

## PREDICTING STUNTING IN TODDLERS IN WEST JAVA USING LINEAR REGRESSION BASED ON POVERTY LEVELS

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**Abstract**— Children's growth is disrupted by stunting, a chronic nutritional condition brought on by a prolonged shortage of nutrient intake. Under-five stunting is a major issue that affects many nations, particularly those with high rates of poverty. The aim of this research is to use the linear regression method based on the proportion of poverty to predict the risk of stunting in children under five in West Java. Growing children are particularly vulnerable to stunting, which can have long-term effects on their development and health. The research site was selected in West Java Province due to the region's high stunting rates and nofigur poverty rate. Precise forecasts are required to surmount the current issues. The research methodology employed is the descriptive quantitative technique. The data, which was projected using percentage values, covered the years 2014–2020. This study uses linear regression as its algorithm. According to the study's findings, there will be an 8.55% chance of toddler stunting in West Java in 2024. It is hoped that the government would be able to lower the risk of stunting by estimating the proportion of risk.

**Keywords:** linear regression, poverty level, stunting risk.

**Intisari**— Stunting merupakan masalah gizi kronis akibat kurangnya asupan gizi dalam jangka waktu panjang sehingga mengakibatkan terganggunya pertumbuhan pada anak. Stunting pada balita adalah masalah serius yang banyak terjadi di berbagai negara, terutama di daerah dengan tingkat kemiskinan yang tinggi. Tujuan dari penelitian ini adalah untuk melakukan prediksi risiko stunting pada balita di Jawa Barat dengan menggunakan metode regresi linier berdasarkan persentase kemiskinan. Stunting adalah masalah serius dalam pertumbuhan anak yang dapat memiliki dampak jangka panjang terhadap kesehatan dan perkembangan mereka. Provinsi Jawa Barat dipilih

sebagai lokasi penelitian karena memiliki tingkat kemiskinan yang signifikan dan tingginya kasus stunting di wilayah tersebut. Prediksi yang akurat diperlukan untuk mengatasi permasalahan yang ada. Jenis penelitian yang digunakan yaitu metode kuantitatif deskriptif. Data yang digunakan dalam memprediksi dari tahun 2014–2020 dengan menggunakan nilai persentase. Algoritma yang digunakan pada penelitian ini yaitu regresi linier. Adapun hasil yang diperoleh dari penelitian ini yaitu pada tahun 2024 risiko stunting pada balita di Jawa Barat diprediksi sebesar 8.55%. Dengan memprediksi persentase risiko stunting, diharapkan pemerintah Jawa Barat maupun lembaga-lembaga terkait dapat membantu menekan terjadinya stunting.

**Kata Kunci:** regresi linier, tingkat kemiskinan, risiko terhambatnya pertumbuhan.

### INTRODUCTION

Stunting is a condition of growth failure in children under five due to chronic malnutrition so that the child's age is too short. Malnutrition occurs since the baby is in the womb and in the early period after the baby is born, the stunting condition is only seen after the baby is 2 years old (Madhe et al., 2021).

According to WHO, stunting is characterized by a child's height or height below normal, which is less than -2 standard deviations (SD) on the WHO growth curve. Growth retardation is caused by the lack of nutritional intake of infants from the beginning of the first life period, from the womb to the age of 2 years (Purnamasari, 2022). The impacts of stunting include inhibition of physical growth, impaired cognitive development, metabolic disorders, and increased risk of adult diseases such as diabetes, obesity, and heart disease. Stunting can also have long-term impacts, including a decrease in

the quality of a country's human resources. Therefore, it is important to prevent stunting through nutritional supplementation during pregnancy, exclusive breastfeeding, and improved environmental hygiene. Although the stunting rate in Indonesia has decreased, efforts to prevent and control stunting are still needed to achieve more optimal stunting reduction goals (Kemenkeu, 2022). Can be seen in Table 1. the following is stunting data by province.

Table 1. Stunting Index by Province in 2019

Province	Year	
	2018	2019
Aceh	58,36	61,95
Sumatera Utara	55,9	58,56
Sumatera Barat	61,88	63,97
Riau	57,95	60,04
Jambi	61,26	61,03
Sumatera Selatan	56,96	60,22
Bengkulu	59,41	60,41
Lampung	61,03	64,27
Kep. Bangka Belitung	61,73	60,68
Kep. Riau	64,02	62,76
DKI Jakarta	67,63	70,56
Jawa Barat	64,65	66,22
Jawa Tengah	69,38	71,17
DI Yogyakarta	78,54	79,94
Jawa Timur	68,25	70,69
Banten	62,13	64,32
Bali	67,67	69,71
Nusa Tenggara Barat	70,01	72,97
Nusa Tenggara Timur	62,56	64,81
Kalimantan Barat	55,36	56,46
Kalimantan Tengah	57,66	58,16
Kalimantan Selatan	64,4	66,77
Kalimantan Timur	62,66	64,94
Kalimantan Utara	62,63	64,04
Sulawesi Utara	63,3	64,78
Sulawesi Tengah	63	63,83
Sulawesi Selatan	65,01	66,21
Sulawesi Tenggara	58,5	61,66
Gorontalo	64,94	69,48
Sulawesi Barat	64,06	66,03
Maluku	47,35	50,91
Maluku Utara	52,46	53,42
Papua Barat	52,83	56,45
Papua	40,01	41,7

Source : (Central Statistics Agency of West Java Province, 2020)

It can be seen in Table 1. above that West Java occupies the 12th position in the provincial stunting index in 2019 and has increased from the previous year by 1.57%, which means that the stunting case is one of the serious cases that needs to be addressed in West Java.

In recent years, West Java Province has also topped the list of provinces with the highest number

of poor people in Java. One of the reasons why many people migrate from rural areas to cities is the opportunity to hold higher positions, especially those with better infrastructure and facilities than in the villages. However, this has created problems in urban areas, namely the increase in poverty in West Java. Table 2 below shows the development of urban poverty in West Java.

Table 2. Poverty in Cities in West Java Province 2021-2023 (Percent)

West Java Area	Year		
	2021	2022	2023
Bogor	8,40	7,73	7,62
Sukabumi	8,13	7,34	7,27
Cianjur	7,70	10,55	7,01
Bandung	11,18	6,80	10,22
Garut	7,15	10,42	6,40
Tasikmalaya	10,65	10,73	9,77
Ciamis	11,15	7,72	10,28
Kuningan	7,97	12,76	7,42
Cirebon	13,10	12,01	12,12
Majalengka	12,30	11,94	11,20
Sumedang	12,33	10,14	9,36
Indramayu	10,71	12,77	12,13
Subang	13,04	9,75	9,52
Purwakarta	10,03	8,70	8,46
Karawang	8,83	8,44	7,87
Bekasi	8,95	5,01	4,93
Bandung Barat	5,21	10,82	10,52
Pangandaran	11,30	9,32	8,98
Kota Bogor	9,65	7,10	6,67
Kota Sukabumi	7,24	8,02	7,50
Kota Bandung	8,25	4,25	3,96
Kota Cirebon	4,37	9,82	9,16
Kota Bekasi	10,03	4,43	4,10
Kota Depok	4,74	2,53	2,38
Kota Cimahi	2,58	5,11	4,66
Kota Tasikmalaya	5,35	12,72	11,53
Kota Banjar	13,13	6,73	6,14

Source : (Central Statistics Agency of West Java Province, 2024)

Table 2 above shows the poverty rate in cities in West Java, where in the last year, 2023, the highest poverty rate was in Indramayu city at 12.13% Cirebon 12.12%, Tasikmalaya city 11.53%. That means poverty is a serious problem in West Java.

As written by Aulia Ningsih, according to Futurchman and Marcellinus Moko quoted by Beti Aryani, poverty is the inability of individuals or households to fulfill their basic needs (NINGSIH, 2022). One risk factor that appears to be closely related to the degree of stunting is poverty. Poverty, and the limited resources that come with it, can hinder access to adequate nutrition, good health services, and a healthy and safe environment. Therefore, it is important to understand the relationship between poverty levels and the risk of

stunting in children under five in West Java to develop effective nutrition and health policies.

Based on the results of the Indonesian Nutrition Status Survey (SSGI) in 2021, the prevalence of stunting in Indonesia is 24.4%, which means that the prevalence of stunting in Indonesia is 24.4% compared to the results of the SSGBI in 2019 which reached 27.7%. Of course, when viewed from this data, the stunting prevalence rate has decreased. 27 provinces are still listed in the acute chronic stunting category, including West Java province with a stunting prevalence of 24.5% (Ministry of Health RI, 2021). The prevalence of stunting in toddlers in West Java is a worrying problem. It can now have long-term impacts and problems, such as cognitive and health development, physical growth, and can increase the risk of developing chronic diseases in adulthood (Hidayatillah, AR2, & Astuti, 2023). Understanding the factors that contribute to stunting is crucial for effective intervention strategies. Therefore, one potential factor that can significantly influence the risk of stunting in children under five is poverty. West Java is one of the provinces with a high poverty rate, based on data from the Central Statistics Agency, the poverty rate in West Java reached 8.40% in the first semester of 2021 (Badan Pusat Statistik, 2024). Poverty can affect toddlers' access to proper health services which can cause stunting. Therefore, research is needed that can identify poverty factors associated with the risk of stunting in toddlers in West Java and find ways to predict the risk of stunting with effective methods. This study aims to analyze the relationship between the percentage of poverty and the risk of stunting using linear regression.

The previous research written by Widya Cholid Wahyudin, Fida Maisa, and Agung Prihandono discussed the use of the Naive Bayes Classifier algorithm to improve the accuracy of the classification of stunting nutritional status in toddlers based on 2018 toddler data from the Pandanaran Health Center in 2018. Semarang City resulted in an accuracy of 85.33% in the classification of stunting nutrition cases in toddlers (Wahyudina, Hanab, & Prihandono, 2023). In addition, research compiled by Muhamad Amirudin and Alz Danny Wowor which discusses the comparison of Decision Tree and Support Vector Machine (SVM) methods in classifying toddlers at risk of stunting produces an accuracy value of 83% using SVM and 78% using Decision Tree (Amirudin & Wowor, 2023). As well as research written by Fadellia Azzahra, Nana Suarna, and Yudhistira Arie on the Application of Random Forest and Cross Validation Algorithms for Stunting Data Prediction at UPT Puskesmas XYZ resulted in an accuracy value of 77.55% and evaluation using Cross Validation

resulted in an accuracy of 78% (Azzahra, Suarna, & Wijaya, 2024). And previous research written by Alma Hidayanti, Amril Mutoi Siregar, Santi Arum Puspita Lestari, and Yana Cahyana entitled Covid-19 Case Analysis Model in Indonesia Using Linear Regression and Random Forest Algorithms resulted in the highest accuracy value produced by the linear regression method against Covid-19 in Indonesia of 99.73% (Hidayanti, Siregar, Lestari, & Cahyana, 2022). When viewed, the linear regression algorithm is the best algorithm as evidenced by the accuracy value produced using the linear regression algorithm is greater than other algorithms such as naive bayes classifier, decision tree, support vector machine (SVM), random forest, and cross validation. Therefore, this study was conducted using the linear regression algorithm.

The linear regression model can be used to predict stunting in West Java based on poverty level. This model helps assess the relationship between factors that influence stunting, such as maternal height, exclusive breastfeeding, and low birth weight. Some studies using linear regression models also show factors that influence stunting, such as complete basic immunization, food preparation facilities that meet health requirements, and the number of poor people. Linear regression models can help assess the strength of the relationship between poverty levels and stunting rates (Manaf, Erfiani, Indahwati, Fitrianto, & Amelia, 2022). As for the variables in the dataset, there are several variables that have a significant influence such as the number of births, where the number of births in an area can be an indicator of population density and pressure on resources which can ultimately affect the nutritional status of children. In addition, the percentage of poor people can also affect access to nutritious food, health services, sanitation, and a healthy environment, all of which are major risk factors for stunting in children under five. Therefore, changes in poverty levels are likely to have a significant impact on the incidence of stunting.

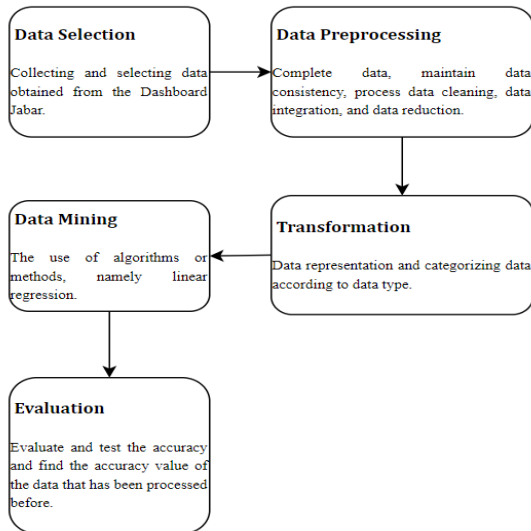
In addition, this study is expected to provide valuable input for policy makers in developing more targeted and effective intervention programs to reduce the risk of stunting in early childhood in West Java.

## MATERIALS AND METHODS

The research method used is a quantitative research method by systematically collecting and analyzing numerical data. While the algorithm used is a linear regression algorithm by creating a mathematical model and can be used to predict the

target value of new data based on several variables used.

To achieve the desired goal and get a solution in predicting the risk of stunting in West Java Province, a series of steps and procedures are used using the Knowledge Discovery in Database or KDD methodology as can be seen in Figure 1. where the stages carried out by the author's methodology are data selection, data preprocessing, transformation, data mining, and evaluation.



Source: (Research Results, 2024)  
 Figure 1. Flow of Knowledge Discovery in Database Methodology

#### a. Data Selection

At this stage, data collection and selection are carried out which will become targets or variables in the next process. The data used is data on the percentage of stunting growth and the percentage of poverty levels stored in csv form sourced from the West Java Provincial Health Office (opendata.jabar) and can later be used and uploaded into the program using the pandas library in the python programming language. The data used is 2022 data with a total of 737 records of baby birth data and 188 records of combined data. The data consists of 8 initial attributes in baby birth data, namely id, province code, province name, city district code, city district name, birth status, gender, number of births, unit, and year. And the combined data consists of 4 initial attributes, namely the name of the city district, the percentage of poor people, the year, and the percentage of stunting toddlers.

#### b. Data Preprocessing

Performing stages in the form of a process to complete the data if there is missing data and maintain data consistency. At this stage, several processes are carried out including data cleaning, data integration, and data reduction so that the

results of the process carried out are more accurate and can be accounted for.

#### c. Transformation

This stage changes the data representation so that it can facilitate the data mining process used. Changing the data representation includes changing the data structure, data format, and data values used as datasets to suit the mining process and algorithms used.

#### d. Data Mining

At this stage, model development is carried out to get the appropriate pattern from the data that has been used. Selection of the right model is needed for maximum and more accurate results. At the data mining stage, this research uses the Linear Regression algorithm as its development model.

#### e. Evaluation

This stage evaluates and tests the accuracy so that it can be seen how much percentage of data is obtained and can be trusted. This stage also searches for accuracy that can be used as a reference in using the appropriate learning model.

### RESULTS AND DISCUSSION

In the data collection and selection stage, the data used is data on the poor population and combined data, namely data on the poor population and stunted toddlers sourced from the West Java Provincial Health Office (opendata.jabar). The data used is 2022 data with a total of 737 records of baby birth data and 188 records of combined data. The data consists of 8 initial attributes in baby birth data, namely id, province code, province name, city district code, city district name, birth status, gender, number of births, unit, and year. And the combined data consists of 4 initial attributes, namely the name of the city district, the percentage of poor people, the year, and the percentage of stunting toddlers. As for the preprocessing stage, several processes are carried out including data cleaning, data integration, and data reduction so that the results of the process carried out are more accurate and can be accounted for. First, the data was grouped by year using the groupby function and calculated the average percentage of stunted children under five and the percentage of poor people each year. The results are stored in the dataframe data\_per\_tahun. A bar chart plot is used to display the growth data of stunted toddlers, where the x-axis value is taken from the data\_per\_tahun index, namely year, while the y-axis value is taken from the 'percentage\_of\_stunted\_children' column. While the line chart plot is used to display data on the growth of the percentage of poor people, with the x and y

axis values taken from the 'percentage\_poor' column. The axes are labeled according to the information presented and the plot title is given as "Growth of Stunted Toddlers and Percentage of Population per Year". A legend is added to explain each element of the plot. Thus, this visualization helps in analyzing the trend and correlation of the two variables from year to year, allowing for a better understanding of the dynamics of stunting growth and the percentage of poor population.

Linear regression is a method used to analyze the relationship between dependent and independent variables. The method aims to model the variables and obtain a regression line equation that can be used to predict the value of the dependent variable based on the values of the independent variables. The dependent variable in this study is the risk of stunting in toddlers and the independent variable (poverty level).

A statistical technique called regression analysis looks at the relationship between a set of independent variables ( $X_1, \dots, X_p$ ) and the dependent variable ( $Y$ ). The purpose of this method is to predict the value of  $Y$  given the value of  $X$ . The most basic regression model with only one independent variable is the simple linear regression model. Predicting the dependent variable  $Y$  is one of the many applications of regression analysis (Dikananda, Nurdiawan, Faqih, Surip, & Saputra, 2022). The basic linear regression model has the following equation:

$$Y = a + bX \quad (1)$$

$Y$  is the predicted dependent variable, the value of  $a$  is the slope,  $b$  is the cut-off point, and  $n$  is the data set used in the calculation.

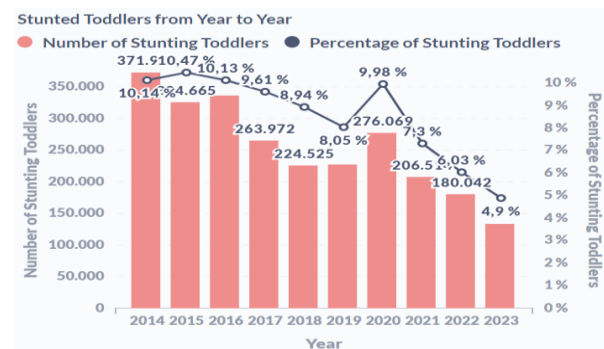
$$b = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2} \quad (2)$$

$$a = \frac{\sum y}{n} - b(\frac{\sum x}{n}) \quad (3)$$

Linear regression methods have been widely used in various studies. For example, in this study we apply linear regression algorithms to predict the risk of stunting in toddlers in West Java using linear regression algorithms. Variable  $X$  is a feature matrix that contains the feature values to be used for prediction. In this case, the selected features are 'year' and 'percentage\_population\_poor'. Variable  $y$  is a target array that contains the value of the dependent variable to be predicted, namely 'percentage\_of\_child\_stunting'. Then to train the linear regression model using the data. Here,  $X$  is the feature matrix and  $y$  is the target array. The model

will learn the relationship between those features and their associated targets. The variables `percentage_prediction_population` and `prediction_year` are used to store the values of the percentage of poor population and the specific year to perform stunting prediction. The training results predict the growth of stunting cases in 2024 to be 8.55%.

The number and percentage of stunting cases in West Java can be seen in Figure 2 below.



Source: (Dashboard Jabar, 2023)

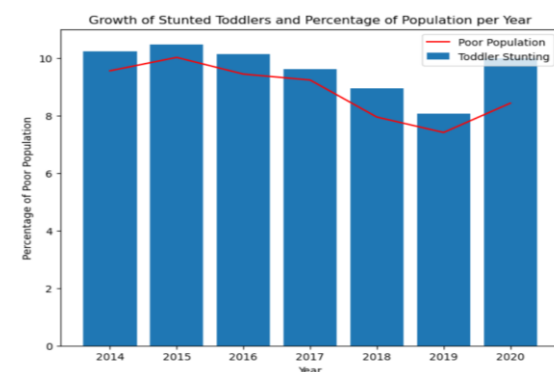
Figure 2. Number and Percentage of Stunting Toddlers

There was an increase in stunting cases in West Java in 2020 of 276,069 cases or around 9.89% from the previous 8.05%. There are many factors that cause stunting, one of which is poverty. As shown in Table 3. and Figure 3. Percentage of Poor Population.

Table 3. Data on the Percentage of Growth of Stunted Toddlers and Poor Population

Year	Percentage of Poor Population	Percentage of stunted toddlers
2014	9.550000	10.231538
2015	10.015185	10.470741
2016	9.435556	10.131852
2017	9.229630	9.608519
2018	7.941852	8.935556
2019	7.406667	8.049630
2020	8.424815	9.980000

Source: (Research Results, 2024)



Source: (Research Results, 2024)

Figure 3. Comparison Results of Percentage Growth of Stunted Toddlers and Poor Population

From the results obtained, it can be seen that the percentage of poverty in 2020 has increased compared to the previous year by 1,018,148 cases. This will also have an impact on the increase in stunting cases in West Java. The frequency of stunting in children under five based on family income characteristics is in line with Unicef's statement that one of the main causes of stunting in children under five is the economic crisis. The head of the family cannot guarantee the nutritional adequacy of both babies qualitatively and quantitatively, which has an impact on the nutritional growth of babies (Wansyah, 2020). In addition, families with low or poor socioeconomic status usually face the problem of undernutrition, in contrast to the problem of overnutrition and good family income can support child growth and development (Saudaraton, 2006). And as stated by the Menko PMK in a series of Roadshows to Accelerate Stunting Reduction and Elimination of Extreme Poverty (Menko PMK, 2023), extreme poor families tend to have considerable stunting potential. This means that overcoming extreme poverty can also ward off the problem of stunting. That is why the interventions must also go hand in hand.

Nutritional problems during infancy and pregnancy result in stunted growth. Stunted growth is the result of inadequate maternal education on health and nutrition before and after childbirth, lack of access to antenatal and postnatal services, lack of nutrient-rich foods, and lack of clean water and sanitation (Yuwanti, Mulyaningrum, & Susanti, 2021).

In addition to the factors above, the impact of stunting can also affect the future of the country. In the short term, children may experience brain and intelligence disorders, physical growth disorders, and metabolic disorders in the body. Conversely, in the long term, cognitive and learning abilities decrease, the immune system weakens so that it is more susceptible to disease, leading to diabetes, obesity, heart and blood vessel disease, cancer, stroke, and physical disability. The risks are higher. Aging not only increases the risk of perinatal illness and neonatal mortality, but also leads to uncompetitive work quality and substandard human resources, which ultimately lowers economic productivity (Anggryni et al., 2021).

The poverty alleviation strategy presented by the World Bank, that poverty alleviation strategies have evolved every decade ranging from job creation, income generation, health and education development, protection to empowerment of the poor.

The model used in this study is predictive, where all variables are considered important to estimate the regression coefficient at once. Overall,

the model can predict the risk of stunting in children under five.

It is proven that the poverty level as an independent variable has a major influence in stunting cases. The predicted growth of the risk of stunting in children under five in West Java based on the poverty rate in 2024 using a linear regression algorithm is 8.55%.

## CONCLUSION

The risk of stunting in children under five in West Java is caused by poverty, where poverty can affect stunting in children under five through several interrelated mechanisms such as poor environmental quality, lack of access to nutritious food, and limited access to health services. The result of this study is that it can be predicted that in 2024 the number of stunting cases in children under five in West Java will be 8.55%. The results obtained show that linear regression is able to provide excellent results by obtaining a greater accuracy value compared to other algorithms such as naive bayes, random forest, decision tree, and super vector machine (SVM) as described in previous studies. In order to overcome stunting in West Java, there needs to be attention from all parties and activities between the government and between programs and communities by increasing social sensitivity that can handle nutritional problems properly, paying attention to increasing education and community openness. Increase employment opportunities, improve the socio-economic conditions of the community for the better, so that the problem of stunting in toddlers, especially in West Java, can be resolved immediately.

Suggestions that the author can give based on the research that has been done, namely in further research it is hoped that it can add features to the dataset so that the model training is more accurate for prediction. In addition, other methods or algorithms can be used to get better results.

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