DETERMINANT FACTORS OF THE IMPROVEMENT OF NUTRITIONAL STATUS (BASED ON HEIGHT-FOR-AGE INDEX CATEGORY) IN CHILDREN DURING THE COVID-19 PANDEMIC: A COHORT STUDY OF CHILDREN'S GROWTH AND DEVELOPMENT IN BOGOR

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Abstract. The COVID-19 pandemic is predicted to trigger a global economic and food supply crisis, which further affects children's nutritional status as a vulnerable group. This study aimed to observe alterations in nutritional status before and during the COVID-19 pandemic (during 2019-2021) and determinant factors involved in the improvement of nutritional status (based on the height-for-age Z-score (HAZ) index category) during the COVID-19 pandemic. The findings were intended as evidence-based suggestions for policy formulation concerning the improvement of child nutritional status and stunting reductions. This study was part of a cohort study of children's growth and development conducted by National Institute of Health Research and Development (NIHRD) in Bogor city-Indonesia. The analysis was conducted on 565 children under five in 2019 with height measurement data in 2019 and 2021, environmental conditions, parental education, consumption habits, and social assistance. Children were classified as having an improved nutritional status if the HAZ category increased in 2021 compared to 2019. In addition, multiple logistic regression analyses were performed to predict determinant factors involved in improving the child's nutritional status. In this study, 17.5% of children had improved nutritional status, and 79.3% had a steady nutritional status. However, there were 3.2% of children with decreased nutritional

status. Model factors determinant related to improved nutritional status includes consumption more than once per week of red meat (adjusted odds ratio (aOR) = 2.15; 95% confidence interval (CI): 1.06-4.35, p=0.034), milk consumption more than once per week (aOR = 1.56; 95% CI: 0.89-2.74, p=0.119), and age under 5 years old (aOR = 1.86; 95% CI: 1.14-3.15, p=0.016). Children under five years old, the consumption of red meat and milk more than once a week have the opportunity to improve nutritional status (by height-for-age index) in children.

Keywords: stunting, under five years, height-for-age index, improved nutritional status

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INTRODUCTION

The COVID-19 pandemic is predicted to trigger a global economic and food supply crisis, which further affects people's health and nutrition status (Fahim *et al*, 2021). Mobility restrictions, food supply chain disruptions, and limited access to nutrition and health programs resulted in the reduction of food quantity, quality, and variety to consume. If this problem lasts for a long time, it can induce a decrease in a child's nutritional status and child growth disruptions (UNICEF/USAID/WHO, 2022).

Children's nutritional status is commonly determined based on anthropometric measurement categorization, with height-for-age z-score (HAZ) as one of the measurement parameters. The nutritional status category based on the height-for-age index includes severely stunted, stunted, normal, and high. Indonesia shows an increase in the nutritional status of its children under five with a decrease in stunting incidence by 24.2% in 2021 (during the COVID-19 pandemic) compared to 27.7% in 2019 (NIHRD, 2021).

Nutritional status stunting reflects a failure to grow condition.

Stunting is usually related to poor maternal health and nutrition conditions; children often get sick, and improper care and feeding of children early in life (WHO, 2021). The causes of stunting in Indonesia based on a meta-analysis are: boys are more vulnerable, young age (12-32 months old), low birth length (<48 cm), low birth weight (LBW), maternal height <150 cm, mothers at a vulnerable age for pregnancy (<20 years or >35 years), number of household members five people, number of children under five in the household three children, antenatal care <4 times, living in a slum environment, low parental education, less active in Posyandu, or living in rural areas (Yuana *et al*, 2021).

Very little evidence describes the size of the nutrition problem and alteration in the nutritional status of children especially children under five, during the COVID-19 pandemic. Therefore, this study aimed to observe alterations in nutritional status before and during the COVID-19 pandemic (during 2019-2021) and determinant factors involved in the improvement of nutritional status (based on the HAZ index category) during the COVID-19 pandemic. The findings were intended as evidence-based suggestions for policy formulation concerning the improvement of child nutritional status and stunting reduction. Factors that influence the improvement of nutritional status in children over time need to be known as input for policy-making in preventing and reducing stunting.

MATERIALS AND METHODS

This study was conducted in Bogor City as part of The Child Growth and Development Cohort Study, carried out by The National Institute of Health Research and Development (NIHRD), Ministry of Health, Republic of Indonesia. The population of this study was children in 2019 who were the respondents of the Child Growth and Development Cohort Study from 2012-2021. As the samples of this study, children in 2019 were measured for height and their parent was interviewed about the children and household conditions in 2019 and 2021 with structured questionnaire. The analysis was conducted on the selected sample with complete data on the analyzed variables (565 children).

The inclusion criteria in this study were children under five-year-old in 2019 who were involved as a study sample in The Child Growth and Development Cohort Study and had high measurement data in 2019 and 2021 (to see changes in nutritional status compared to 2019) and have another necessary data variable which was collected in 2021 (data on living environment conditions, parental education, consumption habits and social assistance provided to households). The year selection describes before the COVID-19 pandemic (in 2019) and during the COVID-19 pandemic (in 2021). In this study, children who had incomplete necessary data variables were excluded.

The social assistance variable asked whether they received assistance during the COVID-19 pandemic. Variables of consumption habits were processed from data on the consumption habits of food groups during the COVID-19 pandemic. The handling of household liquid waste was classified as not good if the liquid waste had no sewage (flooded in the yard), liquid waste absorbed at a distance of <10 meters from the well, or drained out of the house through open sewers. The facility of defecation in the household is said to be good if the latrine is in the shape of a swan's neck and drained into a septic tank.

Height samples were measured using a portable height meter with an accuracy of 0.01 cm. Data on children's height and age were processed to obtain a HAZ index, categorized as the nutritional status, namely severely stunted, stunted, normal and high (Ministry of Health, 2020b). Changes in nutritional status in 2021 compared to 2019 are categorized as improvement in nutritional status (increasing in the category of HAZ) and not improvement (decreasing or constant in the category of HAZ). Other relevant data were obtained through the respondent's interview using a structured questionnaire.

Statistical analysis

Data analysis was carried out in stages: 1) examining the characteristics of the respondents, 2) calculating the prevalence of stunted children in 2019

and 2021, 3) conducting a Chi-square test to explore the relationship of factors related to improvement in nutritional status in 2021 compared to 2019 (parent's education, child's age, number of members in the household, the frequency of red meat, poultry, egg, fish, milk, and fruits consumption, getting social assistance, the quality of handling liquid waste, and the quality of defecation facility, 4) multivariate analyzes were performed to determine the factors associated with improvement in nutritional status (in 2021 compared to 2019) by looking at an adjusted odds ratio (aOR) and 95% confidence interval (CI); p-value <0.05 was considered statistically significant. Data were analyzed using Statistical Package for the Social Sciences (SPSS) software version 25 developed by IBM Corporation, Armonk, NY.

Ethical consideration

The Child Growth and Development Cohort Study protocols have gone through review and received ethical approval from the Health Research Ethics Committee (KEPK) of the Health Research and Development Agency, Ministry of Health of the Republic of Indonesia, with number LB.02.01/2/KE.102/2019 and LB.02.01/2/KE.362/2021.

RESULTS

The characteristics of the children were presented in Table 1. Based on gender, the proportion of boys (44.8%) was smaller than girls (55.2%). As for the age in 2021, 48% aged <5 years, and 52% aged ≥5 years. The education of parents, both father and mother, mostly graduated from high school or college with a proportion of 65.8% in the father group and 60.7% in the mother group.

The nutritional status of sample children according to the HAZ is illustrated in Fig 1. There was a decrease in the prevalence of severely stunted children, from 4.1 percent in 2019 to 1.6 percent in 2021. A decline in prevalence was also seen in stunted children, from 22.5 percent in 2019 to 12.9 percent in 2021. There was an increase in children with normal height

Table 1

Participants' characteristics (N = 565)

Characteristics	Frequency, n (%)
Gender	
Male	253 (44.8)
Female	312 (55.2)
Age in 2019	
0-23 months	170 (30.0)
24-59 months	395 (70.0)
Age in 2021	
24-59 months	272 (48.0)
60 months and over	293 (52.0)
Father's education	
Junior High School/below	193 (34.2)
Senior High School/college	372 (65.8)
Mother's education	
Junior High School/below	222 (39.3)
Senior High School/college	343 (60.7)

in 2021 (85.5%) compared to 2019 (73.5%).

The percentage of alteration in the nutritional status of children is as Fig 2. Most of the samples (79.3%), even though they increased in height but remained in the same category (constant). As much as 3.2 percent sample experienced a decrease in the category. Only 17.5 percent of the sample showed an increase in height which also increased the category of HAZ (experienced an improvement in nutritional status).

Bivariate tests of the relationship of variables related to improvement in nutritional status (Table 2) show that the father's or mother's education, number of household members, facility of defecation, liquid waste handling,
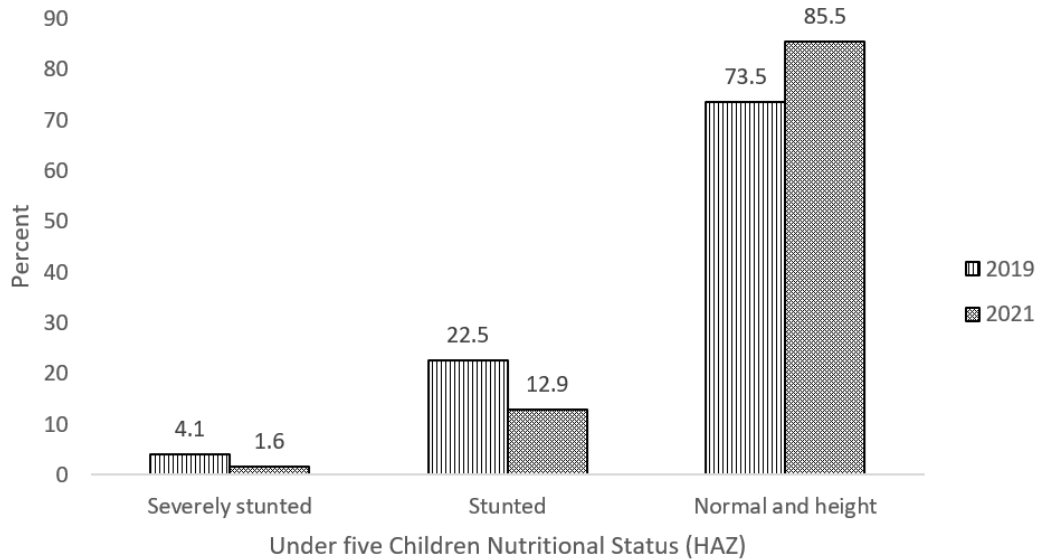
Fig 1 - Children nutritional status according to the height-for-age z-score (HAZ) index category in 2019 and 2021
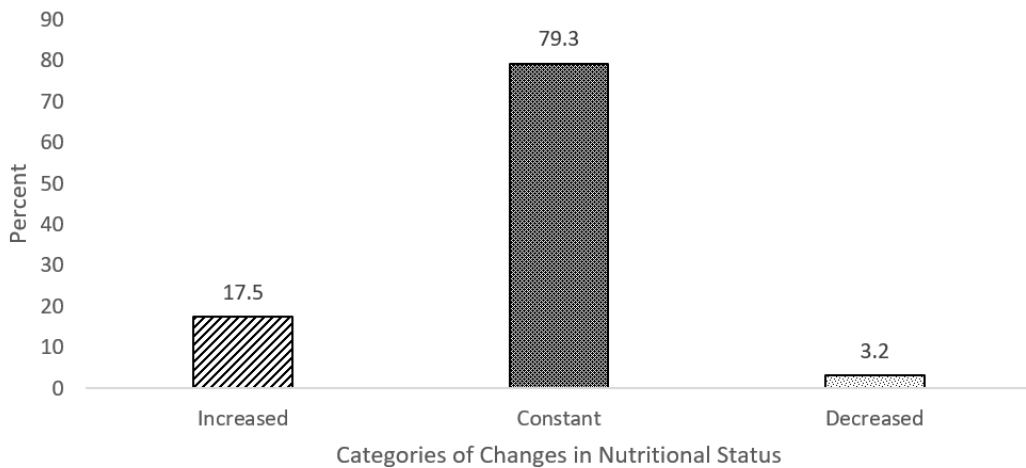

Fig 2 - Percentage of alteration in nutritional status of children according to the height-for-age z-score (HAZ) index category in 2019 and 2021

Table 2

Bivariate test results relationship of factors related to improvement in nutritional status in 2021 compared to 2019 (N = 565)

Variable	Improvement of nutritional status		cOR (95% CI)	p-value*
	Yes, n (%)	No, n (%)		
Father's education				
Senior high school/College	61 (16.4)	311 (83.6)	0.827 (0.527-1.299)	0.479
Junior high school/below	37 (19.2)	156 (80.8)		
Mother's education				
Senior High School/college	57 (16.6)	286 (83.4)	0.88 (0.565-1.369)	0.650
Junior High School/below	41 (18.5)	181 (81.5)		
Child's age				
Under five years	63 (23.2)	209 (76.8)	2.22 (1.414-3.491)	0.001*
Five years and over	35 (11.9)	258 (88.1)		
Number of members in household				
1-4 people	54 (16.3)	278 (83.7)	0.83 (0.538-1.294)	0.486
5 people and more	44 (18.9)	189 (81.1)		
Red meat consumption				
More than once a week	13 (30.2)	30 (69.8)	2.23 (1.116-4.446)	0.035*
Less and equal than once a week	85 (16.3)	437 (83.7)		

Table 2 (cont)

Variable	Improvement of nutritional status		cOR (95% CI)	p-value*
	Yes, n (%)	No, n (%)		
Poultry consumption				
More than once a week	53 (15.8)	283 (84.2)	0.77 (0.494-1.187)	0.279
Less and equal than once a week	45 (19.7)	184 (80.3)		
Egg consumption				
More than once a week	67 (16.2)	347 (83.8)	0.75 (0.465-1.200)	0.279
Less and equal than once a week	31 (20.5)	120 (79.5)		
Fish consumption				
More than once a week	19 (14.6)	111 (85.4)	0.77 (0.448-1.329)	0.421
Less and equal than once a week	79 (18.2)	356 (81.8)		
Fruits consumption				
Every day	16 (20.0)	64 (80.0)	1.23 (0.676-2.232)	0.605
Not Everyday	82 (16.9)	403 (83.1)		
Milk consumption				
More than once a week	75 (21.1)	280 (78.9)	2.18 (1.318-3.600)	0.003*
Less and equal than once a week	23 (11.0)	187 (89.0)		

Table 2 (cont)

Variable	Improvement of nutritional status		cOR (95% CI)	p-value*
	Yes, n (%)	No, n (%)		
Get social assistance				
Yes	88 (17.8)	406 (82.2)	1.32 (0.652-2.682)	0.543
Not	10 (14.1)	61 (85.9)		
Handling of liquid waste				
Good	80 (18.8)	346 (81.2)	1.55 (0.895-2.698)	0.148*
Not good	18 (12.9)	121 (87.1)		
Facility of defecation				
Good	48 (17.8)	221 (82.2)	1.07 (0.691-1.652)	0.851
Not good	50 (16.9)	246 (83.1)		

*Variables with p-value <0.25 were selected for the multivariate test

CI: confidence interval; cOR: crude oods ratio

Handling liquid waste is considered good when household had a closed sewage or waste absorbed at ≥10 meters from the well; not good when household had an open sewage (flooded in the yard) or waste absorbed at <10 meters from the well.

The facility of defecation is considered good when household had swan's neck latrine and drained into a septic tank; not good when household didn't have swan's neck latrine or not drained into a septic tank.

recipients of social assistance and consumption habits of fruits, fish, poultry, and eggs were not significantly related to improvement in nutritional status. Variables that related significantly statistics with improvement in nutritional status were: children's age in 2021 (crude odds ratio (cOR) = 2.22; 95% CI: 1.414-3.491, p=0.001), consumption habits of red meat (cOR = 2.23; 95% CI: 1.116-4.446, p=0.035) and consumption habits of milk (cOR = 2.18; 95% CI: 1.318-3.600, p=0.003).

Variables in the bivariate test, which have a p-value <0.25, were included in the multivariate test to obtain the best model of factors that influence the improvement of nutritional status. Four variables have a p-value <0.25, consisting of the category of children's age in 2021, red meat consumption, milk consumption, and handling liquid waste in the household.

The final results of the multivariate test are presented in Table 3. Variables that were related and statistically significant (p-value <0.05) with improved nutritional status (increased category of HAZ in 2021 compared to 2019) were the child's age under 60 months and red meat consumption habits. Milk consumption habit was categorized as a confounding factor due to milk consumption interfering with the relationship between red meat consumption and children's age in improving nutritional status.

The habit of consuming red meat has an aOR of 2.15, which means that consumption of red meat more than once a week has a 2.15 times chance of an improvement in nutritional status compared to children who eat red

Table 3

Multivariate test results determinant factors of improvement in nutritional status in 2021 compared to 2019

Variable	aOR (95% CI)	p-value
Red meat consumption (>1 time/week)	2.15 (1.060 – 4.346)	0.034
Child's age (<60 months)	1.86 (1.141 - 3.150)	0.016
Milk consumption (>1 time/week)	1.56 (0.891 - 2.740)	0.119

aOR: adjusted oods ratio; CI: confidence interval

meat at least once a week after being controlled by the age variable and milk consumption habits (95% CI: 1.060-4.346, *p*=0.034). Ages under five years old (toddlers) have a 1.86 times chance of an improvement in nutritional status compared to children aged five years and over (95% CI: 1.141-3.150, *p*=0.016). The habit of consuming milk (formula milk, powdered milk or liquid milk, excluding sweetened condensed milk) more than once per week has a 1.56 times chance of an improvement in nutritional status compared to children who drink milk at least once a week, where the relationship is not significant (95% CI: 0.891-2.740, *p*=0.119).

DISCUSSION

In the same children whose height was measured before COVID-19 (the year 2019) and during COVID-19 (the year 2021), it was seen that the prevalence of children with stunting in 2021 decreased compared to 2019. If it was observed from the children's nutritional status alteration point of view, the majority of the child had no significant nutritional status alteration between 2019 and 2021 (79.3%). However, 17.5 percent of the children experienced nutritional status improvement (based on the HAZ index category). Although the sampling method is not precisely the same, the results obtained are in line with the 2021 Indonesian Nutritional Status Study (SSGI) results, which showed an improvement in nutritional status. The SSGI 2021 showed that the prevalence of stunting in children under five had decreased to 24.4 percent in 2021 compared with 27.67 percent in 2019 (NIHRD, 2021).

The COVID-19 pandemic and its consequences are a serious threat to children's development (Dewi *et al*, 2022). However, the results of this study show a decrease in the percentage of stunting in children under five. The decrease in the percentage of stunting in children under five during the COVID-19 pandemic can be due to various efforts that the Indonesian government has made to prevent and eradicate stunting. Since 2019, the Indonesian government has massively implemented a national strategy for stunting eradication by overcoming direct and indirect causes through

multisectoral collaboration (Secretariat of the Vice President of the Republic of Indonesia, 2018). In addition, the government provides social assistance to vulnerable families affected by COVID-19 with various schemes in the form of cash transfers and food supply assistance, where low-income families who have pregnant women and stunted children become priority beneficiaries (Ministry of Social Affair, 2021). Furthermore, the Indonesian government immediately enacted a special health protocol regulation aimed at growth monitoring services at Posyandu (Ministry of Health, 2020a), so the monitoring and intervention program for children with nutritional problems can continue. Social restriction policy during the COVID-19 pandemic period has also made lifestyle changes, households and children spend more time at home, consuming food cooked at home compared to ready-to-eat food and snacks from outside the home (Directorate of Social Welfare Statistics, 2022). Afrinis *et al* (2021) study's results indicated that children's nutritional status during the COVID-19 pandemic was closely related to the knowledge of mothers of children under five. This means that mothers of under five-year-old children play a major role in child growth and development. According to health ethnographic research, a child is defined as sustenance to be grateful (Fuada *et al*, 2017). Implementing this concept makes nutritional status improvement during the COVID-19 pandemic achievable.

This study found many children who showed a nutritional status improvement. Therefore, we studied the determinant factors that affect the improvement of nutritional status. This study found that the determinants of a child's nutritional status improvement (based on the HAZ category) were age and consumption habits of red meat (beef/goat meat) and milk. Children with more than once-a-week red meat consumption had a 2.15 times higher possibility of experiencing an increase in nutritional status compared to children with red meat consumption of less than or equal to once a week, which was significant statistically. Scientific literature states that red meat consumption contributes to the intake of essential nutrients for child growth, such as protein, essential fatty acids, several vitamins and minerals, and high iron content, especially meat with high myoglobin (Juárez *et al*, 2021). Red meat is also high in sodium, potassium, and vitamin D (Cashman and

Hayes, 2017). Animal food products, especially meat, are important because of their high level of bioavailability (the ability of available nutrients to be absorbed by the body) including protein, iron, zinc, and vitamin B complex, especially B12. There is a decreasing trend in the proportion of stunted children in various countries with increasing meat consumption per capita (Headey *et al*, 2018). Amino acids in meat protein and other nutrients mainly play a role in growth, development, cell regeneration, and repair (Bohrer, 2017; Pereira and Vicente, 2013).

This study also found that age is a statistically significant determinant factor in improving children's nutritional status. Children under five years potentially experience an increase in growth of 1.86 times higher than children over five years, which also showed a statistically significant relationship. This is understandable because children under five years show rapid growth compared to an older age. It is widely known that there is a growth spurt during the first five years of age (Cleveland Clinic, 2021; Graber, 2021). At toddlers' age, the most important period for growth is referred to as the critical period (window of opportunity), which is the first 1000 days of life that requires adequate nutritional intake for growth and development (UNICEF, 2017).

The habit of drinking milk more than once a week has an effect of 1.56 times an improvement in nutritional status compared to children who drink milk less and equal to once a week. Milk and its products are sources of high-quality protein and micro-minerals that are important in preventing stunting, containing vitamin A, vitamin B12, iron, iodine, zinc, folic acid and choline, thiamine (vitamin B1), riboflavin (vitamin B2), niacin (vitamin B3), pantothenic acid (vitamin B5), vitamin D3, vitamin B6, calcium, phosphorus, selenium, and potassium (Adegosan and Dahl, 2020; Givens, 2020; Dror and Allen, 2011; GÓrska-Warsewicz *et al*, 2019). The role of milk in improving nutritional status is not statistically significant (95% CI: 0.891-2.740, *p*=0.119), which may be due to the low amount of milk each time consumed. Indonesia is included in the Southeast Asia region, where milk consumption is low, related to the affordability and accessibility of dairy products (Kapaj, 2018; OECD-FAO, 2019).

The World Health Organization (WHO) states that animal-source foods are the best sources of high-quality, nutrient-rich foods, where feeding children with animal foods increases body weight and decreases stunting incidence (Adesogan *et al*, 2020; Pimpin *et al*, 2019). In this study, food sources originating from animals, red meat, and milk are the determinant factors for improving nutritional status. The other food sources of protein, such as eggs, fish, and white meat, were not significantly improved nutritional status. There is a possibility that they play a role in maintaining the nutritional status as before, and the children's nutritional status have not yet improved. The quantity of food consumed also plays a role in children's growth. This paper has limitations, it only has data on the frequency of food consumption habits, and there were no data on the weight of the food consumed.

In summary, there is a decline in the prevalence of stunting in children. In addition, there is an alteration in nutritional status based on the height-for-age z-score (HAZ) index category during 2019-2021 (before and during the COVID-19 pandemic); 79.3 percent of children with steady nutrition status, 3.2 percent experienced a decrease, and the rest 17.5 percent experienced an improvement in the nutritional status. Determinant factors associated with improvement in nutritional status include consumption of red meat more than once a week (OR = 2.15; 95%CI: 1.060-4.346), age under five years old (OR = 1.86; 95%CI: 1.141-3.150) and milk consumption habit more than once per week (OR = 1.56; 95%CI: 0.891 - 2.740). It is necessary to further study the role of the amount consumed in various types of food in improving nutritional status.

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CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflict of interest.

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