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Low Birth Weight, Child Gender, Number of Children, and Maternal Education as Risk Factors for Stunting in Palu City - Indonesia

Berat Lahir Rendah, Jenis Kelamin Anak, Jumlah Anak dan Pendidikan Ibu Sebagai Faktor Risiko Stunting di Kota Palu - Indonesia

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ABSTRACT

Background: The worldwide issue of stunting, which is prevalent up to 20.5%, can have an impact on future productivity and health
Objectives: to determine the risk factors and prevalence of stunting in children aged 0-23 months in Palu City, Indonesia.
Methods: This study used a cross-sectional analytical design in eight sub-districts of Palu City (January-June 2024), involving 516 pairs of mothers and children aged 0-23 months. Data were collected by 20 enumerators under the supervision of the Health Office, through interviews related to breastfeeding, complementary feeding, infection history, and other variables as well as anthropometric measurements using length Board Measuring calibrated tools. The data were analyzed using univariate analysis, chi-square test bivariate, and logistic regression. Data collection is carried out through the Cobocollect platform.
Results: Logistic regression analysis shows several important findings. Children of mothers with low education (OR=1.9), male children (OR=2.2), low birth weight (OR=3.1), and families with more than 3 children (OR=2.1) have a higher risk of stunting. Of the 516 children, 20.5% experienced stunting. These findings highlight the importance of maternal education, gender, birth weight, and number of children as risk factors for stunting, as well as their implications for health policies.
Conclusions: Factors such as low birth weight, male sex, the number of children over three, and mothers' education of less than 9 years significantly increased the risk of stunting in children. Targeted nutrition interventions for mothers with low education and families with many children are essential to reduce the prevalence of stunting in Palu City.

INTRODUCTION

Stunting is a global community problem[1–8]. The prevalence of stunting varies between countries and between regions is 7.9% to 57.4%[2]. Stunting prevalence is 21.6% in Indonesia[3], East Java Province - Indonesia 19.2%[8] and stunting prevalence is 12% in Malang - Indonesia[7]. Previous studies showed that the prevalence of clowns in Palu City, Central Sulawesi was 33.0%[9]. Previous studies have shown that the danger of stunting is low productivity when entering adulthood and increasing the risk of heart disease, diabetes, and hypertension[10]. Several studies show that the risk factors for stunting in children are low birth weight[11–13], sex[14–16], number of children in the family[16-17], and maternal education[9,19–23]. According to a prior study by Hafid et al. (2023)[24], in Palu City, stunting was linked to a history of childhood diseases (AOR = 4.1, 95% CI = 1.3–12.9), cesarean sections (AOR = 2.3, 95% CI = 1.3–4.2), maternal education (AOR = 2.3, 95% CI = 1.1–4.8), and maternal employment (AOR = 1.9, 95% CI = 1.1–3.4). Some factors that prevent stunting include the provision of early breastfeeding initiation[3], exclusive breastfeeding[25], higher paternal education[3], nutrition education, micronutrient intake, balanced consumption, multi-mineral micro supplementation, school children's supplementary food, calcium milk[3], maintaining personal hygiene and water availability[26], and the habits of nutritious food consumption such as fish[27].

To answer the need for efforts to reduce stunting in the city of Palu, a role of the Indonesian Ministry of Health Polytechnic educational institution is to provide recommendations in stunting prevention in Palu City and Central Sulawesi Province, support the implementation of health transformation of the Indonesian Ministry of

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Health, as well as the implementation of research and publication cooperation with Management and Science University of Malaysia is the background for the implementation of this research. The purpose of this study is to determine the prevalence and risk factors for stunting in children 0-23 months in Palu City – Indonesia.

METHODS

Design, Place, Time, and Sampling Method

The design of this study is an analysis with a cross-sectional approach, carried out in eight sub-districts in Palu City, Central Sulawesi, between January and June 2024. The study involved 516 pairs of mothers and children aged 0-23 months, with data collection carried out by 20 enumerators educated in Bachelor Diploma of Nutrition supervised by the Palu City Health Office. This process has been approved by the Health Research Ethics Commission of the Ministry of Health of Palu on February 14, 2023 Number: 0015/KEPK-KPK/1/2023, ensuring appropriate research ethics. In addition, training for enumerators will ensure the quality and consistency of the data collected, as well as the use of measurement tools that have been calibrated for the accuracy of anthropometric data.

Data Collection

Several systematic steps in the collection of research data are designed to ensure that the data obtained is accurate and in accordance with the research objectives. The first step is the identification of respondents, which is focused on the mother of a child aged 0-23 months in Palu City. The mothers were chosen as respondents because they had important information related to their characteristics and their toddlers, breastfeeding and complementary feeding patterns, and a history of infectious diseases in their toddlers. The second step is collecting data through direct interviews with mothers of toddlers. This interview aims to obtain information about the characteristics of toddlers and mothers, breastfeeding and complementary feeding practices, as well as a history of infectious illnesses that toddlers have had in the previous month, like diarrhea and ARI. The third step is anthropometric measurements using a calibrated Length Board Measuring tool to ensure accurate measurement results. Measurements were taken at least twice to ensure accuracy and reduce potential errors due to movement or positioning of the child. To ensure precise results, the position of both the subject and the enumerator was arranged as follows. Subject Position: The child was laid flat on the length board, with the head firmly positioned against the headboard and legs fully extended. Ensuring the legs are straight and the feet are flat against the footboard is essential for accurate results. Enumerator Position: The enumerator ensured a direct view of the measurements to avoid parallax errors. Their task was to keep the child steady, prevent movement, and ensure the measuring device was properly aligned. The length measurements were then compared to the WHO 2005 standards for height-for-age. These WHO 2005 standards provide internationally recognized growth curves used to assess a child's growth status based on age and length or height. Data is collected using the Kobocollect platform.

Data Analysis

The data analysis of this study included several stages to understand and explore the relationship between variables that have been collected from the respondents. Univariate analysis was used to describe the variables collected from the data, such as the characteristics of toddlers and mothers, breastfeeding patterns, type and frequency of complementary feeding, history of infectious diseases and nutritional status, and body length. All of these data were analyzed separately. The frequency distribution or distribution percentage of each variable was recorded and analyzed to see the overall characteristics of the sample. The association between the two variables in the study was ascertained through bivariate analysis. The logistic regression and chi square test are the statistical tests used in this investigation.

RESULTS AND DISCUSSIONS

Out of the total 516 children studied, 20.5% experienced stunting, while 79.5% had normal nutritional status. Children from North Palu have the highest stunting percentage (43.6%) compared to other sub-districts. This shows that North Palu faces greater child health problems than other regions. In contrast, children from Mantikulore (10.3%) and Ulujadi (13.3%) showed a lower percentage of stunting. Stunting is more common in children of mothers with less than nine years of education (31.7%) than in children of mothers with more than nine years of education (17.2%). This emphasizes the importance of maternal education in managing child nutrition. Boys experience stunting more often (26.5%) than girls (14.5%). These differences may indicate the presence of social or biological factors that affect nutritional status by gender. Compared to children of normal birth weight (17.6%), children of low birth weight had a significantly high frequency of stunting (39.7%). This demonstrates that one of the main risk factors for stunting is low birth weight.

The frequency of stunting was higher in children who did not receive early breastfeeding initiation (16.4%) than in those who did (21.7%). This shows that early initiation of breastfeeding can play an important role in stunting prevention. Children who received exclusive breastfeeding had a lower prevalence of stunting (19.7%) compared to children who did not receive exclusive breastfeeding (22.4%). This supports the importance of exclusive breastfeeding in supporting children's nutritional status. Almost all families have latrines (98.4%). However, latrine ownership did not show a direct significant relationship with the nutritional status of the children in this analysis, perhaps because most of the sample already had access to adequate latrines. Children who consumed unhealthy snacks showed a higher prevalence of stunting (25.0%) compared to children who did not consume unhealthy snacks (20.2%). This highlights the influence of an unhealthy diet on children's nutritional status. The prevalence of stunting was lower in children who received stimulation (19.7%) than in those who did not (22.8%). This demonstrates

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that stimulation also contributes to children's growth and development.

Table 1. Distribution of child nutrition status based on sub-district and health risk factors in Palu City

Variable	Nutritional Status				p-value
	Normal		Stunting		
	n (410)	% (79.5)	n (106)	% (20.5)	
Sub-District					
Mantikulore	78	89.7	9	10.3	<0.001*
West Palu	34	75.6	11	24.4	
South Palu	55	87.3	8	12.7	
East Palu	65	86.7	10	13.3	
North Palu	22	56.4	17	43.6	
Tatanga	39	72.2	15	27.8	
Tawaeli	45	64.3	25	35.7	
Ulujadi	72	86.7	11	13.3	
Mother's Age					
<20 years	20	69.0	9	31.0	0.150
≥20 years	390	80.1	97	19.9	
Mother's Education					
<9 years	82	68.3	38	31.7	0.001*
≥9 years	328	82.8	68	17.2	
Child's Gender					
Male	191	73.5	69	26.5	0.001*
Female	219	85.5	37	14.5	
Type of Delivery					
Normal	291	80.8	69	19.2	0.240
Cesarean Section	119	76.3	37	23.7	
Child's Age					
0-6 Months	93	81.6	21	18.4	0.015*
7-11 Months	135	86.0	22	14.0	
12-23 Months	182	74.3	63	25.7	
Source of Drinking Water					
Not Improved	0	0.0	1	100.0	0.049*
Improved	410	79.6	105	20.4	
Family Latrine Ownership					
No	8	100.0	0	0.0	0.147
Yes	402	79.1	106	20.9	
Early Breastfeeding Initiation					
No	143	83.6	28	16.4	0.158
Yes	264	78.3	73	21.7	
Birth Length					
<48 cm	109	71.7	43	28.3	0.005*
≥48 cm	301	82.7	63	17.3	
Low Birth Weight					
No	369	82.4	79	17.6	<0.001*
Yes	41	60.3	27	39.7	
Exclusive Breastfeeding					
Not exclusive	118	77.6	34	22.4	0.344
Exclusive	289	80.3	71	19.7	

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Variable	Nutritional Status				p-value
	Normal		Stunting		
	n (410)	% (79.5)	n (106)	% (20.5)	
Number of Children					
>3 Children	41	65.1	22	34.9	0.003*
≤3 Children	369	81.5	84	18.5	
Birth Interval					
≤3 years	282	81.3	65	18.7	0.250
>3 years	128	75.7	41	24.3	
Healthcare Facility Utilization					
No	30	93.8	2	6.3	0.031*
Yes	380	78.5	104	21.5	
Supplementary Feeding (PMT)					
No	402	80.2	99	19.8	0.011*
Yes	8	53.3	7	46.7	
Stimulation Provision					
No	105	77.2	31	22.8	0.449
Yes	305	80.3	75	19.7	
Family Smoking					
No	126	81.3	29	18.7	0.499
Yes	284	78.7	77	21.3	
History of Pneumonia					
No	404	79.4	105	20.6	0.680
Yes	6	85.7	1	14.3	
History of Respiratory Infections (ISPA)					
No	387	79.8	98	20.2	0.454
Yes	23	74.2	8	25.8	
History of Diarrhea					
No	382	79.7	97	20.3	0.555
Yes	28	75.7	9	24.3	
History of Measles					
No	397	79.9	100	20.1	0.225
Yes	13	68.4	6	31.6	
History of Parasitic Infections					
No	409	79.4	106	20.6	0.611
Yes	1	100.0	0	0.0	
Consumption of Unhealthy Snacks					
No	380	79.8	96	20.2	0.468
Yes	30	75.0	10	25.0	

*chi-square test, significant if p-value<0.05

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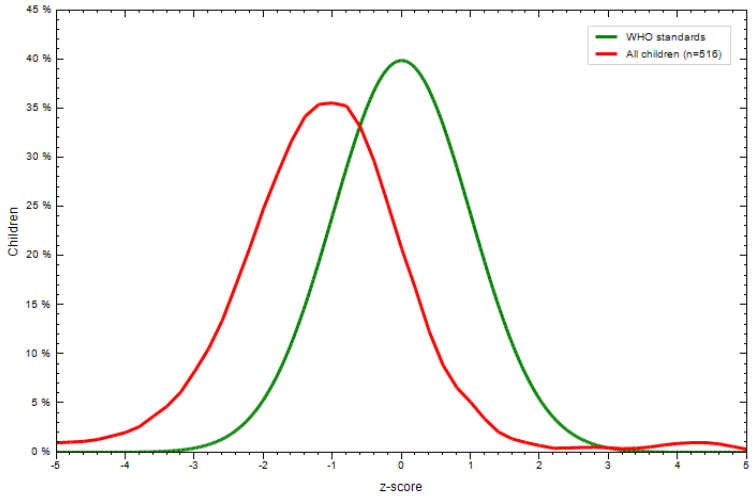

Images 1. Nutritional status curve of height for age children under two in Palu City compared to the standard curve of WHO Antro 2005

Based on bivariate analysis of the distribution of nutritional status by sub-district, children in North Palu showed the highest prevalence of stunting (43.6%) compared to other sub-districts. This indicates the presence of significant health problems in these areas that may require special intervention. Meanwhile in Mantikulore and Ulujadi, these two sub-districts show a lower prevalence of stunting, 10.3% and 13.3%, respectively. These differences may reflect local factors or the effectiveness of different health programs in the region. Children of mothers with less than 9 years of education have a higher prevalence of stunting (31.7%) compared to children of mothers with more than 9 years of education (17.2%). This suggests that maternal education plays an important role in preventing stunting, which is consistent with previous research that suggests that maternal education is closely related to children's health. Boys have a higher prevalence of stunting (26.5%) than girls (14.5%). This may indicate differences in biological or social factors that affect the health of boys compared to girls.

Stunting was significantly more common in low-birth-weight children (39.7%) than in normal-birth-weight children (17.6%). This demonstrates the significance of birth weight monitoring as a measure of a child's health and shows that low birth weight is a significant risk factor for stunting. Stunting was less common in children ages 0–6 months (18.4%) than in those ages 12–23 months (25.7%). This may indicate that the risk of stunting increases as the child ages, possibly as a result of a decrease in the quality or quantity of nutritional intake over time. Children who live at home with an unrepaired drinking water source show a very high prevalence of stunting (100%). However, only one child was identified in this category. these results may not be representative enough and require further confirmation.

All families without latrines showed normal nutritional status for all their children while among families with latrines the prevalence of stunting was 20.9%. This suggests that latrine ownership may not be a major factor in determining nutritional status, considering that almost all families have latrines. There was no significant difference in the prevalence of stunting between children who received early breastfeeding initiation and those who did not (16.4% vs. 21.7%. p-value=0.158). This may indicate that other factors, such as the duration or quality of breastfeeding, are more important than the timing of breastfeeding initiation. Children who received supplementary food (PMT) showed a much higher prevalence of stunting (46.7%) compared to those who did not receive (19.8%). These results may indicate that PMT administration may be inadequate or not implemented in a way that supports the child's growth effectively. Children who consumed unhealthy snacks had a slightly higher prevalence of stunting (25.0%) compared to those who did not consume unhealthy snacks (20.2%). Although these differences are not statistically significant. Unhealthy diets can still contribute to stunting risk.

Table 2. Risk factors affecting child stunting: results of logistics regression analysis in Palu City

Variables	p-value	AOR	95% CI	
			Lower	Upper
Low Birth Weight				
Yes	<0.001*	3.1	1.7	5.4
No		1.0		
Child's Gender				
Male	0.001*	2.2	1.4	3.5
Female		1.0		

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Variables	p-value	AOR	95% CI	
			Lower	Upper
Number of Children				
>3 Children	0.013*	2.1	1.2	3.9
≤3 Children		1.0		
Mother's Education				
<9 years	0.012*	1.9	1.1	3.1
≥9 years		1.0		

AOR: Adjusted Odds Ratio
*Regression logistic test, significant if p-value<0.05

Here are some intriguing conclusions and interpretations that can be made from the data based on the outcomes of logistic regression analysis. The first conclusion is concerned with educational background of mothers that impacts children's nutritional status. Children of mothers with less than 9 years of education have an odds ratio (OR) of 1.9 (95% CI = 1.1–3.1) on the risk of stunting. This indicates that children of mothers with lower levels of education are nearly twice as likely to suffer from stunting as children of mothers with higher levels of education. These findings highlight how crucial maternal education is in affecting the nutritional condition of children. Higher education is typically linked to improved access to health resources and a better understanding of diet and health. Second, the gender of the child may also impact the nutritional status. In terms of the risk of stunting, boys have an odds ratio of 2.2 (95% CI = 1.4–3.5). This indicates that boys are more likely than girls to experience stunting. These results are in line with a number of studies that demonstrate that the risk of stunting varies across the sexes either as a result of biological differences, variations in dietary habits, or sex-specific health treatment. Third, the nutritional status may also be affected by birth weight. Children with low birth weight had an Odds Ratio of 3.1 (95% CI = 1.7–5.4) to experience stunting compared to children born with normal weight. This confirms that low birth weight is a significant risk factor for stunting. Low birth weight often serves as an indicator of nutritional or health problems during pregnancy, which can affect the child's future growth.

The impact of family size on nutritional status, compared to children from households with three or fewer children, children from families with more than three children have an odds ratio of 2.1 (95% CI = 1.2–3.9) for stunting risk. This implies that a child's risk of stunting may rise with the number of family members. This element could have to do with how children share resources like food, care, and medical care, which can affect a child's nutritional state. This study sheds important light on the variables influencing stunting in particular and children's nutritional health in general. 79.5% of the 516 children in the study showed normal nutritional status, whereas 20.5% experienced stunting. These results have significant ramifications for nutrition treatments and public health strategies across various geographies.

The study highlights several significant benefits. ranging from an in-depth understanding of stunting risk factors to practical policy implications. One of the main benefits is the identification of strong risk factors, such as low birth weight, child gender, family size, and maternal education.

The study's findings also highlighted how crucial birth weight is a major risk factor. Compared to children born with normal weight, children with low birth weight have a 3.1 odds ratio for stunting. Low birth weight was linked to a >2-fold greater risk of stunting in children. according to a study by Vats et al. (2024) (combined OR = 2.32; 95% CI = 2.05–2.62)[12]. The study by Nasrul et al. (2024) showed that one of the significant determinants that contributed to the incidence of stunting in Sigi Regency was the low birth weight (AOR = 2.2. 95% CI = 1.1-4.5)[28]. The study in Asia showed a relatively higher risk than the study in Africa in a stratified analysis[12]. Children with low birth weight had a significantly higher risk of stunting than children with normal birth weight (44.3% vs. 33.8%). According to a study by Halli et al. (2022), the startling result was that BBLR infants had a 19% higher likelihood of producing a child with stunted growth (AOR = 1.19; 95% CI = 1.14. 1.24; p-value<0.001) than babies with a normal birth weight, even after controlling for other significant disrupting factors including BMI and ANC[29].

Three key stages necessitate the mother's best performance in order to avoid stunted child growth during the golden phase. Preconception, pregnancy, and the baby-toddler stage are some of these stages. Mothers play a number of roles, such as providing for the nutritional needs of mothers, fetuses, infants, and children, breastfeeding exclusively, and offering suitable supplemental foods, maximizing the environment for children's growth and development, maximizing family support, and avoiding various psychosocial factors that can impede children's development[30]. Indonesia has developed the Elsimil Application, which is an effort to prevent stunting by conducting health screening followed up with marriage and pregnancy readiness assistance for 31-year-old brides[31]. According to the Maulina et al. (2024) study, there are several maternal complications that may increase the risk of stunting. They are hepatitis B, preeclampsia, heart disease, human immunodeficiency virus/acquired immunodeficiency syndrome, the coronavirus disease 2019 (COVID-19) with pneumonia, and sexually transmitted infections[32]. According to the Sari et al. (2024) study, mothers of children with stunted growth had considerably lower serum lipase levels than mothers of children with normal

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growth. These low serum lipase levels could mean that a mother is not getting enough calcium for her unborn kid while she is pregnant, which would raise the infant's risk of growth problems[33].

Stunting risk, for instance, has been demonstrated to be significantly influenced by maternal education. The frequency of stunting is higher in children of mothers with less than nine years of education (31.7%) than in children of mothers with higher education backgrounds (17.2%). This highlights how important maternal education is for controlling the nutrition of children and highlights the necessity to work toward expanding mothers' access to education[34–37]. Relevant to the Nasrul et al Study (2024), which showed that a significant determinant contributing to the incidence of stunting in Sigi Regency was the education of mothers <9 years old (AOR = 2.3. 95% CI = 1.4-3.9)[28]. In terms of similarities, this study is consistent with previous studies that show that maternal education plays an important role in stunting prevention[38–41].

Previous research has also linked low birth weight to a high risk of stunting, which is in line with the findings of Nasrul et al. (2024) who found that a significant determinant contributing to the incidence of stunting in Sigi Regency was low birth weight (AOR = 2.2. 95% CI = 1.1-4.5)[28].

In addition, the difference in stunting prevalence between the sexes of children is also consistent with several studies that show differences in risk based on gender[42]. A study by Thurstan et al (2022) showed boys had a higher prevalence of malnutrition than girls[43]. The prevalence ratio of males to females, according to Garenne et al. (2021), was 1.18 on average for stunting (Z-height score to age < −2.0), 1.01 for wasting (Z-weight to height score < −2.0), 1.05 for underweight (Z-weight score to age < −2.0), and 1.29 for both stunting and wasting concurrently (Z-weight to height score and height to age < −2.0)[44]. The study of Thurstan et al (2023) showed that in the food intervention group the average daily weight gain was consistently lower in boys compared to girls[16].

However, the study found differences in the effectiveness of nutrition interventions. For example, supplemental feeding (PMT) showed a higher prevalence of stunting, different from studies showing the benefits of PMT. This may indicate a problem in the implementation or quality of the PMT provided. In addition, although early breastfeeding initiation is usually considered important, the results of this study did not show a significant difference in stunting prevalence between children who received early breastfeeding initiation and those who did not. This suggests that other factors, such as the duration or quality of breastfeeding, may play a greater role. This research opens up several opportunities for further development. One of them is longitudinal studies can be conducted to monitor changes in children's nutritional status over time and evaluate the impact of nutritional interventions. This will offer a more thorough understanding of the long-term effects of risk factors on stunting and the efficacy of therapies.

In addition, qualitative analyses that identify social and cultural factors that influence diet and health practices can provide deeper insights into the causes of stunting. This development can involve interviews and case studies in communities with high stunting prevalence. Evaluation of intervention programs is also very important to determine the most effective strategies and ensure adequate implementation.

The study has several strengths, including a wide range of variables and the use of clear data on stunting prevalence. Broad coverage allows for the identification of various risk factors and provides a comprehensive picture of the nutritional status of children in different sub-districts. On the other hand, this study also has some weaknesses. Determining cause and effect and tracking changes in nutritional status over time are limited by cross-sectional designs. Furthermore, some characteristics, such children with unimproved drinking water sources, may not be sufficiently represented by small sample numbers.

CONCLUSIONS

This study revealed several significant risk factors of stunting prevalence in Palu City, including low birth weight, child gender, number of children in the family, and maternal education. Children born to mothers with poor education (less than 9 years of compulsory education) have almost twice the risk of stunting compared to children from more educated mothers. Children with low birth weight also have a triple risk of stunting. These findings show the importance of more targeted nutrition interventions, especially in improving maternal education to reduce stunting rates in Palu City.

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CONFLICT OF INTEREST AND FUNDING DISCLOSURE

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AUTHOR CONTRIBUTIONS

FH: conceptualization, supervision, methodology, investigation, resources, writing–review and editing writing–original draft, writing–review and editing; NN: methodology, supervision; AA: methodology, supervision; KR: methodology and formal analysis; TR: methodology, supervision; SS: methodology, formal analysis, writing–original draft.

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