e-ISSN : 2597-6052

MPPKI MEDIA PUBLIKASI PROMOSI KESEHATAN INDONESIA

Research Articles Open Access

Spatial Analysis of Stunting Prevalence According to Family Data Collection Indicators in Indonesia

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ARTICLE INFO

Manuscript Received: 20 Dec, 2024
Revised: 18 Feb, 2025
Accepted: 02 Mar, 2025
Date of Publication: 06 Mar, 2025
Volume: 8
Issue: 3
DOI: 10.56338/mppki.v8i3.6931

KEYWORDS

Child Health;
Stunting;
Spatial Analysis;
Family Data Collection;
Spatial Error Model

ABSTRACT

Introduction: Stunting is malnutrition in children that reduces productivity and susceptibility to degenerative diseases. In 2021, West Java Province recorded the highest stunting prevalence on Java Island. We analyzed the distribution and risk factors for the prevalence of stunting in the West Java Province by considering spatial effects.

Methods: This study was ecologically designed using a spatial approach. Data were obtained from Studi Status Gizi Indonesia/Indonesian Nutritional Status Study and Pendataan Keluarga/Family Data Collection, which will be released in 2021 especially in West Java. Data analysis was conducted using a spatial error model (SEM) in GeoDa, and stunting prevalence mapping was performed using QGIS (Quantum geographic information system) 2.1.8 version.

Results: No spatial correlation was identified for stunting prevalence in West Java Province in 2021. However, a spatial correlation was observed in the residual value of the determinants of stunting prevalence. SEM analysis showed that the proportion of low-income families, inadequate drinking water sources, unmet needs, inactive Bina Keluarga Balita/Toddler Family Development, unwanted pregnancies, family planning, and limited access to internet-based information had a significant effect on stunting prevalence.

Conclusion: This study provides suggestions for increased focus on addressing environmental problems in rural areas and overcoming poverty in all districts/cities in West Java Province which was the province with the highest number of population.

Publisher: Fakultas Kesehatan Masyarakat Universitas Muhammadiyah Palu

INTRODUCTION

Stunting is one of the targets of the Sustainable Development Goals (SDGs) which includes the second Sustainable Development Goals, namely eliminating hunger and all forms of malnutrition by 2030 and achieving food security (1). Stunting in toddlers is a condition of malnutrition that can also have an impact on reducing productivity, increasing the risk of degenerative diseases, and decreasing intelligence (2).

Nutritional problems have multifactorial causes so their handling also requires the involvement of various cross-sectors in Indonesia. One of the obstacles in the implementation of policies to reduce nutritional problems consists of difficult coordination problems, strategies that are not strong enough, limited human resources, and lack of guaranteed budget availability (3). The results of other studies showed that many existing policies had been born as an effort to accelerate stunting control, but in reality, the stunting reduction rate is still far from the target. Besides, still, many people who do not have sufficient knowledge regarding stunting, both its effects and causes. Therefore, there is still a need for massive socialization regarding stunting, its causes, impacts, the urgency of handling it, and efforts to tackle stunting in the community. This is done as a form of preventive effort because stunting is an urgent problem that must be addressed by various parties or existing sectors (4).

Indonesia's commitment to reducing the prevalence of stunting is contained in Presidential Regulation Number 72 of 2021 which includes a national strategy to accelerate stunting reduction. The national strategy to accelerate the reduction in the prevalence of stunting aims to reduce the prevalence of stunting, improve the quality of preparation for family life, ensure fulfillment of nutritional intake, improve parenting, improve access and quality of health services, and increase access to drinking water and sanitation. Regulation of the National Population and Family Planning Agency Number 12 of 2021 concerning the National Action Plan to Accelerate the Reduction of Stunting in Indonesia for 2021-2024 contains the RAN PASTI policy (*Rencana Aksi Nasional Percepatan Penurunan Stunting*/ National Action Plan to Accelerate the Reduction of Stunting) which was prepared to implement the national strategy according to the president's direction to encourage and strengthen convergence between programs through a stunting-risk family approach. One of the targets in the national strategy to accelerate stunting prevalence reduction is for 100% of districts/cities to implement convergence action (5).

West Java is the largest population province in Indonesia so conditions in West Java can have a big impact on Indonesia. When compared with the 2019 SSGBI data, the prevalence of stunting in Indonesia in 2021 decreased by 3.3%, while the prevalence of stunting in West Java Province in 2021 only decreased by 1.7%. In addition, the prevalence of stunting in West Java ranks highest in Java 2021, which is 24.5% (6).

The West Java Provincial Health Office has collected routine data on the percentage of stunting prevalence since 2014 which shows disparities in the prevalence of stunting among toddlers in districts/cities of West Java Province in 2019-2020. This indicates that there are differences in interventions for each district/city so spatial analysis needs to be carried out to identify interventions based on area. In addition, several areas are priority stunting interventions in 2019 but the prevalence of stunting in 2020 does not show a decrease in stunting under five, namely Sumedang, Garut, and Cirebon Regencies (7).

Previous spatial analysis studies found that these three areas are stunting hotspots in West Java Province so the increase in stunting can be influenced by the high stunting rate in the surrounding areas (8,9). Therefore, areas that become hotspots need to receive more intervention as well as neighboring areas. The importance of spatial analysis on stunting, namely risk factors for stunting such as environmental factors and health programs (Toddler Family Development) are factors that are quite closely related to the location of a region (10).

The Regional Government of West Java Province is targeting the number of stunted toddlers in 2024 to remain at 14%. However, in 2021 there will still be four areas with a high prevalence of 30-40 percent, namely Tasikmalaya Regency, Bogor Regency, Cimahi City, and West Bandung Regency. Based on the Decree of the Minister of National Development Planning, the priority locations for stunting in West Java Province were 23 cities/regencies in 2021, then in 2022 all cities/regencies in West Java will become priority stunting locations (11), by adding four areas in 2022 namely Cirebon City, Sukabumi City, Banjar City, and Pangandaran Regency.

Various efforts to reduce the prevalence of stunting have been carried out. Global monitoring and evaluation have led to analyzing the situation in a geographical context (12). Spatial analysis of secondary data that identifies the determinants of child stunting must be carried out to enable appropriate interventions according to the local context (13).

Spatial analysis is important to identify areas and types of interventions that are important in stunting prevention efforts. Previous studies still lack of analysed the spatial effects on stunting prevalence based on the family indicators. Therefore, this study aims to analysed the determinants of stunting according to family data collection indicators as seen from spatial effects at the district/city level in West Java Province in 2021.

METHODS

Study Design and setting

This research was a quantitative study using an ecological study design (14). Ecological studies are used because the research data comes from reports that have been published or are open-access in nature, where several reports used in this study contain data on stunting and its determinants at the district/city level (aggregate data), especially in West Java. This study will explore spatial data to see the relationship between stunting prevalence areas and risk factors.

Source of data

Data was collected through SSGI (Studi Status Gizi Indonesia/Indonesian Nutritional Status Study) reports compiled by the Indonesian Ministry of Health and PK (*Pendataan Keluarga*/ Family Data Collection) reports were collected by BKKBN (15). The SSGI and PK report can be accessed online and free.

Data analysis

Mapping was carried out to describe the distribution of stunting prevalence in West Java Province in 2021 based on WHO categories using the QGIS (Quantum Geographic Information System) application. Then, spatial statistical analysis was carried out by entering spatial weights. The spatial weighting used is Queen Contiguity because regencies/cities in West Java Province are directly adjacent to each other and are not separated by sea. Therefore, Queen Contiguity weights are suitable for use in areas that are attached. Then in the multivariate analysis, spatial regression was carried out which is the development of multiple linear regression. Hence, OLS (Ordinary Least Square) modeling is carried out first to see if the classical regression assumptions have been fulfilled. Then perform the spatial modeling using SEM (Spatial Error Models) because the LM (Lagrange Multiplier) test meets the assumptions for SEM modeling. Various studies both in Indonesia and in other countries have also found that the error value or residual of the stunting prevalence model has a spatial effect so that the SEM modeling of stunting prevalence meets the assumptions (16–19). Several studies that have compared the SEM and SAR (Spatial Autoregressive) models also show that the SEM model is better at modeling the prevalence of stunting spatially (20,21).

SEM (Spatial Error Model)

The SEM is applied when the error value at a location is correlated with the error value at the surrounding locations (neighbors). In this model, the error at location i is a function of the error at location j, where j represents the neighboring locations of i. The function equation of the SEM model is as follows, assuming rho is zero and lambda is not equal to zero ($\rho = 0$, $\lambda \neq 0$):

$$\boldsymbol{y} = \boldsymbol{X\beta} + \mathrm{u}$$
$$\boldsymbol{u} = \lambda \boldsymbol{W u} + \varepsilon$$

where y = dependent variable, x = independent variable, $\boldsymbol{\beta}$ = coefficient of x, W = spatial weighting, λ = parameters for spatial residual lag, ε = error value in linear regression, and $\boldsymbol{u}$ = error value in spatial regression

Ethical approval

This study was approved by the Research and Community Engagement Ethical Committee of the Faculty of Public Health, Universitas Indonesia with number 176/UN2.F10.D11/PPM.00.02/2022.

RESULTS

Geographically, the West Java province is located between 5° 50' and 7° 50' South Latitude and 104° 48' to 108° 48' East Longitude. The Java Sea borders it to the north, the Central Java Province to the east, the Indian Ocean to the south, and Banten and DKI Jakarta to the west. The Province has an area of 35,377.76 square km and comprises 27 regencies/cities, including 18 regencies and nine cities (Table 1).

Table 1. Stunting Prevalence in Regencies/Cities of West Java Province in 2021

No	Regencies/Cities	Prevalence of stunting (%)
1	BOGOR	28.6
2	SUKABUMI	24.2
3	**CIANJUR**	**33.7**
4	**BANDUNG**	**31.1**
5	**GARUT**	**35.2**
6	TASIKMALAYA	24.4
7	CIAMIS	16.0
8	KUNINGAN	18.7
9	CIREBON	26.5
10	MAJALENGKA	23.0
11	SUMEDANG	22.0
12	INDRAMAYU	14.4
13	SUBANG	18.1
14	PURWAKARTA	20.6
15	KARAWANG	20.6
16	BEKASI	21.5
17	BANDUNG BARAT	29.6
18	PANGANDARAN	22.7
19	BOGOR CITY	16.9
20	SUKABUMI CITY	19.1
21	BANDUNG CITY	26.4
22	**CIREBON CITY**	**30.6**
23	**BEKASI CITY**	**13.8**
24	**DEPOK CITY**	**12.3**
25	CIMAHI CITY	19.9
26	TASIKMALAYA CITY	28.9
27	BANJAR CITY	23.9

The prevalence of stunting in West Java Province in 2021 was 24.5%. Four areas reported a high prevalence of stunting (> 30%): Garut (35.2%), Cianjur (33.7%), Bandung (31.1%), and Cirebon (30.6%). Other areas had moderate and low prevalence rates. However, only two regions achieved a stunting prevalence target of less than 14%: Depok City at 12.3% and Bekasi City at 13.8%.

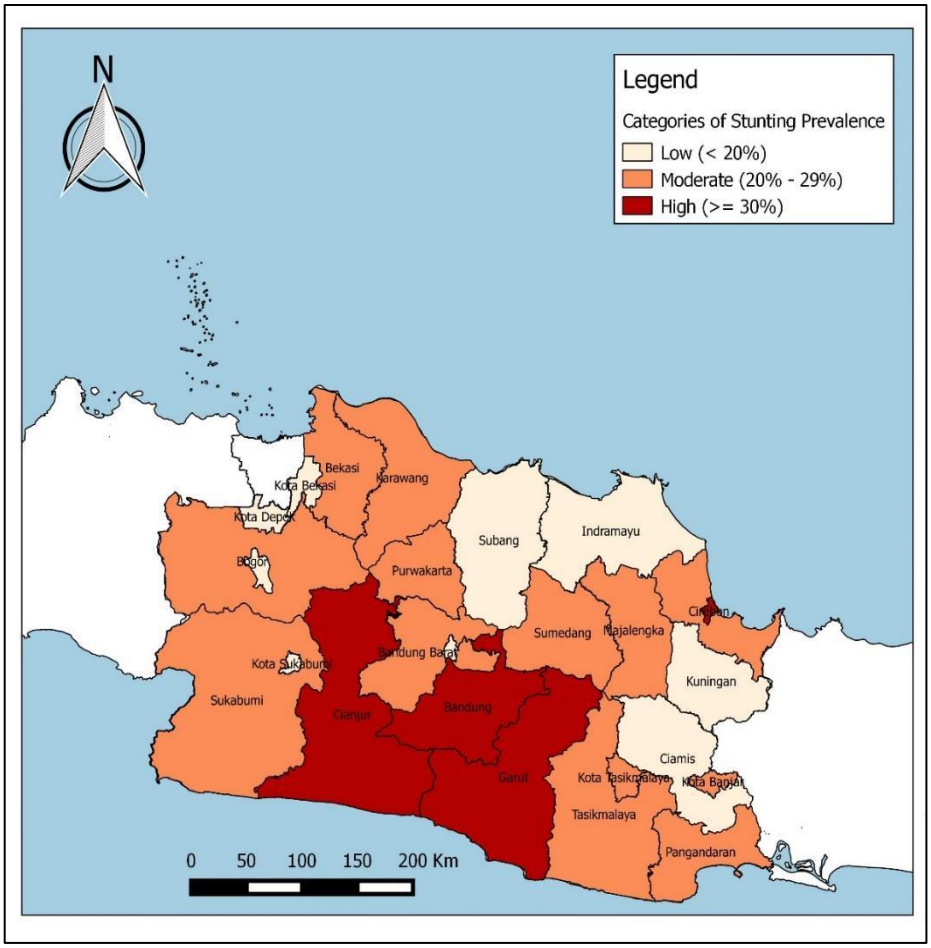

Figure 1. Map of Stunting Prevalence in West Java in 2021

Figure 1 shows the prevalence of stunting in West Java Province in 2021, illustrating the distribution pattern of stunting prevalence. The map shows that the prevalence of stunting was high in all four regions: Cianjur, Bandung, Garut, and Cirebon. Three of the four areas are close to each other on the southern side of West Java Province and are surrounded by regions with a moderate prevalence of stunting.

The results of the analysis showed that unwanted pregnancies, inadequate latrines, lack of health insurance, and mothers with education below junior high school remain significant challenges in the West Java Province compared to conditions at the national level.

Descriptive Statistical Description of Stunting Determinants in West Java

Table 2 shows the determinants of the prevalence of stunting in this study. These determinants were statistically described as the proportion of food that did not vary, pregnant women at risk, at-risk parity, unwanted pregnancies, inadequate latrines, drinking water sources, inadequate housing, unmet needs, the prevalence of family planning, inactive posyandu (Pos Pelayanan Terpadu/Integrated Service Center), inactive TFD, the proportion without health insurance, the proportion of low-income families, the proportion of mothers with less than junior high school education, and the proportion without Internet access.

Table 2. Descriptive Statistics on the Determinants of Stunting in West Java Province in 2021

Variables	Mean	Mean (national)	SD	Min	Max
The proportion of families who did not eat varied	1.90	3.70	.84	.60 (Sumedang)	3.33 (Cianjur)
The proportion of pregnant women at risk	17.51	17.54	2.54	12.91 (City of Bandung)	26.09 (City of Banjar)
The proportion of parity at risk	26.22	32.10	3.44	19.87 (City of Bekasi)	33.28 (Ciamis)
The proportion of unwanted pregnancies	**12.08**	**10.62**	1.86	9.38 (Pangandaran)	16.64 (City of Cirebon)
The proportion of latrines is not proper	**19.08**	**17.72**	13.90	1.23 (City of Bekasi)	49.82 (City of Sukabumi)
The proportion of drinking water sources is not feasible	6.25	14.09	6.36	.19 (City of Bekasi)	23.09 (Garut)
The proportion of occupancy is not feasible	34.17	38.27	16.54	9.71 (Bekasi)	59.27 (Tasikmalaya)
The proportion of unmet need	16.28	21.19	4.88	8.75 (Sumedang)	26.69 (City of Bekasi)
The prevalence of family planning user	59.32	52.63	7.15	45.27 (City of Bekasi)	72.73 (Sumedang)
The proportion of families not active in the Integrated Services Center	12.12	15.67	3.44	5.52 (City of Banjar)	17.61 (City of Bandung)
The proportion of inactive families for Toddler Family Development (TFD)/*Bina Keluarga Balita (BKB)*	57.11	57.14	11.78	29.74 (City of Banjar)	75.62 (Bogor)
The proportion does not have health insurance	**34.93**	**28.53**	12.58	11.13 (City of Cirebon)	54.80 (Tasikmalaya)
The proportion of low-income families	2.94	4.51	1.08	1.48 (City of Banjar)	4.92 (Karawang)
The proportion of mother's education below junior high school	**34.52**	**34.35**	13.38	10.72 (City of Bekasi)	57.81 (Cianjur)
The proportion of not having internet access	19.26	22.50	5.96	6.79 (City of Bekasi)	31.33 (Pangandaran)

SD: Standard Deviation; Min: The Lowest Score; Max: The Highest Score

Table 3 shows that the variables that significantly affected stunting in the West Java Province were unwanted pregnancies, inadequate drinking water sources, unmet needs, prevalence of family planning, families who were not active in TFD, low-income families, and no Internet access. The prevalence of stunting in West Java decreased by 2.985% as the proportion of unwanted pregnancies increased by 1%. The prevalence of stunting increased by 0.533% for every 1% increase in the proportion of unsuitable drinking water sources, 3.016% for every 1% increase in the proportion of unmet needs, 1.522% for every 1% increase in family planning prevalence, 0.316% for every 1% increase in the proportion of families not participating in the TFD, and 6.015% for every 1% increase in the proportion of low-income families. Conversely, stunting prevalence decreased by 0.956% for every 1% increase in the proportion of families without Internet access. The dominant variable in this study was the low-income family, with a coefficient of 6.0145. This indicates that if other variables were held constant, every 1% increase in low-income families would result in a 6.015% increase in stunting prevalence.

Table 3. Results of Spatial Regression Determinants of Stunting Prevalence in West Java Province in 2021

Variables	Coefficients	SE	t	*P*-value
The proportion of families not eating varied	0.688	1.1641	0.591	0.55448
The proportion of pregnant women at risk	0.145	0.2966	0.488	0.62558
The proportion of parity at risk	-0.189	0.1650	-1.149	0.25042
The proportion of unwanted pregnancies	-2.985	0.7054	-4.231	**0.00002****
The proportion of latrines is not proper	0.097	0.2524	0.384	0.70102
The proportion of drinking water sources is not feasible	0.553	0.2459	2.248	**0.02457***
The proportion of occupancy is not feasible	0.320	0.3204	-0.999	0.31792
The proportion of unmet need	3.016	0.9638	3.129	**0.00176***
The Prevalence of Family Planning User	1.522	0.6025	2.527	**0.01152***
The proportion of families not active in the Integrated Services Center	0.392	0.4964	-0.789	0.42959
The Proportion of inactive families for Toddler Family Development (TFD)/*Bina Keluarga Balita* (BKB)	0.316	0.0707	4.465	**0.00001****
The proportion does not have health insurance	0.178	0.1125	1.584	0.11314
The proportion of low-income families	**6.015**	1.8382	3.272	**0.00107***
The proportion of mother's education below junior high school	-0.199	0.2083	-0.954	0.34010
The proportion of not having internet access	-0.956	0.2586	-3.696	**0.00022****
LAMBDA value	1.405	0.0438	32.026	**0.00000**

Source: Data processed Notes: *$p < 0.05$ **$p < 0.001$
SE:Standard Error
t: Student's t-value

DISCUSSION

This study aims to analyze the risk factors for stunting in West Java by considering spatial effects so that it uses aggregate data at the district/city level. The results of this study showed that the percentage of unwanted pregnancies is related to stunting. Unwanted pregnancies can be overcome by using effective modern contraceptives and stakeholders efforts to ensure access to comprehensive sexuality education for young people in and out of school; quality contraceptive services and commodities, including for adolescents; as well as services that prevent and respond to gender-based violence and harmful practices such as child marriage (22,23). The results of previous studies found that children born from unwanted pregnancies show a much higher risk of stunting (24,25). The results of family data collection showed that Cirebon City, which is classified as having a high prevalence of stunting according to WHO, has the highest proportion of unwanted pregnancies in West Java Province. Cirebon City is an urban area where mothers who live in urban areas are more likely to have LBW babies and have many children (more than 2 children) which is the underlying cause of stunting (26,27).

In 2020, West Java Province has 5957 villages and 1662 villages are rural areas (28). The results show that four areas that have a high prevalence of stunting are Garut, Cianjur, Bandung, and Cirebon City, Garut, and Cianjur are districts with the largest number of villages in West Java Province. Likewise, Bandung still has several rural areas. different from Cirebon City, where all of its villages are urban areas (29).

This study provides information that a significant predictor of stunting prevalence was inadequate drinking water. This is in line with previous studies that used aggregate data that indicated that households with a proper source of drinking water affected the prevalence of stunting (30). Another study with individual analysis units also showed that children with protected drinking water sources were more likely to prevent stunting than children with access to unprotected drinking water sources (31,32). The results of this study also showed the three highest prevalence areas in West Java Province, namely Garut, Cianjur, and Bandung also have a high proportion of unsuitable drinking water sources when compared to the provincial average.

The results showed that unmet need has a significant effect on stunting. The results of this study are in line with previous spatial analysis studies which state that the prevalence of unmet need for family planning shows a significant relationship to the prevalence of stunting at the aggregate level. Women who live in areas with a prevalence

of unmet need above the average have a 12 percent higher chance of being stunted compared to women who live in areas with unmet need below the average (33), and another research also explained by Irma, et al that women between 20–29 years old, with educated husband and larger family size, who consider smaller family size as ideal, are more likely to have unmet need. The study funding emphasizes the importance of designing appropriate targeted interventions that are tailored to the local context and not apply a 'one-size-fits-all' policy (34). A qualitative study provides information on reasons for discontinuing the use of contraceptives including side effects, method failures, and failures in the health system (35).

The results show that BKB inactive families had a significant effect on the prevalence of stunting. Previous studies have found that families who have participated in BKB tend to have a higher level of participation in parenting and child development than families who have never participated in the BKB group (36). Several innovative stunting reduction programs. such as BKB EMAS (*Bina Keluarga Balita Eliminasi Masalah Anak Stunting*/ Toddler Family Development Elimination of Child Stunting Problems) can raise awareness. commitment. parenting practice. and nutritional adequacy of mother and child (37). This research showed that more than 50 percent of families in West Java Province are not active in BKB. The four regions with the highest prevalence of stunting in West Java Province, namely Garut, Cianjur, Bandung, and the City of Cirebon also showed a very low level of BKB participation when compared to the provincial average. Besides that, Cianjur and Bandung were areas that were attached or directly adjacent, so it is suspected that there were the same obstacles in accessing BKB services in these three regions.

The results of this study indicated that there was an effect of access to information via the internet on stunting. Another study that shows access to internet use is strongly related to stunting. where children from households that use the internet are less likely to be stunted (38). Other research has also found that children of mothers who are exposed to the mass media have a lower prevalence of stunting (39). Another study examines the negative impact of hoaxes on health information accessed via the internet, one of which is stunting (40). Previous studies have also found that female adolescents who have children tend to have access to both print and electronic media, but vice versa to exposure to family planning information (41). This means that the existing media is not maximized to educate the public regarding health information.

The results of this study provided information that the proportion of poverty in one region has an effect on the prevalence of stunting. This is in line with previous research which also found family income had a significant effect on stunting (42). The higher the poverty in an area, the higher the prevalence of stunting (43). Children whose family wealth index is low are more likely to experience malnutrition as a result of high levels of poverty and food insecurity. where children are not given enough food due to insufficient family income (44).

This study also showed that economic factors were the dominant variable affecting the prevalence of stunting. This is in line with previous studies using SEM (Structure Equation Model) analysis which found that economic factors were the dominant predictor variable influencing stunting (45). Previous studies have also found a significant relationship between poverty and health problems in children such as toddler diarrhea and stunting, and also in child health behavior such as basic immunization which were related to the early childhood parenting (14,46–48). However, other study also found that family income were not correlated with stunting (49).

CONCLUSIONS

The high prevalence of stunting in West Java Province is in four regions namely Garut, Bandung, Cianjur, and Cirebon City. The factors that influence stunting in West Java Province were poor families as the dominant factor, inadequate drinking water sources, unmet needs, inactive BKB (*Bina Keluarga Balita*/ Toddler Family Development), prevalence of family planning, unwanted pregnancies, and access to information via the internet.

The descriptive results support that environmental factors (especially inadequate drinking water sources) were still a problem in the Garut, Bandung, and Cianjur areas where these three areas are adjacent and have a higher percentage of rural areas than urban areas. While unwanted pregnancies, unmet needs, and contraception are still a problem in Cirebon City, which does not have a rural area. As for poverty, BKB is not active, and not accessing information via the internet was the problem in all areas, both those that do not have rural areas and areas that are mostly rural areas. Therefore, it is suggested that stakeholders pay more attention to environmental interventions, namely inadequate drinking water sources in rural areas and to overcome poverty in all areas, both rural and not because poverty is the most influential factor in stunting which is a chronic problem.

This study has limitations in involving risk factors that are not yet comprehensive because this study only used secondary data so the variables used were limited to the availability of secondary data. Therefore, we suggest that the variables used can be enriched, such as breastfeeding parenting patterns which are important factors in predicting the prevalence of stunting. In addition, breastfeeding parenting patterns can differ depending on location because they are related to factors of access to health services and integrated health posts.

AUTHOR'S CONTRIBUTION STATEMENT

YPD: Conceptualization, Analyzing data, Writing original article, and Review article; MH: Conceptualization and Supervision; MM: Writing original article and Review article; ME: Writing original article, Review article; NR: Review article; KM: Review Article.

CONFLICTS OF INTEREST

The authors declared that there is no conflict of interest in this study.

SOURCE OF FUNDING STATEMENTS

This study was supported by Universitas Airlangga.

ACKNOWLEDGMENTS

We gratefully acknowledge the National Population and Family Planning Board for providing the open-source data (*Pendataan Keluarga*/ Family Data Collection 2021) and the Ministry of Health for providing *Studi Status Gizi Indonesia*/ Indonesian Nutritional Status Study in 2021.

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