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A Stunting Prevention Risk Factors Pathway Model for Indonesian Districts/Cities with a Stunting Prevalence of ≥30%

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Abstract

The prevalence of stunting in Indonesian children aged 0-23 months is a public health problem caused by direct and indirect factors. This study aimed to discover the path of the relationship between various risk factors and the stunting prevalence of ≥30% in 165 districts/cities in Indonesia. Data were obtained from the 2018 National Basic Health Research, National Socioeconomic Survey, and the Statistics Indonesia with a cross-sectional approach. The secondary data on stunting and risk factors were aggregated at the district/city level from individual data; children aged 0-23 months. The path analysis used to determine a stunting prevention model showed that antenatal care at the district/city level decreased stunting rates by at least 2.56% (b = -0.16; p-value = 0.04). A contraceptive user at the district/city level decreased stunting rates by 2.25% (b = -0.15; p-value = 0.05), and handwashing with soap at the district/city level by 5.76%, (b = -0.24; p-value = 0.003). Antenatal care, contraceptive use, and handwashing with soap contributed to the reduction of stunting prevalence by 18.18%. The study results suggested that districts/cities can play an important role in reducing stunting.

Keywords: children under two, handwashing with soap, path analysis, prevention risk factors, stunting

Introduction

The stunting prevalence in Indonesian children aged 0-23 months was 32.9% in 2013, 26.1% in 2016, and 29.9% in 2018.[1] The high prevalence of stunting in Indonesia is also accompanied by a vast disparity in stunting prevalence between districts/cities.[2] The 2018 National Basic Health Research/*Riset Kesehatan Dasar* (*Riskesdas*) and the integrated results from the 2019 National Socioeconomic Survey/*Survei Sosial Ekonomi Nasional* (*SUSENAS*) and Indonesian Toddler Nutritional Status Survey/*Survei Status Gizi Balita Indonesia* (SSGBI) found that stunting rates varied significantly among regions in Indonesia.[3,4] The highest prevalence of stunting was found in the Western and Eastern parts of Indonesia and is more widespread in rural areas than urban areas.[5,6]

Many cases demonstrate that the stunting condition of children in the first 1,000 days of life—children aged 0-23 months—cannot be changed.[7] The negative health and socioeconomic impacts of stunting can last a lifetime and even affect the next generation.[7] A study of 2,443 children aged 6-16 years spread across 20 primary schools in Cambodia showed that stunted children had significantly lower scores than those not stunted on all intelligence tests.[8] A case-control study in the Southern Iran on children aged 6-7 years reported that stunting was significantly associated with chronic disease.[9] A study in Nigeria reported that stunted children under five had experienced diarrhea in the two weeks before the survey.[10] Another study in Cambodia noted that stunting in children was associated with infections caused by *Strongyloides stercoralis* and had chronic effects.[11] Stunting in children carries a three-fold risk of death from other infections, including sepsis, meningitis, tuberculosis, hepatitis, and cellulitis. This indicates an abnormal immune condition in children with poor linear growth.[11] Therefore, stunting prevention is a top priority in Indonesia.

The experiences of Peru, Ethiopia, Senegal, Nepal, and Kyrgyzstan in stunting prevention showed that maternal education, maternal nutrition, maternal and newborn care, and decreased fertility/reduction in the interval between pregnancies are strong contributors to stunting prevention.[12] Ethiopia reported that the key factors in reducing stunting were an increase in total edible crop yields (32%), an increase in the number of health work-

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ers (28%), a decrease in open defecation (13%), parental education (10%), maternal nutrition (5%), economic improvement (4%), and decreased incidence of diarrhea (4%).[13] Peru has reduced child stunting by making socioeconomic improvements, implementing sustainable changes inside and outside the health sector, and implementing health interventions.[14]

Stunting prevention efforts are associated with several risk factors. According to the United Nations International Children's Emergency Fund (UNICEF), the conceptual framework for stunting, which is adapted to Indonesian conditions, states that access to nutritious food, access to health care facilities, infant and child feeding, hygiene, education, access to clean water in households, and good sanitation facilities are factors that affect child stunting.[15] Studies in India have suggested that the leading risk factor for stunting is the low birth weight (LBW),[16] while in the Republic of the Congo, poor nutrition and failure to implement early initiation of breastfeeding (EIB) are the main risk factors for stunting.[17] Low household food diversity, food insecurity, poor feeding practices, and poverty are stunting factors in Lao PDR.[18] A poor environment is also expected to significantly impact stunting in the South Asia, Sub-Saharan Africa, East Asia, and the Pacific.[19]

Data analysis of the 2013 National Basic Health Research consisting of 24,657 children aged 0-23 months reported that the risk of child stunting increases if children live in households with more than three children under five, children live in a household with more than seven members, the mother visited health care facilities less than four times during pregnancy, the child is male, the child is aged 12-23 months, and birth weight is less than 2,500 grams. This study also found that stunting in children aged 0-23 months in Indonesia occurred due to differences in subdistrict/district/province as well as individual and household characteristics.[20]

The stunting prevention program running in Indonesia is reported not to have significantly contributed to stunting reduction because the stunting rate is not below 20%.[21] The high stunting rate in Indonesia impacts children's height growth being less than maximal, and the potential for irreparable loss of children's cognitive development is a major threat to child development.[22] To accelerate the prevention of stunting and reduce the stunting gap at the district or city level in Indonesia, an analysis of the direct and indirect relationships between various risk factors for stunting at the district/city level was carried out.

The analysis aimed to determine the stunting prevention pathway model in Indonesian districts/cities with a stunting prevalence of ≥30% (very high saturation category). The selection of a stunting prevalence threshold of ≥30% was based on the World Health Organization (WHO) threshold in classifying stunting as a moderate and severe public health problem.[23,24] The analysis was carried out using a conceptual framework for the causes of stunting problems adapted to Indonesian conditions.

Method

This study used a cross-sectional design to determine the mechanism of the relationship between various risk factors and stunting prevalence in children aged 0-23 months at the district/city level in Indonesia. The stunted children's data was retrieved from the 2018 National Basic Health Research, a nationally-representative health survey conducted by the Indonesian Ministry of Health. Indonesia has a total of 514 districts and cities within 34 provinces, and the stunted children's data were aggregated at the district/city level.[3]

The target sample of the 2018 National Basic Health Research was 300,000 households from 30,000 census blocks from the 2018 National Socioeconomic Survey with two-stage sampling. First, the survey team selected 180,000 census blocks using probability proportional to size (PPS) from 720,000 census blocks listed in the population census from 2010. Additionally, the team selected 30,000 census blocks in each urban dan rural using the PPS.

Next, the team systematically chose ten households using implicit stratification of the education level of household heads (to maintain the variation among households). The team interviewed each household member and examined participants who met the inclusion criteria (data criteria from the 2018 National Basic Health Research). The interview response rate for the 2018 National Basic Health Research was relatively high at 95% of target households nationally.[25] The sample included 165 districts/cities with a prevalence of stunting of ≥30% from a total of 514 districts/cities in Indonesia.

Indicators of stunting risk factors were obtained from the 2018 National Basic Health Research, National Socioeconomic Survey, and the Statistics Indonesia. The variables of early childhood education, complete basic immunization, access to health care facilities, food, safe drinking water, basic sanitation, and handwashing with soap were taken from the 2018 National Basic Health Research. The variables of LBW and access to health care facilities and food were taken from the 2018 National Socioeconomic Survey. Gross Regional Domestic Product (GRDP) per capita was taken from the Statistics Indonesia in 2018. All variables were presented at the district/city level.

Stunting was used as a dependent variable—the cut-off values (Z-score < -2.0 SD) were compared to the WHO child growth standards median.[26] The results of measuring each child's body length (cm) were converted into a standardized value (Z-score) using the WHO

Anthro 2018 version 3.2. Furthermore, based on the Z-score of the body length/age indicator with a stunting limit (Z-score < -2.0 SD), the percentage of stunted children was calculated using the number of children with a Z-score of < -2.0 SD divided by the number of children whose body length was measured multiplied by 100%.[27] Stunting prevalence was calculated as the number of stunted children divided by the number of children in the same period.[25]

Before the analysis was carried out, the completeness of data was first checked according to the study variables. All variables were presented in percentages at the district/city level and Indonesian Rupiah (IDR) for the per capita GRDP variable. Quantitative analyses were performed using descriptive statistics and path analysis. Descriptive statistics included the prevalence of stunting by district/city. Path analysis is a statistical method applied to see the direct and indirect relationships of a variable hypothesized as a cause to a variable acting as an effect.[28]

Path analysis proceeded through several stages. Model specifications used a research concept framework involving path diagrams to determine the relationship between variables to be tested, in which the relationship between constructs (X1-X15) was expressed through arrows. Straight arrows indicated a direct causal relationship between constructs, with arrows at each end indicating a correlation between constructs.

The next stage was the model identification, characterized by the degree of freedom (df). Path analysis could be done if df≥0. After determining the path analysis of all observed variables (X1-X15), the path coefficients for parameter estimation could be obtained.

The final stage was the goodness of fit model feasibility test, consisting of the value of significance probability (p) Chi-square = 0.05, Tucker-Lewis Index (TLI) = 0.90, Comparative Fit Index (CFI) = 0.90, Standardized Root Mean Square Residual (SRMR) less than 0.05, and Root Mean Square Error of Approximation (RMSEA) = 0.08. The goodness-of-fit index was used to test the suitability of the path model obtained using the data.[29]

All variables contained in the fit model were calculated according to the percentage of their contribution to the reduction in stunting prevalence, based on the path coefficients of each variable. The results of the descriptive analysis were presented in tables. While, the analysis path was shown in tables and figures.

Result

Based on the 2018 National Basic Health Research, the percentage of stunted children aged 0-23 months in Indonesia was 29.9%, spread across all provinces with wide variations. The East Nusa Tenggara and West Sulawesi Provinces were the two provinces reported as having stunting more than 40%.[3] While, Papua Province and Special Region of Nanggroe Aceh Darussalam were recorded having most districts/cities with a stunting prevalence of more than or equal than 40%.[3]

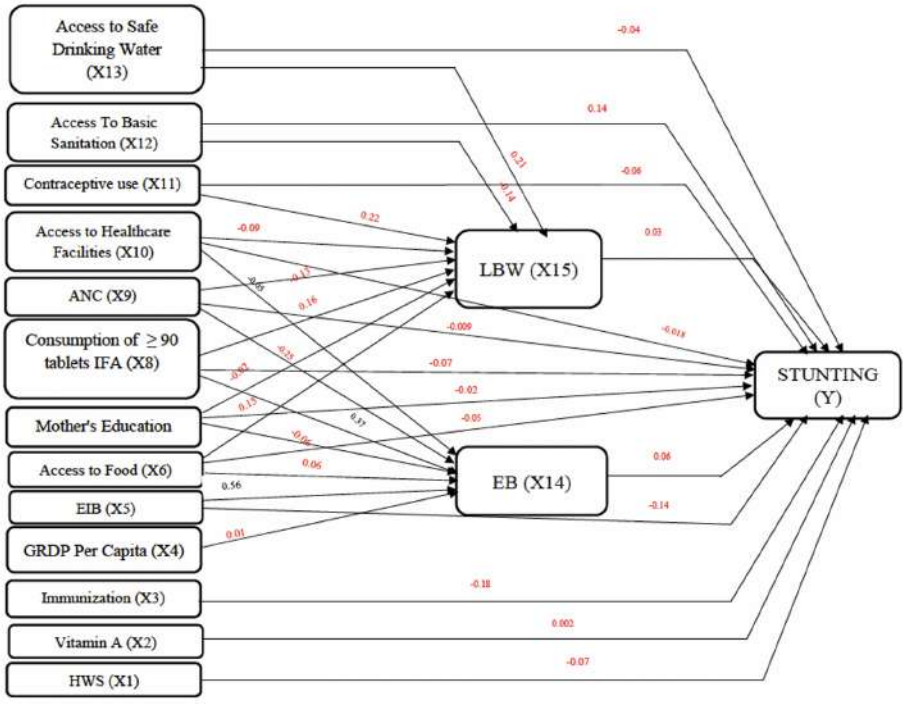
The characteristics of the risk factors for stunting in Table 1 show that access to safe drinking water was well distributed (87.19%) in all districts/cities with a stunting prevalence of ≥30%. However, it was found that only 12.85% of households with children aged 0-23 months had access to food that was sufficiently safe and nutritious to live a physically, socially, and economically active and healthy life.

Path analysis resulted in identifying the path model by referring to the degree of freedom (df) number, which, at 35, showed that the model was over-identified (df>0), meaning that there were more data points than parame-

Table 1. Description of Stunting Risk Factors at the District/City Level with a Stunting Prevalence of ≥30% in Indonesia, 2018 (n = 165)

Variable	Mean	SD	Min-Max
Stunting	37.03	6.07	30.00–66.67
Consumption of 90 tablets of iron-folic acid (%)	26.94	17.32	0.00–80.55
Antenatal care (%) (1-1-2)	59.04	19.54	0.00–92.86
Contraceptive use (%)	59.47	21.18	0.00–93.02
Low birth weight (less than 2,500 gram) (%)	12.96	6.58	0.00–31.13
Exclusive breastfeeding (%)	49.87	15.39	12.5–90.28
Vitamin A supplementation (2x a year) (%)	29.00	12.21	0.00–58.70
Early initiation of breastfeeding (%)	53.41	16.58	12.5–87.04
Complete basic immunization (%)	46.78	24.16	0.00–88.67
Access to health care facilities (%)	66.04	15.58	18.37–100.0
Access to basic sanitation (%)	36.85	18.43	0.00–86.30
Access to food (%)	12.85	13.60	0.00–88.24
Access to safe drinking water (%)	87.19	14.12	25.00–100.0
Handwashing with soap (%)	73.42	21.01	0.00–100.0
Mother's education (≥ senior high school) (%)	15.47	8.18	0.00–43.68
GRDP per capita (thousand rupiahs) (%)	41.761	42.265	9.435–337.450

Notes: SD = Standard Deviation, GRDP = Gross Regional Domestic Product



Notes: The red-printed path coefficient has a p-value of >0.05, X1-X13: Exogenous constructs are independent variables that were not predicted by other variables in the model.
X14-X15, Y: Endogenous or endogenous constructs are factors predicted by one or more constructs.
LBW = Low Birth Weight, EB = Exclusive Breastfeeding, ANC = Antenatal Care, IFA = Iron-Folic Acid, EIB = Early Initiation of Breastfeeding, GRDP = Gross Regional Domestic Product, HWS = Handwashing with Soap.

Figure 1. The First Model of the District/City Level Stunting Risk Prevention Pathway with a Stunting Prevalence of ≥30%

ters. Thus, path analysis could be completed on this model. The path diagram presented in Figure 1 tested the model's assumptions (homoscedasticity, existence, independence, linearity, and normality), and the model fulfilled five types of assumption tests (Table 2).

The path analysis model showed that variables were not significantly related to the stunting prevalence (Table 2). Therefore, to arrive at the best model, variables that were not significantly related to stunting prevalence were omitted from the model, starting with removing the variable with the largest p-value, so that a model with a variable with a p-value of less than 0.05 was obtained (Figure 2).

Simultaneous relationships between exclusive breastfeeding (EB), low birth weight (LBW), GRDP per capita, maternal education, consumption of ≥90 iron-folic acid (IFA) tablets by pregnant women, antenatal care (ANC), family planning, vitamin A supplementation, complete basic immunization, access to health care facilities, food, safe drinking water, sanitation, and handwashing with soap were related to stunting prevalence in district/city level with a stunting prevalence of ≥30% at R2 = 0.5151. The variable contribution of EB, LBW, GRDP per capita, maternal education, IFA tablets for pregnant women, pregnancy check-ups, family planning, vitamin A supplementation, complete basic immunization, access to health care facilities, food, safe drinking water, sanitation, and handwashing with soap towards stunting prevalence in district/city level with stunting prevalence of ≥30% was 0.5151 x 100% = 51.51%. The remainder (residual) was 1 - 0.5151 = 0.4849 x 100% = 48.49% influenced by other factors.

The complete model that was built fulfilled the model fit test with the data using a fit index. The next stage involved removing the variable with the largest p-value from the model to obtain a fit and significance model (Figure 2). The final path model obtained was a suitable and significant model. This means that the path model obtained was acceptable and fit the theory and data well. Simultaneous relationship between pregnancy check-ups,

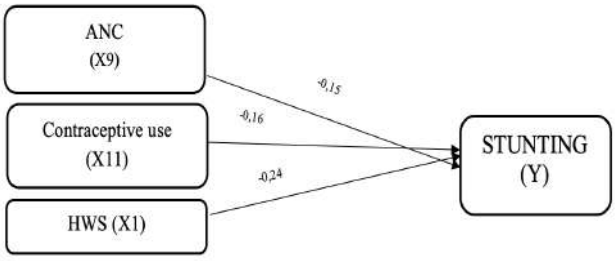
Table 2. Direct, Indirect, and Total Relationships of Stunting Risk Factors at District/City Level with a Stunting Prevalence of ≥ 30%, 2018 (n = 165)

	Relationship				
	Direct	Indirect		Total	Contribution (%)
		Through EB Variable	Through LBW Variable		
Stunting (Y) ← EB (X14)	0.06	-	-	0.06	0.36
Stunting (Y) ← LBW (X15)	-0.19	-	-	-0.19	4.0
Stunting (Y) ← GRDP Per Capita (X4)	-	0.001	-	0.001	0.001
Stunting (Y) ← Maternal Education (X7)	-0.02	-0.003	0.004	-0.018	4.0
Stunting (Y) ← Consumption of ≥90 tablets of IFA (X8)	-0.06	0.02*	-0.03	-0.070.49	
Stunting (Y) ← ANC (X9)	-0.009	-0.014	0.03	0.002	0.04
Stunting (Y) ← Contraceptive use (X11)	-0.06	-	-0.04	-0.11	1.21
Stunting (Y) ← Vitamin A (X2)	0.002	-	-	0.002	0.001
Stunting (Y) ← EIB (X5)	-0.15	0.03*	-	-0.12	1.44
Stunting (Y) ← Immunization (X3)	-0.19	-	-	-0.19	3.61
Stunting (Y) ← Access to health care facilities (X10)	-0.18	-0.001	0.01	-0.16	2.56
Stunting (Y) ← Access to food (X6)	-0.05	0.003	-0.03	-0.08	0.64
Stunting (Y) ← Access to safe drinking water (X13)	-0.04	-	-0.04	-0.08	0.25
Stunting (Y) ← Access to basic sanitation (X12)	0.14	-	-	-0.07	2.56
Stunting (Y) ← HWS (X1)	-0.07	-	-	-0.07	0.49

Notes: *p-value<0.05, EB = Exclusive Breastfeeding, LBW = Low Birth Weight, GRDP = Gross Regional Domestic Product, IFA = Iron-Folic Acid, ANC = Antenatal Care, EIB = Early Initiation of Breastfeeding, HWS = Handwashing with Soap.

family planning, and handwashing with soap and the stunting prevalence at the district/city level with a stunting prevalence of ≥30% was R2 = 0.1818. The magnitude of the contribution of the variables of pregnancy check-ups, family planning, and handwashing with soap with the stunting prevalence at the district/city level in the stunting category of ≥30% was 0.1818 x 100% = 18.18%. The rest (residual) was 1 - 0.1818 = 0.8182 x 100% = 81.82% influenced by other factors.

Based on the fit test index for the stunting risk prevention pathway model at the district/city level (Table 3), the stunting prevalence of ≥30% tested met four of the five existing fit index criteria. Thus, the stunting risk prevention pathway model at the district/city level with a stunting prevalence of ≥30% can be statistically fit. While, the stunting risk prevention pathway model showed that the risk factors that significantly contributed to the stunting prevalence at the district/city level were ANC (2.56%), contraceptive use (2.25%), and HWS (5.76%) (Figure 3).



Notes: ANC = Antenatal Care, HWS = Handwashing with Soap.
X1, X9, X11: Exogenous constructs were independent variables not predicted by other variables in the model. Y: Endogenous or endogenous constructs were factors predicted by one or more constructs.

Figure 2. The Best District/City Level Risk Prevention Pathway Model with a Stunting Prevalence of ≥30%

Discussion

District/City Level Stunting Prevalence

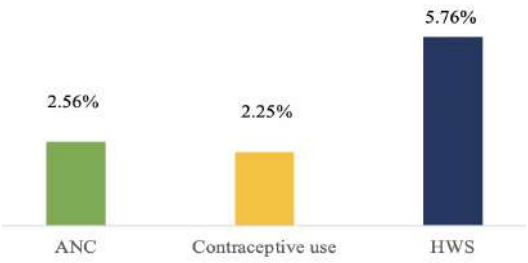
Referring to the WHO classification regarding the magnitude of the public health problem, which is stunting,[24] from the data of 165 districts/cities in Indonesia that were analyzed, 40 districts/cities (24.24%) had a stunting prevalence of >40%. Although there has been a decline in stunted children under five in Indonesia, it has not yet reached 14%, which is the National Medium-Term Plan 2024 target.[30] The 2018 National Socioeconomic Survey and 2019 Indonesian Toddler Nutritional Status showed that stunting was reported only in children aged 0-59 months (30.8% in 2018 and 27.67% in 2019).[4] Therefore, this study focused on analyzing the stunted children aged 0-23 months at the district/city level and various risk factors for stunting to find a pathway model to help reduce stunting at the district/city level.

Relative to the percentage values of several stunting handling indicators in the Special Index for Handling Stunting 2018-2019,[31] and expert's opinion,[32] it is understood that promotional and preventive efforts at stunting prevention are effective if they reach 90% of the goals. This study results found that 20 districts/cities had

Table 3. The Goodness of Fit Test Pathway Model for Risk Prevention at Indonesian District/City Level with a Stunting Prevalence of ≥30%

Fit Index		First Model		Best Model		Fit Criteria
		Value	Conclusion	Value	Conclusion	
Absolute	p-value (Chi-square)	0.40	Fit	0.001	Not Fit	>0.05
	RMSEA	0.028	Fit	0.001	Fit	0.08
	SRMR	0.037	Fit	0.001	Fit	<0.05
Incremental	CFI	0.964	Fit	1.0	Fit	>0.9
	TLI	0.9	Threshold	1.0	Fit	>0.9

Notes: RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root Mean Square Residual, CFI = Comparative Fit Index, TLI = Tucker-Lewis Index.



Notes: ANC = Antenatal Care, EIB = Early Initiation of Breastfeeding, HWS = Handwashing with Soap.

Figure 3. The Contribution of Antenatal Care, Contraceptive Use, and Handwashing with Soap at the District/City Level with a Stunting Prevalence of ≥30%

100% access to safe drinking water, while 59 districts/cities had below 87.19%. This means that most of children aged 0-23 months in districts/cities with a stunting prevalence of ≥30% had access to and used drinking water that met the quality requirements (branded bottled water, tap water, or local water company, borehole wells or pumps, wells protected digging, protected springs, recharged water, or rainwater reservoir). Following the Regulation of the Minister of Health of the Republic of Indonesia No. 32 of 2017 Concerning Water Requirements for Sanitation Hygiene Purposes, the physical quality of drinking water must meet health requirements, which must be not cloudy, clear, tasteless, odorless, not contaminated with chemicals, and free of various microorganisms that can cause harm.[33] The 2014 Indonesian Family Life Survey data reported that children under five living in households with inadequate drinking water sources were at 1.21 times higher risk of stunting than children living in households with access to better drinking water sources.[34]

Access to food as a risk factor for stunting in districts/cities with a stunting prevalence of ≥30% was recorded at 12.85%, meaning that a total of 114 (69.09%) districts/cities had below 12.85% access to food. Thus, in general, there were a few households with children aged 0-23 months in districts/cities with a stunting prevalence of ≥30% that had physical, social, and economic access to sufficient, safe, and nutritious food based on the food needs of household members for an active and healthy life. In other words, children in families with limited access to food tended not to meet their intake needs, which impacted stunting. Food-insecure households tend to provide less intake to children. Study on stunted and non-stunted children in the coastal area of the Probolinggo District, East Java Province, Indonesia found a difference in the amount of intake given to stunted and non-stunted children. Stunted children tend to be given less intake, and the children's nutritional needs are not met.[35] Families of stunted children are also reported to dislike diverse foods, especially vegetables and foods from the sea.[36]

District/City-Level Stunting Risk Prevention Pathway Model

The stunting risk prevention pathway model in districts/cities with a stunting prevalence of ≥30% was based on the model explaining the causal relationship between research variables. The path model also fulfilled six assumption tests in path analysis: normality, linearity, multicollinearity, independence, existence, and homoscedasticity. The path model at the district/city level with a stunting prevalence of ≥30% showed that there were direct and indirect relationships between various endogenous variables and the stunting prevalence at the district/city level. The final path model showed that standard ANC, contraceptive use, and handwashing with soap had a significant relationship with the stunting prevalence at the district/city level and had a negative path coefficient value. This means that an increase in the percentage of ANC, contraceptive use, and handwashing with soap according to standards (path coefficient = -0.15, -0.16, and -0.24, respectively) will result in a decrease in the stunting prevalence in districts/cities with a

stunting prevalence of ≥30%.

Handwashing with soap contributed significantly to the reduction in stunting prevalence at the district/city level. Stunting prevalence was ≥30%, and the most significant contribution was stunting prevalence of 5.76%. A previous study described the association of handwashing with soap and the incidence of stunting.[37] Handwashing with soap can eliminate bacteria and viruses on the hands. Since the mother is active with the child, handwashing with soap can prevent the spread and transmission of disease. Deaths of children under five in Indonesia can be prevented by better hygiene, especially handwashing with soap. Moreover, handwashing with soap can potentially prevent diarrheal diseases, especially in developing countries.[37] The 2018 National Basic Health Research reported that 12.3% of diarrhea occurred in children under five in Indonesia.[3] Diarrhea is the cause of 18% of all deaths of children under five in Indonesia.[3] Although this study cannot prove the relationship between handwashing with soap and infectious diseases (diarrhea), referring to the United Nations Children's Emergency Fund (UNICEF) stunting conceptual framework, which states that repeated infections are the direct cause of stunting, an increase in the percentage of handwashing with soap will reduce stunting prevalence.[38]

The National Basic Health Research in 2018 reported that ANC in Indonesia increased compared to the 2013.[3] In 2018, 96.1% of expectant mothers had first ANC visit (K1), compared to 95.2% in 2013. The fourth pregnancy check-up visit (K4) was 74.1% in 2018 and 70% in 2013. Although there has been an increase in the percentage of pregnancy check-ups nationally, the distribution at the provincial level shows a significant disparity. The Eastern Indonesia regions (Maluku and Papua) have lowest rates of ANC. The Sumatra region has a distribution of ANC one level above it. In contrast, the best ANC distribution is concentrated in Indonesia's central regions (Java and Bali).[39] This study's result also found a significant variation in the distribution of prenatal care at the district/city level. Districts/cities with a stunting prevalence ≥30% found the highest percentage of ANC in Sukoharjo District, Central Java Province, Indonesia (92.86%) and the lowest (0%) in Nduga and Puncak Districts, Papua Province.

The stunting prevention pathway model suggests that contraceptive use is directly related to reducing stunting prevalence at the district/city level. The use of modern contraceptives aimed at regulating the birth of children, achieving an ideal spacing between childbirths, regulating pregnancy, and creating a quality family.[40] Planning birth spacing may give mothers enough time to recover after giving birth to provide good parenting for their children.[41] Analysis of the 2013 National Basic Health Research data showed that the risk of child stunting increased if the child lived in a household with more than three toddlers.[20] Maintaining birth spacing is important in preventing stunting in children aged 0-23 months at the district/city level with a stunting prevalence ≥30%.

There were certain limitations to this study. First, the data used were cross-sectional. Hence, the analysis could not provide evidence of a significant relationship between stunting prevalence and the success of the intervention. Furthermore, data on private practice were based on mothers' memories, which was likely biased. Despite its limitations, this study achieved a model of the stunting risk prevention pathway for children aged 0-23 months at the district/city level that can be taken into consideration by policymakers at the district/city level in an effort to accelerate the reduction in stunting prevalence in Indonesia.

Conclusion

The stunting risk prevention pathway model at the district/city level shows that stunting ini districts/cities with a stunting prevalence of ≥30% is caused by many factors as evidenced by the direct and indirect relationship of various stunting risk factors with stunting prevalence. The path model showed a direct relationship between antenatal care visit, contraceptive use, and handwashing with soap with stunting. A high number of ANC visits, high contraceptive use, and regular handwashing with soap are directly related to a reduction in stunting prevalence at the district/city level with a stunting prevalence of ≥30% by 18.18%.The path model meets all the goodness of fit criteria, so the model obtained is in accordance with the theoretical framework.

Abbreviations

Riskesdas: *Riset Kesehatan Dasar*; *SUSENAS*: *Survei Sosial Ekonomi Nasional*; SSGBI: *Survei Status Gizi Balita Indonesia*; UNICEF: the United Nations Children's Emergency Fund; LBW: Low Birth Weight; EIB: Early Initiation of Breastfeeding; WHO: World Health Organization; PPS: Probability Proportional to Size; GDRP: Gross Regional Domestic Product; SD: Standard Deviation; IDR: Indonesian Rupiah; df: Degree of Freedom; TLI: Tucker-Lewis Index; CFI: Comparative Fit Index; SRMR: Standardized Root Mean Square Residual; RMSEA: Root Mean Square Error of Approximation; IFA: Iron-folic Acid; EB: Exclusive Breastfeeding; ANC: Antenatal Care; HWS: Handwashing with Soap.

Ethics Approval and Consent to Participate

This study was conducted with an ethical permit from the Research Ethics Committee and Community Engagement of Faculty of Public Health University of Indonesia, number: Ket-09/UN2.F10. D11/PPM.00.02/2022 dated January 27, 2022. The 2018 Indonesian Basic Health Research data were obtained with an ethical permit from the Commission on Health Research Ethics, National Institute of Health

Research and Development, No. LB.02.01/2/KE.024/2018, Ref: Approval No: LB.02.01/2/KE.267/2017 dated July 27, 2017.

Competing Interest

This paper is important because the path model can be used to predict the magnitude of the relationship between risk factors and stunting at the district/city level to find an evidence-based prevention model to accelerate the achievement of the stunting reduction target of 14% in 2024, according to the National Medium-Term Plan. The paper should be of particular interest to readers in public health nutrition.

Availability of Data and Materials

The data were retrieved from the 2018 National Basic Health Research, National Socioeconomic Survey, and Statistics Indonesia.

Authors' Contribution

NF conceptualized the data analysis, interpreted data, and composed and completed manuscripts. TS and AK contributed to interpreting the data and drafting the manuscript. ELA and B contributed to the design and draft of the manuscript, while all authors read and approved the final version of the manuscript and agreed to be responsible for all aspects of the work.

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