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Impact Of Agricultural Production on Stunting Prevalence in Central Java Province

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Abstract: Stunting is a chronic nutritional problem that impairs children's growth and development. This study aims to examine the influence of agricultural production and food access indicators on stunting prevalence across 35 districts and cities in Central Java Province from 2021 to 2023. The independent variables include rice production, horticultural production, broiler chicken production, cow milk production, egg price index, and paddy field area. Panel data regression using a fixed effects model (FEM) was selected as the most appropriate analytical approach, based on the results of the Chow and Hausman tests. The results show that rice production, egg price index, and paddy field area have a statistically significant influence on stunting prevalence. In contrast, horticultural production, broiler chicken production, and cow milk production do not show significant effects. These results suggest that improving food availability alone is not sufficient; it must be accompanied by enhanced access and affordability. The study highlights the importance of localized agricultural and nutritional strategies in reducing stunting. Analysis indicates the decline in stunting prevalence in Central Java, although several areas still record high rates. Rice production, paddy field area, and egg prices index as significant factors influence stunting, highlighting the need for integrated policies that combine agricultural development with improved access, affordability, and nutrition education.

Keywords: child nutrition; food accessibility; panel regression; regional disparities; secondary data analysis

Introduction

Stunting is a major health problem that affects children's physical growth and cognitive development, especially in developing countries. This condition is caused by chronic nutrition deficiency rooted in a variety of factors, including maternal nutritional status, consumption pattern, and food accessibility. The long-term results of stunting include constraints on learning ability, declining productivity in adults, and increased risk of various diseases, both contagious and contagious (Indonesian Ministry of Health in Ardiana et al., 2020). The Food and Agriculture Organization (FAO) defines household food security based on the ability to obtain sufficient food to meet nutritional needs. Food accessibility involves physical aspects, namely availability and ease of acquisition when needed. High and low income and consumption patterns are one of the factors that affect household food availability (Krasevec et al., 2017).

Failure to diversify agriculture is one of the factors limiting household access to a variety of foods, which negatively impacts public health, including the emergence of stunting and obesity problems (Deller et al., 2020). The agricultural sector plays a major role in food production and household food security (Harper et al., 2009). According to Grace et al. (2016), small-scale agricultural output influences childhood stunting

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among at-risk children. Research by Purwestri et al. (2017), concluded that households that primarily grow rice for self-consumption and have small paddy fields are more likely to have stunted children than non-stunted ones. Analysing data from about half of the world's countries over 20 years, Rogna (2024) found that mineral fertilizers significantly contribute to reducing child stunting. Other agricultural inputs, such as farmland per capita and manure, positively reduce child stunting, but their statistical significance appears only in some models. However, irrigation shows no significant impact in reducing child stunting. Access to nutritious food continues to be hampered by economic limitations, inequality in food distribution, and dependence on certain types of food (Castro-Bedriñana *et al*., 2021).

Indonesia is currently making concerted efforts to reduce stunting, in accordance with Presidential Regulation No. 72 of 2021 on the Acceleration of Stunting Reduction. This regulation outlines five strategic pillars: commitment and leadership, stunting prevention, program convergence, provision of nutritious food, and breakthrough innovations supported by accurate data. According to the Indonesian Nutritional Status Survey (SSGI), the national stunting prevalence declined from 24.4% in 2021 to 21.6% in 2022. Further, data from the 2023 Indonesian Health Survey indicate that the combined prevalence of stunting and severe stunting decreased to 18.3%. These figures suggest that Indonesia's stunting reduction initiatives are showing progress and meeting the World Health Organization's (WHO) standard, which sets the acceptable prevalence of stunting below 20%.

Several factors have been found to be significantly associated with stunting in children aged 24–59 months. Nugroho et al. (2023) identified energy intake, birth weight, maternal education, household income, parenting practices, and dietary diversity as key determinants. Similarly, research by Widyaningsih et al. (2018) found that dietary diversity was a more dominant factor than parenting in influencing stunting among toddlers. However, Latifah et al. (2024) noted a significant increase in acute nutritional problems in 2022, suggesting that stunting reduction efforts may still be overly focused on curative interventions (treating existing cases) rather than preventive measures aimed at avoiding the onset of nutritional problems. toddlers), but are not yet strong in the preventive aspect of preventing nutritional problems.

Central Java remains one of the provinces with a relatively high prevalence of stunting. According to SSGI 2022, the stunting rate in Central Java was 20.8%, only slightly lower than the national average of 21.6%.

On the other hand, Central Java Province is one of the main centers of agricultural commodity production in Indonesia. According to BPS (2024), Central Java ranks as the largest rice-producing province in the country. Rice production plays a crucial role in supporting regional food security, particularly in ensuring the availability and stability of food supplies. This province is also a national center for food crop and horticultural production. Based on the 2013 Agricultural Census, the food crops subsector is the most dominant subsector, comprising 3.29 million agricultural households. Conversely, the fisheries subsector has the fewest number of agricultural households, at only 0.26 million households (BPS, 2023).

Cilacap Regency has the largest area of paddy fields among all districts and cities in Central Java, with the dominant irrigation system being technical irrigation (BPS Provinsi Jawa Tengah, 2023). Although Brebes Regency ranks second in terms of paddy field area, its rice production is still lower than that of Grobogan, Demak, Sragen, and several other regencies. This lower productivity is primarily due to the fact that rice cultivation in Brebes is generally conducted only once a year. In contrast, in Cilacap and several other regions, a larger proportion of rice fields are planted two or more times per year, resulting in higher production levels. Despite Central Java's role as a major contributor to national agricultural production, the majority of agricultural households in the province are smallholders. Most of them own less than 0.5 hectares of land, which limits their capacity to scale up production and adopt more intensive agricultural practices.

Central Java also produces a variety of vegetables and livestock products. According to Bakhtsiyarava & Grace (2021), increasing farm production diversity reduces the risk of chronic food insecurity, measured by child height-for-age, but has no impact on acute food insecurity, measured by child weight-for-height. These findings highlight the importance of considering the relationship between farm-level food production and child nutrition within the context of climate change. Research by Mary et al. (2020) found evidence of a moderate effect of agricultural aid on reducing child stunting. Agricultural aid that supports agricultural education, research, services, water infrastructure, and policy effectively reduces child stunting, with food aid being the most effective intervention.

Understanding the linkages between agriculture and stunting at the district level is critical for developing more effective and context-appropriate strategies to address the issue. While many studies have examined the causes of stunting, few have systematically analyzed the role of the agricultural production economy in shaping stunting outcomes at the district level over multiple years. This study makes a novel contribution by using longitudinal data and integrating information on agricultural production (rice, horticulture, livestock products), economic access (egg price index), and land use (paddy field area) to assess their association with stunting rates in 35 districts/cities in Central Java over the period 2021–2023. By focusing on region-specific determinants, this research provides a more localized and evidence-based understanding of stunting and offers recommendations for more targeted and effective policy interventions at the regional level.

Method

Time and location of research

The study included all 35 administrative districts/cities, with data collected annually from 2021 to 2023. Secondary data were sourced from the Central Statistics Agency (BPS), the Ministry of Home Affairs, and the Central Java Province Commodity Price and Production Information System (SiHaTi).

Method of research

This study employed a quantitative approach using panel data regression analysis to examine the influence of agricultural production and food access indicators on stunting prevalence in Central Java Province.

Research stages

The dependent variable was the prevalence of stunting in children under five in each district per year. Independent variables comprised rice production (X1), horticultural production (X2), broiler chicken production (X3), cow's milk production (X4), egg price index (X5), and paddy field area (X6), measured annually per district. The regression model was formulated as follows:

$$Yt = \beta_0 + \beta_1 X1 + \beta_2 X2 + \beta_3 X3 + \beta_4 X4 + \beta_5 X5 + \beta_6 X6 + \varepsilon, \quad (1)$$

where Yt denotes the prevalence of stunting in the i-th regency at time t, β_0 is the intercept, β_1 to β_6 are the coefficients of the respective independent variables, and ε is the error term capturing unobserved factors.

This study also tested the significance of the independent variables in explaining the variation in stunting prevalence across districts. The null hypothesis (H_0) stated that rice production, horticultural production, broiler chicken production, cow's milk production, egg price index, and paddy field area did not have a statistically significant effect on the stunting prevalence in Central Java Province. In contrast, the alternative hypothesis (H_1) posited that at least one of these variables exerted a significant influence on the observed prevalence of stunting.

Data analysis

The analysis, including model estimation and diagnostic testing, was conducted using EViews 12 statistical software. To determine the most appropriate estimation model, three diagnostic tests were performed sequentially. The Chow test was conducted to assess whether the common effect model (CEM) or the fixed effect model (FEM) was more suitable by examining the homogeneity of intercepts across observational units. Subsequently, the Hausman test was employed to evaluate the correlation between individual effects and the independent variables, thereby determining whether the FEM or the random effect model (REM) provided more consistent and efficient estimates. In addition, the Lagrange Multiplier (LM) test was applied to detect the presence of random effects, helping to decide between the CEM and the REM.

Result and Discussion

Stunting trends in districts and cities in Central Java Province

Figure 1 shows a decreasing trend in stunting incidents in districts/cities in Central Java Province, however, several areas still experience relative stunting cases that have not yet decreased, including in Magelang, Blora, Pati, Pekalongan, and Pemalang Regencies. Analysis of changes/growth in stunting cases in districts/cities in Central Java Province is shown in Table 1.

Table 1. The Growth in Stunting Prevalence Cases in Regency/City in Central Java Province

Regency/City	Growth		
	2021-2022	2022-2023	Average
Cilacap	-0.017	-0.778	-0.398
Banyumas	-0.231	0.073	-0.079
Purbalingga	0.595	-0.534	0.031
Banjarnegara	-0.047	-0.191	-0.119
Kebumen	0.390	-0.547	-0.079
Purworejo	0.357	-0.370	-0.007
Wonosobo	-0.192	-0.262	-0.227
Magelang	0.265	-0.633	-0.184
Boyolali	-0.034	-0.555	-0.295
Klaten	0.152	-0.247	-0.048
Sukoharjo	-0.010	-0.642	-0.326
Wonogiri	0.286	-0.396	-0.055
Karanganyar	0.377	-0.757	-0.190
Sragen	0.293	-0.540	-0.124
Grobogan	1.010	-0.703	0.154
Blora	0.200	-0.530	-0.165
Rembang	0.299	-0.472	-0.087
Pati	0.117	-0.672	-0.278
Kudus	0.080	-0.808	-0.364
Jepara	-0.272	-0.627	-0.450
Demak	-0.365	-0.841	-0.603

Regency/City	Growth 2021-2022	2022-2023	Average
Semarang	0.140	-0.786	-0.323
Temanggung	0.410	-0.531	-0.061
Kendal	-0.175	-0.369	-0.272
Batang	0.083	-0.541	-0.229
Pekalongan	0.205	-0.519	-0.157
Pemalang	-0.198	-0.422	-0.310
Tegal	-0.204	-0.182	-0.193
Brebes	0.106	-0.449	-0.172
Magelang City	0.045	0.108	0.077
Surakarta City	-0.206	-0.688	-0.447
Salatiga City	-0.066	-0.578	-0.322
Semarang City	-0.512	-0.890	-0.701
Pekalongan City	0.121	-0.677	-0.278
Tegal City	-0.297	-0.326	-0.312
Central Java Province	0.036	-0.511	-.238

Source: Primary Data Analysis (2025)

The data in Table 1 show fluctuations in the growth rate of stunting prevalence over the four-year period. While the overall trend in Central Java indicates a gradual decline with an average growth rate of -0.238, the pattern varies significantly across districts. Pati Regency recorded the highest average increase in stunting cases, followed by Pekalongan and Pemalang Regencies. This suggests the need for targeted interventions in these areas despite the general downward trend.

Although the majority of districts and cities show a reduction in stunting cases, maintaining a stunting prevalence below the World Health Organization's recommended threshold of 20% remains a critical challenge. According to a study by Susanti et al. (2023), Central Java Province contains clusters with high stunting prevalence. The first cluster, identified as having high stunting risk factors, includes 16 districts and cities: Cilacap, Banyumas, Purbalingga, Banjarnegara, Kebumen, Purworejo, Wonosobo, Magelang, Blora, Jepara, Temanggung, Kendal, Batang, Pekalongan, Pemalang, and Brebes. These areas require prioritized and sustained intervention strategies to effectively reduce the burden of stunting.

Descriptive Statistics of Variables

Table 2 presents the descriptive statistics of the variables used in this study. The dataset comprises 105 observations over the years 2021 to 2023, covering various districts and cities in Central Java Province.

Table 2. Descriptive Statistics

Variable	Obs	Mean	SD	Min	Max
Year	105			2021	2023
Stunting (%)	105	16.917	6.518	1.14	29.10
Rice production (toones)	105	269,137.551	216,807,317	156	800,945
Vegetable production (quintal)	105	131,700.128	211,427.143	0	1,029,727
Broiler chicken production	105	7,737,966.699	5,637,758.095	366,564.7	24,500,000
Milk cow production (liters)	105	2,996,863.772	9,535,999.021	0	53,003,680
Egg price index	105	36,408.049	3,013.6733	29,935	43,701.75
Paddy field area (hectares)	105	35,325.581	18,287.340	1,250	70,000

Source: Primary Data Analysis (2025)

The data reveal significant variability in some variables, notably broiler chicken production and milk cow production, as indicated by their large standard deviations. Particularly, the milk cow production variable shows a minimum value of zero, suggesting that certain districts do not produce cow's milk or did not report production data. This variation reflects regional disparities in agricultural and livestock productivity across Central Java. As noted by Woestho et al. (2021), Wonogiri and Semarang Regencies serve as food crop production bases in the province. Moreover, Kartikowati & Maria (2024) emphasized that the livestock sub-sector in Central Java is among the fastest growing, competitive, and contributes significantly to regional development and economic acceleration.

Classical Assumption Test

In the FEM model, classical assumption tests were conducted to ensure the validity of the regression estimates. These included multicollinearity and heteroscedasticity tests.

Multicollinearity test

Multicollinearity was assessed using the correlation matrix of the independent variables, as presented in Table 3.

Table 3. Correlation Matrix of Independent Variables

	X1	X2	X3	X4	X5	X6
X1	1.000000	-0.029423	-0.409788	-0.054835	-0.192804	0.691590
X2	-0.029423	1.000000	0.153037	0.129617	0.143252	0.157484
X3	-0.409788	0.153037	1.000000	0.502658	0.056247	-0.293069
X4	-0.054835	0.129617	0.502658	1.000000	0.051210	0.036087
X5	-0.192804	0.143252	0.056247	0.051210	1.000000	-0.086406
X6	0.691590	0.157484	-0.293069	0.036087	-0.086406	1.000000

Source: Primary Data Analysis (2025)

The correlation matrix shows that no pair of independent variables has a correlation coefficient exceeding 0.8, which is the commonly accepted threshold indicating potential multicollinearity (Gujarati & Porter, 2009). This suggests that the independent variables are not highly correlated with each other. As a result, the regression model satisfies the classical assumption of no multicollinearity, ensuring that the estimated coefficients are unbiased and efficient (Wooldridge, 2016).

Heteroscedasticity test

The assumption of homoscedasticity was evaluated using both graphical inspection of the residual scatterplot and statistical significance testing. As shown in Figure 3, the scatterplot of residuals does not reveal any systematic or funnel-like pattern, which would typically indicate heteroscedasticity. Instead, the residuals appear to be randomly dispersed, suggesting constant variance across observations.

Furthermore, the statistical test yielded significance values exceeding 0.05. According to Gujarati & Porter, (2009), a p-value above the conventional 5% level indicates that the null hypothesis of homoscedasticity cannot be rejected. In line with this, the results support the conclusion that the residuals are homoscedastic.

This finding affirms that the FEM model satisfies the classical assumption of constant error variance, thereby ensuring more reliable and efficient parameter estimates (Wooldridge, 2020).

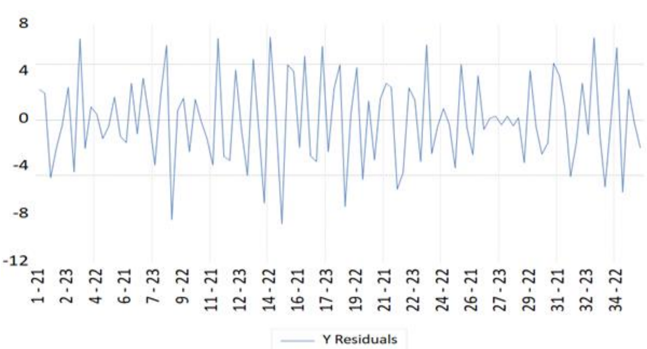

Figure 3. Checking Heteroscedasticity Using the Graph Method
Source: Primary Data Analysis (2025)

Normality Test

The normality test is performed to find out if the residues of the regression model are distributed normally, which is one of the important assumptions in classical regression analysis. The test was carried out using the Jarque-Bera method through the Histogram – Normality Test at Eviews (Anandita & Septiani, 2023). Based on the test results, the Jarque-Bera statistical value was obtained of 4.009297 with a probability (p-value) of 0.134708. Since the p-value is greater than the significance level of 5% (0.05), it can be concluded that the residual in this regression model is normally distributed. Thus, the model has met the assumption of normality and the results of the regression estimation can be considered statistically valid.

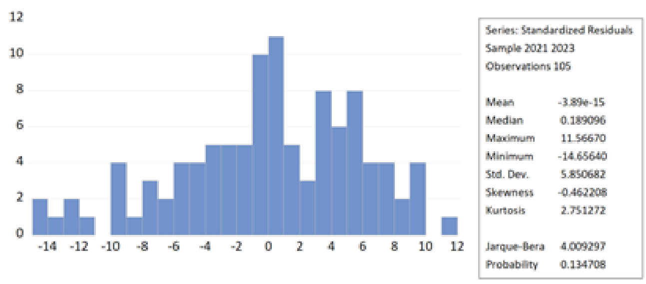

Figure 4. Checking Normality Test
Source: Primary Data Analysis (2025)

Autocorrelation Test

The autocorrelation test aims to find out whether there is a relationship between residuals in the regression model, especially if the data is time series data. One of the methods used is the Durbin-Watson test (Mawanda & Setiyono, 2023). Based on the regression results, the Durbin-Watson value was obtained as 3.226031. This value is well above the number 2, which is the ideal threshold without autocorrelation. In general, a DW value of > 2.5 indicates a negative autocorrelation in the model. Therefore, it can be concluded that this regression model undergoes a negative autocorrelation, which means that residual values tend to move in opposite directions over time.

Impact of agricultural production on stunting prevalence

The results of the Fixed Effect Model (FEM) regression presented in Table 4 reveal that among the six independent variables examined, three variables show statistically significant relationships with stunting prevalence: rice production (X1), egg price index (X5), and paddy field area (X6). The model demonstrates a good overall fit, as indicated by an F-statistic of 3.460674 and an R-squared value of 0.683837, suggesting that approximately 68.38% of the variation in stunting prevalence can be explained by the independent variables included in the model.

Rice production (X1) has a positive and statistically significant relationship with stunting prevalence (p = 0.0199). At first glance, this result seems counterintuitive, as rice is a staple food in Indonesia. However, this finding may reflect regional disparities where high production areas prioritize commercial distribution rather than local nutritional needs. Previous studies, such as Fan et al. (2012) emphasize that mere calorie sufficiency from staples like rice does not address micronutrient deficiencies that contribute to stunting. Sitaresmi et al. (2023) added that rice varieties with better nutritional quality, such as high zinc content, can help prevent stunting. Therefore, the stable availability of staple foods plays a role in maintaining children's energy intake while still being equipped with sources of protein and other micronutrients so that nutritional intake is balanced. That is why Montolalu et al. (2024), emphasize that policies should focus on increasing average rice production and improving access to nutritious food for the poor to combat stunting. Besides that, Bakri et al. (2025), revealed that in rural areas of Indonesia, farming households are more vulnerable to stunting due to smaller rice field sizes and limited access to resources.

Table 4. Fixed Effect Regression Results on Stunting Prevalence

Variables	Coefficient	t-statistic	Probability
Rice production (X_1)	7.07E-05	2.39	0.0199
Vegetable production (X_2)	8.06E-06	1.01	0.3154
Broiler chicken production (X_3)	-2.33E-07	-0.79	0.4345
Milk cow production (X_4)	1.15E-06	1.86	0.0680
Egg price index (X_5)	-0.001331	-5.76	0.0000
Paddy field area (X_6)	-0.000981	-2.33	0.0231
R-squared			0.683837
F-statistic			3.460674
Prob(F-statistic)			0.000005
Durbin-Watson stat			3.226031

Source: Author's analysis using FEM in Eviews (2025)

The egg price index (X5) shows a negative and highly significant relationship with stunting ($p < 0.001$), indicating that an increase in egg prices tends to reduce stunting prevalence. This counter-directionality may imply that higher egg prices reflect stronger regional demand or purchasing power, thereby indirectly signifying better household economic conditions and nutrition access.

The negative and significant coefficient for paddy field area (X6) (p = 0.0231) supports the notion that agricultural land contributes to household food security and nutrition. Larger paddy field areas may indicate more sustained rice availability, local food access, or employment opportunities, which can indirectly reduce stunting. These findings are supported by Sari et al., (2021), who showed that access to agricultural land correlates positively with children's nutrition indicators in rural Java. Irma et al., (2022) added that the production and productivity of rice fields directly determine the availability and sufficiency of food. Areas such as West Andoolo District which experience a surplus of rice production are examples of how land use planning, agricultural intensification, and efficient use of resources can realize regional food security and support national self-sufficiency.

On the other hand, vegetable production (X2), broiler chicken production (X3), and milk cow production (X4) are not statistically significant at the 5% level. This shows that although fruit and vegetable consumption is important, this factor does not directly affect the incidence of stunting in toddlers. Pediatrician Fitri Hartanto stated that children under 2 years of age should not be given too much fiber intake because it can cause prolonged satiety and reduce the intake of other important nutrients. Although animal-based foods and vegetables are critical sources of essential nutrients, the lack of significance may stem from uneven access, market distribution inefficiencies, or regional consumption preferences (Mitscherlich et al., 2021).

Nevertheless, the milk cow production variable (X4) is marginally significant at the 10% level (p = 0.0680), hinting at a potential positive role in future analyses. According to Saleh et al. (2021), regular milk consumption among toddlers is strongly associated with reduced stunting, particularly when accompanied by proper health education for mothers. Research by the Haile & Headey (2023) revealed that increasing milk consumption in developing countries is associated with reduced stunting, because milk contains high-quality protein and important micronutrients. However, they also noted that limited access to milk and unequal distribution are major obstacles to exploiting the benefits of milk for children's health. This shows that to harness the potential of milk in reducing stunting, there needs to be interventions that improve the distribution and affordability of milk among vulnerable children.

These results collectively reinforce the importance of both production and access dimensions in agricultural-nutrition linkages. They align with broader findings by Raiten & Bremer (2020), who underscore that stunting is not merely a result of food scarcity but also reflects broader issues in food systems, household behavior, and economic access.

Conclusion

The trend analysis indicates a general decline in stunting prevalence across districts/cities in Central Java Province. However, several regions, including Magelang, Blora, Pati, Pekalongan, and Pemalang, continue to experience relatively high stunting rates that have not yet shown significant improvement. The fixed effect regression results reveal that among the six agricultural and economic variables examined, rice production, egg price index, and paddy field area significantly influence stunting prevalence. Specifically, higher rice production and larger paddy field areas contribute to improved food security, which is essential for adequate child nutrition. In contrast, an elevated egg price index negatively impacts protein consumption, increasing the risk of stunting. Meanwhile, vegetable production, broiler chicken production, and cow milk production did not show statistically significant effects, possibly due to limitations in food distribution, accessibility, or consumption behaviors at the community level.

These findings suggest that increasing agricultural productivity alone may not be sufficient to reduce stunting without addressing equitable food access, affordability, and consumption patterns. Therefore, policies aiming to reduce stunting should integrate agricultural development with targeted strategies to improve nutrient-rich food availability and affordability, alongside nutrition education.

Future research is recommended along several strategic pathways to address the limitations of this study. Market and distribution system analysis is needed to trace why certain local foods did not provide expected impacts on stunting reduction. The integration of quantitative and qualitative methods can reveal cultural food preferences and barriers to obtaining nutritious foods that are difficult to explain through numerical analysis alone. Additionally, multisectoral impact evaluation and comparative studies across regions are important for validating findings and identifying contextual factors that influence the relationship between agriculture and nutrition.

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Author Contributions

Conceptual and Author of original draft by MAR; TMP, ES, YW, and DNZ performed the Conceptual, Monitoring, and Supervision; YW contributed Validation and Monitoring. The authors read and approved the final manuscript. MAR = Maria; TMP = Tinjung Mary Prihtanti; ES = Esther Sheliena; YW = Yuliawati; DNZ = Damara Dinda Nirmalasari Zebua.

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Conflicts of Interest

The authors declare no conflict of interest.

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