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# Analysis of Stunting Risk Factors in Toddlers

## *Analisis Faktor Risiko Stunting pada Balita*

**Atikah Adyas[*1], Sri Rejeki Wuwuh Handayani[2], Achmad Djamil[3], Ai Kustiani[4], Nathasa Khalida Dalimunthe[5]**
[1,3,4,5]Faculty of Health, Mitra Indonesia University, Indonesia
[2]BKKBN Representative in Lampung Province, Indonesia

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**ABSTRACT/ ABSTRAK**

Stunting is a childhood condition that experiences growth disorders characterized by a child's height that is not appropriate for their age and results from chronic nutritional problems. This study analyses the risk factors for stunting in West Tulang Bawang Regency. This study was a cross-sectional study. Data were collected through self-administered questionnaires from 265 mothers of children under five in three West Tulang Bawang Regency districts. This research used multivariate logistic regression to determine risk factors for stunting. The study assessed that 10.9% of their children were stunted. Nearly half of the mothers had low education (48.7%), and most did not work (79.6%). As many as 94.3% of mothers said they had a protected source of drinking water, while around 23.4% did not have sewerage. Most of the respondent's energy, fat, and carbohydrate adequacy level was classified as insufficient, and most children did not suffer from infectious diseases. The results of the correlation test showed that sewerage (AOR=4.309; p-value=0.000) was correlated with the occurrence of stunting, while a history of measles (AOR=3.482; p-value=0.150), energy adequacy level (AOR=2.691; p-value=0.057), birth order (AOR=2.949; p-value=0.050) not significantly correlated to stunting but had a high risk of stunting. Multivariate test results showed that no sewerage in families had a risk of about 4.192 times the occurrence of stunting in children compared to the presence of sewerage in West Tulang Bawang Regency.

**Kata kunci:**

Sanitasi lingkungan;
Faktor risiko;
*Stunting;*
Balita.

Stunting adalah suatu kondisi anak mengalami gangguan pertumbuhan yang ditandai dengan tinggi badan anak yang tidak sesuai dengan usianya dan merupakan akibat dari masalah gizi kronis. Penelitian ini bertujuan untuk menganalisis faktor risiko stunting di Kabupaten Tulang Bawang barat. Studi desain ini adalah studi potong-lintang, Data dikumpulkan melalui kuesioner yang dikelola sendiri dari 265 ibu anak balita di tiga kecamatan di Kabupaten Tulang Bawang barat. Penelitian ini menggunakan regresi logistik multivariat untuk menentukan faktor risiko terhadap kejadian stunting. Hasil studi tersebut menilai, 10.9% anaknya menderita stunting. Hampir setengah dari ibu berpendidikan rendah (48.7%) dan sebagian besar tidak bekerja (79.6%). Sebanyak 94.3% ibu mengatakan memiliki sumber air minum yang terlindungi, namun sekitar 23.4% tidak memiliki saluran pembuangan air limbah. Sebagian besar tingkat kecukupan energi, lemak, karbohidrat responden tergolong kurang dan sebagian besar anak tidak menderita penyakit infeksi. Hasil uji hubungan menunjukkan saluran pembuangan air limbah (AOR=4.309; *p-value*=0.000) berhubungan dengan kejadian stunting, sedangkan riwayat campak (AOR=3.482; *p-value*=0.150), tingkat kecukupan energi (AOR=2.691; *p-value*=0.057), urutan kelahiran (AOR=2.949; *p-value*=0.050) tidak berhubungan signifikan dengan kejadian stunting namun memiliki risiko yang besar terhadap kejadian stunting. Hasil uji multivariat menunjukkan tidak adanya saluran pembuangan air limbah pada keluarga berisiko 4,192 kali terhadap keadian stunting pada anak dibandingkan adanya saluran pembuangan air limbah di Kabupaten Tulang Bawang Barat.

**Corresponding Author:**

**Atikah Adyas**
Fakultas Kesehatan, Universitas Mitra Indonesia
Email: atikah@umitra.ac.id

## INTRODUCTION

Stunting is a childhood condition that experiences growth retardation characterized by a child's height that does not appropriate for the age. It happens due to chronic nutritional problems, namely lack of nutritional intake in the long term (Kementrian Kesehatan RI, 2020). Stunting does not only have an impact on physical growth disorders but also on intelligence. Based on height measurements, a child is said to be stunted if the Height for Age Z-score (HAZ) is less than -2 based on the WHO-NCHS international reference. Stunted toddlers in the future will undoubtedly experience difficulties in achieving optimal physical and cognitive development (Kementrian Kesehatan RI, 2018). If stunting is not addressed, it will threaten the quality of human resources in Indonesia. The estimated economic loss is quite significant due to stunting is about Rp. 3,057-13,758 billion of Indonesia's total Gross Domestic Product (GDP) (Renyoet, 2021).

The Indonesian government is currently carrying out a mandate to achieve the target of the 2020-2024 RPJMN, which must be completed two years from now to reduce stunting to 14%. However, the Toddler Nutrition Status Survey (SSGI) results in Indonesia 2022 showed that the stunting rate was still relatively high (21.6%). Following Presidential Regulation number 72 in the year 2021 concerning the acceleration of stunting reduction, a national action plan was designed using a family-at-risk approach which contains data on families at risk of stunting, assistance for families at risk of stunting, assistance for all prospective brides, and surveillance for families at risk in stunting and audits of stunting cases. So, one of Indonesia's RAN PASTI (National Action Plan to Accelerate Reducing Stunting Rate) approaches for 2021-2024 is preventing families at risk of stunting (Badan Kependudukan dan Keluarga Berencana Nasional, 2022).

Based on the results of the 2020 Report of the Directorate of Community Nutrition, Ministry of Health of the Republic of Indonesia, stunting is caused by multi factors, meaning that more than one factor can cause stunting. These causes can occur from the root of the problem, indirect causes, and direct causes. Lampung Province data in 2021 showed the stunting prevalence rate was 18.5%, with three regencies that experienced an increase in the prevalence from 2019 to 2021. The three regencies, namely West Tulang Bawang (4.71%), Pesisir Barat (2.91%), and Pringsewu (1.24%), were included being priority regency for stunting management, namely (Kementrian Kesehatan RI, 2019, 2021b).

The problem roots in stunting, such as education level, economic status, and employment, causes poor maternal parenting patterns, household food insecurity, and no access to proper sanitation and clean water. Those factors indirectly impact the poor food variety on children's consumption, diarrhea in infants and other infectious diseases, and low health services. Those factors can directly cause stunting in toddlers. Based on the result of Indonesia Nutrition Status Survey 2021 (*Survei Status Gizi Indonesia (SSGI)* (Kementrian Kesehatan RI, 2021b), determinant nutritional problems which are suspected to be the cause of stunting were ownership of health service insurance, deliveries in health facilities, modern family planning (KB), supplementation of iron and folic acid in pregnant women, 24-hour exclusive breastfeeding for babies 0-5 months, various foods for toddlers, mother-child health book, weight weighing, measurement of height, low birth weight, birth length <48 cm, administration of vitamin A, complete basic immunizations, a good source of drinking water, proper sanitation, and infectious diseases (upper respiratory tract infection, pneumonia, diarrhea).

In addition, the relation to environmental health factors was found in a study in Kurma Village, West Sulawesi found that there was a significant correlation between environmental sanitation, exclusively drinking water sources p=0.040, latrines ownership p=0.029, sewerage p=0.023 with the occurrence of stunting (Mia & Sukmawati, 2021). Therefore, this research is essential due to the combination of underlying, indirect, and direct causes and the use of multivariate logistic regression to determine the dominant risk factor of stunting. The dominant factor is necessary for the effectiveness of stunting management, especially in West Tulang Bawang Regency, considering this regency had the highest increase of stunting prevalence rather than three other regencies in Lampung Province.

## METHOD

The design study was cross-sectional. West Tulang Bawang Regency was purposively chosen as the research location due to the regency with the highest increase in the prevalence of stunting in Lampung Province based on the Indonesian Nutrition Status Study data for 2020-2021 (Kementrian Kesehatan RI, 2021b), which was represented by the three

working areas of the public health centre in the Tulang Bawang Udik, Tulang Bawang Tengah, and Lambu Kibang Districts. The research was conducted in September-November 2022. Before being interviewed, mothers were asked about their willingness to be respondents in writing by informed consent. The ethical clearance from Mitra Indonesia University No. S.25/232/FKES10/2022.

Subject inclusion criteria in the study were biological mothers who had children under five (12-59 months), who were willing to be respondents in the study, and children aged 12-59 months who were healthy and not disabled. Exclusion criteria were mothers with hearing impairment and or speech impairment. The sampling technique was carried out by cluster sampling in each public health centre working area. The total number of respondents whose data was collected was 270 in the three working areas of the Kartaraharja, Panaragan Jaya, Gilang Tunggal Makarta public health centre in Tulang Bawang Barta Regency, while the number of eligible respondents for analysis was 265, so the subject response rate was 98%.

The data was collected by a self-administered questionnaire accompanied by enumerators. The dependent variable of the research was the occurrence of stunting (0= stunting; 1= not stunting). The independent variables collected included basic/underlying causes such as the mother's education (0=low; 1=high), mother's occupation (0=worked; 1=not worked), birth order (0=3rd or more; 1=1st or 2=2nd), maternal age during pregnancy (0=at risk; 1=not at risk).

The indirect variables were maternal parenting pattern [exclusive breastfeeding (0=no; 1=yes), colostrum administration (0=yes; 1= no), pre-lacteal food (0=yes; 1= no), starting age of complementary food (0=not appropriate; 1= appropriate), child caregiver (0= by others; 1= by mother)], health services [integrated healthcare visit (0=<8 times; 1= ≥8 times), Ante Natal Care (ANC) (<4 times; 1≥4 times), environmental sanitation [source of drinking water (0=unprotected; 1=protected), latrines (0=healthy; 1=not healthy), wastewater sewerage (0=not available; 1=available)].

The direct variables were food consumption (other than breast milk) [Energy/ Protein/ Carbohydrate/ Fat Adequacy Level (0=insufficient; 1=sufficient)] and infectious disease history [diarrhea (0=yes; 1=no), meals (0=yes; 1=no), upper respiratory tract infection (0=yes; 1=no].

Data processing assisted by the Microsoft Excel 2013 application and data analysis using the Statistical Package for Social Science (SPSS) version 16.0 for Windows. The analysis used univariate, bivariate, and multivariate. Multivariate logistic regression was used to determine the risk factors for stunting.

## RESULT

The results of univariate analysis on each independent variables are presented in Table 1.

**Table 1. Univariate Analysis on The Occurrence of Stunting**

| Stunting Status | n | % |
|---|---|---|
| Stunting | 29 | 10.9 |
| Not stunting | 236 | 89.1 |

**Table 2. Univariate Analysis The Direct Causes of Stunting**

| Variables | n | % |
|---|---|---|
| **Food Consumption** | | |
| Energy Adequacy Level | | |
| Insufficient | 172 | 64.9 |
| Sufficient | 93 | 35.1 |
| Protein Adequacy Level | | |
| Insufficient | 27 | 10.2 |
| Sufficient | 238 | 89.8 |
| Fat Adequacy Level | | |
| Insufficient | 172 | 64.9 |
| Sufficient | 93 | 35.1 |
| Carbohydrate Adequacy Level | | |
| Insufficient | 206 | 77.7 |
| Sufficient | 59 | 22.3 |
| **Infection Disease History** | | |
| Diarrhea | | |
| Yes | 46 | 17.4 |
| No | 219 | 82.6 |
| Upper respiratory tract infection | | |
| Yes | 223 | 84.2 |
| No | 42 | 15.8 |
| Measles | | |
| Yes | 9 | 3.4 |
| No | 256 | 96.6 |

Toddlers aged 12-59 months who experience stunting in the three working areas of a West Tulang Bawang Regency health centre are 10.9%. Nearly two-thirds of the respondents' energy and fat intake needed to be increased. More than three-quarters of the respondents had insufficient carbohydrate intake, while most protein intake was sufficient. Between the three infectious diseases that were asked, it was seen that more respondents had upper respiratory tract infections in the past year, while <20% of

respondents had diarrhea, and only 3.4% had measles.

**Table 3. Univariate Analysis of Indirect Causes**

| Variable | n | % |
|---|---|---|
| **Maternal Parenting Pattern** | | |
| Exclusive Breastfeeding | | |
| No | 112 | 42.3 |
| Yes | 153 | 57.7 |
| Colostrum Administration | | |
| No | 70 | 26.4 |
| Yes | 195 | 73.6 |
| Pre-Lacteal Food | | |
| Yes | 93 | 35.1 |
| No | 172 | 64.9 |
| Starting age of Complementary Foods | | |
| Not appropriate | 156 | 58.9 |
| Appropriate | 10 | 41.1 |
| Child Caregiver | | |
| By others | 23 | 8.7 |
| By mother | 242 | 91.3 |
| **Health Services** | | |
| Integrated healthcare visits | | |
| <8 times = not routine | 82 | 30.9 |
| ≥8 times = routine | 183 | 69.1 |
| Ante Natal Care (ANC) | | |
| <4 times | 20 | 7.5 |
| ≥4 times | 245 | 92.5 |
| **Environmental Sanitation** | | |
| Source of drinking water | | |
| Unprotected | 15 | 5.7 |
| Protected | 250 | 94.3 |
| Latrines | | |
| Not healthy | 5 | 1.9 |
| Healthy | 265 | 98.1 |
| Wastewater sewerage | | |
| Not available | 62 | 23.4 |
| Available | 203 | 76.6 |

Less than half of mothers did not provide their children with breast milk only for the first six months or did not pass exclusive breastfeeding; more than a quarter did not provide the colostrum, namely giving the first breast milk that came out. More than a third of children were given pre-lacteal food. This attitude can also increase the proportion of respondents given complementary food at an inappropriate age (<6 months or > six months), equal to 58.9%. However, this research showed that their mothers raised more than 90% of the primary respondents.

Nearly a third of the respondent's mothers did not visit the Integrated Healthcare Center (posyandu) regularly or less than eight times yearly. The results of this study indicate that at least four or more prenatal care visits have been carried out in 92.5% of the respondent's mothers, and only 7.5% had less than four times to prenatal care visits. Mostly, the source of drinking water in their families was protected, and <2% had their own or used unsanitary latrines without septic tanks. Nearly a quarter of the respondent's families did not have sewerage, and they disposed of it in the sewers/gutters/yard.

**Table 4. Univariate Analysis on Underlying Causes**

| Variables | n | % |
|---|---|---|
| **Mother's education** | | |
| Low (<not graduated in JHS) | 129 | 48.7 |
| High (≥graduated in JHS) | 136 | 51.3 |
| **Mother's occupation** | | |
| Worked | 54 | 20.4 |
| Not worked | 211 | 79.6 |
| **Birth Order** | | |
| 3rd or more | 57 | 21.5 |
| 1st or 2nd | 208 | 78.5 |
| **Maternal Age During Pregnancy** | | |
| At risk | 44 | 16.6 |
| Not at risk | 221 | 83.4 |

*JHS = Junior High School

The majority of the toddler were aged 24 months or more. Mothers' education was dominated by higher education or junior high school graduates and above. In addition, more than three-quarters of mothers did not work or as housewives. Nearly a quarter of the respondents were the third child or more of their mothers, while the rest of the respondents were the first or second child. Less than 20% of the mother's age during pregnancy was classified as at risk, meaning that the mother was <20 years or >35 years.

**Table 5. The Correlation Between The Independent Variables and The Occurrence of Stunting**

| Independent Variables | Stunting | | Total | *P-value* | Crude OR (CI 95%) |
|---|---|---|---|---|---|
| | Stunting | Not Stunting | | | |
| | n(%) | n(%) | n(%) | | |
| **Mother's occupation** | | | | | |
| Worked | 4 (7.4) | 50 (92.6) | 54 (100) | 0.351 | 0.595 (0.198-1.789) |
| Not worked | 25 (11.8) | 186 (88.2) | 211 (100) | | |
| **Starting Age of Complementary foods** | | | | | |
| Not appropriate | 15 (9.6) | 141 (90.4) | 156 (100) | 0.407 | 0.722 (0.333-1.564) |
| Appropriate | 14 (12.8) | 95 (87.2) | 109 (100) | | |
| **Colostrum Administration** | | | | | |
| No | 5 (7.1) | 65 (92.9) | 70 (100) | 0.168 | 0.548 (0.201-1.497) |
| Yes | 24 (12.3) | 171 (87.7) | 195 (100) | | |
| **Pra-Lacteal Food** | | | | | |
| Yes | 12 (12.9) | 81 (87.1) | 93(100) | 0.289 | 1.351 (0.615-2.965) |
| No | 17 (9.9) | 155 (90.1) | 172(100) | | |
| **Birth Order** | | | | | |
| 3rd or more | 10 (17.5) | 47 (82.5) | 57(100) | 0.072 | 2.116 (0.923-4.852) |
| 1st or 2nd | 19 (9.1) | 189 (71,3) | 208(100) | | |
| **Measles History** | | | | | |
| Yes | 2 (22.2) | 7 (77.8) | 9 (100) | 0.257 | 2.423 (0.479-12.261) |
| No | 27 (10.5) | 229 (89.5) | 256 (100) | | |
| **Source of Drinking Water** | | | | | |
| Unprotected | 3 (20.0) | 12 (80.0) | 15 (100) | 0.218 | 2.154 (0.570-8.133) |
| Protected | 26 (10.4) | 224 (89.6) | 250 (100) | | |
| **Wastewater sewerage** | | | | | |
| Not available | 15 (24.2) | 47 (75.8) | 62(100) | 0.000* | 4.309 (1.945-9.544) |
| Available | 14 (6.9) | 189 (93.1) | 203(100) | | |
| **Energy Adequacy Level** | | | | | |
| Insufficient | 23 (13.4) | 149 (86.6) | 172(100) | 0.085 | 2.238 (0.877-5.710) |
| Sufficient | 6 (6.5) | 87 (93.5) | 93(100) | | |

Based on Table 5, of 54 respondents who had working mothers, four children were stunted (7.4%). There was no correlation between the status of the mother's work and stunting in West Tulang Bawang Regency in 2022 (OR=0.595; p-value=0.351). Respondents with working mothers have a 0.595 times higher chance of stunting than non-working mothers. There were 15 (9.6%) cases of stunting in the child group with no appropriate age for starting complementary food. There was no correlation between the age of starting complementary food with the occurrence of stunting in West Tulang Bawang Regency in 2022 (OR=0.722: p-value=0.407). Respondents who were given complementary food that was not appropriate age had a 0.722 times greater chance of stunting than respondents who were given complementary food appropriate to their age. Of the 70 respondents who were not given colostrum, there were 5 (7.1%) cases of stunting. There was no correlation between giving colostrum and the occurrence of stunting in West Tulang Bawang Regency in 2022 (OR=0.548; p-value=0.168). Respondents who were not given colostrum had a 0.548 times greater chance of stunting than respondents who were given colostrum.

Of the 93 respondents who were given pre-lacteal food, there were 12 (12.9%) cases of stunting. There was no correlation between pre-lacteal feeding and the occurrence of stunting in West Tulang Bawang Regency in 2022 (OR=1.351; p-value=0.289). Respondents given pre-lacteal food had a 1.351 times greater chance of stunting than those not. About 57 respondents were born on the 3rd or more, and there were 10 (17.5%) stunting incidents. There is no correlation between birth order and the occurrence of stunting in West Tulang Bawang Regency in 2022 (OR=2.116; p-value=0.072). Respondents born 3rd or more had a 2,116 times greater chance of stunting than those born 1st or second.

A total of 9 respondents had a history of measles; there were 2 cases of stunting (22.2%). There was no correlation between a history of measles and the occurrence of stunting in West Tulang Bawang Regency in 2022 (OR=2.423; p-value=0.257). Respondents with a history of measles had a 2.423 times greater chance of stunting than respondents who did not have a history of measles. As many as 15 respondents with unprotected drinking water sources, there were 3 (20.0%) stunting incidents. There was no correlation between the source of drinking water

and the occurrence of stunting in West Tulang Bawang Regency in 2022 (OR=2.154; p-value=0.218). Respondents with unprotected drinking water sources had a 2.154 times greater chance of stunting than those with protected water sources. As many as 62 respondents did not have sewerage; there were 15 (24.2%) cases of stunting. There was a correlation between sewerage and the occurrence of stunting in West Tulang Bawang Regency in 2022 (OR=4.309; p-value=0.000). Respondents with sewerage have a 4.309 times greater chance of stunting in children than those with sewerage.

There was an occurrence of stunting of 23 (13.4%) in 172 respondents with insufficient energy intake. There was no correlation between the energy adequacy level and the occurrence of stunting in West Tulang Bawang Regency in 2022 (OR=2.238; p-value=0.085). Respondents with insufficient energy intake were 2,238 times more likely to experience stunting than respondents with sufficient energy intake. The variables presented in Table 4 were the results of bivariate analysis using chi-square, which statistically has the potential (p-value<0.25) by the literature to be a risk factor for stunting.

**Table 6. Results of Multivariate Analysis Using The Enter Method**

| No | Variables | p-value | Adjusted OR (95%CI) |
|---|---|---|---|
| 1. | Wastewater sewer (0=Not available) | 0.001* | 4.192 (1,810-9,709) |
| 2. | Measles history (0=Yes) | 0.150 | 3.482 (0.636-19.052) |
| 3. | Energy adequacy level (0=Insufficient) | 0.057 | 2.691 (0.222-2.290) |
| 4. | Birth order (0=3rd or more) | 0.050* | 2.494 (1.001-6,213) |
| 5. | Source of drinking water (0=Unprotected) | 0.388 | 1.942 (0.430-8.762) |
| 6. | Pre-lacteal food (0=Yes) | 0.481 | 1.367 (0.573-3.260) |
| 7. | Starting age of complementary food (0=Not appropriate) | 0.561 | 0.776 (0.331-1.823) |
| 8. | Mother's education (0=Low) | 0.570 | 0.713 (0.222-2.290) |
| 9. | Colostrum administration (0=Yes) | 0.154 | 0.390 (0.146-1.357) |

*significant, p<0.05

Based on Table 6, the nine variables analyzed using the logistic regression showed that sewerage was the single factor in stunting in West Tulang Bawang Regency. It could be seen by the variables of birth order, energy adequacy level, and measles history had a high risk of stunting. However, they were not statistically significant. Families without sewerage have a higher risk of stunting in children by 4.192 times compared to families with sewerage.

The value of R Square (Nagelkerke R Square) in the final model was 0.176. It means that the ability of the variable such as measles history, colostrum administration, exclusive breastfeeding, starting age of complementary food, birth order, source of drinking water, sewerage, and energy adequacy level could explain the occurrence of stunting was about 17.6%. The remaining was explained by other independent variables not included in this model.

## DISCUSSION

Stunting is another form of growth failure seen by a short and short child based on the Height-for-Age (HAZ) z-score. The causes of stunting consist of underlying, indirect and direct causes (Kementrian Kesehatan RI, 2014). This study showed about 10.9% of stunting in West Tulang Bawang Regency. While compared with the data from the SSGI 2021, the prevalence of stunting in West Tulang Bawang Regency is 22.1%. Therefore, the government continues to move the organization for accelerating stunting prevention and formulating a National Strategy for the Acceleration of Stunting Prevention 2018-2024 (Kementrian Kesehatan RI, 2019).

The underlying causes in this study, such as the mother's education, occupation, mother's age during pregnancy, and birth order, were not related to stunting. Mother's occupation and education are not related to stunting. However, another study found that non-working mothers had a 23% lower risk of having stunted children under five years old compared to working mothers in Ethiopia (OR = 0.768; p = 0.003) (Amaha & Woldeamanuel, 2021). It was because homemakers in the study tended to breastfeed and pay attention to their children compared to working mothers. Working mothers have less time to care for their children than mothers who do not work, so this will affect the quality of child care and thus affect the nutritional status of children. Mothers who work from morning to evening only have little time to pay attention to their children's food and nutritional needs (Liberty, Aziz, & AP, 2021).

Research on 330 toddlers in Ethiopia in the case and control groups found that mothers with

low formal education were at risk of having children with stunting by 6.4 times (Berhe, Seid, Gebremariam, Berhe, & Etsay, 2019). It also followed the conceptual framework of the problem of stunting nutrition in children; poor parenting and low education of caregivers or mothers are the causes of stunting in children (Wang, Stewart, Chang, & Shi, 2015). Attention to children, good parenting practices, and utilization of affordable health services are influenced by the mother's education level, which ultimately affects stunting and other health problems. A mother's education influences preparing, providing, and selecting nutritious food for herself and her child.

This study found no correlation between birth order and maternal age during pregnancy in children with stunting. The research found that mothers who have given birth more than three times are a risk factor that increases the occurrence of stunting (Titaley, Ariawan, Hapsari, Muasyaroh, & Dibley, 2019). This relates to the condition and quality of reproduction and care for children. Higher-order births result in a lack of attention and care from the parents. Another explanation could be that the allocation of food also decreases with the increase in the number of births in the household (Calimeris & Peters, 2017).

Psychologically, the development of the mindset of a young mother is not mature enough. Hence, the pattern of child nutrition in teenage mothers is better than that of older mothers. This is related to the understanding or culture of the local community, which is still adhered to by some people who think that women do not need to continue their studies to a higher level because they will work in the kitchen (Liberty et al., 2021).

Research from Manggala, Kenwa, Kenwa, Jaya, and Sawitri (2018), mothers who were at risk aged <20 years or >35 years have a 4.24 times greater risk of having a stunted child than those who are not at risk of 20-35 years. Young maternal age at delivery was correlated with an increased risk of preterm birth, intrauterine growth restriction, infant and maternal mortality, and malnutrition (Fall et al., 2015). Psychologically, the development of the mindset of a young mother is not mature enough. Hence, the pattern of child nutrition in teenage mothers is better than that of older mothers. This is related to the understanding or culture of the local community, which is still adhered to by some people who think that women do not need to continue their studies to a higher level because they will work in the kitchen (Liberty et al., 2021).

Indirect causes in this study were parenting patterns such as exclusive breastfeeding, colostrum feeding, pre-lacteal feeding, starting age of complementary food, health services: integrated health care [*Pos Pelayanan Terpadu (Posyandu)*] visits and antenatal care, environmental sanitation: drinking water facilities, toilet facilities, sewerage wastewater were not related to stunting in West Tulang Bawang Regency. This research aligned with Kusumawati, Rahardjo, and Sari (2015) in Watugajah Village, a working area of the Gedangsari II Health Center, Gunungkidul Regency, stated that there was no correlation between prenatal care and antenatal care with stunting.

Regular prenatal care can detect early risks of pregnancy, especially those related to nutritional problems. According to research Amaha and Woldeamanuel (2021), prenatal care can be carried out at least 4 visits to reduce the possibility of stunting by 24% when compared to prenatal care visits of less than 4. Mothers who had prenatal care visits less than 4 were significantly correlated with a higher likelihood of child stunting in Indonesia (Torlesse, Cronin, Sebayang, & Nandy, 2016).

Apart from pregnancy care, integrated health care visits must also be carried out monthly. A study by Ediana and Ningsih (2019) stated that there was a correlation between toddlers who are weighed with poor and undernourished status. Toddlers who are weighed irregularly have 1.5 times the risk of growth failure compared to those who are weighed regularly. Early introduction (2-3 months) of complementary foods significantly correlates with a higher risk of stunting, wasting, and being underweight (Masuke et al., 2021).

Early introduction of complementary foods is correlated with an increased risk of recurrent diarrhea and other infectious diseases that result in malnutrition. On the other hand, babies under six months' intestinal tract and stomach are not fully developed to digest other foods besides breast milk (Naylor & Morrow, 2001). Therefore, there is a need for continuous education about the benefits of exclusive breastfeeding for mothers/caregivers. This can be done during antenatal care, partum and postpartum visits, and monthly child growth monitoring visits (Masuke et al., 2021).

The research from Liberty et al. (2021) Mothers who are not exclusively breastfed are 4 times at risk of having stunted children. Breast

milk is recognized as an essential food for infants during the first six months of life. WHO and the Indonesian Ministry of Health recommends exclusive breastfeeding because it provides adequate nutrition and has advantages over formula milk, such as in developing brain function, improving immune system function, and increasing baby growth and development. Research in Indonesia also shows that non-exclusive breastfeeding increases the risk of stunting (Rahayu, Sofyaningsih, & Hamka, 2011). The lactoferrin content in breast milk binds to iron which functions to inhibit bacterial growth; the peroxidase enzyme in breast milk can destroy pathogenic bacteria. Breast milk produces the protein TGFβ (Transforming Growth Factor Beta), which will balance pro-inflammatory and anti-inflammatory properties so that the intestine can function normally (Permadi, Hanim, & Kusnandar, 2021).

Nutrient intake is one of the direct factors that cause stunting in toddlers. One of the nutritional intakes that play an essential role in the growth and development of children is energy. The results showed that most of the stunted and non-stunted children in West Tulang Bawang Regency experienced insufficient energy intake, as indicated by the respective percentages of 13.4% and 86.6%. The research from Sihite and Chaidir (2022) showed that most stunted toddlers experience a moderate energy deficit. Rufaida, Raharjo, and Handoko (2020) stated that inadequate intake, improper selection of food types and lack of variety and monitoring of nutritional status caused children to experience stunting. The same result by Siringoringo, Syauqy, Panunggal, Purwanti, and Widyastuti (2020) showed that the energy adequacy level was not significantly related to stunting in children under two.

Protein is one of the macronutrients that have a function, one of which is as a receptor that can affect the functions of DNA to control the growth process. Based on the table showed that most of the children who were stunted and not stunted had sufficient protein intake. Sari, Juffrie, Nurani, and Sitaresmi (2016) in their research, showed the same thing, both the stunted and non-stunted children had a percentage of sufficient protein intake. However, even though it is sufficient in quantity, it is necessary to consider protein intake in terms of quality. Sources of high-quality protein are found in animal foods such as eggs, fish and milk.

There was no correlation between the fat adequacy level and the occurrence of stunting ($p > 0.05$). This was in line with Permadi et al. (2021) that fat intake was unrelated to stunting. Most of the stunted and non-stunted children had a low level of fat adequacy. Also, Yuliantini, Kamsiah, Maigoda, and Ahmad (2022) found that most stunting toddlers have low-fat intake. Fat is an energy source with more calories than carbohydrates and protein, namely 9 kcal of each gram of fat. Rosadi, Rahayuh, Yulidasari, Putri, and Rahman (2016) stated that toddlers who had low fat intake have a higher risk of stunting than toddlers with sufficient fat intake.

Carbohydrates are one of the main energy-producing macronutrients, with 4 calories per gram of carbohydrates. The analysis showed that most of the stunted and non-stunted children had insufficient carbohydrate levels and were not significantly different between stunted and non-stunted children. Research results from Nurhayati, Mardiah, and Setyorini (2020) showed that most of the stunting children had carbohydrate intake in the category of moderate deficit. Insufficient carbohydrate intake can affect the process of growth and development in children. This is due to carbohydrates being the primary energy producer in the body. If carbohydrate intake is lacking, the body will use fat deposits as a source of energy, and continuous events will affect the process of growth and development.

Based on the theoretical framework in this study, infectious diseases are the direct cause of nutritional problems, in this case, stunting. According to Indonesia's health profile report 2021 (Kementrian Kesehatan RI, 2021a), infectious diseases such as diarrhea (10.3%) and pneumonia are included in the upper respiratory tract infection (9.4%). Diarrhea is the cause of death in children under five years old (12-59 months). Upper respiratory tract infection disease has become the most significant cause of death in children in the world (Wishaupt, van der Ploeg, de Groot, Versteegh, & Hartwig, 2017).

This study showed that the most common types of infectious diseases experienced by respondents in the past year were upper respiratory infections, diarrhea, and measles. Upper respiratory tract infections in this study are upper respiratory tract disorders, including coughs and flu. Infectious diseases in this study can occur repeatedly, with an average frequency of 2 times/per year. This study found no association between upper respiratory infections, diarrhea and measles with stunting. In contrast to the results of other studies, children with a history of upper respiratory tract infections risk stunting by 8.8 times (Kusumawati et al., 2015). The occurrence of infection causes disturbances

in the body's metabolism and immune system due to inflammation. Apart from inadequate nutritional intake due to decreased appetite, the association between a history of infection and growth disorders is related to the mechanism of inflammation that occurs. When inflammation or inflammation occurs, the hsRC protein (High-sensitivity C-reactive Protein) is secreted by the body. It impacts growth hormone resistance GH (Growth Hormone) (DeBoer et al., 2017).

Children with recurrent diarrhea have a risk of 5.2 times stunting (AOR = 5.3) (Berhe et al., 2019). In addition to receiving poor nutrition, this period (6-24 months) is correlated with increased exposure to infections, intake of other fluids (not breast milk) and/or solid foods and consumption of contaminated materials as children begin to explore their needs. Poor nutrition can enhance the risk of infection, and recurrent illness can affect nutritional conditions (Dewey & Mayers, 2011).

Infection can reduce appetite, interfere with the absorption of nutrients, increase metabolic needs, and affect food consumption, affecting the nutritional status of children under five. If this condition lasts long, it will impact the child's linear growth (Dewi & Adhi, 2016). Enteropathogenic Escherichia coli bacteria more often cause diarrheal disease. These bacteria exist due to poor environmental sanitation (drinking water facilities, ownership of latrines, sewerage) (Purba, Sunarsih, Trisnaini, & Sitorus, 2020). Research in the working area of the Baranti Public Health Center, Sidrap Regency, showed that sewerage could affect the occurrence of diarrhea (p=0,000) (Saleh, 2014).

This is related to the results of the logistic regression test in this study; sewerage is the most significant risk factor for stunting. Wastewater is the residue from a business and or activity in liquid form, both for household activities and other activities. That has been disposed of in a dirty form and generally contains materials or substances and or germs that can harm human health and disrupt the environment. Previous studies have stated that the quality of sewerage was related to the occurrence of stunting. Children with poor household wastewater disposal were at risk of experiencing stunting by 1.15 times compared to children with suitable household wastewater disposal (Badriyah & Syafiq, 2017).

Poor quality of water disposal causes contaminants to seep into water reservoirs so that the water is polluted and becomes a source of transmission of infectious diseases. Unqualified sewers become a source of disease vectors such as cockroaches and flies and, in the end, will contaminate the water, food, and environment, causing infectious diseases. Improving sewerage quality is a choice of sensitive intervention in preventing stunting in toddlers. Various research proved that clean water sources and early complementary foods are essential variables that affect the occurrence of stunting. However, this research found no correlation between those variables with stunting. Several factors might be involved, based on Table 5., such as the respondents already used the protected drinking water source and the mothers already providing the appropriate age of starting the complementary food, so there was no difference between stunting and not stunting.

Our limitation shown by the variables we used was explaining the outcomes only 17.6%; the rest was explained by the other factors not included in the model. This research used non-probability sampling, so it could not be generalized to other regions besides its location. The use of a cross-sectional design study was limited to explaining the cause and effect of the significant factor with the outcome in terms of stunting. On the other hand, this research would be advantageous to support the policy regarding environmental sanitation related to stunting. This study result has been utilised in assisting the process of publishing the policy brief for the government of West Tulang Bawang Regency.

## CONCLUSION

Availability of Sewerage significantly correlated with stunting in West Tulang Bawang Regency. At the same time, a history of measles, energy adequacy level, and birth order was not significantly correlated to stunting. The results of the binary logistic regression test showed that families without sewerage had a risk of about 4.192 times greater than the family with sewerage to the occurrence of stunting in children in West Tulang Bawang Regency.

## REFERENCES


Amaha, N. D., & Woldeamanuel, B. T. (2021). Maternal factors associated with moderate and severe stunting in Ethiopian children: analysis of some environmental factors based on 2016 demographic health survey. *Nutrition Journal*, *20*(1), 1-9. https://doi.org/10.1186/s12937-021-00677-6

Badan Kependudukan dan Keluarga Berencana Nasional. (2022). *RAN PASTI (Rencana Aksi Nasional Percepatan Penurunan Angka Stunting Indonesia)*. Jakarta.

Badriyah, L. u., & Syafiq, A. (2017). The association between sanitation, hygiene, and stunting in children under two-years (an analysis of Indonesia's Basic Health Research, 2013). *Makara Journal of Health Research*, *21*(2), 1. https://dx.doi.org/10.38165/jk

Berhe, K., Seid, O., Gebremariam, Y., Berhe, A., & Etsay, N. (2019). Risk factors of stunting (chronic undernutrition) of children aged 6 to 24 months in Mekelle City, Tigray Region, North Ethiopia: An unmatched case-control study. *PloS one*, *14*(6), e0217736.

Calimeris, L., & Peters, C. (2017). Food for thought: the birth-order effect and resource allocation in Indonesia. *Applied Economics*, *49*(54), 5523-5534.

DeBoer, M. D., Scharf, R. J., Leite, A. M., Férrer, A., Havt, A., Pinkerton, R., . . . Guerrant, R. L. (2017). Systemic inflammation, growth factors, and linear growth in the setting of infection and malnutrition. *Nutrition*, *33*, 248-253. https://doi.org/10.1016/j.nut.2016.06.013

Dewey, K. G., & Mayers, D. R. (2011). Early child growth: how do nutrition and infection interact? *Maternal & child nutrition*, *7*, 129-142. https://doi.org/10.1111/j.1740-8709.2011.00357.x

Dewi, I., & Adhi, K. T. (2016). Pengaruh konsumsi protein dan seng serta riwayat penyakit infeksi terhadap kejadian stunting pada anak balita umur 24-59 bulan di wilayah kerja Puskesmas Nusa Penida III. *Arc Com Health*, *3*(1), 36-46.

Ediana, D., & Ningsih, N. S. D. M. (2019). Faktor-faktor yang berhubungan dengan partisipasi ibu balita ke posyandu di Jorong Tarantang. *Jurnal Endurance*, *4*(2), 220-234. http://dx.doi.org/10.22216/jen.v4i2.3626

Fall, C. H., Sachdev, H. S., Osmond, C., Restrepo-Mendez, M. C., Victora, C., Martorell, R., . . . Adair, L. (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. http://doi.org/10.1016/S2214-109X(15)00038-8

Kementrian Kesehatan RI. (2014). *Pedoman Gizi Seimbang*. Jakarta: Kemenkes RI.

Kementrian Kesehatan RI. (2018). Menyusui sebagai Dasar Kehidupan. Retrieved from https://www.kemkes.go.id/article/view/19011500003/menyusui-sebagai-dasar-kehidupan.html

Kementrian Kesehatan RI. (2019). *Laporan Riskesdas 2018*. Retrieved from Jakarta: http://repository.bkpk.kemkes.go.id/3514/1/Laporan Riskesdas 2018 Nasional.pdf

Kementrian Kesehatan RI. (2020). *Situasi Stunting di Indonesia*. Jakarta: Pusat Data dan Informasi Kemkes RI.

Kementrian Kesehatan RI. (2021a). *Profil Kesehatan Indonesia 2021*. Jakarta: Kementrian Kesehatan RI.

Kementrian Kesehatan RI. (2021b). *Survei Status Gizi Indonesia (SSGI)* Retrieved from Jakarta:

Kusumawati, E., Rahardjo, S., & Sari, H. P. (2015). Model pengendalian faktor risiko stunting pada anak bawah tiga tahun. *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*, *9*(3), 249-256. http://dx.doi.org/10.21109/kesmas.v9i3.572

Liberty, I. A., Aziz, M., & AP, M. (2021). Analysis Of Maternal Risk Factor On Stunting In Children In Palembang City. *International Journal of Science, Technology & Management*, *2*(3), 826-836. https://doi.org/10.46729/ijstm.v2i3.198

Manggala, A. K., Kenwa, K. W. M., Kenwa, M. M. L., Jaya, A. A. G. D. P., & Sawitri, A. A. S. (2018). Risk factors of stunting in children aged 24-59 months. *Paediatrica Indonesiana*, *58*(5), 205-212.

Masuke, R., Msuya, S. E., Mahande, J. M., Diarz, E. J., Stray-Pedersen, B., Jahanpour, O., & Mgongo, M. (2021). Effect of inappropriate complementary feeding practices on the nutritional status of

children aged 6-24 months in urban Moshi, Northern Tanzania: Cohort study. *PloS one*, *16*(5), e0250562. https://doi.org/10.1371/journal.pone.0250562

Mia, H., & Sukmawati, S. (2021). Hubungan Hygiene Dan Sanitasi Lingkungan Terhadap Kejadian Stunting Pada Balita Di Desa Kurma. *Journal Peqguruang*, *3*(2), 494-502.

Naylor, A. J., & Morrow, A. L. (2001). Developmental Readiness of Normal Full Term Infants To Progress from Exclusive Breastfeeding to the Introduction of Complementary Foods: Reviews of the Relevant Literature Concerning Infant Immunologic, Gastrointestinal, Oral Motor and Maternal Reproductive and Lactational Development.

Nurhayati, L., Mardiah, W., & Setyorini, D. (2020). Status gizi dan asupan zat gizi makronutrien anak stunted dan tidak stunted 1-3 tahun. *Jurnal Kesehatan*, *11*(2), 83-92. https://dx.doi.org/10.38165/jk

Permadi, M. R., Hanim, D., & Kusnandar, K. (2021). Faktor-Faktor Yang Berhubungan Dengan Kejadian Stunting Pada Anak Usia 6-24 Bulan. *Jurnal Gizi Prima (Prime Nutrition Journal)*, *6*(1), 75-81.

Purba, I. G., Sunarsih, E., Trisnaini, I., & Sitorus, R. J. (2020). Environmental Sanitation and Incidence of Stunting in Children Aged 12-59 Months in Ogan Ilir Regency. *Jurnal Kesehatan Lingkungan*, *12*(3), 189-199. https://doi.org/10.20473/jkl.v12i3.2020.189-199

Rahayu, L. S., Sofyaningsih, M., & Hamka, M. P. D. (2011). Pengaruh BBLR (berat badan lahir rendah) dan pemberian ASI eksklusif terhadap perubahan status stunting pada balita di Kota dan Kabupaten Tangerang Provinsi Banten. Paper presented at the *Prosiding Seminar Nasional "Peran Kesehatan Masyarakat dalam Pencapaian MDG's di Indonesia*.

Renyoet, B. S. (2021). Estimation of the economic losses potential due to underweight toddlers in Indonesia in 2013. *Media Gizi Indonesia*, *16*(2), 111. https://doi.org/10.20473/mgi.v16i2.111-118

Rosadi, D., Rahayuh, A., Yulidasari, F., Putri, A. O., & Rahman, F. (2016). Faktor risiko yang berhubungan dengan kejadian pendek pada anak usia 6-24 bulan. *KEMAS: Jurnal Kesehatan Masyarakat*, *11*(2), 233-240.

Rufaida, F. D., Raharjo, A. M., & Handoko, A. (2020). The Correlation of Family and Household Factors on The Incidence of Stunting on Toddlers in Three Villages Sumberbaru Health Center Work Area of Jember. *Journal of Agromedicine and Medical Sciences*, *6*(1), 1-6. https://doi.org/10.19184/ams.v6i1.9541

Saleh, M. (2014). Hubungan kondisi sanitasi lingkungan dengan kejadian diare pada anak balita di wilayah kerja puskesmas Baranti Kabupaten Sidrap Tahun 2013. *Jurnal Kesehatan*, *7*(1).

Sari, E. M., Juffrie, M., Nurani, N., & Sitaresmi, M. N. (2016). Asupan protein, kalsium dan fosfor pada anak stunting dan tidak stunting usia 24-59 bulan. *Jurnal Gizi Klinik Indonesia*, *12*(4), 152-159. https://doi.org/10.22146/ijcn.23111

Sihite, N. W., & Chaidir, M. S. (2022). Keterkaitan kemiskinan, kecukupan energi dan protein dengan kejadian stunting balita di Puskesmas 11 Ilir Palembang. *Darussalam Nutrition Journal*, *6*(1), 37-47.

Siringoringo, E. T., Syauqy, A., Panunggal, B., Purwanti, R., & Widyastuti, N. (2020). Karakteristik Keluarga Dan Tingkat Kecukupan Asupan Zat Gizi Sebagai Faktor Risiko Kejadian Stunting Pada Baduta. *Journal of Nutrition College*, *9*(1), 54-62. https://doi.org/10.14710/jnc.v9i1.26693

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), 1106. https://doi.org/10.3390%2Fnu11051106

Torlesse, H., Cronin, A. A., Sebayang, S. K., & Nandy, R. (2016). Determinants of stunting in Indonesian children: evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. *BMC public health*, *16*(1), 1-11.

Wang, D., Stewart, D., Chang, C., & Shi, Y. (2015). Effect of a school-based nutrition education program on adolescents' nutrition-related knowledge, attitudes and behaviour in rural areas of China. *Environmental health and preventive medicine*, *20*(4), 271-278. doi:https://doi.org/10.1007/s12199-015-0456-4

Wishaupt, J. O., van der Ploeg, T., de Groot, R., Versteegh, F. G., & Hartwig, N. G. (2017).

Single-and multiple viral respiratory infections in children: disease and management cannot be related to a specific pathogen. *BMC infectious diseases, 17*(1), 1-11. doi:https://doi.org/10.1186/s12879-016-2118-6

Yuliantini, E., Kamsiah, K., Maigoda, T. C., & Ahmad, A. (2022). Asupan makanan dengan kejadian stunting pada keluarga nelayan di Kota Bengkulu. *AcTion: Aceh Nutrition Journal, 7*(1), 79-88. doi:http://dx.doi.org/10.30867/action.v7i1.579