ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 6
June 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2024; 24(6): 26639-26658 https://doi.org/10.18697/ajfand.131.24450

Date	Submitted	Accepted	Published
	19th July 2023	20th May 2024	24th June 2024

EXAMINING THE DIFFERENT PATHWAYS TO STUNTING AMONG CHILDREN UNDER FIVE YEARS OLD IN A LOW-MIDDLE INCOME COUNTRY

Melaniani S[1,9*], Sumarmi S[2], Kuntoro[1], Puspitasari N[1,9], Rachmah Q[2], Husnina Z[3], Sari NMW [6], Pratiwi N[7], Rahmatyah R[8], Triwinarto A[4], Izwardy D[4], Saraswati PH[5] and T Yamano[5]

Soenarnatalina Melaniani

*Corresponding author email: soenarnatalina.m@fkm.unair.ac.id

[1]Department of Epidemiology, Biostatistics, Population Studies, and Health Promotion, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia

[2]Department of Nutrition, Faculty of Public Health Universitas Airlangga, Surabaya, Indonesia

[3]Research Group of Environmental Health and Climate, Department of Environmental Health, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia

[4]National Institute of Health Research and Development, Ministry of Health, Indonesia
[5]Asian Development Bank

[6]Department of Health, Population Control and Family Planning, Trenggalek, Indonesia

[7]Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Universitas Airlangga – Dr. Soetomo General Academic Hospital, Surabaya, Indonesia

[8]Resident in training, Department of Obstetrics and Gynaecology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

[9]Research Group for Health and Wellbeing of Women and Children, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia

CC BY NC ND

ABSTRACT

Stunting is a multi-cause growth failure affecting the growth and development of children. The Government of Indonesia is implementing a National Strategy to Accelerate Stunting Prevention in order to ensure that it targets all individuals including those in the critical period of "the first 1000 days of life" —those with pregnant women or children under the age of two —can access the full package program of services essential to stunting prevention. Indonesia has successfully reduced stunting prevalence, by about 6.4% during 5 years between 2013 and 2018. The present study focused on analyzing the pathway of possible factors affecting stunting, among children under five based on national data from the 2013 and 2018 Indonesia Basic Health Surveys (IBHS). The partial least squares structural equation modeling (PLS-SEM) was used to identify the different pathways affecting stunting in the two data sets. This study found the different pathway within the data from the 2013 and 2018 IBHS. Stunting was significantly affected by birth size (T value=9.78) (low weight and length birth), as well as, the disease factors (T=2.48) in 2013, but only birth size (T=8.75) in 2018. In 2013, socio-economic factors affected stunting indirectly (T=1.497) through maternal factors (T=13.86) that influence disease (T=5.235) via exclusive breastfeeding (T=3.531). This study found that, Low Birth Weight (LBW) babies were two to three times more likely to be stunted children. Click or tap here to enter text. Overall, the stunting prevalence across regions in Indonesia demonstrated a decreasing trend from 2013 (38.4%) and reached lower in 2018 (33.9%). The 2013 IBHS showed an indirect effect of socioeconomic factors on stunting through the pathways of maternal factors, breastfeeding practices, and disease. This indirect effect was not found in the 2018 IBHS. There were different pathways of factors affecting stunting between the two datasets of the 2013 and 2018 basic health survey, but the consistent factor is the birth size (birth weight and length). Birth size is the most important determinant of stunting in Indonesia and must be prioritized and addressed immediately.

Key words: stunting, children health, path analysis, risk factor, developing country

CC BY NC ND

INTRODUCTION

Undernutrition is responsible for over half of fatalities in children under five years old. It also increases the incidence and severity of common diseases in children, and slows down their recovery [1]. Stunting is a condition caused by persistent undernutrition, which often occurs in children. Stunted children experience reduced growth and development due to inadequate psychological stimulation, recurrent infections, and poor nutrition. If a child's height-for-age is more than two standard deviations below the median of the WHO Child Growth Standards, they are considered stunted [2]. World Health Assembly targeted a 40% reduction in the number of children under 5 who are stunted globally until 2025[3].

The relevance of stunting as a significant public health issue has gained more attention on a global scale. In Indonesia, stunting continues to be a national priority. The Indonesian government is implementing a National Strategy to Accelerate Stunting Prevention in order to guarantee that all individual targets in the crucial period of "the first 1000 days of life"—those with pregnant women or children under the age of two—have access to the full package of services essential to stunting prevention. This initiative is inspired by the success story of Peru in reducing stunting in a short period of time [4].

Indonesia successfully reduced stunting prevalence by approximately 6.4% between 2013 and 2018 [5]. This achievement was reflected in the Indonesia Basic Health Surveys (IBHS). The last two waves of the Indonesia Basic Health Survey (2013 and 2018) found that the stunting rate declined from 37.2% (2013) to 29.9% (2018) among those under 2 years old and 30.8% among those under 5 years old [6, 7]. Meanwhile, data from the Indonesia Nutritional Status Survey show a further decrease to 27.7% in 2019 and 24.4% in 2021 [8].

There are some studies about the analysis of stunting determinants using the Indonesia Basic Health Surveys by the Ministry of Health [9, 10], or data from monitoring of nutritional status [10]. Most of these studies used the old data from IBHS 2007 and 2013, and data were analyzed using linear regression. In linear regression, all independent variables are assumed to be at the same level, or positioned relative to the dependent variable. In my opinion, this approach is not proper when it is applied to find all possible factors affecting stunting occurrence, because stunting is multi-causal. Some causal factors do not simultaneously affect stunting cases. Based on the UNICEF conceptual framework, factors affecting stunting consist of direct or immediate causes, underlying causes, and basic causes [11]; because of the nature of the stunting factors, choose Structural Equation Modeling (SEM) analysis and/or Path analysis.

This study is based on UNICEF's conceptual framework on the theoretical

CC BY NC ND

ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 6
June 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

determinants of stunting (malnutrition) which investigates direct and indirect pathways of effect and those determinants. Path analysis will show the pathway of determinants associated with the occurrence of stunting or the HAZ value. Based on national data from the 2013 and 2018 Indonesia's Basic Health Survey (BHS), this study's goal was to analyze the potential pathways of factors causing stunting in children under five years old.

METHODS

Data Source

This study used data from the 2013 and 2018 IBHS, a survey conducted by the National Institute of Health Research and Development (NIHRD), Ministry of Health, Republic of Indonesia. The 2013 IBHS involved households from 33 provinces, and 497 districts/cities in Indonesia. There were 11,986 census blocks visited out of 12,000 census blocks targeted (99.9%); 294,959 households visited, and 1,027,763 household members interviewed with a response rate of 93.0%. Two types of structured questionnaires were used, namely individual and household questionnaires [12]. The IBHS 2018 covered 30,000 census blocks, 295,720 households visited, and 1,091,528 household members interviewed, with a response rate of 93.2% [13]. Another data source was extracted from the 2018 – 2019 Specific Index for Stunting Intervention published by Statistic Indonesia [14]. The data were used to assess the significance of the government intervention program's contribution to reducing stunting prevalence.

Study Sample

The sample population of this study was the younger children in the household, with the consideration of obtaining the maternal-child pair data. The minimal sample size was calculated using the sample size calculation by Lwanga & Lemeshow[43] , which is 8215 (α=0.05; d=0.01).

CC BY NC ND

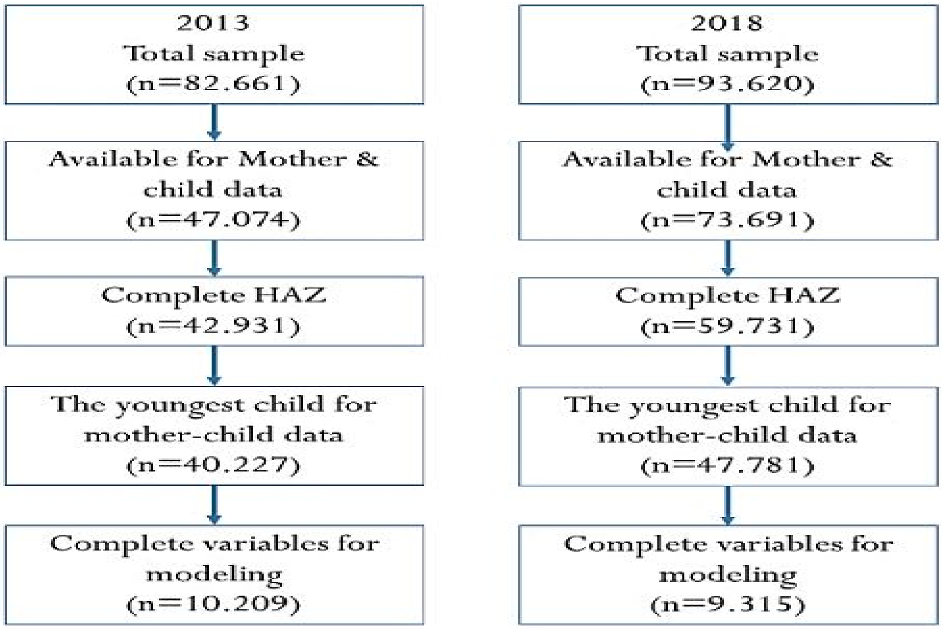


Figure 1: Step of sample selection

Figure 1 shows 47,074 data of mother and child in 2013 were available from a total sample of 82,661 and 42,931 data with complete height-for-age Z score (HAZ), including data of the youngest kid for 40,227 mother-child pairings. This study used data with complete variables to model up to 10,209. In 2018, 73.691 data of mother and child were available from a total sample of 93.620 and 59.731. Data had complete HAZ data including data of the youngest child for 47,781 mother-child pairings' use data with complete variables to model up to 9.315.

Outcome Variable

The primary outcome of this analysis is the anthropometric parameter height-for-age Z score (HAZ) or stunting. Height or stature was assessed for children aged 24-59 months; meanwhile, recumbent length was assessed for children aged <2 years. This study classified a child as being stunted if their HAZ was less than 2.

Independent Variable

Independent variables measured in this study included child characteristics, maternal characteristics, socio-economic factors, child food intake, disease, antenatal care, caring practice, sanitation, and personal hygiene. Anthropometric measurement was also done on the mothers, including height and mid-upper arm circumference (MUAC) measurements. Measurement in this study is using a MUAC measuring tape with a range of up to 56 cm [15] to the nearest 0.1 cm. MUAC measurement was done in one least active arm, the respondent should not hold anything with relaxed arm muscles. Measurer will ask the respondent to fold his arms at an angle of 90 degrees, then determine the midpoint between the

CC BY NC ND

respondent's shoulder base (acromion) and the elbow (olecranon). The arm was straight down, and the MUAC tape was wrapped around it halfway. Results of MUAC measurement were then categorized into chronic-energy deficiency (CED) mother (MUAC <23,5 cm), and non-CED mother (MUAC >23,5 cm) [16].

Children's dietary diversity was obtained from 24 hours of food-group recall; including 9 food groups 1) grains, white roots and tubers, and plantains; 2) nuts and seeds; 3) milk and milk products; 4) meat, poultry, and fish; 5) eggs; 6) vitamin A-rich vegetables; 7) vitamin A-rich fruits; 8) other vegetables; 9) other fruits then categorize into intake <4 food groups and ≥4 food groups.

Statistical Analysis

At the initial stage, we performed a descriptive analysis to determine the frequency distributions of all variables used in the analysis. The pathway of some factors affecting stunting occurrence was modeled using the theoretical framework from The UNICEF Stunting Data in 2013. Path analysis using partial least squares structural equation modelling (SmartPLS), was used to explain the pathway of stunting. A significant value is shown by a T value > 1.96.

RESULTS AND DISCUSSION

Child and Parent's Characteristic

Descriptive analysis was conducted to obtain data on child characteristics, maternal and paternal characteristics including gender, age, as well as socio-economic status such as education level and working status. Data was obtained from the 2013 and 2018 IBHS. The next analysis described the comparison of the frequency distribution of total children. Descriptive analysis, child data, and maternal data are presented in Table 1. In 2013, there were more boys than girls participating, but in 2018, boys were the majority. In 2018, the age of participants was dominated by children above 2 years old, while in 2013, it was dominated by children under 2 years old.

The education level of mothers varied throughout the survey waves. In 2013, the majority attained senior high school education. In 2018, the highest level was incomplete primary school. Meanwhile, the paternal education level also varied. In 2013, the highest percentage graduated from senior high school, while in 2018, the highest percentage graduated from junior high school. According to most children, their fathers do not work.

Anthropometric Data

Table 2, shows the anthropometric data of children, including HAZ (Height-for-Age Z-score), birth weight, length of birth, maternal height, and mid-upper arm circumference. The HAZ value decreased from about 1.30 in 2013 to -1.37 in 2018.

CC BY NC ND
https://doi.org/10.18697/ajfand.131.24450

The mean HAZ in 2018 was the lowest. However, the mean HAZ in both waves of IBHS was in the normal category.

The mean birth weight was recorded as the lowest in 2018, and the highest was in 2013. The mean birth weight of more than 2,500 grams was categorized as the normal weight of newborns, whereas birth weight below 2,500 grams was categorized as low birth weight. The mean birth length in 2018 was slightly lower than in 2013. However, the length is more than 48 cm, which reflects the normal length of newborn babies. A baby with a birth length less than 48 cm, was categorized as neonatal stunting. The gestational age recorded in 2018 is lower than in 2013 but, in general, exceeded 37 weeks, which included pre-term deliveries.

Percentage of stunting among under five years' children and other pregnancy outcomes, such as low birth weight (birth weight < 2,500 grams), neonatal stunting (birth length < 48 cm), and preterm (babies born < 37 weeks), is shown in Table 2. This table also shows the percentage of mothers with short stature (height < 145 cm) and mothers who suffer from chronic energy deficiency (MUAC < 23.5 cm).

Overall, the stunting prevalence across regions in Indonesia demonstrates a decreasing trend from 2013 (38.4%) and reached lower in 2018 (33.9%). The IBHS consistently reported region 7, which covers Bali, West Nusa Tenggara, and East Nusa Tenggara provinces, has the highest stunting prevalence among other regions. On the other hand, region 2, which covers all provinces in Java Island was recorded with the lowest stunting prevalence in the three waves of IBHS. Moreover, the stunting prevalence in this region (West Nusa Tenggara and East Nusa Tenggara), recorded in the three waves of survey periods was always higher than the national stunting prevalence (2007>36.8; 2010>35.6%; 2013 >37.2%). The different prevalence of data performed in study is due to sample selection in this study. This study required a subsequent sample selection to obtain a maternal-child paired dataset for further statistical analysis and to find stunting pathways involving mother and child data.

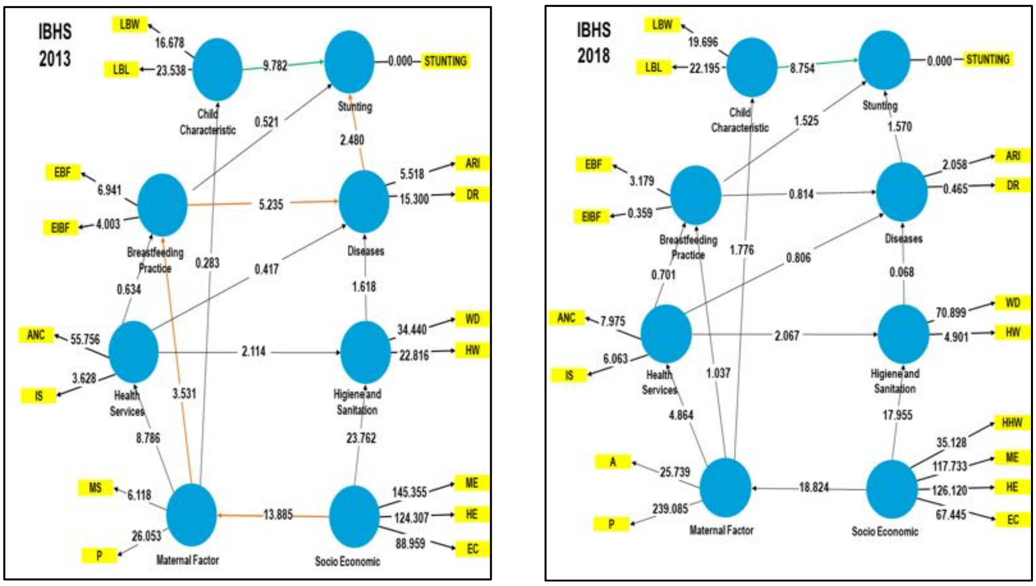
Pathway to Stunting

Path Analysis using the software SmartPLS® was conducted to determine the pathways of all possible factors affecting stunting. Path analysis was done on the 2013 and 2018 datasets separately to find out whether the determinant factors were different between the 2013 and 2018 datasets. Using the model construction, we have a pathway model of stunting based on the 2013 IBHS dataset and the 2018 IBHS dataset. Path analysis using partial least squares structural equation modeling was used to explain the pathway of stunting. A significant value is indicated by a T value > 1.96. Figure 2, illustrates the results of path analysis conducted on the 2013 and 2018 datasets.

CC BY NC ND

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 6
June 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

The path analysis result (Figure 2a) shows that the pathway of some factors affecting child stunting is different between the 2013 and 2018 IBHS data. In 2013, stunting was strongly affected by birth size (T=9.78), as well as the disease factors (T=2.48). Moreover, the characteristic of birth size was strongly dominated by neonatal stunting and low birth weight, with the T values of 23.538 and 16.678. The disease factors were dominantly characterized by diarrhea and acute respiratory infection (ARI), with T values of 15.300 and 5.518. Based on the T value, it indicates that neonatal stunting is the stronger direct factor affecting child stunting, relatively compared to other indicators. Furthermore, exclusive breast-feeding did not influence stunting directly (T=0,521 or < 1.96) but indirectly through the disease's factors (T=5.235) that were affected by maternal factors (T=3.531) influenced by socioeconomic factors (T=13.885). Socio-economic factors, as explained by education, occupation status, and household economic level, affect hygiene sanitation (T=23.762) but did not significantly affect the diseases.



(**a**) (**b**)

Figure 2: Pathway to stunting of selected factors based on a theoretical framework from the 2013 IBHS dataset (a) and the 2018 IBHS dataset (b)

LBW, low birth weight; LBL, low birth length; EBF, exclusive breastfeeding; EIBF, early initiation of breastfeeding; ANC, antenatal care; IS, iron supplementation; MS, mother stature; A, age of mother; P, parity; ARI, acute respiratory infection; DR, diarrhea; WD, waste disposal; HW, hand washing; HHW, head of household's work; ME, mother's education; HE, head of household's education; EC, economic level

The 2013 and 2018 IBHS showed that birth size had a significant direct effect on stunting (T=9.782 and T=8.754), but in the 2018 IBHS, the disease (T=1.570) did not have the same effect as in the 2013 IBHS (T=2.480). The consistent pathway between the two datasets of 2013 and 2018 IBHS is the direct effect of birth size

CC BY NC ND

on stunting. In addition, the two datasets showed a significant effect of socioeconomic factors on hygiene and sanitation practices (T=2.114 and T=2.067) through access to health services (T=8.786 and T=4.864) and maternal factors (T=13.885 and T=18.824).). Although the indirect pathway is not proven to significantly affect stunting, it shows the same pathway pattern. This can be taken into consideration that, there are problems in the pathway that are repeated/unresolved in the data collection period (2013 to 2018). However, maternal factors did not affect birth size directly (T=0.283 and T=1.776).

The most striking findings from the present stunting pathway analysis were the consistent effect of birth size on stunting in both the 2013 and 2018 IBHS; and the indirect socioeconomic effect on stunting through maternal factors via exclusive breastfeeding, which has an impact on infectious diseases that finally has a significant effect on stunting in 2013 but not in 2018. Birth size showed the most significant factors that affect stunting directly, but were not affected by diseases and breastfeeding practices factor in both 2013 and 2018. These findings indicated that birth size, characterized by birth weight and length, was the main factor determining the occurrence of stunting in the children. More so than birth weight, birth length had a stronger impact on it. Birth length is the strongest indicator of linear growth status and stunting in the first two years of life, adhering to a preconception maternal nutrition intervention [17]. It has been proved that birth length significantly influenced the linear growth of children [18] and should be the main birth outcome indicator of prenatal environment, and a predictor of infant growth and survival [19].

A shorter birth length characterizes neonatal stunting [20] as a form of long-term malnutrition primarily caused by prenatal malnutrition [21]. As long as it persists, it can damage children's physical and mental development throughout the first 1000 days of life [22]. The severe physical and cognitive impairment syndrome of neonatal stunting has recurrent sequelae and irreversible effects since conception [12,13].

The direct effect of Low Birth Weight (LBW) on stunting, as in the present study, is consistent with the results of studies used in the 2010 IBHS dataset [14], 2013 IBHS dataset [9], and 2007-2014 IFLS dataset [23]. This study found that LBW babies were two to three times more likely to be stunted children [9, 21, 23] and the risk increases when LBW babies get diarrhea [24]. Various studies have proved that these two indicators (LBW and PBLR) are strong predictors of stunting [17, 25, 26, 27, 28].

It was reminiscent of the "Barker Hypothesis" or "fetal programming hypothesis," which proposed that, the environment of the fetus and infant – determined by the

CC BY NC ND
https://doi.org/10.18697/ajfand.131.24450

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 6
June 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

mother's nutrition and the baby's exposure to infection after birth – determines the pathologies of later life [29]. Malnutrition and unsanitary living conditions are exacerbated during pregnancy. Babies of chronically malnourished and short-stature mothers were more likely to be born stunted [21]. This indicates that early nutrition intervention is more promising to overcome nutritional problems, including, optimizing nutrition and health during adolescence, preconception, pregnancy, and early life of children [30, 31].

Nevertheless, it was proved that maternal factors (mother stature, age, and parity) did not affect birth size in 2013 and 2018. This research found the indirect effect pathway to stunting over the breastfeeding practice through the effect of the disease that was shown only in 2013 IBHS [Figure 2]. The maternal factor in 2013 and 2018 is the same indicator explained (parity) but different indicators, specifically the short stature of the mother in 2013 and maternal age in 2018. The maternal factor is a consistent indicator, but the short stature of the mother may play a role in the effect given to breastfeeding practice in 2013. Parity influences the hazard of worse breastfeeding practices of primiparous mothers, such as, shorter breastfeeding duration, early breastfeeding problems, breastfeeding-associated pain during the first week, and stopping breastfeeding [32]. Breastfeeding practice reflected by early initiation of breastfeeding (EIBF) and exclusive breastfeeding (EBF) has an important role in building the immune system of children. Breastfeeding plays an important role in infant immune development, intestinal tissue repair, and protection against infectious diseases [33]. Infectious diseases have a significant effect on stunting in children under five years of age [34, 35]. Infectious diseases, namely diarrhea and respiratory tract infections are predictors of stunting in children [36]. Lactoferrin and immunoglobin A in breast milk, can boost the immune system of children under the age of five who are suffering from acute respiratory infections (ARI) [37]. Good breastfeeding practices could reduce the risk of infectious diseases like ARI and diarrhea. To improve breastfeeding outcomes, prenatal and postnatal breastfeeding support should be targeted differently for primiparous women. Regarding the short stature of the mothers, the differentiating indicators of the maternal factors in 2013 and 2018 that influence breastfeeding practice have yet to be explained. Further research is needed to investigate the potential of the endocrine system or maternal lack of ability to receive information due to stunting.

In India, there is evidence that LBW infants born to short women are more likely to be stunted and have slower postnatal growth velocity, resulting in lower reached length for age Z scores in infancy [38]. Another evidence from Bogor, Indonesia, showed that birth weight, birth length, and maternal short stature were the dominant risk factors of stunting among children aged 0-23 months [26]. However,

CC BY NC ND

in this present study, maternal factors did not show a significant effect on stunting, either explained by maternal age and parity in the 2013 IBHS or explained by maternal short stature and parity in the 2018 IBHS.

This study proved that socioeconomic significantly affected maternal factors in both 2013 and 2018 IBHS. Socioeconomics is explained by the mother's education, head of the family's education, and household economic level in the 2013 IBHS. While in the 2018 IBHS, the head of family's occupation was another indicator explained together with the same other indicators in 2013. The same socioeconomic indicators were the mother's and head of the family's education and the household economic level that affected maternal factors, hygiene, and sanitation in both periods. It has been proved that a mother's education influences nutritional problems in children related to parenting, sanitation, and clean water sources [25, 39, 40]. However, the indicators explained hygiene and sanitation in this present study were time of hand washing practice and waste disposal practice. Solid waste disposal in unapproved areas was heavily influenced by socioeconomic factors other than household income or welfare [41]. Regarding the indirect effect of maternal education as one of the maternal factor's indicators, another 2013 IBHS study found a significant effect of maternal education level on stunting [9]. A cross-country study found that children of low-education mothers are three times more likely to be stunted than children of higher-education mothers [42]. Nevertheless, socioeconomic did not have an effect on stunting in the 2018 IBHS, but it significantly affected stunting indirectly through maternal factors by exclusive breastfeeding by means of the effect on the disease in 2013. This difference could be attributed to improvements in various elements, which have no substantial effect on stunting in 2018 as they did in 2013. In addition, there is the dominance of the adverse effect of birth size on stunting and an increase in the percentage of infants born with lower body weight and length in 2018.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

Between the two datasets of the 2013 and 2018 basic health survey, there are different pathways of factors affecting stunting, particularly diseases and the practice of breast feeding, but the consistent component is birth size, which includes birth weight and length. Urgent action is required to implement targeted interventions to improve birth size outcomes. The indirect effect of socioeconomic consists of the mother's education, the head of household's education, and economic level through maternal factor (mother stature and parity) via exclusive breastfeeding, by means of the effect on the disease only shown in 2013. Birth size is the most important determinant of stunting in Indonesia, and it must be prioritized and addressed immediately. Therefore, it is strongly recommended that early intervention, especially during the pre-conception and pregnancy period,

CC BY NC ND

ajfand Since 2001 AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 6
June 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

needs to be a serious concern in handling stunting in Indonesia. Apart from being a recurring problem for 5 years, it has a contribution that must be considered to prevent the emergence of new stunting.

Author Contributions

Conceptualization, S.S., S.M., and D.I.; methodology, S.S., S.M., and K.; formal analysis and writing—original draft preparation, S.M., N.M.W. S.S.; data cleaning and management, visualization, and validation, A.T., N.P., Q.R., Z.H., R.R., N.P., writing—review and supervision, D.I., P.H.S., and T.Y.; All authors have read and agreed to the published version of the manuscript."

Funding

This research was funded by Asian Development Bank grant number 166782-S32372.

Institutional Review Board Statement

This research has received permission to use IBHS data from the Ministry of Health, Republic of Indonesia, Number IR.03.01/4/5387/2021. Ethical permission was obtained from Universitas Airlangga, Indonesia, Number No: 18/EA/KEPK/2021.

ACKNOWLEDGEMENTS

We would like to thank the National Institute of Health Research and Development, Ministry of Health, Republic of Indonesia for sharing a subset of the 2013 and 2018 Basic Health Research data used in our analysis.

Conflicts of Interest

The authors declare that they have no conflict of interest.

CC BY NC ND

ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 6
June 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 1: The distribution of child and parent's characteristic

Characteristics	2013	2018
Child characteristics		
Gender		
Male	23,884 (50.7%)	28,957 (48.5%)
Female	23,190 (49.3%)	30,774 (51.5%)
Age		
< 2 years	27,892 (59.3%)	25,093 (42%)
≥ 2 years	19,182 (40.7%)	34,638 (58%)
Maternal characteristics		
Age		
< 20 years	1,292 (2.7%)	2,267 (4%)
20-35 years	35,195 (74.8%)	40,328 (70.9%)
35-50 years	10,531 (22.4%)	14,166 (24.9%)
>50 years	57 (0.1%)	129 (0,2%)
Education Level		
Not completed elementary school	5,347 (11.4%)	18,448 (32.4%)
Graduated elementary school	12,687 (27.0%)	13,315 (23.4%)
Graduated junior high school	10,744 (22.8%)	17,775 (31.2%)
Graduated senior high school	13,585 (28.9%)	2,837 (5%)
Graduated from collage	4,711 (10.0%)	4,515 (7,9%)
Working Status		
Does not work	29,311 (62.3%)	31,492 (55.4%)
Work	17,763 (37.7%)	25,398 (44.6%)
Paternal Characteristics		
Education Level		
Not completed in primary school	4,901 (11.0%)	18,190 (34.1%)
Graduated elementary school	11,527 (25.9%)	11,342 (21.2%)
Graduated junior high school	9,235 (20.8%)	18,077 (33.9%)
Graduated senior high school	14,577 (32.8%)	1,761 (3.3%)
Graduated from collage	4,184 (9.4%)	4,012 (7.5%)
Working Status		
Does not work	1,462 (3.3%)	1,071 (2%)
Work	42,962 (96.7%)	52,311 (98%)
Socioeconomic level		
Quintile 1	9,486 (20.2%)	16,254 (27.2%)
Quintile 2	8,706 (18.5%)	13, 481 (22.6%)
Quintile 3	9,111 (19.4%)	11, 620 (19.5%)
Quintile 4	9,933 (21.1%)	10,154 (17%)
Quintile 5	9,838 (20.9%)	8,222 (13.8%)

CC BY NC ND

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 6
June 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 2: Percentage of child stunting and other potential problems related to stunting based on the 2013 and 2018 basic health survey

Variables	2013	2018
Child data		
% stunting	38.6 (n=42,999)	33.9 (n=59,731)
% low birth weight	5.7 (n=26,048)	6.5 (n=30,983)
% Neonatal stunting	20.4 (n=21,481)	23.1 (n=25,035)
% Preterm	36.2 (n=47,074)	33.4 (n=59,731)
Maternal Data		
% short stature	9.0 (n=46,951)	9.9 (n=56,832)
% CED	20.4 (n=46,301)	1 (n=56,267)

Note: Short stature = height <145 cm; CED=Chronic energy deficiency (MUAC<23.5 cm)

CC BY NC ND

REFERENCES

1. **UNICEF.** The State of the World's Children 2017: Children in a Digital World. 2017. Available from: https://www.unicef.org/reports/state-worlds-children-2017 *Accessed 18 August 2023.*

2. **World Health Organization (WHO).** Stunting in a nutshell. 2015. Available from: https://www.who.int/news/item/19-11-2015-stunting-in-a-nutshell *Accessed 18 March 2023.*

3. **World Health Organization (WHO).** Global nutrition targets 2025: policy brief series. 2014. Available from: https://www.who.int/publications/i/item/WHO-NMH-NHD-14.2 *Accessed 19 January 2023.*

4. **The World Bank**. Indonesia: Making the Resources Work to Reduce Child Stunting. 2018. Available from: https://www.worldbank.org/en/news/feature/2018/12/20/indonesia-making-the-money-work-to-reduce-child-stunting *Accessed 20 January 2023.*

5. **TP2AK**. Laporan Baseline Program Percepatan Pencegahan Stunting 2018-2024: Stunting (Baseline Report for the 2018-2024 Accelerated Stunting Prevention Program: Stunting). 2018.

6. **NHRD**. The Indonesia Basic Health Survey 2013. Jakarta; 2013.

7. **NHRD.** The Indonesia Basic Health Survey 2018. Jakarta; 2018.

8. **Litbangkemkes.** Materi Launching Hasil Studi SSGI Tahun 2021 (*Material for Launching 2021 SSGI Study Results*). 2021. https://www.litbang.kemkes.go.id/materi-launching-hasil-studi-ssgi-tahun-2021/ *Accessed February 2023.*

9. **Titaley CR, Ariawan I, Hapsari D, Muasyaroh A and MJ Dibley** Determinants of the Stunting of Children Under Two Years Old in Indonesia: A Multilevel Analysis of the 2013 Indonesia Basic Health Survey. *Nutrients.* 2019; **11(5):** 1106. https://doi.org/10.3390/nu11051106

10. **Mulyaningsih T, Mohanty I, Widyaningsih V, Gebremedhin TA, Miranti R and VH Wiyono** Beyond personal factors: Multilevel determinants of childhood stunting in Indonesia. *PLoS One.* 2021 Nov 19; **16(11):** e0260265. https://doi.org/10.1371/journal.pone.0260265

cc BY NC ND

11. **UNICEF.** Improving Child Nutrition: The Achievable Imperative for Global Progress. New York: United Nation Children's Fund; 2013.

12. **Victora CG, de Onis M, Hallal PC, Blössner M and R Shrimpton** Worldwide Timing of Growth Faltering: Revisiting Implications for Interventions. *Pediatrics*. 2010 ;**125(3):** e473–80. https://doi.org/10.1542/peds.2009-1519

13. **Miller AC, Murray MB, Thomson DR and MC Arbour** How consistent are associations between stunting and child development? Evidence from a meta-analysis of associations between stunting and multidimensional child development in fifteen low- and middle-income countries. *Public Health Nutr.* 2016;**19(8):**1339–47. https://doi.org/10.1017/S136898001500227X

14. **Aryastami NK, Shankar A, Kusumawardani N, Besral B, Jahari AB and E Achadi** Low birth weight was the most dominant predictor associated with stunting among children aged 12–23 months in Indonesia. *BMC Nutr.* 2017; **3(1):** 16. https://doi.org/10.1186/s40795-017-0130-x

15. **UNICEF.** Mid-upper arm circumference (MUAC) measuring tapes – technical bulletin: A description of the MUAC tapes available through UNICEF Supply Division. https://www.unicef.org/supply/documents/mid-upper-arm-circumference-muac-measuring-tapes-technical-bulletin *Accessed 12 September 2023.*

16. **Bliss J, Lelijveld N, Briend A, Kerac M, Manary M, McGrath M, Prinzo ZW, Shepherd S, Zagre NM, Woodhead S, Guerrero S and A Mayberry** Use of Mid-Upper Arm Circumference by Novel Community Platforms to Detect, Diagnose, and Treat Severe Acute Malnutrition in Children: A Systematic Review. *Glob Health Sci Pract*. 2018; **6(3):** 552–64. https://doi.org/10.9745/GHSP-D-18-00105

17. **Krebs NF, Hambidge KM, Westcott JL, Garcés AL, Figueroa L, Tshefu AK, Lokangaka AL, Goudar SS, Dhaded SM, Saleem S, Ali SA, Bouserman MS, Derman RJ, Goldenberg RL, Das A and D Chowdhury** Birth length is the strongest predictor of linear growth status and stunting in the first 2 years of life after a preconception maternal nutrition intervention: the children of the Women First trial. *Am J Clin Nutr*. 2022; **116(1):** 86–96. https://doi.org/10.1093/ajcn/nqac051

CC BY NC ND

18. **Hastuti, Hadju V, Citrakesumasari and M Maddeppungeng** Stunting prevalence and its relationship to birth length of 18–23 months old infants in Indonesia. *Enferm Clin*. 2020; **30**: 205–9. https://doi.org/10.1016/j.enfcli.2019.10.069

19. **Bosquet Enlow M, Sideridis G, Bollati V, Hoxha M, Hacker MR and RJ Wright** Maternal cortisol output in pregnancy and newborn telomere length: Evidence for sex-specific effects. *Psychoneuroendocrinology*. 2019; **102**: 225–35. https://doi.org/10.1016/j.psyneuen.2018.12.222

20. **Sumarni S** Maternal Short Stature and Neonatal Stunting: An Inter-Generational Cycle of Malnutrition. In: International Conference on Health and Well-Being (ICHWB) 2016. 2016.

21. **Gonete AT, Kassahun B, Mekonnen EG and WW Takele** Stunting at birth and associated factors among newborns delivered at the University of Gondar Comprehensive Specialized Referral Hospital. *PLoS One*. 2021; **16(1):** e0245528. https://doi.org/10.1371/journal.pone.0245528

22. **Soliman A, Sanctis V, De, Alaaraj N, Ahmed S, Alyafei F and N Hamed** Early and Long-Term Consequences of Nutritional Stunting: From Childhood to Adulthood. *Acta Biomed*. 2021;**92(1)**. https://doi.org/10.23750/abm.v92i1.11346

23. **Mulyaningsih T, Mohanty I, Widyaningsih V, Gebremedhin TA, Miranti R and VH Wiyono** Beyond personal factors: Multilevel determinants of childhood stunting in Indonesia. *PLoS One.* 2021; **16(11):** e0260265. https://doi.org/10.1371/journal.pone.0260265

24. **Sartika AN, Khoirunnisa M, Meiyetriani E, Ermayani E, Pramesthi IL and AJ Nur Ananda** Prenatal and postnatal determinants of stunting at age 0–11 months: A cross-sectional study in Indonesia. *PLoS One*. 2021; **16(7):** e0254662. https://doi.org/10.1371/journal.pone.0254662

25. **Beal T, Tumilowicz A, Sutrisna A, Izwardy D and LM Neufeld** A review of child stunting determinants in Indonesia. *Matern Child Nutr*. 2018; **14(4)**. https://doi.org/10.1111/mcn.12617

26. **Utami RA, Setiawan A and P Fitriyani** Identifying causal risk factors for stunting in children under five years of age in South Jakarta, Indonesia. *Enferm Clin*. 2019; **29**: 606–11. https://doi.org/10.1016/j.enfcli.2019.04.093

CC BY NC ND

27. **Lukman TNE, Anwar F, Riyadi H, Harjomidjojo H and D Martianto** Birth Weight and Length Associated with Stunting among Children Under-Five in Indonesia. *Jurnal Gizi Pangan*. 2021;**16**.

28. **Sawitri AJ and B Purwanto** Birth Weight and Birth Length Affecting Stunting Incident In Toddler. *Indonesian Midwifery and Health Sciences Journal*. 2021 ;**5(3):** 325–32.

29. **Preedy V and VB Patel** Handbook of Famine, Starvation, and Nutrient Deprivation. *Cham: Springer International Publishing*; 2017.

30. **Koletzko B, Godfrey KM, Poston L, Szajewska H, van Goudoever JB and M de Waard** Nutrition During Pregnancy, Lactation and Early Childhood and its Implications for Maternal and Long-Term Child Health: The Early Nutrition Project Recommendations. *Ann Nutr Metab.* 2019; **74(2):** 93–106. https://doi.org/10.1159/000496471

31. **Taneja S, Chowdhury R, Dhabhai N, Mazumder S, Upadhyay RP and S Sharma** Impact of an integrated nutrition, health, water sanitation and hygiene, psychosocial care and support intervention package delivered during the pre- and peri-conception period and/or during pregnancy and early childhood on linear growth of infants in the first two years of life, birth outcomes and nutritional status of mothers: study protocol of a factorial, individually randomized controlled trial in India. *Trials*. 2020; **21(1):** 127. https://doi.org/10.1186/s13063-020-4059-z

32. **Hackman NM, Schaefer EW, Beiler JS, Rose CM and IM Paul** Breastfeeding Outcome Comparison by Parity. *Breastfeeding Medicine.* 2015;**10(3):**156–62. https://doi.org/10.1089/bfm.2014.0119

33. **Molès J, Tuaillon E, Kankasa C, Bedin A, Nagot N and A Marchant** Breastmilk cell trafficking induces microchimerism-mediated immune system maturation in the infant. *Pediatric Allergy and Immunology*. 2018; **29(2):** 133–43. https://doi.org/10.1111/pai.12841

34. **Torlesse H, Cronin AA, Sebayang SK and R Nandy** Determinants of stunting in Indonesian children: evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. *BMC Public Health.* 2016; **16**: 669. https://doi.org/10.1186/s12889-016-3339-8

CC BY NC ND

35. **Semba RD, de Pee S, Berger SG, Martini E, Ricks MO and MW Bloem** Malnutrition and infectious disease morbidity among children missed by the childhood immunization program in Indonesia. *Southeast Asian J Trop Med Public Health.* 2007; **38(1):** 120-9. PMID: 17539257.

36. **Marume A, Archary M and S Mahomed** Predictors of stunting among children aged 6–59 months, Zimbabwe. *Public Health Nutr*. 2023; **26 (4):** 820–33. https://doi.org/10.1017/S1368980023000046

37. **Fatimah, Massi MN, Febriani ADB, Hatta M, Karuniawati A and S Rauf** The role of exclusive breastfeeding on sIgA and lactoferrin levels in toddlers suffering from Acute Respiratory Infection: A cross-sectional study. *Annals of Medicine & Surgery*. 2022 May;77. https://doi.org/10.1016/j.amsu.2022.103644

38. **Sinha B, Taneja S, Chowdhury R, Mazumder S, Rongsen-Chandola T and RP Upadhyay** Low-birthweight infants born to short-stature mothers are at additional risk of stunting and poor growth velocity: Evidence from secondary data analyses. *Matern Child Nutr*. 2018 ;**14(1)**. https://doi.org/10.1111/mcn.12504

39. **Biswas T, Townsend N, Magalhaes RJS, Hasan M and A Mamun** Patterns and determinants of the double burden of malnutrition at the household level in South and Southeast Asia. *Eur J Clin Nutr*. 2021; **75(2):** 385–91. https://doi.org/10.1038/s41430-020-00726-z

40. **Laksono AD, Wulandari RD, Amaliah N and RW Wisnuwardani** Stunting among children under two years in Indonesia: Does maternal education matter? *PLoS One*. 2022; **17(7):** e0271509. https://doi.org/10.1371/journal.pone.0271509

41. **Adzawla W, Tahidu A, Mustapha S and SB Azumah** Do socioeconomic factors influence households' solid waste disposal systems? Evidence from Ghana. Waste Management & Research: *The Journal for a Sustainable Circular Economy*. 2019; **37(1_suppl):** 51–7. https://doi.org/10.1177/0734242X18817717

42. **Amaha N D and BT Woldeamanuel** Maternal factors associated with moderate and severe stunting in Ethiopian children: analysis of some environmental factors based on 2016 demographic health survey. *Nutrition Journal.* 2021; **20(1)**: 1-9. https://doi.org/10.1186/s12937-021-00677-6

CC BY NC ND

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 6
June 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

43. **Lwanga S and S Lemeshow** Sample Size Determination in Health Studies. A Practical Manual*. Journal of the American Statistical Association* 1991; **15(416)**. https://doi.org/ 10.2307/2290547