



## Mapping Stunting and Its Risk Factors in Sub-Districts Throughout Semarang City in 2022

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### Abstract

**Background:** The prevalence of stunting in Semarang City is the lowest compared to other districts/cities at 10.40%. Semarang City has not used a mapping system in handling stunting cases even though mapping stunting and its risk factors with GIS can help policymakers read areas that can be used as a basis for determining stunting-related programs because each region has different characteristics.

**Methods:** This study combined an ecological study and mapping approach with a cross-sectional design. This research was conducted in 2022. The population in this study were all 16 sub-districts in Semarang City. The sampling technique in this study was total sampling.

**Results:** The results showed that in the mapping of correlated risk factors, the variables of the percentage of households that have access to safe sanitation, percentage of households with shared toilet, percentage of LBW, percentage of pregnant women with parity >4, and percentage of pregnant women aged >35 years old were significantly associated with the prevalence of stunting.

**Conclusions:** Sub-districts that can be prioritized for stunting prevention, treatment, and screening are Semarang Selatan, Semarang Utara, Semarang Tengah, Semarang Timur, and Tugu.

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## INTRODUCTION

Stunting is a form of malnutrition due to chronic malnutrition that causes growth disorders in children (Ferreira, 2020). Stunting can also be referred to as linear growth retardation. Children are said to be stunted if their height for age is lower than children of the same age and is confirmed by a Z-score value  $< -2.0$  SD (Perumal et al., 2018). Stunting has been designated as one of the six global nutrition targets for 2025 by the World Health Assembly in 2012, that the stunting target is a 40% reduction in children under five years of age or around 128 million by 2025 (WHO, 2014). In 2012, the prevalence of stunting in children under five years of age globally reached 26.3% and decreased to 22.3% or around 148.1 million children under five years of age by 2022. Almost all stunted children under five live in Asia and Africa. The prevalence of stunting in the Southeast Asia region is the second highest compared to other subregions in Asia. In 2020, Indonesia ranked second in Southeast Asia with a high prevalence of stunting (Asian Development Bank (ADB), 2021).

Indonesia has a stunting reduction target set out in the RPJMN 2020-2024 where the national stunting prevalence is targeted to fall to 14% by 2024 (Kementerian Sekretariat Negara RI, 2023). According to the results of the Indonesian Nutrition Status Survey (SSGI) that in 2022, the prevalence of stunting in Indonesia was 21.6%, down 2.8% points compared to 24.4% in 2021. Despite the decrease, the prevalence of stunting in Indonesia is still higher than the WHO threshold of 20%. Central Java is included in the 5 provinces with the highest number of stunted toddlers in Indonesia. The five provinces are West Java, East Java, Central Java, Banten, and North Sumatra. Nationally, Central Java ranks 20th out of 34 Indonesian provinces in the prevalence of stunting (Kementrian Kesehatan RI, 2023).

Central Java is one of the priority loci for accelerating stunting reduction because it has not yet reached the national target (14%). In 2021, the prevalence of stunting in Central Java was 20.9%, and by 2022, it had only declined by 0.1% to 20.8% (SSGI, 2022). Semarang City is one of the cities with the lowest stunting prevalence among 35 other districts/cities in

Central Java Province.

Semarang City has been appointed as a pilot project for the zero stunting program in 2021 by BKKBN. Semarang City Government also targets zero stunting cases by 2024 (detikjateng, 2023). Based on the SSGI results, in 2021 the prevalence of stunting in Semarang City still reached 21.3% and decreased to 10.40% in 2022 (SSGI, 2022). Thus, stunting is a priority for Semarang City to achieve zero stunting.

There have been many studies that discuss the factors associated with the incidence of stunting in toddlers. Previous research using ecological studies and mapping of the incidence of stunting in Indonesia showed that the coverage of complete basic immunization, the percentage of pregnant women with TTD, the ratio of health centers per sub-district, and the percentage of poor people were significantly related to the incidence of stunting (Maria et al., 2020). Research in Klaten District also showed that the prevalence of LBW, prevalence of pregnant women with CED, average birth length, and prevalence of ANC coverage (K4) were significantly associated with prevalence of stunting (F. Astuti & Anggraini Ningrum, 2023).

Semarang City Health Office already has data related to stunting incidence and the risk factors that influence it, but the data is generally processed manually and presented in the form of tables and graphs. Mapping stunting and its risk factors with GIS can help policy makers read areas that can be used as a basis for determining programs related to stunting because each region has different characteristics in terms of socio-economics, demographics, and others that can be factors that cause stunting. The aim of this research is to see the distribution of stunting prevalence and its risk factors and map the factors associated with the prevalence of stunting based on Geographic Information System (GIS) in Sub-districts throughout Semarang City in 2022.

## METHODS

This research combined an ecological study and mapping approach with a cross-sectional design. This research was conducted in 2022. The population in this study was 16

sub-districts in Semarang City. The sampling technique in this study was a total sample. The data collection technique was obtained directly from Semarang City Health Office in the form of

routine nutrition reports in 2022 and Semarang City Health Office Dashboard Website Reports. The dependent and independent variables are presented in Table 1.

Table 1. Research Variable

Variable	Description	Unit
Y	Prevalence of Stunting	%
X <sub>1</sub>	Percentage of households that have access to proper sanitation	%
X <sub>2</sub>	Percentage of households that have access to safe sanitation	%
X <sub>3</sub>	Percentage of households with shared toilet	%
X <sub>4</sub>	Percentage of households that practice Handwashing with Soap (CTPS)	%
X <sub>5</sub>	Percentage of households that practice drinking water and food management (PAMMRT)	%
X <sub>6</sub>	Percentage of households that practice waste management (PSRT)	%
X <sub>7</sub>	Percentage of households that practice liquid waste management (PLCRT)	%
X <sub>8</sub>	Percentage of toddlers receiving vitamin A	%
X <sub>9</sub>	Percentage of infants receiving early initiation of breastfeeding (IMD)	%
X <sub>10</sub>	Percentage of infants receiving exclusive breastfeeding	%
X <sub>11</sub>	Percentage of pregnant women receiving Iron Folate Supplementation (TTD)	%
X <sub>12</sub>	Percentage of LBW (Low Birth Weight)	%
X <sub>13</sub>	Percentage of toddlers with diarrhea	%
X <sub>14</sub>	Percentage of ANC K4 coverage	%
X <sub>15</sub>	Percentage of pregnant women with CED (Chronic Energy Deficiency)	%
X <sub>16</sub>	Percentage of pregnant women with parity >4	%
X <sub>17</sub>	Percentage of pregnant women aged >35 years old	%
X <sub>18</sub>	Percentage of pregnant women aged <20 years old	%

Statistical analyses primarily performed in this study include univariate and bivariate analyses. Univariate analysis aims to obtain a descriptive picture of the studied variables. The bivariate analysis was used to see the correlation between the dependent variable and independent variables, that have a  $p\text{-value} < \alpha$ , with a significance level of 5%. The bivariate test used in this study was the rank-spearman test because the data were not normally distributed. Mapping analysis was used to determine the distribution of stunting prevalence and its risk factors per sub-district in Semarang City. Mapping analysis was conducted using the Quantum Geographic Information System (QGIS) mapping application. Categories on the mapping were classified with the help of QGIS software.

Data from the Semarang City Health Dashboard website was compiled by the Semarang City Health Office based on public health center, of which there are 37. Meanwhile, data from the routine nutrition report is data for one year, 2022, compiled by the Semarang

City Health Office by neighborhood, where Semarang City has 177 neighborhoods. The data were then converted into data per subdistrict, resulting in 16 data records/reports for each variable within one year. The flow of secondary data collection can be seen through the following link: <https://bit.ly/flowchartdatacollect>. The Health Research Ethics Commission of UNNES (Komisi Etik Penelitian Kesehatan UNNES) has given this study ethical clearance, along with the ethical numbers 114/KEPK/FK/KLE/2024.

**RESULTS AND DISCUSSIONS**

Table 2. Shows variables that are normally and abnormally distributed. Seven variables are normally distributed including the prevalence of stunting (Y), the percentage of households that have access to proper sanitation (X1), the percentage of households that have access to safe sanitation (X2), the percentage of pregnant women who received Iron Folate Supplementation (TTD) (X11), the percentage of LBW (X12), the percentage of women with

CED (X15), the percentage of pregnant women aged >35 years old (X17), and the percentage of pregnant women aged <20 years old (X18) with average values of 1.99%, 61.15%, 34.52%, 94.73%, 3.23%, 7.87%, 10.73%, and 3.70%. The seven variables have a less varied data distribution, this is because the standard deviation value is smaller than the average.

**Table 2.** Univariate analysis of the prevalence of stunting and the prevalence of risk factors for stunting among children under five years in Semarang City in 2022

Variable (Normally Distributed)	N	Size of Centering			Size of Spread	
		Mean	Median	Mode	Standard Deviation	Variants
Y	16	1.99	1.72	0.60	1.10	1.20
X <sub>1</sub>	16	61.15	63.56	15.30	26.38	695.71
X <sub>2</sub>	16	34.52	27.81	0.00	25.16	633.24
X <sub>11</sub>	16	94.73	95.19	100.00	4.48	20.11
X <sub>12</sub>	16	3.23	2.51	1.11	1.85	3.43
X <sub>15</sub>	16	7.87	7.99	3.96	2.48	6.16
X <sub>17</sub>	16	10.73	11.46	3.14	3.74	13.97
X <sub>18</sub>	16	3.70	3.31	1.42	1.70	2.88

Variable (Abnormally Distributed)	N	Size of Centering			Size of Spread	
		Median	Mode	Minimum	Maximum	Range
X <sub>3</sub>	16	0.14	0.00	0.00	26.71	26.71
X <sub>4</sub>	16	100.00	100.00	70.01	100.00	29.99
X <sub>5</sub>	16	99.56	100.00	59.99	100.00	40.01
X <sub>6</sub>	16	95.61	29.99	29.99	100.00	70.01
X <sub>7</sub>	16	95.02	100.00	39.98	100.00	60.02
X <sub>8</sub>	16	92.48	100.00	64.01	100.00	35.99
X <sub>9</sub>	16	82.27	100.00	30.31	100.00	69.69
X <sub>10</sub>	16	99.94	100.00	64.01	100.00	35.99
X <sub>13</sub>	16	27.02	17.55	17.55	57.53	39.98
X <sub>14</sub>	16	97.40	100.00	77.06	100.00	22.94
X <sub>16</sub>	16	1.39	0.31	0.31	7.68	7.37

The remaining variables are not normally distributed. The median percentage of household with toilet sharing (X3) is 0.14% with the lowest percentage of 0% and the highest at 26.71%. The median percentage of household that practice handwashing with shop (CTPS) (X4) is 100.00% with the lowest percentage being 70.01% and the highest at 100.00%. The median percentage of household that practice PAMMRT (X5) was 99.56% with the lowest percentage at 59.99% and the highest at 100.00%. The median percentage of household that practice waste management (PSRT) (X6) is 95.61% with the lowest percentage at 29.99% and the highest at 100.00%. The median percentage of households that practice liquid waste management (PLCRT) (X7) was 95.021% with the lowest percentage of 39.98% and the highest at 100.00%. The median percentage of toddlers receiving vitamin A (X8) is 92.48% with the lowest percentage at 64.01% and the

highest at 100.00%. The median percentage of infants receiving IMD (X9) was 82.27% with the lowest percentage at 30.31% and the highest at 100.00%. The median percentage of infants receiving exclusive breastfeeding (X10) is 99.94% with the lowest percentage at 64.01% and the highest at 100.00%. The median percentage of toddlers with diarrhea (X13) is 17.02% with the lowest percentage at 17.55% and the highest at 57.53%. The median percentage of ANC K4 coverage (X14) is 97.40% with the lowest percentage at 77.06% and the highest at 100.00%. The median percentage of pregnant women with parity >4 (X16) is 1.39% with the lowest percentage at 0.31% and the highest at 7.68%.

Table 3. shows that the variables are significantly associated with the prevalence of stunting are percentage of households with access to safe sanitation (X2) (p-value = 0.037), the percentage of households with shared

toilets (X3) (p-value = 0.008), the percentage of LBW (X12) (p-value = 0.012), the percentage of pregnant women with parity > 4 (X16) (p-value = 0.030), and the percentage of pregnant women over 35 (X17) (p-value = 0.027). The prevalence of stunting with percentage of households with access to safe sanitation (r = -0.525), percentage of pregnant women with parity >4 (r = -0.550), and percentage of pregnant women aged >35 years old (r = -0.559) showed a moderate correlation with a negative relationship direction. This means that the higher the percentage of households with access to safe sanitation, the percentage

of pregnant women with parity >4, and the percentage of pregnant women aged >35 years old, the lower the prevalence of stunting in Semarang City. There was a strong correlation with a positive direction between the percentage of households with shared toilets and the prevalence of stunting (r = 0.636). The prevalence of stunting with the percentage of LBW are similar (r = 0.624). This meaning that the higher the percentage of households with shared toilet and the higher the percentage of LBW, the higher the prevalence of stunting in Semarang City.

**Table 3.** Correlation analysis between the prevalence of stunting risk factors and the prevalence of stunting among children under five years in Semarang City in 2022

Variables	Prevalence of Stunting				Explanation
	N	P-value	R	r <sup>2</sup>	
X <sub>1</sub>	16	0.505	0.179	0.0320	Not Significant
X <sub>2</sub>	16	0.037*	-0.525	0.2756	Significant
X <sub>3</sub>	16	0.008*	0.636	0.4045	Significant
X <sub>4</sub>	16	0.417	-0.218	0.0475	Not Significant
X <sub>5</sub>	16	0.374	0.239	0.0571	Not Significant
X <sub>6</sub>	16	0.549	-0.162	0.0262	Not Significant
X <sub>7</sub>	16	0.292	-0.281	0.0790	Not Significant
X <sub>8</sub>	16	0.506	-0.179	0.0320	Not Significant
X <sub>9</sub>	16	0.220	0.324	0.1050	Not Significant
X <sub>10</sub>	16	0.434	0.210	0.0441	Not Significant
X <sub>11</sub>	16	0.362	0.244	0.0595	Not Significant
X <sub>12</sub>	16	0.012*	0.624	0.3894	Significant
X <sub>13</sub>	16	0.891	-0.038	0.0014	Not Significant
X <sub>14</sub>	16	0.304	-0.274	0.0751	Not Significant
X <sub>15</sub>	16	0.338	-0.256	0.0655	Not Significant
X <sub>16</sub>	16	0.030*	-0.550	0.3025	Significant
X <sub>17</sub>	16	0.027*	-0.559	0.3125	Significant
X <sub>18</sub>	16	0.253	-0.303	0.0918	Not Significant

The remaining variables were not significantly associated with the prevalence of stunting because the p-value >  $\alpha$ , including the percentage of households that have access to proper sanitation (X1) (p-value = 0.505), the percentage of households that practice handwashing with soap (CTPS) (X4) (p-value=0.417), the percentage of households that practice drinking water and food management (PAMMRT) (X5) (p-value = 0.374), the percentage of households that practice waste management (PSRT) (X6) (p-value = 0.549), the percentage of households that practice liquid waste management

(PLCRT) (X7) (p-value = 0.292), the percentage of toddlers receiving vitamin A (X8) (p-value = 0,506), the percentage of infants receiving IMD (X9) (p-value = 0.220), the percentage of infants receiving exclusive breastfeeding (X10) (p-value = 0.434), percentage of pregnant women receiving Iron Folate Supplementation (TTD) (X11) (p-value = 0.362), percentage of toddlers with diarrhea (X13) (p-value = 0.891), percentage of ANC K4 coverage (X14) (p-value = 0.304), percentage of pregnant women with CED (X15) (p-value = 0.338), and percentage of pregnant women aged < 20 years old (X18) (p-value = 0.253).

The coefficient of determination ( $r^2$ ) assesses the impact of the independent variable on the dependent variable. The percentage of households that have access to safe sanitation has a coefficient of determination of 0.2756 (27.56%), meaning that the prevalence of stunting of 27.56% can be determined by the percentage of households that have access to safe sanitation, the rest (72.44%) is determined by other factors/variables. The percentage of households with shared toilet has a coefficient of determination of 0,4045 (40.45%), meaning that the prevalence of stunting of 40.45% can be determined by the percentage of households with shared toilet, the rest (59.55%) is determined by other factors/variables. The percentage of LBW has a coefficient of determination of 0.3894 (38.94%), meaning that the prevalence of stunting of 38.94% can be determined by the percentage of LBW, the rest (61.06%) is determined by other factors/variables. The percentage of pregnant women parity >4 has a coefficient of determination of

0.3025 (30.25%), meaning that the prevalence of stunting of 30.25% can be determined by the percentage of pregnant women parity >4, the rest (69.75%) is determined by other factors/variables. The percentage of pregnant women aged >35 years old has a coefficient of determination of 0.3125 (31.25%), meaning that the prevalence of stunting of 31.25% can be determined by the percentage of pregnant women aged >35 years old, the rest (68.75%) is determined by other factors/variables.

Figure 1. shows the distribution map of stunting prevalence with five independent variables: percentage of households with access to safe sanitation (X2 ), percentage of households with shared toilet (X3), percentage of LBW (X12) percentage of pregnant women with parity >4 (X16), and percentage of pregnant women aged >35 years (X17). Risk factor mapping of stunting prevalence in Semarang City can be accessed at the following link: <https://bit.ly/mappingstuntingsemarang2022>.

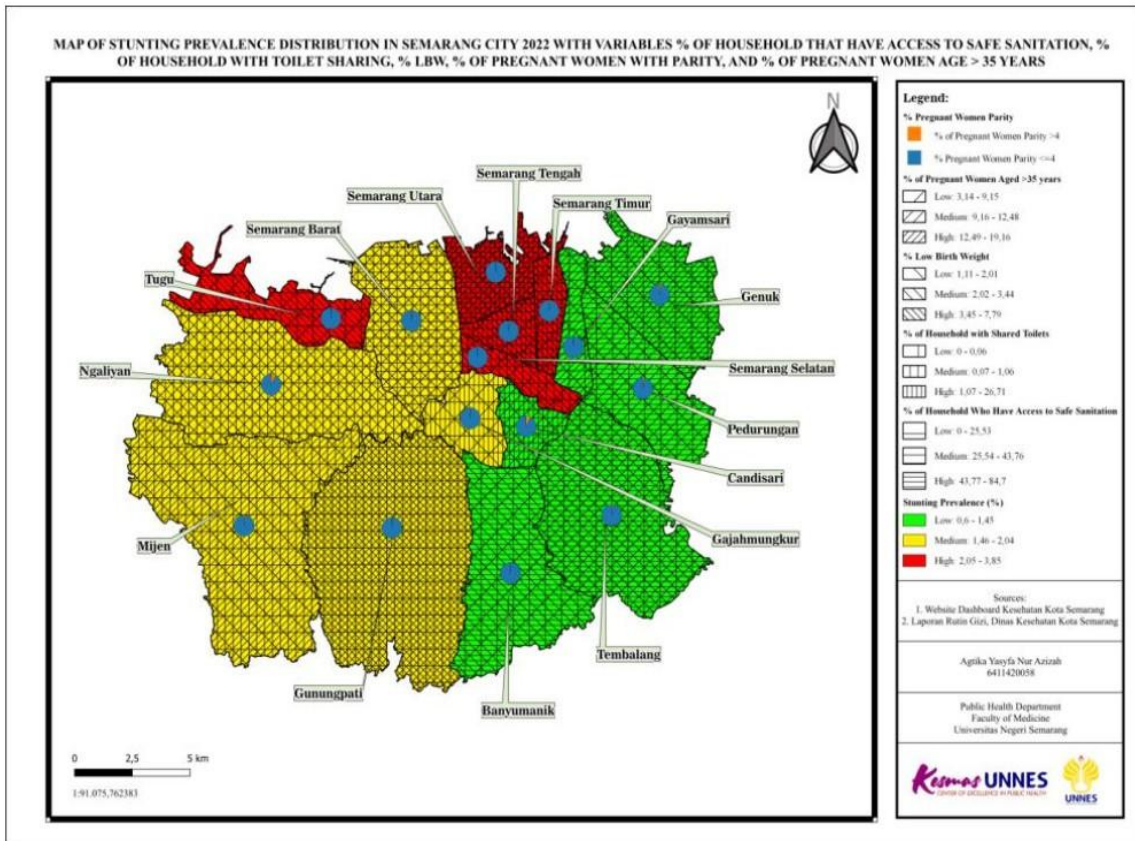


Figure 1. Overlay map of stunting prevalence, percentage of households that have access to safe sanitation, percentage of households with shared toilet, percentage of LBW, percentage of pregnant women with parity >4, and percentage of pregnant women aged >35 years in Semarang City in 2022.

Each variable is divided into three categories: low, medium, and high. Stunting prevalence is divided into three categories: low (0.6-1.45%) with a green symbol, medium (1.46-2.04) with a yellow symbol, and high (2.05-3.85) with a red symbol. A horizontal line represents the percentage of households that have access to safe sanitation; the tighter the line, the higher the percentage of households in that area. A vertical line represents the percentage of households with shared toilet; the tighter the line, the higher the percentage of households with shared toilet in that area. A left-sloping line represents the percentage of LBW babies; the tighter the line, the higher the percentage of LBW babies in that area. A right-sloping line represents the percentage of pregnant women aged >35 years old; the tighter the line, the higher the percentage of pregnant women aged >35 years in that area. The percentage of pregnant women with parity are divided into two categories; namely pregnant women with parity >4 and pregnant women with parity ≤4. This is depicted using a pie chart, pregnant women with parity >4 are given an orange symbol, and pregnant women with parity ≤4 are given a blue symbol.

The sub-districts with high stunting prevalence are Semarang Selatan, Semarang Utara, Semarang Tengah, Semarang Timur, and Tugu. Semarang Selatan sub-district had a high prevalence of stunting (3.85%), a low percentage of households that have access to safe sanitation (0%), a medium percentage of households with shared toilet (0.07%), a high percentage of LBW (7.79%), a percentage of pregnant women with parity >4 (0.31%), a percentage of pregnant women with parity ≤4 (99.69%), and a low percentage of pregnant women aged >35 years old (7.03%). Semarang Utara sub-district had a high prevalence of stunting at 3.64%, a high percentage of households that have access to safe sanitation (56.31%), a high percentage of households with shared toilet (5.31%), a medium percentage of LBW (2.34%), a percentage of pregnant women with parity >4 (0.97%), a percentage of pregnant women with parity ≤4 (99.03%), and a high percentage of pregnant women aged >35 years old (12.99%). Semarang Tengah sub-district had a high prevalence of stunting (3.80%), a medium percentage of

households that have access to safe sanitation (27.15%), a high percentage of households with shared toilet (26.71%), a high percentage of LBW (4.50%), a percentage of pregnant women with parity >4 (1.51%), a percentage of pregnant women with parity ≤4 (98.49%), and a low percentage of pregnant women aged >35 (7.79%). Semarang Timur sub-district had a high prevalence of stunting (3.33%), a medium percentage of households that have access to safe sanitation (25.76%), a high percentage of households with shared toilet (4.17%), a high percentage of LBW (5.09%), a percentage of pregnant women with parity >4 (1.68%), a percentage of pregnant women with parity ≤4 (98.32%), and a low percentage of pregnant women aged >35 years old (8.06%). Tugu sub-district had a high prevalence of stunting (2.19%), a low percentage of households that have access to safe sanitation (25.53%), a low percentage of households with shared toilet (0.06%), a high percentage of LBW (5.74%), a percentage of pregnant women with parity >4 (0.63%), a percentage of pregnant women with parity ≤4 (99.37%), and a low percentage of pregnant women aged >35 years old (6.62%).

Based on the statistical test results, there was no significant relationship between percentage of households that have access to proper sanitation (X1) with the prevalence of stunting. The results of this study are not in line with research (Y. R. Astuti, 2022) that access to proper sanitation variable affects stunting. This difference may occur because the coverage of Community-Based Total Sanitation (STBM) in Pillar 1 regarding access to proper sanitation in 2022 in Semarang City has reached 100%, meaning that households already have access to basic sanitation facilities with freedom from defecation in any place (Dinas Kesehatan Kota Semarang, 2022).

The variable percentage of households that have access to safe sanitation (X2) is significantly associated with the prevalence of stunting (Y) (p-value = 0.037). This result is in line with research (Hasanah & Susanti, 2018). This was consistent with a previous study conducted in Ethiopia, India, Peru, and Vietnam, where access to safe sanitation has significantly associated with the incidence of

stunting (Septiyani et al., 2021). However, this results differed from (Hasan et al., 2022). This difference may occur because access to safely managed sanitation in Semarang City is still low, reaching only 3.21%. This low achievement is because many households do not regularly desludge their septic tanks every 3 - 5 years. This is also supported by households' lack of knowledge about the impacts and consequences of not desludging septic tanks regularly (Dinas Kesehatan Kota Semarang, 2022).

The percentage of households with shared toilet (X3) is also significantly associated with the prevalence of stunting (Y) (p-value = 0.008). This is in line with research (Habimana & Biracyaza, 2019) and (Partap et al., 2019). Research in Ethiopia showed that children from households without access to hygienic private toilet and cleanable floors were 26% more likely to be stunted than children from households with access to private toilet (Haile et al., 2016). The usage of shared toilet is seen to be more difficult to maintain and unsanitary. According to (Jain et al., 2023), unsanitary conditions have the potential to expose users to fecal contamination, which is associated with a number of infectious disease such as helminth infections, which are transmitted through soil, schistosomiasis, trachoma, and diarrhea.

The variable percentage of households that practice Handwashing with Soap (CTPS) (X4) is not significantly associated with the prevalence of stunting. This study contradicts with research (Ahmadi et al., 2020), which claims that there was a significant relationship between the habit of washing hands with soap and stunting in children. This difference may occur because the percentage of households that practice Handwashing with Soap (CTPS) in Semarang City is already high at 95.92%. The behavior of people who have implemented CTPS behavior both before and after the activity can have a positive impact on children's nutritional status.

The variable percentage of households that practice drinking water and food management (PAMMRT) (X5) is not significantly associated with the prevalence of stunting. According to research, the study's findings are consistent with (Soeracmad et al., 2019). This may be due to the high percentage

of households in Semarang City that practice water and food management.

The variable percentage of households that practice waste management (PSRT) (X6) is not significantly associated with the prevalence of stunting. The results was consistent with a study by (Al-firdausyah et al., 2021). This can occur because household waste management in the area is good, so the possibility of stunting is getting smaller and the possibility of toddlers being infected with environmentally based diseases can be minimized.

The variable percentage of households practice liquid waste management (PLCRT) (X7) is not significantly associated with the prevalence of stunting. The results of this study are in consistent with a study by (Arirahmat, 2022) that found no relationship between the incidence of stunting and the safety of household wastewater. However, this outcome contradicts study (Arief Lopa et al., 2022). This difference may occur because household wastewater management in Semarang has reached 90.31%.

The variable percentage of toddlers receiving vitamin A (X8) is not significantly associated with the prevalence of stunting. The results of this study are in line with research (Bahmat et al., 2015) and (Sartika et al., 2021). However, the results of this study are not in line with research (Habir et al., 2023). This difference may occur because the achievement of vitamin A administration to children under five in Semarang City in 2022 was already high (96.6%). Vitamin A is an essential micronutrient that helps mucosal epithelial cells in the gastrointestinal tract retain their structure and function. A lack of vitamin A can hinder the production and release of growth hormones, which can cause somatic growth failure (Ssentongo et al., 2020).

The variable percentage of infants who received early breastfeeding initiation (IMD) (X9) is not significantly associated with the prevalence of stunting. The results of this study are in line with research by (Gupta & Santhya, 2020) and (Wiyono et al., 2023). However, the results of this study are not in line with research by (Sunartiningsih et al., 2021). This difference may occur because the percentage of newborns in Semarang City who received IMD was quite



high, at 83.5%.

The variable percentage of infants receiving exclusive breastfeeding (X10) is not significantly associated with the prevalence of stunting. The results of this study are in line with research (Hikmahrachim et al., 2019) and (Andrieni & Syahrizal, 2023). However, this result is not in line with (Muliani et al., 2023). This is because the achievement of exclusive breastfeeding for infants 0-6 months in Semarang City in 2022 has reached the target of the Semarang City Strategic Plan (65.60%). The achievement of exclusive breastfeeding in Semarang City in 2022 was 94.83%. The absence of an association between exclusive breastfeeding and exclusive breastfeeding may be because health workers in Semarang City are committed to assisting mothers who are having difficulty breastfeeding, increased knowledge of the benefits of breastmilk and proper breastfeeding practices, family support, and socialization of Semarang Mayor's Regulation No. 7 dated January 16, 2013, on the Program to Increase Exclusive Breastfeeding in Semarang City.

The variable percentage of pregnant women who received Iron Folate Supplementation (TTD) (X11) is not significantly associated with the prevalence of stunting. The results of this study are similar to other previous studies by (Habir et al., 2023) and (Wiyono et al., 2023). However, the results differed from (Maria et al., 2020) which states that there is a significant negative relationship between stunting and the percentage of pregnant women with Blood Addition Tablets. This difference may be due to the high percentage of pregnant women who received at least 90 tablets in Semarang City, which was 94.73%.

The variable percentage of LBW (Low Birth Weight) (X12) is significantly associated with the prevalence of stunting (Y). The results of this study are similar to other previous studies by (F. Astuti & Anggraini Ningrum, 2023), (Harahap et al., 2022), (Chaveepojnkamjorn et al., 2022), and (Podungge et al., 2021). A baby who weighs less than 2500 grams at birth, regardless of gestational age, is considered Low birth weight (LBW). Mothers who give birth to LBW babies, during pregnancy cause

intrauterine growth retardation (IUGR) and will continue until the next age after birth. Infants suffering from IUGR are characterized by malnutrition at birth. Most cases of IUGR in developing countries are caused by poor maternal nutritional status, low maternal weight, and inadequate fetal nutrition. (Aboagye et al., 2022). Most Intra-uterine Growth Retardation (IUGR) babies cannot catch up with their growth period to grow normally like other normal children. This lagging growth can cause stunting (Nurmalasari et al., 2019). In addition, children born small are more likely to be stunted than children of normal size, because birth size is connected with birth height, which predicts height in old age (Yang et al., 2018).

The variable percentage of toddlers with diarrhea (X13) is not significantly associated with the prevalence of stunting. The results of this study are in line with (Kasaye et al., 2019). This could be because diarrhea that does not occur for a long period will not have an impact on the growth and health of toddlers.

The variable percentage of ANC K4 coverage (X14) and the percentage of pregnant women who experience CED (Chronic Energy Deficiency) (X15) is not significantly associated with the prevalence of stunting. This was consistent with a previous study conducted in East Java Province (Mamlua'atul Mufidah & Basuki, 2023).

The variable percentage of pregnant women with parity >4 (X16) is significantly associated with the prevalence of stunting. This was consistent with a previous study conducted in Nairobi, African, and Mexico (Faye et al., 2019), (Seidu et al., 2023), (Campos et al., 2020). Many people with primiparous and multiparous parity have a lower risk of having stunted toddlers than mothers with grand multiparous parity (Rahayu et al., 2019). Poor health and suboptimal nutritional status in households with many children is due to inappropriate allocation of food and other resources. Large of households can lead to reduced food availability, accessibility, resource depletion, and competition for scarce resources. The presence of more than one child under five years old in a household can also result in suboptimal breastfeeding and complementary feeding practices (Titaley et al., 2019).

Age during pregnancy can be one of the factors associated with stunting. Based on the results of the study, the percentage of pregnant women aged >35 years (X17) is significantly associated with the prevalence of stunting (Y). The results of this study are similar to other previous studies by (Seidu et al., 2023), (Cetthakrikul et al., 2018), and (Fall et al., 2015). Older mothers (35 years old) have a greater chance of giving birth prematurely, hypertension, severe preeclampsia, and poor fetal growth. This is because, at the age of >35 years, there is a decrease in the absorption of nutrients due to the aging process and decreased reproduction, resulting in an imbalance in nutritional intake during pregnancy and increasing the risk of childbirth. The increased risk of preterm birth can reach 30%. This premature birth can cause stunting in children (Cavazos-Rehg et al., 2015). Pregnant women aged >35 years are more experienced in parenting practices, which may benefit their children's nutritional status, education, and height as adults (Fall et al., 2015).

This is contrary to the variable percentage of pregnant women aged <20 years old (X18) which is not significantly associated with the prevalence of stunting. This result is in accordance with research conducted by (Susyani et al., 2022). This can occur because young mothers may have good parenting. After all, in this technological era, young people are more adept at finding information than older people (Wanimbo & Wartiningsih, 2020).

## CONCLUSIONS

Based on the results of the study, five independent variables are significantly associated with the incidence of stunting in the Semarang City Region, namely the variable percentage of households with access to safe sanitation, percentage of households with shared latrines, percentage of LBW babies, percentage of pregnant women with parity >4, and percentage of pregnant women aged >35 years old. The Semarang City Health Office is expected to prioritize the handling and prevention of stunting with regional considerations such as sub-districts and can also prioritize in areas with high stunting clusters. The sub-districts that can be prioritized for stunting prevention,

handling, and screening are Semarang Selatan, Semarang Utara, Semarang Tengah, Semarang Timur, dan Tugu.

The weakness of this study is that it uses secondary data where not all risk factor variables associated with stunting are available such as social, economic, health insurance, and history of infectious diseases. In addition, the risk factors of hygiene and sanitation did not collect data by observation even though hygiene and sanitation need to be reviewed directly so that the results obtained are by environmental conditions in the field. This study also uses an ecological approach where the unit of analysis is regionally based so that the results cannot be generalized to individual units. Future researchers are expected to examine other risk factors related to stunting such as early marriage, the percentage of poor people, or use primary data sources to examine the education and employment status of parents of toddlers.

## REFERENCES

- Aboagye, R. G., Ahinkorah, B. O., Seidu, A. A., Frimpong, J. B., Archer, A. G., Adu, C., Hagan, J. E., Amu, H., & Yaya, S. (2022). Birth Weight and Nutritional Status of Children Under Five in sub-Saharan Africa. *PLoS ONE*, 17(6 June), 1–19. <https://doi.org/10.1371/journal.pone.0269279>
- Ahmadi, A., Sulistyorini, L., Azizah, R., & Otkarizal, H. (2020). Association Between Toilet Availability and Handwashing Habits and the Incidence of Stunting in Young Children in Tanjung Pinang City, Indonesia. *Malaysian Journal of Medicine and Health Sciences*, 16(2), 215–218.
- Al-firdausyah, K. S. P., Thaha, A. R., Dachlan, D. M., Virani, D., & Battung, S. M. (2021). Hubungan Sanitasi Lingkungan dan Riwayat Penyakit Infeksi dengan Kejadian Stunting pada Anak Usia 6-23 Bulan di Wilayah Kerja Puskesmas Patimpeng Kabupaten Bone. *JGMI: The Journal of Indonesian Community Nutrition*, 10(1), 52–66.
- Andrieni, J., & Syahrizal, S. (2023). Risk Factors for Stunting in Children Aged 24 – 60 Months in Cilegon City. *International Journal of Social Service and Research*, 3(7), 1806–1810. <https://doi.org/10.46799/ijssr.v3i7.424>
- Arief Lopa, A. F., Darmawansyih, D., Helvian, F. A., Suryaningsih, R., & Maidin, S. (2022). Hubungan Pelaksanaan Lima Pilar Sanitasi Total Berbasis Masyarakat dengan Kejadian

- Stunting. *UMI Medical Journal*, 7(1). <https://doi.org/10.33096/umj.v7i1.143>
- Arirahmat, F. (2022). The Relationship of 5 Pillars Community-Based Sanitation Implementation with Children Stunting at Tambora Health Center. *Lux Mensana*, 1(3), 184–192.
- Asian Development Bank (ADB). (2021). Prevalensi Stunting Balita Indonesia Tertinggi ke-2 di Asia Tenggara. Databoks. *Katadata*. Co.Id. <https://databoks.katadata.co.id/datapublish/2021/11/25/prevalensi-stunting-balita-indonesia-tertinggi-ke-2-di-asia-tenggara>
- Astuti, F., & Anggraini Ningrum, D. N. (2023). Pemetaan Kejadian Stunting pada Balita di Kabupaten Klaten Tahun 2021. *Care: Jurnal Ilmiah Ilmu Kesehatan* Vol, 11(3), 483–497. <https://jurnal.unitri.ac.id/index.php/care>
- Astuti, Y. R. (2022). Pengaruh Sanitasi dan Air Minum Terhadap Stunting di Papua dan Papua Barat. *Poltekita : Jurnal Ilmu Kesehatan*, 16(3), 261–267. <https://doi.org/10.33860/jik.v16i3.1470>
- Bahmat, D. O., Bahar, H., & Jus'at, I. (2015). *Hubungan Asupan Seng, Vitamin A, Zat Besi, dan Kejadian Stunting pada Balita (24-59) Bulan di Kepulauan Nusa Tenggara (RISKESDAS 2010)*. 1–14. <https://digilib.esaunggul.ac.id/public/UEU-Undergraduate-5792-Jurnal.pdf>
- Campos, A. P., Vilar-Compte, M., & Hawkins, S. S. (2020). Association Between Breastfeeding and Child Stunting in Mexico. *Annals of Global Health*, 86(1), 1–14. <https://doi.org/https://doi.org/10.5334/aogh.2836>
- Cavazos-Rehg, P. A., Krauss, M. J., Spitznagel, E. L., Bommarito, K., Madden, T., Olsen, M. A., Subramaniam, H., Peipert, J. F., & Bierut, L. J. (2015). Maternal Age and Risk of Labor and Delivery Complications. *Maternal and Child Health Journal*, 19(6), 1202–1211. <https://doi.org/10.1007/s10995-014-1624-7>
- Cetthakrikul, N., Topothai, C., Suphanchaimat, R., Tisayaticom, K., Limwattananon, S., & Tangcharoensathien, V. (2018). Childhood Stunting in Thailand: When Prolonged Breastfeeding Interacts with Household Poverty. *BMC Pediatrics*, 18(1), 1–9. <https://doi.org/10.1186/s12887-018-1375-5>
- Chaveepojnkamjorn, W., Songroop, S., Satitvipawee, P., Pitikultang, S., & Thiengwiboonwong, S. (2022). Effect of Low Birth Weight on Child Stunting among Adolescent Mothers. *Open Journal of Social Sciences*, 10(11), 177–191. <https://doi.org/10.4236/jss.2022.1011013>
- detikjateng. (2023). *Ada 1.267 Balita Stunting di Semarang, Pemkot Targetkan Nol di 2024*. *Www.Detik.Com*. <https://www.detik.com/jateng/berita/d-6776694/ada-1-267-balita-stunting-di-semarang-pemkot-targetkan-nol-di-2024>
- Dinas Kesehatan Kota Semarang. (2022). *Profil Kesehatan 2022 Dinas Kesehatan Kota Semarang*. [www.dinkes.semarangkota.go.id](http://www.dinkes.semarangkota.go.id)
- Fall, C. H. D., Sachdev, H. S., Osmond, C., Restrepo-Mendez, M. C., Victora, C., Martorell, R., Stein, A. D., Sinha, S., Tandon, N., Adair, L., Bas, I., Norris, S., Richter, L. M., Barros, F. C., Gigante, D., Hallal, P. C., Horta, B. L., Ramirez-Zea, M., Bhargava, S. K., ... Stein, A. (2015). Association Between Maternal Age at Childbirth and Child and Adult Outcomes in the Offspring: A Prospective Study in Five Low-Income and Middle-Income Countries (COHORTS Collaboration). *The Lancet Global Health*, 3(7), e366–e377. [https://doi.org/10.1016/S2214-109X\(15\)00038-8](https://doi.org/10.1016/S2214-109X(15)00038-8)
- Faye, C. M., Fonn, S., & Levin, J. (2019). Factors Associated with Recovery from Stunting Among Under-five Children in Two Nairobi Informal Settlements. *PLOS ONE*, 14(4), 1–17. <https://doi.org/10.1371/journal.pone.0215488>
- Ferreira, H. D. S. (2020). Anthropometric Assessment of Children's Nutritional Status: A New Approach Based on An Adaptation of Waterlow's Classification. *BMC Pediatrics*, 20(1), 1–11. <https://doi.org/10.1186/s12887-020-1940-6>
- Gupta, A. K., & Santhya, K. G. (2020). Proximal and Contextual Correlates of Childhood Stunting in India: A geo-spatial Analysis. *PLOS ONE*, 15. <https://doi.org/10.1371/journal.pone.0237661>
- Habimana, S., & Biracyaza, E. (2019). Risk Factors Of Stunting Among Children Under 5 Years Of Age In The Eastern And Western Provinces Of Rwanda: Analysis Of Rwanda Demographic And Health Survey 2014/2015. *Pediatric Health, Medicine and Therapeutics*, Volume 10, 115–130. <https://doi.org/10.2147/phmt.s222198>
- Habir, L. A., Kadir, S., & Boekoesoe, L. (2023). Risk Factors for Stunting In the First 1000 Days of Life. *International Journal of Medical Science and Clinical Research Studies*, 03(09), 2112–2116. <https://doi.org/10.47191/ijmscrs/v3-i9-55>
- Haile, D., Azage, M., Mola, T., & Rainey, R. (2016). Exploring Spatial Variations and Factors Associated with Childhood Stunting in

- Ethiopia: Spatial and Multilevel Analysis. *BMC Pediatrics*, 16(1), 1–14. <https://doi.org/10.1186/s12887-016-0587-9>
- Harahap, J., Amelia, R., Sri Andayani, L., Aprianti Lubis, N. D., & Aulia, D. (2022). Stunting Risk Factors For Children Aged 6 - 36 Months in The Region of Sambirejo Health Center, Langkat, North Sumatera. *KESANS: International Journal of Health and Science*, 2(3). <https://doi.org/https://doi.org/10.54543/kesans.v2i3.121>
- Hasan, A., Kadarusman, H., & Sutopo, A. (2022). Air Minum, Sanitasi, dan Hygiene sebagai Faktor Risiko Stunting di Wilayah Pedesaan. *Jurnal Kesehatan*, 13(2), 299–307. <https://doi.org/10.26630/jk.v13i2.2984>
- Hasanah, I., & Susanti, H. (2018). Does Water and Sanitation Effects on Children's Physical Development? Evidence from Indonesia Family Life Survey (IFLS) 2014. *E3S Web of Conferences*, 74. <https://doi.org/10.1051/e3sconf/20187409007>
- Hikmahrachim, H. G., Rohsiswatmo, R., & Ronoatmodjo, S. (2019). Efek ASI Eksklusif terhadap Stunting pada Anak Usia 6-59 bulan di Kabupaten Bogor tahun 2019. *Jurnal Epidemiologi Kesehatan Indonesia*, 3(2), 77–82. <https://doi.org/10.7454/epidkes.v3i2.3425>
- Jain, A., Pitchik, H. O., Harrison, C., Kim, R., & Subramanian, S. V. (2023). The Association between Anthropometric Failure and Toilet Types: A Cross-Sectional Study from India. *American Journal of Tropical Medicine and Hygiene*, 108(4), 811–819. <https://doi.org/10.4269/ajtmh.22-0138>
- Kasaye, H. K., Bobo, F. T., Yilma, M. T., & Woldie, M. (2019). Poor Nutrition for Under-five Children from Poor Households in Ethiopia: Evidence from 2016 Demographic and Health Survey. *PLoS ONE*, 14(12), 1–16. <https://doi.org/10.1371/journal.pone.0225996>
- Kementerian Sekretariat Negara RI, S. W. P. (2023). Hasil Perhitungan IKPS Nasional dan Provinsi tahun 2022. *Stunting.Go.Id.*
- Kementrian Kesehatan RI. (2023). *Angka Stunting Tahun 2022 Turun Menjadi 21,6 Persen*. <https://www.badankebijakan.kemkes.go.id/angka-stunting-tahun-2022-turun-menjadi-216-persen/>
- Mamlua'atul Mufidah, I., & Basuki, H. (2023). Analisis Regresi Linier Berganda untuk Mengetahui Faktor yang Mempengaruhi Kejadian Stunting di Jawa Timur. *Indonesian Nursing Journal of Education and Clinic*, 3(3), 51–59.
- Maria, I., Nurjannah, N., Mudatsir, M., Bakhtiar, B., & Usman, S. (2020). Analisis Determinan Stunting Menurut Wilayah Geografi di Indonesia Tahun 2018. *Majalah Kesehatan*, 7(4), 239–250. <https://doi.org/10.21776/ub.majalahkesehatan.2020.007.04.4>
- Muliani, M., Tondong, H. I., Lewa, A. F., Mutmainnah, M., Maineny, A., & Asrawaty, A. (2023). Determinants of Stunting in Children Aged 24-59 Months: A Case-Control Study. *International Journal of Public Health Science (IJPHS)*, 12(3), 1287–1294. <https://doi.org/10.11591/ijphs.v12i3.22313>
- Nurmalasari, Y., Alfarisi, R., & Kartika, S. (2019). The Correlation of the Low Birth Weight with Stunting Incident on Child Aged 6-59 Months in Lampung-Indonesia. *Malahayati International Journal of Nursing and Health Science*, 2(2), 47–51. <https://doi.org/10.33024/minh.v2i2.1525>
- Partap, U., Young, E. H., Allotey, P., Sandhu, M. S., & Reidpath, D. D. (2019). Characterisation and Correlates of Stunting Among Malaysian Children and Adolescents Aged 6-19 years. *Global Health, Epidemiology and Genomics*, 4(March). <https://doi.org/10.1017/ghg.2019.1>
- Perumal, N., Bassani, D. G., & Roth, D. E. (2018). Use and Misuse of Stunting as A Measure of Child Health. *The Journal of Nutrition*, 148(3), 311–315. <https://doi.org/10.1093/jn/nxx064>
- Podungge, Y., Yulianingsih, E., Porouw, H. S., Saraswati, E., Tompunuh, M. M., Claudia, J. G., Zakaria, R., & Labatjo, R. (2021). Determinant Factors of Stunting in Under-Five Children. *Open Access Macedonian Journal of Medical Sciences*, 9(B), 1717–1726. <https://doi.org/10.3889/oamjms.2021.6638>
- Rahayu, S., Djuhaeni, H., Nugraha, G. I., & Mulyo, G. (2019). Hubungan Pengetahuan, Sikap, Perilaku dan Karakteristik Ibu tentang ASI Eksklusif terhadap Status Gizi Bayi. *Action: Aceh Nutrition Journal*, 4(1), 28. <https://doi.org/10.30867/action.v4i1.149>
- Sartika, A. N., Khoirunnisa, M., Meiyetriani, E., Ermayani, E., Pramesti, I. L., & Nur Ananda, A. J. (2021). Prenatal and Postnatal Determinants of Stunting at Age 0–11 Months: A Cross- Sectional Study in Indonesia. *PLoS ONE*, 16(7), 1–14. <https://doi.org/10.1371/journal.pone.0254662>
- Seidu, A. A., Hagan Jnr, J. E., Budu, E., Aboagye, R. G., Okyere, J., Sakyi, B., Adu, C., & Ahinkorah, B. O. (2023). High-Risk Fertility Behaviour and Undernutrition among Children Under-Five

- in Sub-Saharan Africa: A Cross-Sectional Study. *BMJ Open*, 13(6), 1–9. <https://doi.org/10.1136/bmjopen-2022-066543>
- Septiyani, W., Sulistiyani, S., & Joko, T. (2021). Relationship of Access to Clean Water and Drinking Water Quality with Stunting in Toddlers 2010-2020. *International Journal of Health, Education and Social (IJHES)*, 4(1), 1–17. [www.ijhes.com](http://www.ijhes.com)
- Soeracmad, Y., Ikhtiar, M., & S Bintara, A. (2019). Hubungan Sanitasi Lingkungan Rumah Tangga Dengan Kejadian Stunting Pada Anak Balita Di Puskesmas Wonomulyo Kabupaten polewali Mandar Tahun 2019. *J-KESMAS: Jurnal Kesehatan Masyarakat*, 5(2). <https://doi.org/10.35329/jkesmas.v5i2.519>
- Ssentongo, P., Ba, D. M., Ssentongo, A. E., Fronterre, C., Whalen, A., Yang, Y., Ericson, J. E., & Chinchilli, V. M. (2020). Association of Vitamin A Deficiency with Early Childhood Stunting in Uganda: A Population Based Cross-sectional Study. *PLoS ONE*, 15(5), 1–16. <https://doi.org/10.1371/journal.pone.0233615>
- SSGI. (2022). *Hasil Survei Status Gizi Indonesia 2022*. In *Kementerian Kesehatan Republik Indonesia*. <https://promkes.kemkes.go.id/materi-hasil-survei-status-gizi-indonesia-ssgi-2022>
- Sunartiningsih, S., Fatoni, I., & Ningrum, N. M. (2021). Hubungan Inisiasi Menyusu Dini Dengan Kejadian Stunting Pada Balita Usia 12-24 Bulan. *Jurnal Kebidanan*, 10(2), 66–79. <https://doi.org/10.35874/jib.v10i2.786>
- Susyani, S., Febry, F., Margarethy, I., Sadiq, A., Sartono, S., Sari, I. P., & Ni'mah, T. (2022). Maternal Risk Factor on Incidence of Stunting in South Sumatera. *Open Access Macedonian Journal of Medical Sciences*, 10(E), 1599–1604. <https://doi.org/10.3889/oamjms.2022.10761>
- Titaley, C. R., Ariawan, I., Hapsari, D., Muasyaroh, A., & Dibley, M. J. (2019). Determinants of the Stunting of Children Under Two Years Old in Indonesia: A Multilevel Analysis of the 2013 Indonesia Basic Health Survey. *Nutrients*, 11(5). <https://doi.org/10.3390/nu11051106>
- Wanimbo, E., & Wartiningsih, M. (2020). Hubungan Karakteristik Ibu Dengan Kejadian Stunting Baduta (7-24 Bulan). *Jurnal Manajemen Kesehatan Yayasan RS.Dr. Soetomo*, 6(1), 83. <https://doi.org/10.29241/jmk.v6i1.300>
- WHO. (2014). *Global Nutrition Targets 2025: Policy Brief Series* (WHO/NMH/NHD/14.2). In [who.int](http://who.int). <https://doi.org/WHO/NMH/NHD/14.2>
- Wiyono, S., Rachmat, M., Marbun, R. M., Karina, M., Amrihati, E. T., & Miswaty, T. C. (2023). Role of Specific Interventions to Prevent Stunting in Children Under Five Years in the First Thousand Days of Life. *International Journal Of Community Medicine And Public Health*, 10(2), 569–574. <https://doi.org/https://dx.doi.org/10.18203/2394-6040.ijcmph20230206>
- Yang, Y. Y., Kaddu, G., Ngendahimana, D., Barkoukis, H., Freedman, D., Lubaale, Y. A. M., Mupere, E., & Bakaki, P. M. (2018). Trends and Determinants of stunting among Under-5s: Evidence from the 1995, 2001, 2006 and 2011 Uganda Demographic and Health Surveys. *Public Health Nutrition*, 21(16), 2915–2928. <https://doi.org/10.1017/S1368980018001982>