ISSN: 2347-467X, Vol. 10, No. (1) 2022, Pg. 302-310

Current Research in Nutrition and Food Science

www.foodandnutritionjournal.org

Responsive Prediction Model of Stunting in Toddlers in Indonesia

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Abstract

Stunting is a global incident. The Report Global Nutrition Targets 2025 estimates that around 171 million to 314 million children under five year are stunted and 90% of them are in Asian countries including Indonesia. The purpose of this study was to develop responsive prediction index models ofstunting in toddler in Indonesia. Development of the index model used mathematical formulations using the TPB / SDGs indicator and food environment indicators. Time series-aggregate data were selected 14 variables based on data availability from 34 provinces in Indonesia in the span of 4 years (2015 - 2018). Furthermore, the index validation used the backward regression method with IBM SPSS Statistics version 22. The results showed that households with malaria incidence per 1000 people (X3), the population literacy rate is ≥15 years(X10), households have access to proper sanitation services (X13), and all methods of CPR for married couple aged 15-49 years (X14) was a responsive predictor of stunting in toddler in Indonesia. The index model wasstated by the equation $\hat{Y}$=67,464-0,318X_9-0,571X_{14}-0,186X_{12} with a R^2 value of 49.9% and R_{adj} value of 44.9%. Regarding the results of this study, it is suggested to consider the fulfillment of access to household sanitation facilities, specifically in resident area and vulnerable groups such as malaria endemic areas, increasing literacy, especially maternal literacy, and increasing use of all CPR way for EFA aged 15-49 years.

Article History
Received: 07 January 2021
Accepted: 04 June 2021

Keywords
Index Model;
Stunting;
Sanitation.

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Doi: http://dx.doi.org/10.12944/CRNFSJ.10.1.25

Introduction

Stunting in infancy is the best indicator for measuring children's welfare and reflects the existing social inequalities accurately. Stunting in toddler is a chronic nutritional problem, exacerbated with morbidity, infectious diseases, and environmental concern.[1,2] It is associated as weel with delays motor development and lower intelligence levels3. Furthermore, it leads to the depression of the immune function, metabolic changes, decreased motor development, low cognitive scores, and low academic scores. As an adult, the stunted toddlers will be at risk of degenerative diseases, decreased intellectual capabilities and productivity, low birth weight (LBW) in delivery, and preterm.[4–6] The factors related with the problem of stunting in toddlers are poverty, including nutrition, health, sanitation, social and cultural, increased exposure to infectious diseases, food insecurity, and access to health services.[7,8]

Stunting is a global incident. The Report Global Nutrition Targets 2025 estimates that around 171 million to 314 million children under five year are stunted and 90% of them are in Asian countries. Indonesia is included in 17 countries among 117 countries, which having three nutritional problems, stunting, wasting, and overweight in toddler.[9] While the result of Riskesdas showed that the proportion of stunting in Indonesia in 2007 was 37.6% declined in 2010 to 35.8%, which declined by 1.2%, but in 2013 increased again to 37.2% and declined to 30.8% in 2018.[10] However, this proportion is still above the threshold (cut-off) non-public health problem agreed by WHO that stunting above 20% is still a public health problem.[11,12] The prevalence of stunting in children aged 0-59 months is higher than school-aged children. This period is a crucial period that would affect intelligence and work productivity in the future. If the quality of life of the children is not cared properly in this period, it can lead to various disorders at a later age, one of which is a disruption in the physical growth of children.[13]

The existence of various problems of stunting will be a negative impact on the next generation proved by several studies which revealing the future danger of stunting. So far, the government has attempted to reduce stunting rates through two approaches, a specific nutritional approach to address the direct causes of stunting and a sensitive nutrition approach to address the indirect causes. Both approaches are integrated efforts to reduce stunting if carried out simultaneously. Nonetheless, there are various obstacles in its implementation. The existence of these conditions encourages the government to set a breakthrough in addressing and reducing stunting. One of the main pillars of the intervention of stunting is recommendations in monitoring the control action plan and evaluation regularly to ensure the delivery and quality of stunting intervention programs as well as result-based planning and budgeting (results-based budgeting and planning) through national and regional programs.[12,14]

One of the purposes of this research is to make easier for policy makers in running the programs to accelerate the handling of stunting in Indonesia especially in developing a responsive predictive index model for stunting in toddler as part of one of the pillars of the stunting intervention action plan mentioned above. This responsive prediction model of stunting ismethods that can be used to help set priorities and strategies for public services especially for decision makers in formulating, implementing and evaluating stunting prevention policies. Wardani *et al*. (2020) have made a simple and responsive model that can predict the incidence of stunting in toddler in IndonesiaHowever, there has been no research on toddler in Indonesia.[12] Therefore, this research is to develop a responsive prediction index model of stunting in toddler in Indonesia.

Method

This research was conducted from June to August 2019 at the Department of Public Nutrition, FEMA – IPB University, Bogor. This study used a model development design through the mathematical formulation of aggregate data from TPB / SDGs metadata indicators through Bapennas and Riskesdas data with a span of 4 years (2015–2018). This indicator is a time-series data cited from the research of Wardani *et al*, (2020),[12] the results of the literature review related to stunting in Indonesia since the last 17 years. Time series-aggregate data were selected 14 variables based on data availability from 34 provinces in Indonesia. In this study, subjects were children aged 0-59 months. This indicator metadata is one of the ways to measure the achievement of sustainable development in Indonesia by evaluating the progress of development programs that have been implemented.[12] Analysis

of data used the backward regression method with IBM SPSS Statistics software version 26. Backward regression was used to determine which factors are most influential (independent variable) on the dependent variable with the final form of multiple linear regression equation. The equation was selected as the best model to predict stunting on toddlers. The general regression mathematical formulation used the equation below:

$$Y_i=\beta_0+\beta_1 X_{1i}+\beta_{12}X_{2i}+...+\beta_{p-1} X_{p-1,1}+\varepsilon_i$$

In this case :

Yi is the dependent variable for the observation of *i*, for *i* = 1, 2,…, n.

β0, β1, β2,…, βp − 1 are parameters

X1*i*, X2*i*,…, Xp − 1, *i* are independent variables, for *i* = 1, 2,…, n.

εi is an error, which is independent and distributes N (0, σ2).

Backward regression was used to determine which factors are most influential (independent variable) on the dependent variable with the final form of multiple linear regression equation. The selected equation as the best model to predict stunting in toddler. The presentation of the research results was carried out in tabulated and textual forms. The selected variables are presented in Table 1.

Table 1: Research Variable

No	Variable Name	Unit
1.	Stunting prevalence (Y)	%
2.	Population with calorie intake <1400 kcal / capita / day (X1)	%
3.	Infants aged <6 months who are exclusively breastfed (X2)	%
4.	Incidence of malaria per 1000 people (X3)	%
5.	Children aged 12-23 months who received a complete primary immunization (X4)	%
6.	Smoking habits of population aged ≥15 years (X5)	%
7.	Dietary Pattern score Expectations (X6)	%
8.	The growth rate of GDP per capita (X7)	%
9.	Steady state of national roads (X8)	%
10.	People living below the poverty line (X9)	%
11.	The literacy rate of population aged ≥15 years (X10)	%
12.	Children who have a birth certificate (X11)	%
13.	Households had access to safe drinking water service (X12)	%
14.	Households had access to proper sanitation services (X13)	%
15.	All methods of CPR for married couple aged 15-49 years (X14)	%

Source: Bappenas RI andRiskesdas (2015-2018)

Result

This study used multiple linear regression models (backward) to produce a selected equation model by eliminating one by one of the independent variables from the regression model formed. The first stage was carried out a regression analysis between the dependent variable (Y), the stunted toddler prevalence in 2018 with some independent variables (Xi), or the value of k following the rules of k + 1 <n . In this study, n = 34 provinces, then the value of k<33. It means that the first stage regression analysis only includes the independent variable (Xi) fewer than 33 variables. The rule is a further consideration to only 14 independents variables include that exist in the closest the year 2017 to the first stage regression analysis. The significance value in the first regression analysis with the selected significance level is 95% (α = 0.05).

Table 2 shows that from 14 variables in the first regression results, there are four variables that are eligible to participate in the second stage regression

models, such as the incidence of malaria per 1000 people (X3), with p <α (0.000), the literacy rate of population aged ≥15 years (X10), with p <α (0.001), Households had access to proper sanitation services (X13) with p <α (0.001), all methods of CPR to married couple aged 15-49 (X14) with p <α (0.006).

Table 2: The First Stage of Stunting Prediction Model in Toddler

Independent variable (Xi)	Unstandardized Coeffisient		t	Sig.
	B	SE		
Incidence of malaria per 1000 people (X3)	-0,511	0,104	-4,893	0,000
The literacy rate of population aged ≥15 years (X10)	-0,593	0,167	-3,547	0,001
Households had access to proper sanitation services (X13)	-0,277	0,37	-7,384	0,001
All methods of CPR for married couple aged 15-49 years (X14)	-0,192	0,064	-2,988	0,006

Source: Bappenas RI and Riskesdas (2015-2018)

Table 3: Selected Stunting Prediction Model in Toddler

Variabel bebas (X_i)	Unstandardized Coeffisient		Standardized Coeffisient	t	Sig.	R^2	R_{adj}
	B	SE	β				
Constant	105,894	15,835					
Incidence of malaria per 1000 people (X3)	-0,498	0,099	-0,970	-5,022	0,000	0,731	0,694
The literacy rate of population aged ≥15 years (X10)	-0,520	0,157	-0,524	-3,320	0,002		
Households had access to proper sanitation services (X13)	-0,286	0,038	-0,831	-7,509	0,000		
All methods of CPR for married couple aged 15-49 years (X14)	-0,166	0,061	-0,375	-2,732	0,011		

Source: Processed secondary data

After the first stage, the selected variables are obtained, then performed the second stage of advanced test between the dependent variable (Y) which consist of the prevalence of stunted toddler in 2018 with four independent variables from the results of the first stage regression models (X3, X10, X13, and X14) for the data in 2015, 2016, and 2017 with a total of 12 variables from 34 provinces Indonesia. The significance level of the advanced regression analysis selected was 95% (α = 0.05).

The results obtained are presented in Table 3 which shows that from the 12 variables regression results of the second stage is based on the year 2015, 2016, and 2017, there are four variables selected as the best regression model as a prediction model of stunting in toddler, consist of incidence of malaria per 1000 people (X3) in 2017 with p <α (0.000), the literacy rate of population aged ≥15 years (X_{10}) in 2015 with p<α (0.001), the households had access to proper sanitation services (X_{13}) in 2016 with p<α

(0.001), and all methods of CPR to married couples aged 15-49 years (X_{14}) in 2016 with p<α (0.006).

The regression analysis model of the second stage is the best regression model selected as a prediction model of stunting in toddlers in Indonesia. The second stage regression model has a value of R^2 and R_{adj} respectively 0.731 and 0.694, which means that the diversity of the prevalence of stunting in toddlers in Indonesia could be explained by the regression model is by 73.1% or 69.4% and the rest can be explained by other factors. Based on the coefficient values of R2 and R adj, it means that the best regression model developed in this study is quite well used to estimate the prevalence of stunted toddlers in Indonesia. The regression equation, which becomes a prediction model for the responsiveness of stunting in toddlers in Indonesia stated as follows:

$$\hat{Y}=105,894-0,498X_3-0,520X_{10}-0,286X_{13}-0,166X_{14}$$

This equation explains that if the incidence of malaria per 1000 people (X3), the literacy rate of population aged ≥15 years (X10), households had access to proper sanitation services (X13), and all methods of CPR to married couple aged 15-49 years (X14) are zero, then the estimated prevalence of stunted toddler (Y) is 105,894. When the incidence of malaria per 1000 people (X3) lowered one unit, the prevalence of stunted toddler (Y) declined by 0,498. Furthermore, if the literacy rate of population aged ≥15 years (X_{10}) increased by one unit, the prevalence of stunting (Y) declined by 0,520. Similarly, if households had access to proper sanitation services(X_{13}) increased by one unit, the prevalence of stunting (Y) declined by 0,286. As well as, all methods of CPR to married couples aged 15-49 years (X_{14}) increased by one unit, the prevalence of stunting (Y) declined by 0,166.

Discussion

The regression analysis model of the second stage is the best regression model selected as a prediction model of stunting in toddlers in Indonesia. The selected variables are the incidence of malaria per 1000 people, literacy rate of the population aged ≥15years, households had access to proper sanitation services, and all methods of CPR to married couples aged 15-49 years. The model obtained in this study compared with the research results by Wardani *et al*. (2020)[12] described corroborately the diversity of factors on the prevalence of stunting in toddlers with the predictor's value of 73.1% or 69.4% compared to Wardani *et al*. (2020),[12] which only has 49.9% or 44.9% are equally derived from the value of R^2 and R_{adj}. Nevertheless, two of the four variables selected in this study have the same effect on the prevalence of stunted toddlers consist of problem of malaria and access to proper sanitation services.

Malaria is an infectious disease caused by Plasmodium sp and transmitted through the bite of a female Anopheles mosquito.[15] Malaria is one of the problems set out in the Sustainable Development Goals (SDGs) targeted to be terminated in 2030. Malaria can occur due to the interaction among the environment, people, and mosquitoes.[16] Malaria in this study is the first to suspect predictors of the incidence of stunted toddlers in Indonesia. Several regions in Indonesia are classified as malaria-endemic areas are Papua, West Papua, East Nusa Tenggara, Maluku, and North Maluku.[12] Although there is no relationship between stunting with malaria in malaria-endemic areas, the same study by Dal Bom *et al*. (2019) noted that malaria was significantly associated with the length for age z-score (LAZ) in the first year of life.[17] Pinceli *et al*. (2018) stated that mothers who suffered from malaria during pregnancy have a difference in the length of the baby's birth by 0.47 cm shorter than babies whose mothers did not have malaria.[18] It is corroborated by Schmidt *et al*. (2002) that birth length is a strong predictor of stunting.[19] Other than that, Natama *et al*. (2018) revealed that exposure to malaria in antenatal can interfere the development of the fetus and the baby's innate immunity, so that the levels of chemokines, cytokines, and growth factors will be lower.[20] The existence of these circumstances leads to a higher risk of malaria infection in infant aged 6 to 12 months after birth, especially in malaria-endemic areas.

The second predictor of stunted toddlers in Indonesia in this study is the literacy rate of the population aged ≥15 years. Mother's level of education and intelligence is one of the factors that affect the nutritional status of toddlers. The level of education, high intelligence, and good stimulation of mothers at home can act as protective factors.[21] It can reduce the detrimental effects of low birth weight (LBW) or malnutrition in early childhood on development.

Conversely, the same nutritional condition leads to more severe effects on the development of the child if the mother was illiterate. Research results by Uliyanti (2017) showed that mothers who had a high nutritional knowledge only 27.5%, the rest had moderate nutritional knowledge by 56.9% and 15.7% had low nutritional knowledge at South Matan Hilir Subdistrict.[22] Low maternal nutrition knowledge allegedly closely associated with Mother's level of education and there are still people around who are illiterate, so the access and the opportunity to gain knowledge of nutrition are limited.In addition, the findings by Torlesse *et al*. (2016) states that mothers who do not complete primary education likely to increase the incidence of stunting 3.3 times greater chance than mothers who have a high level of education.[23]

The third predictor of child stunting in Indonesia in this study is households that have access to proper sanitation services. One of the determinants of stunting in toddlers is the problem of washing hands before preparing or feeding children.[12,24] Besides, there are still people who do open defecation, especially children living in rural and suburban areas. Research by Fregonese *et al*. (2016) states that children living in a contaminated environment with inadequate sanitation have experienced a 40% risk of stunting and significantly higher in rural (43%) and suburban areas (27%) compared to those living in urban areas (5%).[25] The highest incidence rate of a stunted toddler is who lives in the rural area because most people still do open defecation.[26] Families with low environmental sanitation can increase 8.5 times greater risk of children experiencing stunting.[27] It was corroborated research by Rah *et al*. (2015) that behavior related to lack of access to proper sanitation services is associated with a reduced risk of stunting by 15%.[28] Lack of adequate sanitation facilities can increase disease originating from fecal bacterial contaminants that can infect the intestines of children when inserting a finger into the mouth. Conditions of intestinal infections such as diarrhea and worm infection can affect children's nutritional status by reducing appetite and interfering with the absorption of nutrients cause the children suffered from malnutrition and impaired growth.[29,30] Families with ownership of water facilities and latrines had a lower prevalence of diarrhea and stunting. Therefore, an increase in household access to adequate sanitation services required to reduce the prevalence of stunting in toddlers.[31]

The fourth predictors of the occurrence of stunted toddlers in Indonesia in this study are all method of CPR (Contraception Prevalence Rate) in married couple aged 15-49 years. CPR especially for women of childbearing age (WCA) is an indicator of family planning on the nutritional status of children. CPR related with the literacy rate of women, the poverty rate and anemia in women. The use of contraception does not directly reduce the prevalence of stunting but have an indirect effect on the biological and reproductive mother and child. During pregnancy and breastfeeding, maternal nutritional intake dwindling, if it occurs in the teenage, it will impact the children's linear growth process. Ideally, the reproductive health is around the age of 21 years. Birth in adolescence can increase the risk of a baby born with stunting. This does not affect the risk of children, but also have an impact on maternal risk for reproductive rudimentary that can lead to death. The use of contraception can reduce the risk of death for pregnant women due to the interval of pregnancy. Contraceptive use can improve the nutritional status of mothers and children to the maximum before the next pregnancy.[32] Mothers with long pregnancy intervals can restore their nutritional intake and body weight.[33]

The responsive prediction model of stunting obtained can be used to help set priorities and public service strategies, especially for decision makers in formulating, implementing and evaluating stunting prevention policies in Indonesia to support the acceleration of stunting management in Indonesia.

Limitations of the Study

This research is a research that uses secondary data. Model is a method that can reduce information to stakeholders but needs attention and careful interpretation because Indonesia is a country with a wide area as well as the diversity of each province. Limited data is also an obstacle to the necessary mapping with small-scale coverage at district and sub-district level.

Conclusion

The best regression model selected as a prediction model of stunting in toddlers n Indonesia is Y =

105,894 - 0,498X_3- 0,520X_{10}- 0,286X_{13}- 0,166X_{14}. The regression model can explain the diversity of the prevalence of stunted toddlers in Indonesia by 73.1% or 69.4% of the coefficient value of R2 and Radj, and the rest can be explained by other factors. Related to these results, it is advisable to consider the fulfillment of access to household sanitation facilities, especially in the region of residence and vulnerable groups such as malaria-endemic areas, increased literacy especially the mother, and increased use of all method of contraception to the married couple 15-49 years

Aknowledgment

Thank you to the Education Fund Management Institution (LPDP) of the Ministry of Finance of the Republic of Indonesia for providing a full scholarship.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of interest

the author declares that there is no conflict of interest

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