stunting). 1st ed. Jakarta: Indonesia National Team For The Acceleration Of Poverty Reduction: 2017.
8. Bondowoso Regency Health Office. Semester Concurrent Weighing Reports 2018. Bondowoso; Bondowoso Regency Health Office: 2018, p. 48.
9. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries. Paediatr Int Child Health, 2014; 34(4): 250-265.
10. Fernald LCH, Kariger P, Hidrobo M, Gertler PJ. Socioeconomic gradients in child development in very young children: Evidence from India, Indonesia, Peru, and Senegal. PNAS, 2012; 109(Suppl 2): 17273-17280.
11. Torlesse H, Cronin AA, Sebayang SK, Nandy R. Determinants of stunting in Indonesian children: evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. BMC Public Health. 2016; 669(16): 1-11.
12. Utami RA, Setiawan A, Fitriyani P. Identifying causal risk factors for stunting in children under five years of age in South Jakarta, Indonesia. Enferm Clínica, 2019; 29(S2): 606-611.
13. Millward DJ. Nutrition, infection and stunting: the roles of deficiencies of individual nutrients and foods, and of inflammation, as determinants of reduced linear growth of children. Nutr Res Rev, 2017; 30(1): 1-23.
14. Alkarimi H, Watt R, Pikhart H, Sheiham A, Tsakos G. Dental Caries and Growth in School-Age Children. Pediatrics, 2014; 133(3): 616-624.
15. Sheiham A. Dental caries affects body weight, growth and quality of life in pre-school children. Br Dent J, 2006; 201(10): 625-626.
16. Hashemi DA, Bahrololoomi DZ, Salarian DS. Relationship Between Early Childhood Caries and Anemia: A Systematic Review. Iran J Ped Hematol Oncol, 2018; 8(2): 126-138.
17. Petry N, Olofin I, Boy E, Donahue Angel M, Rohner F. The Effect of Low Dose Iron and Zinc Intake on Child Micronutrient Status and Development during the First 1000 Days of Life: A Systematic Review and Meta-Analysis. Nutrients, 2016; 8(773): 1-23.
18. Soliman AT, Sanctis VD, Kalra S. Anemia and growth. Indian J Endocrinol Metab, 2014; 18(7): 1-5.
19. Ribeiro CCC, Pachêco C de JB, Costa EL, et al. Proinflammatory cytokines in early childhood caries: Salivary analysis in the mother/children pair. Cytokine, 2018; 107: 113-117.
20. Mehta NM, Corkins MR, Lyman B, et al. Defining Pediatric Malnutrition: A Paradigm Shift Toward Etiology-Related Definitions. J Parenter Enter Nutr, 2013; 37(4): 460-481.
21. Owino V, Ahmed T, Freemark M, et al. Environmental Enteric Dysfunction and Growth Failure/Stunting in Global Child Health. Pediatrics, 2016; 138(6):1-12.
22. Santetti D, de Albuquerque Wilasco MI, Dornelles CTL. Serum proinflammatory cytokines and nutritional status in pediatric chronic liver disease. World J Gastroenterol, 2015; 21(29): 8927-8934.
23. Abdou S, El-Boghdady N, Abd El-Maksoud A, Khairy S, El-Sawalhi M. Evaluation of insulin-like growth factor-1, total ghrelin, and insulin resistance in nutritionally stunted Egyptian children. Bull Fac Pharm Cairo Univ, 2019; 57(1): 55-65.
24. Chitnis MM, Yuen JSP, Protheroe AS, Pollak M, Macaulay VM. The Type 1 Insulin-Like Growth Factor Receptor Pathway. Clin Cancer Res, 2008; 14(20): 6364-6370.
25. Prendergast AJ, Rukobo S, Chasekwa B, et al. Stunting Is Characterized by Chronic Inflammation in Zimbabwean Infants. PLoS ONE, 2014; 9(2): 1-11.
26. Ayhan H, Suskan E, Yildirim S. The effect of nursing or rampant caries on height, body weight and head circumference. J Clin Pediatr Dent, 1996; 20(3): 209-212.
27. Kay EJ, Northstone K, Ness A, Duncan K, Crean SJ. Is there a relationship between Birthweight and subsequent growth on the development of Dental Caries at 5 years of age? A cohort study: Birthweight and caries development. Community Dent Oral Epidemiol, 2010; 38(5): 408-414.
28. Khanh LN, Ivey SL, Sokal-Gutierrez K, et al. Early Childhood Caries, Mouth Pain, and Nutritional

Threats in Vietnam. Am J Public Health, 2015; 105(12): 2510-2517.
29. Shen A, Bernabé E, Sabbah W. The bidirectional relationship between weight, height and dental caries among preschool children in China. PLoS ONE, 2019; 14(4): 1-13.
30. Muhoozi GKM, Atukunda P, Skaare AB, et al. Effects of nutrition and hygiene education on oral health and growth among toddlers in rural Uganda: follow-up of a cluster-randomised controlled trial. Trop Med Int Health, 2018; 23(4): 391-404.
31. So M, A Ellenikiotis Y, M. Husby H, Leonor Paz C, Seymour B, Sokal-Gutierrez K. Early Childhood Dental Caries, Mouth Pain, and Malnutrition in the Ecuadorian Amazon Region. Int J Env Res Public Health, 2017; 14(550): 1-13.
32. Wassuna D, Opinya G, Masiga M, Ngatia E, Mutave R. The Nutritional Status of the Children with Severe- ECC Comparison with the Nutritional Status of Children without Caries Aged 3-5-Years-Old and with the Caregiver's Demographics in a Kenyan Hospital. Mod Approaches Dent Oral Health Care, 2018; 2(1): 123-130.
33. WHO. Oral Health Surveys: Basic Methods. 5th ed. Swiss; World Health Organization: 2013.
34. Klabang Public Health Center. Annual Report Klabang Public Health Center 2017. Bondowoso: Klabang Public Health Center: 2017.
35. Klabang Public Health Center. Annual Report Klabang Public Health Center 2018. Bondowoso; Klabang Public Health Center: 2018.
36. Sheiham A, Watt RG. The common risk factor approach: a rational basis for promoting oral health. Community Dent Oral Epidemiol, 2000; 28(6): 399-406.
37. Rangel AG, Angel Rosales-Berber M, Pozos-Guillén A. Significance of observational studies in clinical paediatric dentistry research. Eur J Paediatr Dent, 2017; (3): 213-220.
38. AAPD. American Academy of Pediatrics Policy on early childhood caries (ECC): Classifications, consequences, and preventive strategies. Pediatr Dent, 2008; 30(6): 40-43.
39. Ministry of Health Republic Indonesia. Basic Health Survey Report 2013. Jakarta; Ministry of Health Republic Indonesia: 2013, p. 47.
40. Ministry of Health Republic Indonesia. Basic Health Survey Report 2018. Jakarta; Ministry of Health Republic Indonesia: 2018, p. 588.
41. Ramli null, Agho KE, Inder KJ, Bowe SJ, Jacobs J, Dibley MJ. Prevalence and risk factors for stunting and severe stunting among under-fives in North Maluku province of Indonesia. BMC Pediatr, 2009; 9(64): 1-10.
42. Isnainy DI, Luthfiyah F, Abdi LK, Sofiyatin R. Konsumsi Zat Gizi Makro Pada Balita Stunting (24-59 Bulan). J Gizi Prima, 2017; 2(1): 7-13.
43. El Taguri A, Betilmal I, Mahmud SM, et al. Risk factors for stunting among under-fives in Libya. Public Health Nutr, 2009; 12(8): 1141-1149.
44. Zhang J, Shi J, Himes JH, et al. Undernutrition status of children under 5 years in Chinese rural areas - data from the National Rural Children Growth Standard Survey, 2006. Asia Pac J Clin Nutr, 2011; 20(4): 584-592.
45. Teshome B, Kogi-Makau W, Getahun Z, Taye G. Magnitude and determinants of stunting in children underfive years of age in food surplus region of Ethiopia: The case of West Gojam Zone. Ethiop J Health Dev, 2010; 23(2): 1-10.
46. Akombi BJ, Agho KE, Hall JJ, Merom D, Astell-Burt T, Renzaho AMN. Stunting and severe stunting among children under-5 years in Nigeria: A multilevel analysis. BMC Pediatr, 2017; 17(15): 1-16.
47. Gat-Yablonski G, Phillip M. Nutritionally-Induced Catch-Up Growth. Nutrients, 2015; 7(1): 517-551.
48. Rachmi CN, Agho KE, Li M, Baur LA. Stunting, Underweight and Overweight in Children Aged 2.0–4.9 Years in Indonesia: Prevalence Trends and Associated Risk Factors. PLoS ONE, 2016; 11(5): 1-17.
49. Nguyen HT, Eriksson B, Petzold M, et al. Factors associated with physical growth of children during the first two years of life in rural and urban areas of Vietnam. BMC Pediatr, 2013; 149(13): 1-10.
50. Reyes H, Pérez-Cuevas R, Sandoval A, et al. The family as a determinant of stunting in children living in conditions of extreme poverty: a case-control study. BMC Public Health, 2004; 4(1): 1-10.
51. Mike IO, Nakajjo A, Isoke D. Socioeconomic Determinants of Primary School Dropout: The Logistic Model Analysis. Uganda J Econ Policy Res Cent, 2008; 54: 1-28.
52. Schroth RJ, Moffatt MEK. Determinants of Early Childhood Caries (ECC) in a Rural Manitoba Community: A Pilot Study. Pediatr Dent, 2005; 27(2): 114-120.
53. Ismail AI, Lim S, Sohn W, Willem JM. Determinants of early childhood caries in low-income African American young children. Pediatr Dent, 2008; 30(4): 289-296.
54. Abduljalil HS, Abuaffan AH. Knowledge and Practice of Mothers in Relation to Dental Health of Pre-School Children. Adv Genet Eng, 2016; 5(2): 1-7.
55. Kowash MB. Severity of early childhood caries in preschool children attending Al-Ain Dental Centre, United Arab Emirates. Eur Arch Paediatr Dent, 2015; 16(4): 319-324.
56. Reang T, Bhattacharjya H. Mother's knowledge and practice regarding oral Hygiene and challenges in the prevention of dental caries of under-five children in an urban resettlement colony. Int J Med Sci Public Health, 2014; 3(1): 76-80.
57. Bansal K, Goyal M, Dhingra R. Association of severe early childhood caries with iron deficiency anemia. J Indian Soc Pedod Prev Dent, 2016; 34(1): 36-42.

58. Jorge JR, Jorge MLR, de Paiva SM, Marques LS, Pordeus IA. Dental Caries and Quality of Life Among Preschool Children. In: Virdi MS, ed. Emerging Trends in Oral Health Sciences and Dentistry. InTech; 2015: 117-126.
59. Souganidis E. The Relevance of Micronutrients to The Prevention of Stunting. Sight Life Mag, 2012; 26(2): 10-19.
60. Peacock M. Calcium Metabolism in Health and Disease. Clin J Am Soc Nephrol, 2010; 5(Supplement 1): 23-30.
61. Lima GQT, Brondani MA, Silva AAM da, Carmo CDS do, Silva RA da, Ribeiro CCC. Serum levels of proinflammatory cytokines are high in early childhood caries. Cytokine, 2018; 111: 490-495.
62. De Benedetti F, Alonzi T, Moretta A, et al. Interleukin 6 causes growth impairment in transgenic mice through a decrease in insulin-like growth factor-I. A model for stunted growth in children with chronic inflammation. J Clin Invest, 1997; 99(4): 643-650.
63. Sederquist B, Fernandez-Vojvodich P, Zaman F, Sävendahl L. Recent Research on The Growth Plate : Impact of inflammatory cytokines on longitudinal bone growth. J Mol Endocrinol, 2014; 53(1): 35-44.
64. Decker ED, De Craemer M, De Bourdeaudhuij I. Influencing factors of screen time in preschool children: an exploration of parents' perceptions through focus groups in six European countries: Parents' perceptions of screen time in preschool children. Obes Rev, 2012; 13(Suppl.1): 75-84.
65. Nabuab JD, Duijster D, Benzian H. Nutritional status, dental caries and tooth eruption in children: a longitudinal study in Cambodia, Indonesia and Lao PDR. BMC Pediatr, 2018; 300(18): 1-11.