
Review of Predictions on the Number of Children Affected by Stunting in Mountainous Papua Using Differential Methods

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Abstract

This study aims to analyze the relationship between various factors, such as family characteristics, eating patterns, and infection rates, as well as the incidence of stunting in children in the Papuan Mountains. The method used in this research is a qualitative bibliographic method. The differential equation model developed in this research uses historical trends and key factors to predict the number of stunting cases in 2024. This model combines the rate of change in factors that influence stunting with the current prevalence of stunting in a region. The model results show that the number of stunting cases is expected to increase based on the calculation results for an accuracy level of 25 and a MAPE of 88% in 2024. The differential equation model developed in this research provides a useful tool for policy makers and health professionals to predict and plan stunting management in the Papuan highlands.

Keywords: *Differentiation equation, Stunting, Child health*

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INTRODUCTION

Stunting is a growth and development problem in children or toddlers which is characterized by short height even though their weight is normal for their age. If a child's height does not increase significantly with age or compared to the child's birth height, then the child is considered stunted. Children under five years of age who are underweight or very thin for their age are now called wasted children. When children are small, stunted and very thin, these children experience stunting and wasting which is accompanied by impaired brain development and delays in the child's performance. The condition of stunting itself is generally seen at the age of two years, if the child's growth and development at the age of 2 years does not lack nutritional requirements, it is likely that he will not experience stunting

Growth and development disorders in children are usually caused by malnutrition, repeated infections, and lack of stimulation and psychosocial care for children from the first 1,000 days after conception until the age of 2 years. The problem of stunting children certainly has a negative impact on children's lives, including impaired immune

system, stunted growth, and physical and mental disabilities (Effendi, 2016). Factors that influence stunting can be divided into two direct and indirect factors: nutritional knowledge, maternal education, maternal income, food distribution, and number of family members. (Suparasa, Bakri & Fajar, 2013).

Research (Mediani et al., 2022) shows that stunting is also influenced by poor access to health services, and access to clean water and sanitation also influences the frequency of stunted babies (Pratama and Lismayani, 2023). Based on the Ministry of Health's Indonesian Nutrition Status Survey, the prevalence of stunting in Indonesia in 2021 is 24 cases. Up to a quarter of Indonesian children are affected by stunting (Nurhayati, 2023).

Stunting is an indicator of chronic malnutrition in children and is a serious problem in several countries, including Indonesia. Although great progress has been achieved in the health sector, the prevalence of stunting in Indonesia is still a big challenge and requires special attention (Putra, 2022). Stunting is a chronic malnutrition problem caused by a prolonged lack of nutritional intake due to providing food that does not meet nutritional needs. Stunting occurs when the fetus is still in the womb and does not occur until the child is 2 years old. Malnutrition early in life increases mortality rates in infants and children, and those affected are more susceptible to disease and have less than optimal body posture in adulthood. Observations of the extent of stunting in the country reveal a reality that cannot be ignored and show that the problem is not only regional but national (Kresnawati & Imelda, 2020).

Growth retardation during infancy is the biggest obstacle to the growth and development process of babies, resulting in poor cognitive and physical development, low productivity, poor health, and an increased risk of degenerative diseases. (Mandal et al, 2006) found that stunted children experienced decreased immunity, changes in metabolism, decreased motor development, lower cognitive scores, and lower academic performance. Children who experience stunting are at risk of obesity, impaired glucose tolerance, coronary heart disease, hypertension, osteoporosis, and decreased performance and productivity.

Food intake and infectious diseases are direct factors that influence stunting. Other indirect factors include the mother's health condition during pregnancy, family economic conditions, food availability in the family, child care patterns, environmental sanitation, and health services. Pregnant women suffer from anemia and nutritional

deficiencies that begin before conception, and the condition is exacerbated when they live in an unclean environment. On the other hand, 46.6% of female adolescents of childbearing age (WUS) aged 15 to 19 years in Indonesia in 2013 suffered from Chronic Energy Deficiency (KEK), while 60.45% of female adolescents in Jambi Province suffered from anemia. Apart from that, when pregnant, 24.2% of WUS in Indonesia suffer from CED and 37.1% suffer from anemia.

The above condition is related to the height of Indonesian pregnant women who are generally short (age more than 6 months, intake of 80% of grains (carbohydrates) and other groups such as protein, fruit and vegetables is much lower compared to body height Indonesian pregnant women are low (age more than 6 months, intake of 80% of grains (carbohydrates) and other groups such as protein, fruit and vegetables. Studies and literature on growth retardation show that stunting is associated with deficiency nutrition (micronutrients and macronutrients) and infection. There are several nutrients that are associated with stunting, including: Low protein, iron, zinc, calcium, vitamin D, A and C food intake, as well as non-exclusive breastfeeding.

Data from the 2022 Indonesian Nutrition Status Survey (SSGI) shows that the prevalence of stunting in Papua reached 34.6%, placing it as the province with the third highest prevalence of stunting in Indonesia. This figure shows that 1 in 3 children under five in Papua experience stunting. Several districts in Papua have a stunting prevalence higher than 50%, such as Asmat (54.5%) and Yahukimo (53.3%). The impact of stunting is not only a matter of hampered physical growth, but also results in a decrease in intelligence, learning ability and productivity in the future. Children who experience stunting are more vulnerable to chronic disease and death. Efforts to Reduce Stunting The government has committed to reducing the stunting rate in Papua to 14% by 2024. Various efforts have been made, such as increasing access to drinking water and sanitation, providing education about nutrition and parenting patterns, increasing coverage of exclusive breastfeeding, assisting pregnant women and breastfeeding, and coordination between related agencies. Challenges Reducing stunting rates in Papua requires comprehensive and sustainable efforts. Geographical challenges and limited infrastructure in Papua are obstacles in implementing stunting prevention programs. Strong collaboration is needed between the government, non-government organizations and the community to achieve the stunting reduction target.

The 2021 Indonesian Nutritional Status Study (SSGI) shows that the prevalence of stunting in Papua's mountains reached 55.4%. Poor Environmental Conditions: Data shows that the majority of families in Papua's mountains do not have healthy environmental facilities, such as adequate primary drinking water sources (3,742 families), adequate latrines (1,552 families), and livable houses (3,745 families) . Low Maternal Education: The highest level of maternal education in 2,947 families, which can influence public awareness about the importance of nutrition for toddlers and pregnant mothers. Lack of Public Awareness: Lack of public awareness about the dangers of stunting and the importance of nutrition for toddlers and pregnant women can be one of the inhibiting factors in handling stunting. Network and Long Distance: The distance between the DP3KB Service and several districts and villages which is quite far can affect the quality of services and outreach carried out by the DP3KB Service. In order to tackle stunting in Papua's mountains, several efforts have been made, such as community outreach about the importance of nutrition for toddlers and pregnant mothers, providing outreach to the community to eat nutritious food, and collecting data on communities at risk of stunting.

RESEARCH METHODS

The method used in this research is a qualitative library research method (Hadi, 2022). The required data is obtained from activities of reviewing and tracing data originating from various literature, books, notes, magazines, other references, as well as the results of relevant previous research, to obtain answers and a theoretical basis regarding the problem to be studied.

Library Research has several definitions related to Library Research. (Mirzacon. T, and Purwoko, 2017) explains several definitions of library research by several experts. Namely as follows.

1. Library research is research used to collect information and data using various types of research such as materials available in libraries. documents, books, magazines, historical stories, etc. (Mardalis, 1999).
2. Library research is research that examines the results of various reference books and similar previous studies, thereby helping to obtain a theoretical basis related to the problem being studied (Sarwono, 2006).

Library research is a data collection technique that involves reviewing various sources, such as books, literature, memos and reports, to find answers to the problems

faced. This method involves collecting, processing, and summarizing data systematically using certain methods. This research was conducted to collect information and data from various sources, such as reference books, previous research results, articles and notes, to solve the problems faced.

The step we take regarding calculations is to look for data on stunting sufferers in 2020-2022. Then predict the number of stunting sufferers in 2023, to predict using the logistic equation. Next, look for $P(0)$ which is used to determine the value of c . Once the value of c is known, the next step is to determine the value of $e-a$ using $t = 1$. Once the values of c and $e-a$ are known. The next step is to find $P(2)$ or the increase in stunting sufferers in 2023 using table 2 data. From these calculations, the result $P(2)$ is obtained. Next, calculate the percentage accuracy of the equation that has been obtained using the MAPE formula. Next, predict the number of stunting sufferers in 2024 or $P(3)$ with actual data. Then the level of accuracy is checked by multiplying the result of $P(3)$ by the MAPE percentage.

RESULT AND DISCUSSION

Stunting is a condition where a baby is found to be short in height compared to his age and below WHO child growth standards. Stunting in children under 5 years is the result of malnutrition that occurs when the baby is in the womb and early in life after birth, but does not occur until the child is 2 years old (Choliq et al, 2020).

The cause of stunted growth is poor nursing care provided by mothers when breastfeeding. In general, the problem of stunting is caused by poor maternal parenting patterns in providing food to their babies, or parents' mistakes in giving food to their babies, which can cause chronic diseases and infections in babies from growth retardation (Putra et al, 2020).

Stunting is caused by chronic malnutrition due to poverty and inadequate education. As a result, they remain trapped in poverty because their cognitive abilities do not develop optimally, they are more susceptible to disease, and their competitiveness is low. To overcome stunting, pregnant women and children under five need to be given education about the importance of nutrition (Author, 2019).

Children under 5 years of age (babies under 5 years of age) whose growth is slow due to chronic malnutrition and are too small for their age. Malnutrition occurs when the baby is still in the womb and in the first few days of life. However, new growth restrictions

occur in two-year-old babies. Small (stunted) and very small (stunted) babies are babies who have body length (PB/U) or body length (TB/U) (Coliqet al, 2020).

Table 1. Data on Stunting for 2020-2022

Number	Year	Number of Stunting Sufferers
1	2020	218
2	2021	1262
3	2022	1829

The data was obtained based on news that has been published by the authorities, namely "Number of people affected by stunting in Papua Mountains" below are the data sources that we used to obtain the data results in the table above.

<https://aksi.bangda.kemendagri.go.id/emonev/DashPrev>

What motivates our team to bring out this data is that research on stunting helps identify significant public health problems in an area, for example in the Papua Mountains.

Stunting has become a common health problem experienced by children. Data on the number of stunting can be used by the government and related institutions to develop health policies that are more effective in overcoming the problem of malnutrition. This research also helps in designing appropriate prevention and intervention programs to reduce stunting rates in the area, such as child nutrition programs, education about healthy eating patterns, and maternal empowerment programs.

Table 2. Data on Stunting Disease Sufferers in Mountainous Papua 2020-2023

Year	2020	2021	2022	2023
Number of Stunting Sufferers	218	1262	1829	?
t	-	0	1	2
p	218	1044	567	??

Table 1 was changed to table 2 to predict the number of stunting sufferers in 2023 in Papua Mountains. We obtained the figure from 218 to 1,262 from data on stunting sufferers in the Papua Mountains that we searched on the internet. t starts in 2021 with t = 0, in 2022 t = 1, and in 2023 t = 2. To predict we will use the logistic equation

$$P = \frac{a}{b + [e^{-at}]ac}$$

Information :

$$r = 1.262$$

$$K = 1.829$$

$$a = rk = 1.262$$

$$b = k$$

$$P(0) = 1.044$$

- r is the capacity of an area. Using the latest number of people suffering from stunting disease, namely in 2021, as the regional capacity. This is because the number of people suffering from stunting cannot be predicted by the regional capacity.
- K is the number of individuals in an area. Using the latest number of stunting sufferers, namely in 2022.
- a is obtained from multiplying r by k , so $a = r.k$
- b is obtained from equal to k .
- $P(0)$ is obtained from table 2, namely the growth in the number of stunting sufferers from 2020 to 2021. This is used to determine the value of c .

$$P(0) = \frac{a}{b + [e^{-at}]ac}$$

$$(1.044) = \frac{1.262k}{k + [e^{-a.0}]1.262kc}$$

$$(1.044) = \frac{1.262}{1 + 1.262c}$$

$$1 + 1.262c = \frac{1.262}{(1.044)}$$

$$1.262c = (1,20) - 1$$

$$c = \frac{(0,20)}{1.262}$$

$$= 0,000158$$

Once the value of c is known, the next step is to determine the value of e^{-a} using $t = 1$.

$$P(1) = \frac{a}{b + [e^{-at}]ac}$$

$$567 = \frac{1.262k}{k + [e^{-a.1}]1.262k \left(\frac{(0,20)}{1.262} \right)}$$

$$567 = \frac{1.262}{1 + [e^{-a}](0,20)}$$

$$1 + [e^{-a}](0,20) = \frac{1.262}{567}$$

$$[e^{-a}](0,20) = 2,22 - 1$$

$$[e^{-a}] = \frac{1,22}{(0,20)}$$

$$[e^{-a}] = (6,1)$$

After the values of c and e-a are known. The next step is to find P(2) or the increase in stunting sufferers in 2023 using table 2 data.

$$P(2) = \frac{a}{b + [e^{-at}]ac}$$

$$P(2) = \frac{1.262k}{k + [e^{-a.t}]1.262k \left(\frac{(0,20)}{1.262}\right)}$$

$$P(2) = \frac{1.262}{1 + [6,1]^2(0,20)}$$

$$P(2) = \frac{1.262}{1 + (37,21)(0,20)}$$

$$P(2) = \frac{1.262}{1 + (7,442)}$$

$$P(2) = \frac{1.262}{(8,442)}$$

$$P(2) = (149,49)$$

$$P(2) \approx (150)$$

From these calculations, the result P(2) = 150 is obtained. This means that in 2023 it is predicted that the number of sufferers will increase by 150 people. So the predicted number of stunting sufferers in 2023 is 1,979 people.

Table 3. Data on Stunting Sufferers for 2020-2023

Year	2020	2021	2022	2023
Number of Stunting Sufferers	218	1262	1829	?
t	-	0	1	2
p	218	1044	567	??

The number of stunting sufferers in 2023 is known, namely an increase of 282 people. The next step we have to do is calculate the percentage accuracy of the equation that has been obtained, namely using the MAPE (Mean Absolute Percentage Error) formula (Shidiq, 2022).

$$\begin{aligned} MAPE &= \frac{1}{N} \sum_{t=1}^N \left| \frac{P_t - \check{P}_t}{P_t} \right| \times 100\% \\ &= \left| \frac{282 - 150}{(282)} \right| \times 100\% \\ &= \left| \frac{132}{150} \right| \times 100\% \end{aligned}$$

$$= 0,88 \times 100\%$$

$$= 88 \%$$

So the percentage error rate or error rate for the equation is 88%.

The next step, what needs to be done is to predict the number of stunting sufferers in 2024 or P(3) with actual data.

$$P(3) = \frac{a}{b + [e^{-at}]ac}$$

$$P(3) = \frac{1.262k}{k + [e^{-a.t}]1.262k \left(\frac{(0,20)}{1.262}\right)}$$

$$P(3) = \frac{1.262}{1 + [6,1]^3(0,20)}$$

$$P(3) = \frac{1.262}{1 + (226,98)(0,20)}$$

$$P(3) = \frac{1.2626}{1 + (45,39)}$$

$$P(3) = \frac{1.262}{(46,39)}$$

$$P(3) = (27,20)$$

$$P(3) \approx 28$$

So, in 2024 it is predicted that the number of stunting sufferers will increase by 28 people. Then check the level of accuracy by multiplying the results of P(3) by the MAPE percentage, so that:

$$28 \times 88\% = 24,64 \approx 25$$

So that in 2024 there will be a small addition of 28-25=3 people and the maximum addition will be 28+25=63 people. So the number of stunting sufferers in 2024 will experience an increase of at least 3 people or a large increase of up to 63 people. With total numbers ranging from 2114 to 2174.

Table 4. Data on Stunting Sufferers for 2020-2024

Year	2020	2021	2022	2023	2024
Number of Stunting Sufferers	218	1262	1829	2111	2114 2174
t	-	0	1	2	3
p	218	1044	567	282	3 63

- Actions or steps that should be taken in response to the continuous increase in the number of stunting sufferers in the Papuan mountains:

1. **Strengthening Assistance and Mentoring:** The Coordinating Ministry for Human Development and Culture together with 19 K/L Focusing have provided assistance and strengthening in efforts to reduce stunting in areas that have a high prevalence of stunting, including Papua Mountains. This assistance can help increase community awareness and ability to deal with stunting.
2. **Health Interventions:** The Ministry of Health has developed three intervention efforts to prevent stunting in Indonesia, including providing TTD for young women, physical activity, and consuming balanced nutritious food. This intervention can help prevent stunting by focusing on women before giving birth, both teenagers in grade 7 and above and also during pregnancy.
3. **Commitment and Collective Efforts:** Mountain Papua has developed strategic will and collective efforts to deal with stunting. This involves commitment from regional heads, collective efforts from all parties, as well as interventions carried out by the government through companions and posyandu located near stunting sufferers. This intervention can help reduce stunting rates by adopting children with stunting to be cared for and providing more secure and regular supervision.
4. **Monitoring and Evaluation:** The Papua Provincial Government has held a stunting consultation and performance assessment of stunting convergence actions in districts/cities throughout Papua province in 2023. This activity can help produce mutual agreement and create a commitment from all stakeholders in reducing stunting in Papua province, as well as evaluation of district/city stunting convergence performance in Papua Province and implementation of district/city stunting convergence performance in the following years.

CONCLUSIONS AND SUGGESTIONS

Stunting is still a serious problem in Indonesia, with a high prevalence. The causal factors are complex, including malnutrition, infection, and inappropriate parenting. The impact on children is very serious, hampering physical and cognitive development, and increasing the risk of chronic disease. Mitigation efforts must be comprehensive and

sustainable, involving all parties. Steps that can be taken to overcome stunting include strengthening community assistance and education. Health interventions for pregnant women and children. Commitment and collective effort from all parties. Continuous monitoring and evaluation.

The number of stunting sufferers in Papua's mountains is predicted to increase to 2,114-2,174 people in 2024. This prediction is based on data and mathematical models, but deviations may occur due to unexpected factors. Stunting requires serious and collaborative handling to achieve a healthy and intelligent Indonesian generation.

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