DETERMINANTS OF STUNTING INCIDENCE IN TODDLERS AGED 24-59 MONTHS: AN EPIDEMIOLOGICAL TRIANGLE ANALYSIS IN THE MAMBORO PUBLIC HEALTH CENTRE, PALU CITY, INDONESIA

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Abstract

Context/Background: Based on data from the Palu City Health Office, there is still an incidence of stunting above the WHO standard of 20%. The area is located in the mamboro sub-district 20.22% and Taipa sub-district 24.71. This study aims to determine the determinants of stunting in toddlers aged 24-59 months. Aims/Objectives: analyse the determinants that are risk factors for stunting in children under 24-59 months of age in terms of the epidemiological triangle (Host, Agent, Environment) in the Mamboro Puskesmas Working Area, Palu City. Methodology: This study used a case-control design. The total sample size was 171 consisting of 57 cases and 114 controls selected by simple random sampling method. Data analysis was conducted using Stata version 14. Results: Risk factors for stunting were immunisation history (OR 2.7) CI 95% (1.08-7.10), infectious diseases (OR 2.76) CI 95% (1.30-6.06), energy intake (OR 2.17) CI 95% (1.07-4.41), protein intake (OR 3.23) CI 95% (1.58-6.61), exclusive breastfeeding (OR 2.04) CI 95% (1.01-4.10), cigarette smoke exposure (OR 2,43) 95% CI (1.19-4.94), access to clean water (OR 3.14) 95% CI (1.53-6.42), household waste management (OR 2.95) 95% CI (1.45-6.02), Logistic regression analysis showed that protein intake (OR 3.23) was the main determinant of stunting in children aged 24-59 months. Conclusions: Risk factors for stunting include immunisation history, history of infectious disease, energy intake, protein intake, exclusive breastfeeding history, cigarette smoke exposure, access to clean water and household waste management

Key-words: Host, Agent, Environment, Risk factors, Stunting

Introduction

Optimal nutritional care is one of the important factors needed to produce good growth and development, especially in children. One form of malnutrition that is a global problem is stunting, because stunting has the highest prevalence compared to other nutritional problems.[1]

Stunting is an assessment of nutritional status based on the parameters of body length by age or height by age. The PB/U or TB /U index describes the growth of a child's body by age. This index can identify children who are short or very short.[2]

Based on data from UNICEF, WHO and *World Bank Group*, that *stunting* affects around 21,3%. This figure has increased by 22% in children under 5 years old. The highest prevalence of *stunting* is in the African region with 30,7%, followed by the Asian region with a prevalence of 21,8%. The prevalence of stunting in Indonesia is 31,8% with the second highest number of *stunting* cases.[3]

Based on data from Indonesian Nutrition Status Survey (SSGI) in 2021, the prevalence of stunting in Indonesia showed a rate of 24.4%, a decrease in prevalence of 2,8% from 2021, which was 21,6% in 2022. However, this figure is still above the WHO standard of 20%. The prevalence of stunting in Central Sulawesi Province is among the 10 provinces that have the highest prevalence of stunting with a prevalence of 21,6%, which is still very far from the expected target of 14% by 2024.[4]

Based on data from the Palu City Health Office, Palu City experienced an increase in stunting from 2021, which was 20,8%, increasing in 2022 to 24,7%. In Palu city there is still an incidence of *stunting* in toddlers above WHO standards, namely in the Mamboro sub-district as much as 20,22% and Taipa sub-district as much as 24,71%, the sub-district is in the working area of the Mamboro Health Centre.[5] Based on e-PPGBM data from Palu City, it shows that of the 124 children aged 0-59 months who experienced stunting at the Mamboro Health Center in 2023, 45.54% of them were cases of stunting that occurred in children aged 24-59 months.[6]

The epidemiological approach based on the theory of John Gordon and La Richt (1950) through the concept of the epidemiological triangle is a model that describes the interaction of three components that cause disease or problems that afflict the population, namely the *host*, *agent*, and *environment*. Host is a human or living being, such as LBW, history of hand washing with soap, history of immunisation. Agent is an element, living organism or infective germ that can cause a disease, such as an infectious disease. Agents can be in the form of biological elements, nutrition (food intake), exclusive breastfeeding, chemical elements and physical elements while

environmental factors are factors that come from outside the individual such as exposure to cigarette smoke, access to clean water, and household waste management.[7]

Currently, stunting prevention programmes that have been implemented in Indonesia have not been able to have an optimal impact on the prevalence of stunting. This is due to various obstacles found in the field. Many obstacles occur during the intervention process.

With cross-sectoral cooperation, it is hoped that it can reduce the stunting rate in Indonesia so that the Sustainable Development Goals (SDGs) target in 2025 can be achieved, namely a reduction in stunting rates by 14%. In addition, the Palu City Health Office has certainly implemented the 5 pillars in stunting prevention and has made every effort to control stunting rates. However, these efforts have not been able to control the prevalence of stunting in Palu City, especially in the Mamboro Health Centre Working Area.

Based on the above background, the researchers wanted to identify stunting problems based on the epidemiological triangle in the Mamboro Health Centre Working Area, Palu City.

Objectives:

Analyse the determinants that are risk factors for stunting in children under 24-59 months of age in terms of the epidemiological triangle (*Host, Agent, Environment*) in the Mamboro Puskesmas Working Area, Palu City.

METHODOLOGY:

Population and Sample

This study was conducted on 20 November - 23 December 2023 in Palu City, precisely in the work area of the Mamboro Puskesmas. This research is a type of analytical observational study with a case control study design. The population in this study were all toddlers aged 24-59 months whose data were recorded at the Mamboro Health Centre of Palu City who took measurements of PB/U or TB/U and were recorded in the e-PPGBM report of the Palu City Health Office in 2023.

The sample in this study were children aged 24-59 months in the working area of Puskesmas Mamboro. The minimum sample of cases was determined using the Leme-show formula. The sample size was 52 cases and 104 controls with a ratio of 1:2, to avoid drop out, 10% was added so that the total sampling was 171 respondents with a ratio of 57 cases and 114 controls.

The sampling technique used in this study is to use the *simple random sampling* technique method, namely the selection of samples from a population where each member of the population has the same opportunity.

Data collection:

Primary data was obtained by conducting interviews with respondents using questionnaires, observation sheets, and *2 x 24-hour Food Recall forms.* Secondary data was obtained from the recording and reporting of the Palu City Health Office and Mamboro Community Health Centre regarding *stunting* incidence reports.

Data Analysis:

In this study, the data collected were analysed using the *Stata version 14* program. Data analysis was carried out using univariate, bivariate, and multivariate analysis. The relationship and magnitude of risk factors between dependent and independent variables were analysed using the chi-square test. Multivariate analysis used was logistic regression test with 95% confidence level ($\alpha = 0.05$).

Ethics approval:

This study has obtained ethical approval with Number: 5743/UN4.14.1/TP.01.02/2023, issued by the Hasanuddin University research ethics commission.

RESULTS:

Table 1 Distribution of Respondents in the Mamboro Health Centre Working Area in 2023

Mother's characteristics	Case		Control	
	n=57	%	n=114	%
Mum's Age				
19-29 (Years)	26	45,61	60	52,63
30-40 (Years)	22	38,60	39	34,21
41-52 (Year)	9	15,79	15	13,16
Age at Marriage				
< 20 Years	28	49,12	30	26,32
≥ 20 Years	29	50,88	84	73,68
Education				
Not in School	0	0,00	1	0,88
Graduated from elementary/middle school	6	10,53	2	1,75
Graduated from junior high school / secondary school				
Graduated from high school/MA	9	15,79	14	12,28
Diploma completion				
Bachelor's degree	22	38,60	53	46,49
Master's degree				
	8	14,04	20	17,54
	12	21,05	23	20,18
	0	0,00	1	0,88
Jobs				
Not Working	31	54,39	46	40,35
PNS	3	5,26	7	6,14
Private Employee	2	3,51	10	8,77
Trade / Self-employed	6	10,53	33	28,95

Honorary	3	5,26	4	3,51
Farmers	9	15,79	5	4,39
More	3	5,26	9	7,89
Number of family members				
< 5 people	25	43,86	69	60,53
≥ 5 people	32	56,14	45	39,47

Primary Data Source, 2023

Table 1. show that the proportion of respondents in the age group 19-29 years had more non-stunted children (52,63%), while the age group 30-40 years and the age group 41-52 years had more stunted children (38,60%) and (15,79%). Respondents who married for the first time at the age of<20 years had more stunted children (49,12%) while respondents who married for the first time at the age of ≥ 20 years had more children who were not stunted (73,68%).

In education characteristics, most respondents who did not attend school had children who were not stunted (0,88%), respondents with the last education graduated from elementary scholl and graduated from junior high school had more stunted children (10,53%) and (15,79%) respectively. Then respondents with a high school education level had more children who were not stunted (46,49%). Furthermore, respondents with a diploma level of education had more children who were not stunted (17,54%), responden with a bachelor's level of education had more stunted children (21,05%) and respondents with a master's level of education had more children who were not stunted (0,88%).

Based on the type of work of the respondents, respondents who didi not work had more stunted children (54,39%), respondents who worked as civil servants, private employees, and traders had more children who were not stunted (6,14%), (8,77%) and (28,95%). Respondents who worked as honorary workers and farmers had more stunted children (5,26%) and (15,79%). Respondents who had other jobs had more children who were not stunted (7,89%).

Based on the number of family members, respondents with <5 family members had more children who were not stunted (60,53%) while respondents with ≥5 family members had more children who were stunted (56,14%).

Table 2. Distribution based on the characteristics of toddlers in the Mamboro Health Centre Working Area in 2023

Characteristics of Toddlers	Case		Control	
	n=57	%	n=114	%
Toddler Age				
24-35 Months	19	33,33	48	42,11
36-47 Months	21	36,84	31	27,19
48-59 Months	17	29,82	35	30,70
Gender				
Male	30	52,63	60	52,63
Women	27	47,37	54	47,37

Primary Data Source, 2023

Table 2 show the distribution of child characteristics by age group, showing that the age groups of 24-35 months (42,11%) and 48-59 months (30,70%) were more likely to be non-stunted, while the age group of 36-47 months was more likely to be stunted (36,84%). Based on gender, male and female children in the stunting and normal nutritional status groups had the sane number (53,63%) and (47,37%), respectively.

Table 3. Bivariate Analysis on the Incidence of Stunting

Variables	Case		Control		P	*Odds Ratio*
	n=57	%	n=114	%	*Value*	*(95% CI)*
LBW (*Host*)						
High Risk	4	7,02	12	10,53	0,45*	0,64
Low Risk	53	92,98	102	89,47		(0,14-2,25)
Immunisation History (*Host*)						
High Risk	14	24,56	12	10,53	0,01	2,76
Low Risk	43	75,44	102	89,47		(1,08-7,10)
HWWS behaviour (*Host*)						
High Risk	17	29,82	42	36,84	0,36*	0,72
Low Risk	40	70,18	72	63,16		(0,34-1,51)
History of Infectious Diseases (*Agent*)						
High Risk						
Low Risk	43	75,44	60	52,63	0,00	2,76
Energy Intake (*Agent*)	14	24,56	54	47,37		(1,30-6,06)
High Risk						
Low Risk	28	49,12	35	30,70	0,01	2,17
Protein Intake (*Agent*)	29	50,88	79	69,30		(1,07-4,41)
High Risk						
Low Risk	33	57,89	34	29,82	0,00	3,23
Exclusive breastfeeding history (*Agent*)	24	42,11	80	70,18		(1,58-6,61)
High Risk						
Low Risk						
Cigarette Smoke Exposure (*Environment)*	31	54,39	42	36,84	0,02	2,04

High Risk	26	45,61	72	63,16		(1,01-4,10)
Low Risk						
Clean Water Access (*Environment)*						
High Risk	29	50,88	34	29,82	0,00	2,43
Low Risk	28	49,12	80	70,18		(1,19-4,94)
Waste Management (*Environment)*						
High Risk						
Low Risk	32	56,14	33	28,95	0,00	3,14
	25	43,86	81	71,05		(1,53-6,42)
	34	59,65	38	33,33	0,00	2,95
	23	40,35	76	66,67		(1,45-6,02)

Primary Data Source, 2023

Table 3 on *host* factors shows that LBW is not a significant risk factor for stunting with an (OR) value of 0,64 and (CI) 95% of (0,14-2,25). Immunisation history is a significant risk factor for stunting with an OR of 2,76 and 95% CI of (1,08-7,10). Handwashing with soap behaviour was not a significant risk factor for stunting, with an OR of 0,72 and 95% CI of (0,34-1,51). *Agent* factors shows that infectious disease is a risk factor for stunting with an OR value of 2,76 and 95% CI of (1,30-6,06). Energy intake was a significant risk factor for stunting with an OR of 2,17 and 95% CI of (1,07-4,41). Protein intake had an OR of 3,23 and 95% CI of (1,58-6,61). Exclusive breastfeeding history was a significant risk factor for stunting with an OR value of 2,04 and 95% CI of (1,01-4,10). *Environmental* factors shows that cigarette smoke exposure is a significant risk factor for stunting with an OR of 2,43 and 95% CI of (1,19-4,94). Access to clean water is a significant risk factor for stunting with an *OR* of 3,14 and 95% CI of (1,53-6,42). Household waste management is a significant risk factor for stunting with an OR of 2,95 and 95% CI of (1,45-6,02).

Table 4 Multivariate Test Results of Risk Factors for Stunting Incidence

Variables	Coef	*p-value*	*Adjusted Odds Ratio (AOR)*	95% *CI*
Immunisation History	1,245987	0,011	3,47	1,32-9,12
Household Waste Management	0,9873447	0,009	2,68	1,39-6,19
Protein Intake	1,257814	0,001	3,51	1,66-7,41
Cigarette Smoke Exposure	0,8155518	0,036	2,26	1,05-4,83
Clean Water Access	1,080008	0,004	2,94	1,39-6,19
Constant	-2,681365	0,000	0,68	-3,50-(-1,86)

Table 4 shows that the results of the multivariate test. The variables used as candidates in this logistic regression test are variables that in the bivariate analysis have a p value <0,25, consisting of eight variables, namely immunisation history, infectious diseases, energy intake, protein intake, exclusive breastfeeding, cigarette smoke exposure, access to clean water and household waste management meet the requirements to continue multivariate analysis. Based on the OR value, it shows that protein intake is the main determinant of stunting in children aged 24-59 months with an OR value of 3,51 and a CI value of 1,66-7,41.

DISCUSSION:

The results showed that LBW history was not a significant risk factor for stunting. This is because children who have a history of LBW get more attention from health workers regarding information on mandatory immunization and exclusive breastfeeding, and if accompanied by good food intake during their growth period. Birth weight is related to child growth, but as long as the child gets adequate intake and maintains their health, then the condition of body length can be pursued with growth as they get older. This because infants who experience LBW can experience normal growth and nutritional status as infants who do not experience LBW.

The results of this study are not in line with research Sholihah which where LBW has a 4,333 times greater chance of experiencing *stunting* cases compared to toddlers who are not LBW.[8] But this study is in line with research Trisiswati, et al's conducted by obtained a p-value of 0,144, OR 1,6 with 5% CI (0,848 – 3,019).[9]

LBW infants are more likely to grow short compared to LBW children. LBW children indicate a lack of nutrition in the mother's care during pregnancy and lifestyle so that fetal growth is not optimal and also very early marriage which results in babies born having low LBW.[10]

The results showed that immunisation history was a risk factor for stunting because there were still many children who did not receive complete immunisation in the case group, namely 24.56%.

This research is in line with research conducted by Wanda, et al's obtained (*p=0*,000) with *OR* and *CI* (4,958 (2,074-11,852) There is an association between the history of basic immunisation status on the incidence of *stunting* toddlers.[11] This research is also supported by research conducted by togodly Where p-value 0,033 OR 1.416 CI 95% 1,029-1,948 which means that there is a significant relationship between the completeness of basic vaccinations and the incidence of stunting.[12]

Timing of vaccine administration may reduce the risk of stunting if given on time and may increase the risk if given late. This may be due to the anti-inflammatory profile of the neonatal immune system changing to a pro-inflammatory profile as infants grow into children.[13]

The results showed that handwashing with soap behaviour was not a significant risk factor for stunting. This is due to the lack of awareness of mothers to apply handwashing with soap behaviour to their toddlers, so that toddlers are more easily exposed to germs because their hands are not clean.

The results of this study are not in line with research Katharina, et al's where the P-value is 0,672 (OR = 1,73 CI 95%; 0,42-7,087) which means that there is no influence between hand washing with soap behaviour on the incidence of stunting.[14] This study is also supported by research Togodly where hand washing behaviour and stunting had a value (OR) = 0,43; 95% CI: 0,33- 0,57, p < 0,001).[15]

The habit of washing hands does not just arise, but must be familiarised from childhood. Children are agents of change to provide *education* for themselves and their environment while teaching a clean and healthy lifestyle.[16]

The results showed that a history of infectious disease is a significant risk factor for the incidence of stunting in toddlers, this is because many toddlers suffer from repeated infectious diseases. As in six months usually toddlers experience infectious diseases> 2 times.

The results of the study are not in line with research Maulidah, et al's which obtained a value of p=0,010 with an OR of 0,29 and 95% CI 0,11-0,76 indicating that there was no relationship between the history of chronic infectious diseases and the incidence of stunting in toddlers.[17] Research supported by Hidayani, where the ρ-value is 0,030 which means the ρ-value <0,05 so it can be concluded that there is a significant relationship between the history of infectious diseases and stunting with an OR of 3,067.[18]

Children with infectious diseases have poor appetite and digestive problems, resulting in malnutrition. In addition, infections that children receive such as diarrhoea and ARI will increase the potential for stunting due to a reduction in nutrients when children are sick.[19]

The results of this study indicate that energy intake is a significant risk factor for stunting. This is because respondents rarely give their children snacks that are high in energy sources. The results of this study are in line with research Putri there is a significant relationship between the level of energy adequacy and the incidence of stunting with a *p-value* = 0,000 *OR 1,91 CI 95%; 1,440-2,496.*[20] The results of this study are also in line with Yuliantini there is a relationship between energy intake and the incidence of stunting in toddlers (p < 0,05), toddlers with low energy adequacy levels have a 9,5 times higher risk of being stunted than toddlers with adequate energy levels.[21]

Energy intake that is less than the adequate energy needed, the energy reserves contained in the body stored in the muscles will be used. This lack of intake if it continues for a long period of time will result in weight and other nutritional deficiencies.[22]

The results showed that protein intake is a significant factor in the incidence of stunting. Based on the results of multivariate analysis, it was found that protein intake is the main determinant of stunting in children under 24-59 months of age. This is because the family's daily diet is not in accordance with good nutritional care, especially consuming additional food.

This is in line with research Putri obtained the results of a significant relationship between the level of protein adequacy and the incidence of stunting in toddlers with a p-value = 0,000. *(OR 1,14 CI 95%; 0,765-1,715).*[23] *The results of this study are also in line with* research (Sulistianingsih & Yanti, 2016), where there is a relationship between protein intake and the incidence osf stunting in toddlers.Where there is a relationship between protein intake and the incidence of *stunting* in toddlers. Based on the OR value of 10,00, the *ρ-value is* 0.002 and *CI is* 2,262 - 44,203.[24]

Protein intake is one of the macronutrients needed by toddlers in the growth process. Protein plays a role in the formation of new tissues and body development. Lack of protein nutrient intake can result in chronic energy deficiency, which will affect growth linearly over a long period of time.[25]

The results of this study indicate that exclusive breastfeeding history is a significant risk factor for stunting. This is because most babies are not exclusively breastfed when they are newborns because the milk has not been released so they replace it with formula milk.

This is in line with research nurin that obtained a value (OR = 8,516; 95% CI: 2,953-24,561). Which shows that toddlers who do not get exclusive breastfeeding will have an opportunity as much as 8,516 times for *stunting*.[26] But this study is not in line with research Campos that infants who are not exclusively breastfed have an OR value of 0,33; 95% CI (0,13-0,81).[27] However, another study also explained that there was no association between exclusive breastfeeding and the incidence of stunting with a value of (AOR = 0,82, 95% CI (0,52-1,30)).[28]

Breastfeeding in the first months of life is a very important factor for the baby's life. Breast milk is optimised to meet the needs of the infant through its amino acid composition, fatty acids, vitamins, immune factors and energy content. When breastfeeding is discontinued and the infant is given complementary foods, the infant may receive less energy- and nutrient-dense foods.[29]

The results of this study indicate that cigarette smoke exposure is a significant risk factor for stunting. This is because there are still many respondents' parents who smoke in the house, so their children are exposed to cigarette smoke.

The results of this study are in line with research conducted Cao, et al's obtained a value of (OR = 1,520, 95% CI; 1,318- 1,753].[30] This research is also supported by Muchlis, that the cause of stunting in children under 5 years old is the presence of family members who smoke, with a value of (AOR 1,8; 95% CI 1,281-4,641).[31]

Prolonged exposure to cigarette smoke leads to increased nicotine levels in the body. Nicotine can reduce 30-40% of oxygen supply and interfere with the absorption of nutrients such as calcium, minerals, and vitamin C which are important for children's height growth.[32]

The results of this study indicate that access to clean water is a significant risk factor for stunting. This is because there are still many people whose clean water facilities do not meet health requirements which can be seen from water reservoirs that do not have a lid.

The results of this study are in line with research conducted Asmirin where the value (OR: 7,178 95% CI (1,992-25,866)).[33]

This is also supported by research Nisa, et al's that there is a significant relationship between sanitation of clean water supply and the incidence of stunting, the p-value in this study is 0,047 ($p \leq 0,05$). The OR value in this study was 2,705 with (CI 95% 1,103-6,634).[34]

Water is very easily contaminated with bacteria if the management is not good such as not cooking until boiling and the container used to store drinking water is not clean and does not have a lid. If consumed, the water can cause digestive system disorders such as diarrhoea.[35]

The results of this study indicate that household waste management is a significant risk factor for stunting. This is because household waste management in some respondents already have landfills, it's just that there are still many people who don't close their trash cans tightly, so that the garbage is accessible to vectors.

The results of this study are in line with research Mayasari, et al's that there is a relationship between waste management and the incidence of stunting with a p value (0,026) (OR = 5,935; 95% CI = 1,279-27,51).[36] The results of this study are also supported by research Jasrida, et al's, that household waste management has a value of (OR = 11,91; 95% CI = 5,53 to 25,58; p <0,001 related to the incidence of stunting.[37]

Household waste safety behaviour is manifested through the activities of sorting household waste according to its type and disposing of household waste regularly, reducing, reusing, reprocessing, providing and maintaining household waste disposal facilities outside the home.[38]

Conclusion:

Risk factors for stunting in children aged 24-59 are immunisation history, history of infectious disease, energy intake, protein intake, exclusive breastfeeding history, cigarette smoke exposure, access to clean water and household waste management. Protein intake is the main determinant of stunting in children aged 24-25 months.

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