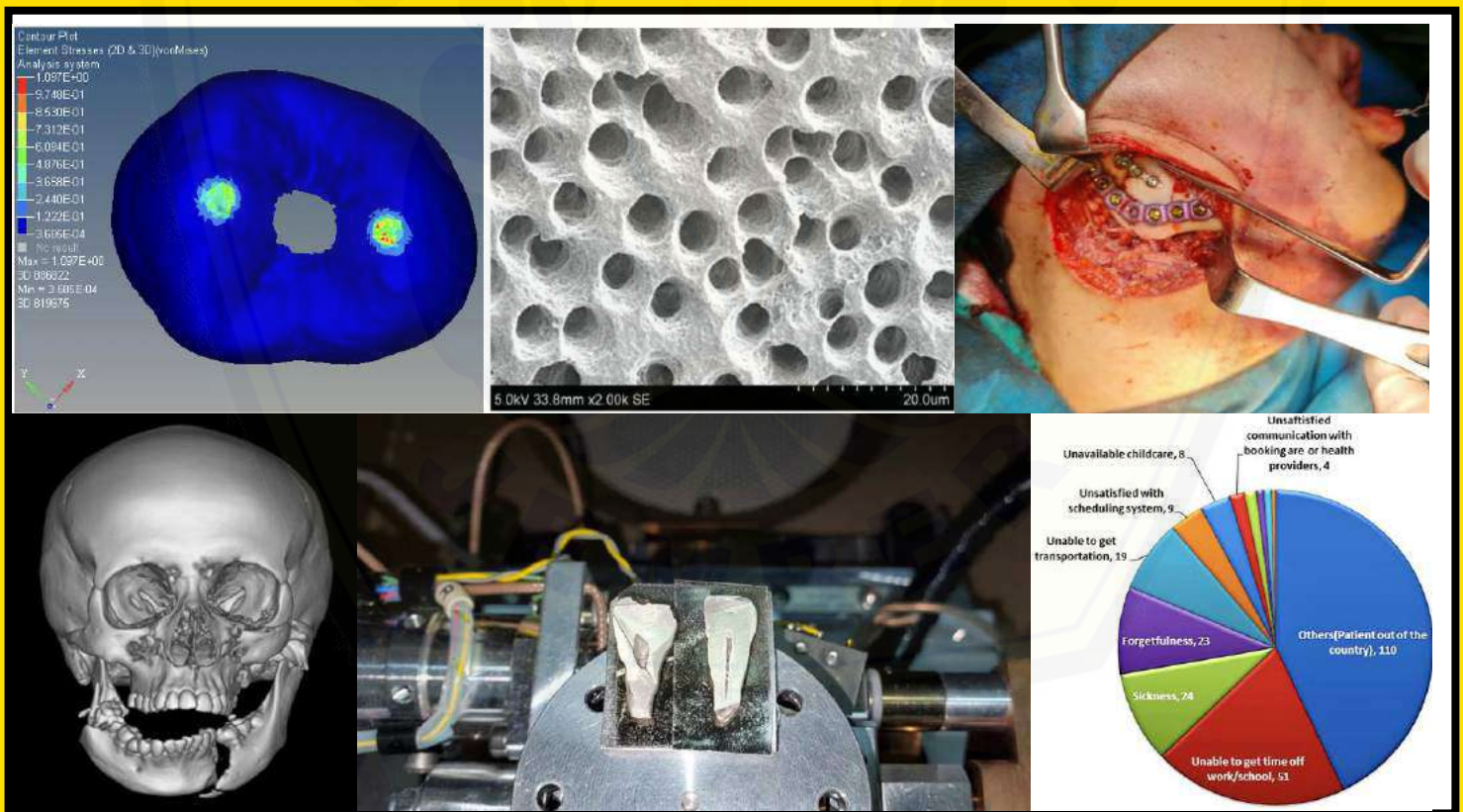


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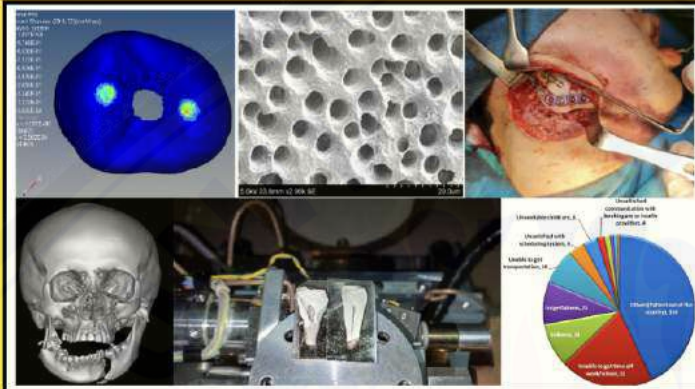
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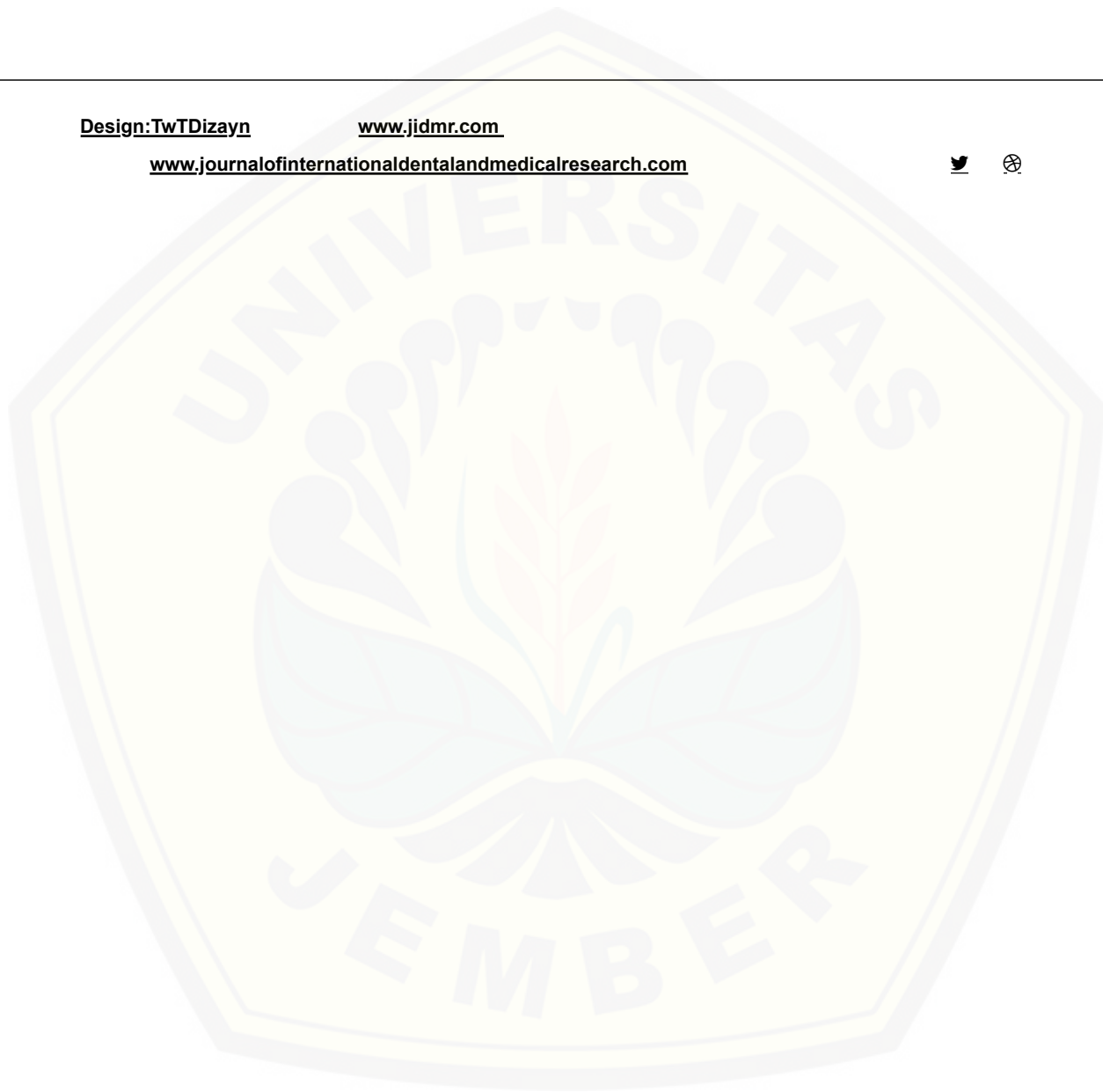
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Dental Caries Status and Dietary Characteristics During the Covid-19 Pandemic Towards Increased Risk of Stunting among Preschool Children

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Abstract

Preschool children were highly at risk to be stunted as a result of decreasing chewing hard foods characterized by high dental caries and unhealthy food intake due to the rapid impoverishment of families by the Covid-19 pandemic. Yet, recent few studies present contradictory results.

This study aimed to determine dental caries as a risk factor on the stunting occurrence after being controlled by dietary characteristics during the Covid-19 Pandemic. A nested case-control study was conducted from August to September 2021. 62 of 295 children who were registered in the birth cohort born from January 2016 to December 2016, were obtained by purposive sampling and then, divided into two groups, i.e., 31 were in the stunting group and the other 31 normal children were in the case group.

High dental caries status is significantly associated with stunting occurrence (COR = 21; 95% CI, 0.80–156.20). High dental caries shows as a significant risk factor on stunting occurrence in multivariable logistic regression test (AOR = 37.50; 95% CI, 6.97 – 201.76). Dental caries is a dominant risk factor that increases the risk of stunting and it is confounded by less protein intake.

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Introduction

Globally, the emergence of a new Coronavirus Disease, called COVID-19 in the world in 2019-2020 has turned the globe upside down and disrupted the main determinants of health.¹ The most serious risks posed by the COVID-19 crisis in children are not those of the disease itself, but its collateral damages allow nutritional problems.² Various studies during the pandemic showed that food was consumed less and food quality became worse as a result of the family's declining economic resilience.³⁻⁵ Another finding suggests that the COVID-19 pandemic has shifted to unhealthy nutritional behaviours: such as increased snacking (21%), decreased consumption of fresh foods (27%), increased consumption of sweets (22%).⁶

An estimated 6.7 million children in 2020 especially in regions already affected by the humanitarian crisis is expected to get undernutrition with the adding of the 47 million children under 5 already suffering from wasting, and the 144 million children mostly in Asia and Africa suffered by stunting.^{1,7,8} Stunting is a condition of growth failure in children due to long-term malnutrition so that the child is shorter or shorter of stature than a normal child his age and has delays in cognitive development.⁹ Children who experience stunting become more susceptible to disease and will have a risk of declining productivity levels due to not maximal intelligence and it is leading to intergenerational poverty by reducing the job market and incomes of adult workers.¹⁰

According to WHO, every young child had their growth potential and could catch up their growth potential although they were born and living in sub-optimal health conditions.¹¹ Hence, other conditions including nutritional factors and infection may also affect the growth.^{12,13} For decades, raised also concerns about chronic infection characterized by dental caries result in

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inadequate nutritional intake and thus linear growth through decreasing chewing ability.^{14,15} Various studies also found a possible link of dental caries with growth failure^{14,16-18} including stunting¹⁹ and yet other studies still have contradictory results.²⁰⁻²² Recent emerging evidence suggests that chronic infection of untreated dental caries in children can increase the levels of pro-inflammatory cytokines²³ which is also seen as a component of the pathogenesis of illness related malnutrition^{24,25} and can impair linear growth.²⁶

Dental caries is one of the most prevalent chronic infections even before the COVID-19 pandemic affecting 3-4-years old children in Indonesia and more prevalences at 5-years old.²⁷ Hence, it could be getting a much worse prevalence due to dental care limitations during the COVID-19 pandemic.²⁸ Klabang District is one of the sub-districts in Bondowoso Regency at East Java Province Indonesia, which also faced a high level of dental caries in preschool children with 58.8% of children suffering from dental caries in 2017 and increased to 62.9% in 2018.^{29,30} On the other hand, Klabang district also had the highest prevalence of the seven sub-districts of Bondowoso Regency's intervention locus.³¹ Klabang district also reported an exacerbated the already dire situation of a high level of stunting children within two years in a row. In 2017, this case was the third-highest prevalence with 30.8% stunted children and this number increased to 35.6% in 2018.³²

A previous study about the association of dental caries towards stunting among preschool with a cross-sectional design has been conducted in Indonesia and found no relationship.³³ To our knowledge, there is still no study regarding the magnitude of dental caries as a risk factor of stunting using a case-control nested in cohort design. Therefore, this present study was aimed to investigate the effect of dental caries as a risk factor on stunting occurrence in preschool children who were selected from a pre-existent cohort with considering the dietary characteristic of children during the Covid-19 pandemic.

Materials and methods

This research was conducted at the Health Center of Klabang Sub-district using a

nested case-control in cohort design from August to September 2021 after obtaining approval from the Health Research Ethics Commission (KEPK), Faculty of Dentistry, University of Jember. The population of this study was 295 children under five who were recorded in the birth cohort from January 2016 to December 2016. 31 children were selected as cases and 31 children as controls through purposive sampling and matching techniques. For fitting some covariates, as the stunting is multifactorial aetiology, we also excluded the children with systemic disease and mental-intellectual disorder, low birth weight record, mother height of <150 cm, who have been hospitalized due to infection (e.g Acute Respiratory Infection or diarrhoea), and did not receive complete vaccination.

Dental caries status was obtained retrospectively from the dental record at the first dental examination at the age of 2-years old to 1 month before the date of stunting diagnosis using oral examination protocol of the Indonesian Ministry of Health during the Covid-19 pandemic.³⁴ The number of cavities, the number of teeth extracted due to caries, and the number of teeth filled were accumulated according to WHO criteria³⁵, then simply dichotomized into 0=low (def-t≤4) by merging very low categories (0.0-1.1), low (1.2-2.6), moderate (2.7-4.4), and 1=high (def-t >4) which is consisting for high categories (4.5-6.5) and very high (>6.5). Data on dietary characteristics for 6 months before the index date were obtained through an online food recall survey using the link for free access Google form application and sent to the respondents' parents through Whats-App. Protein intake was measured by the total amount of protein intake consumed for 24 hours and converted to Recommended Dietary Allowance (RDA) 2013, then classified into 0=good (80% - 120%) and 1=less (<80%). Sugar-Sweetened Beverage consumption frequencies were categorized into 0=low (≤1x per day) and 1=high (>1x per day). Snack-food consumption frequencies were categorized into 0=low (≤1x per day) and 1=high (>1x per day). Data analysis was carried out using the SPSS for Windows Ver 16.0 program using univariate analysis, bivariate analysis with the Mc Nemar test, and multivariate analysis with logistic regression test.

Results

The univariate analysis showed the mean age of all respondents was 53.10 ± 3.37 months at the time of the study. More than half of the case group (54.84%) are male children. 90.72% of the case group have high dental caries status, while more than half of the control group has low dental caries status (74.19%). More than half of both the case group and the control group has less protein intake, respectively 51.61% and 77.42%. More than half of both of the case group and control group have low Sugar-Sweetened Beverage (SSB) consumption frequency, respectively 54.84% and 70.97%. While, more than half of both of the case group and control group have high snack-food consumption frequency, respectively 83.87% and 67.74%. Characteristics of the respondent and their dietary characteristic are presented in Table 1.

Characteristics	Case n (%)	Control n (%)
Age at the time of the study (month) ^a	53.10 ± 3.37	53.10 ± 3.37
Sex		
Male	17 (54.84)	17 (54.84)
Female	14 (45.16)	14 (45.16)
Dental Caries Status		
High (def-t >4)	28 (90.72)	8 (25.81)
Low (def-t ≤4)	3 (9.68)	23 (74.19)
Protein Intake		
Good (80% - 120%)	15 (48.39)	7 (22.58)
Less (<80%)	16 (51.61)	24 (77.42)
Sugar-Sweetened Beverage (SSB) Consumption Frequency		
High (>1x per day)	14 (45.16)	9 (29.03)
Low (≤1x per day)	17 (54.84)	22 (70.97)
Snack-Food Consumption Frequency		
High (>1x per day)	26 (83.87)	21 (67.74)
Low (≤1x per day)	5 (16.13)	10 (32.26)

Table 1. Characteristics of respondent.

^a(Mean): SD. SD: Standard Deviation.

	Stunting	Control	OR (95% CI)	P	
Dental Caries Status	High (def-t >4)	7 (75.00)	21(66.67)	21	0.001*
	Low (def-t ≤4)	1(25.00)	2(33.33)	(0.80–156.20)	
Protein Intake	Good (80% - 120%)	3 (42.86)	12 (50.00)	3	0.049*
	Less (<80%)	4 (57.14)	12 (50.00)	(0.97–9.30)	
Sugar-Sweetened Beverage (SSB) Consumption Frequency	High (>1x per day)	4 (44.44)	10 (45.45)	2	0.210*
	Low (≤1x per day)	5 (55.56)	12 (54.55)	(0.68–5.85)	
Snack-Food Consumption Frequency	High (>1x per day)	18 (85.71)	8 (80.00)	2.6	0.145*
	Low (≤1x per day)	3 (14.29)	2 (20.00)	(0.71–10.01)	

Table 2. Selection of variables candidate for multivariate analysis.

The bivariate analysis was conducted for the selection of each variable that would include in the multivariate analysis with a p-value <0.25.

The result of the bivariate analysis revealed that all variables are equitable for the multivariate analysis. The selection of the variable candidate for multivariate analysis is presented in Table 2.

The full model multivariable analysis was conducted for modifier and confounding effect detection. Unadjusted associations between stunting and each variable are presented as Crude OR (COR). Based on the result of modifier effect analysis, no interaction variable has the modifier effect (p-value<0.05) as shown in Table 3.

Variables	Crude OR (95% CI)	P
Dental caries status	3.06 (0.096 – 97.27)	0.529
Protein Intake	7.47 (0.41 – 135.38)	0.174
Sugar-Sweetened Beverage (SSB) Consumption Frequency	0.87 (0.061 – 12.34)	0.918
Snack-Food Consumption Frequency	0.48 (0.024 – 9.73)	0.635
Dental caries status* Protein Intake	0.58 (0.014 – 24.08)	0.776
Dental caries status* Sugar-Sweetened Beverage (SSB) Consumption Frequency	11.21 (0.269 – 466.78)	0.204
Dental caries status* Snack-Food Consumption Frequency	14.79 (0.21 – 732.06)	0.176

Table 3. Full model Analysis with Modifier Effect.

Furthermore, a confounding effect analysis was conducted to detect the state of the confounding variable. The variable was confounding if the value of %ΔOR was >10% and the confounding variable must be included in the final model. Based on the confounding analysis, protein intake was the confounding variable with the %ΔOR = 25.41% as presented in table 4.

Excluded Potential Confounder	Crude OR (Full Model)	Adjusted OR (Reduced Model)	ΔOR	%ΔOR	Confounding Effect
Dental caries status	39.24	-	-	-	-
Protein Intake	39.24	29.27	9.97	25.41%	+
Sugar-Sweetened Beverage (SSB) Consumption Frequency	39.24	35.60	3.64	9.27%	-
Snack-Food Consumption Frequency	39.24	42.54	-3.30	-8.41%	-

Table 4. Full model Analysis without Modifier Effect and Analysis of Confounding.

After excluding the modifier effect and detection for confounding, the final analysis was conducted to include the variables in the final model of dental caries and dietary characteristics on stunting occurrence. Based on the final analysis, preschool children who have high dental caries status and less protein intake was

37.5 fold prone to be stunted than children with low dental caries status and good protein intake as shown in table 5.

Stunting	Adjusted OR (95% CI)	P
Dental caries status	37.50 (6.970 – 201.762)	0.000*
Protein intake	5.89 (1.101 – 31.563)	0.038*

Table 5. Final Model Between Dental Caries and Dietary Characteristic Toward Stunting Occurrence

Discussion

From the present study, we observed that children with a mean age of 53.1 months belong to a group that is prone to stunting. This finding is following the results of Indonesia Basic Health Surveillance in 2013 and 2018^{36,27} and a similar study in Maluku³⁷. 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 increase. Children at this age are risked of malnutrition cases unless their needs for nutrients are fulfilled.³⁸

This study also indicates that male children were more prone to be stunted than female children. The finding is in line with other studies in Libya³⁹, China⁴⁰, Ethiopia⁴¹, and Maluku Province.³⁷ Male children tend to be more physically active than their counterparts, so they spend more energy on activities but not on growth.⁴² A negative energy balance for a long time causes plasma insulin to decrease thus reducing the synthesis of Liver Insulin Growth Factor (IGF-1), and affects the performance of IGF binding protein-1, thyroid hormone, and other systemic factors involved in Fibroblast Growth Factor (FGF- 21) linear growth.¹²

High physical activity in male children is often not supported by adequate nutritional intake. Lack of food intake results in a surge in GH and insulin, increasing lipolysis or a reduction in white fat reserves, and a decrease in leptin levels. Hypoleptinemia causes the production and works constraints of chondrocyte growth factor so that the conversion of T₄ to active T₃ is disrupted, leading to impaired chondrocyte maturation.⁴³

This study also revealed that more than half (90.72%) of the case group have high dental caries status. This result strengthened another

previous case-control study.¹⁶ This result is also in line with the finding that suggests that the number of caries may have increased sharply during the COVID-19 pandemic due to parents avoiding dental care or suspending temporarily the dental treatment for their children.²⁸

During the COVID-19 pandemic, the Indonesian Government issued various policies, including social distancing, physical distancing, and Large-Scale Social Restrictions (LSSR) which may not only strike the community with anxiety but suffers from tremendous panic.⁴⁴ Children have a tremendous impact on their household food security, limiting the accessibility, availability, and affordability of healthy food items due to the rapid impoverishment of families by the Covid-19 pandemic.⁴⁵ Also, the majority of our respondents have shifted the family dietary intake to high snack-food consumption frequencies, respectively 83.87% and 67.74% but by contrast, Klabang sub-district is a rural area that has greater opportunities to diversify food to obtain more protein sources from animals and vegetables. Yet, thus highly-snacking in preschool children in rural areas was also reported by another study in Nicaragua.⁴⁶

Besides the durability of much-packaged food, its price is also less volatile and often cheaper than fresh food.⁴⁷ Hence, according to Deloitte Indonesian Consumer Insights 2015, spending on beverage and packaged foods increases in households across all income levels, ranging from 18 to 32% of monthly household expenditure. Interestingly, persons with less favourable nutritional trends were more likely to have lower incomes.⁴⁸ The majority of our respondents is Madura Tribe and this condition might be aggravated with the most common term used in Madura Tribe, i.e *Nyangleh* or *Kenyang Moleh* that used to describe the habit of making as much money as possible on that day and spending it instantly.

The results of this study also proved that dental caries played a role as a risk factor that increased the risk of stunting. After adjusting for confounding variables, the OR value of the dental caries variable was 21 fold to 37.5 times higher. This result was following the previous study.^{14,16,17,19} Several mechanisms have been postulated to explain this relationship, including the direct effect of dental caries on children's eating ability and nutritional intake as well as indirect effects of chronic dental inflammation on

children's growth via metabolic and immunological pathways.¹⁴ Pain and discomfort due to untreated dental caries in children plausibly result in a decreased ability of children, resulting in avoiding chewing hard foods that contain protein.

A continuation of the untreated dental caries process, such as pulpitis or abscess, increased a series of inflammatory complex activities in response to the body's chronic infection.⁴⁹ The activity of the inflammatory complex which is seen in untreated dental caries in children is a component of the pathogenesis found in malnutrition associated with the disease.^{25,43,50} 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^{9,51}. This condition will lead to a decrease in cartilage tissue which results in the formation of the epiphyseal plate of long bones causing delayed endochondral ossification.^{52,53}

This present study also suggested that less protein intake was a confounder of the relationship between dental caries and the occurrence of stunting in preschool children. This result was comparable with another study in Indonesia that was conducted in 6-8-years-old children.⁵⁴ The plausible mechanism could explain that less protein intake can have an impact on linear growth due to protein providing aromatic amino acids that the body needs to modify the secretion and action of the osteotropic hormone, namely Insulin-Like Growth Factor 1 (IGF-1), which is a mediator of growth hormone and bone matrix-forming protein.^{55,56} Insufficient protein intake can damage bone mineral mass by impairing the production of IGF-1, which affects bone growth by stimulating the proliferation and differentiation of chondrocytes in the epiphyseal plate of long bones and will affect osteoblasts.⁵⁷ This is the first study regarding the magnitude of dental caries as a risk factor on stunting occurrence in preschool children and found a significant association after being controlled by dietary characteristics. On the contrary, few studies investigated this association using various assessment methods with varying results. Our study may have many limitations with limited samples which may not be generalized with other populations but we strengthened this study by using a nested case-control design, assuming

that cases and control groups were selected from a pre-existent cohort that maintained the same level of risk during the study time. Moreover, dietary characteristics were analysed based on a single-application questionnaire concerning food consumption in the preceding month, which may not reflect an individual's usual intake. However, given that the study was conducted during the challenging confinement period imposed by the pandemic, food consumption evaluation was simplified aiming to avoid a negative effect of the questionnaire length on response rates. We consider that our research managed to capture the impact of dental caries on protein intake thus affecting linear growth and less protein intake as a limitation of families to accessing healthy food items due to the rapid impoverishment by the Covid-19 pandemic.

Conclusions

Dental caries is a risk factor for stunting occurrence in preschool children and it was confounded by dietary characteristics, such as protein intake. Preschool children were highly at risk to be stunted as a result of decreasing chewing hard foods containing protein characterized by high dental caries. Less protein intake during the Covid-19 pandemic that was found as potential confounders in this study revealed that stunting is a public health problem that requires holistic treatment. This finding could be used to develop a potential strategy to reduce the stunting occurrence in preschool children.

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Declaration of Interest

The authors report no conflict of interest.

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