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Original Article

Modeling of Stunting Events Based on Nutritional Status of Elementary School Students

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Abstract

Background: The purposes of this study were to describe the variables that influence the stunting events and to find a model of stunting events in elementary school students using logistic regression analysis.

Methods: This study uses a survey method. The respondents were elementary school students. The data in this study were obtained using observation, questionnaires and interviews techniques. The data analysis used was a binary logistic regression test with the category of stunting and normal children. Parameter estimation was tested using Maximum Likelihood Estimation (MLE) so that parameters were obtained that could explain the occurrence of stunting and to test the suitability of the model used the stepwise method.

Results: Variables that influence the incidence of stunting include family income, energy adequacy level, protein adequacy level, maternal education level, energy consumption habits, and protein consumption habits. The mathematical model of stunting event swhich is found illustrates $Z = 10.081 – 2.494X_3 – 2.343X_4 – 1.794X_5$ where, 10,081 are constants, X_3 = Protein Adequacy Rate, X_4 = Maternal Education Level, X_5 = Energy Consumption Habits. $P_i = 1 / (1 + e\text{-}z)$ is the probability for each individual stunting child and the probability for a normal child is $1\text{-}P_i$.

Conclusion: Logistic regression equation model can be used for decision making in determining the category of stunting student. The probability of stunting occurrence in elementary school students in Gorontalo is significantly affected by the level of protein adequacy, maternal education level and energy consumption habits

Keywords: Modeling, Stunting, Nutritional Status, Elementary School Students

Introduction

Malnutrition is now an acute problem specifically in the Asian region. According to a 2017 report by the World Health Organization (WHO), the United Nations Children's Fund (UNICEF) and the World Bank Group stated that more than half of all stunted children, almost half of all overweight children and more than two thirds of all wasted children live in the region[1,2]. Although there are few follow-up studies from childhood to adult age, substantial evidence suggests an association between stunting and present cognitive ability school performance in children from low-income and middle income countries [3]. Globally in 2017, 151 million children under the age of five (22%) were stunted (too short for their age), with three quarters of the WHO South-East Asia Region or WHO African Region [4].

Child undernutrition and stunting remain serious public health problems in Indonesia [5]. With an average prevalence of stunting toddlers in 2005-2017 of 36.4%, Indonesia is the third country with the highest prevalence in the Southeast Asia / South-East Asia Regional (SEAR)[6]. In Gorontalo province, the percentage of nutritional status of stunting children in 2017 is 31.7% with characteristics of acute-chronic nutritional problems[7].

Stunting is a child who is too short for his or her age. It is important to pay special attention to the incidence of stunting because the condition of this growth disorder can lead to increased morbidity and mortality, loss of physical growth potential, reduced neurodevelopmental and cognitive function and the risk of chronic disease in adulthood[8]. Observational human studies indicate stunting can be associated with nutritionally poor, mainly plant-based diets [9].

In an effort to deal with stunting problems, decision making certainly must involve and utilize data or tables that must be translated qualitatively. Preparation of data in a more continuous and objective form is needed so that new data is obtained around the existing data - but not as observational data - then we can interpret new data based on old data[10]. For this reason, observation data needs to be expressed model shape. This study was conducted to describe the variables that influence the stunting events and to find a model of stunting events in elementary school students using logistic regression analysis. Logistic regression which is one of the most used statistical analyzes in multivariable models especially in medical research[11].

Logistic regression analysis is one of the mathematical model approaches used to analyze between one or several independent variables with a dependent variable category that is

dichotomous or binary. The dichotomous categorical variables are variables that have two values of variation, for example satisfied - not satisfied, smoking - not smoking and others. In logistic regression, the independent variable may be a mixture of categorical and numerical variables. But the independent variable should be used in the form of categorical because in interpreting the results of the analysis will be easier [12].

Methods

This study uses a survey method. The respondents were elementary school students. Sampling is done in stages, namely from the selection of schools, classes and students. Determination of school samples is done purposively. Elementary School 24 of Gorontalo was chosen with the consideration that in this school there were students who had a tendency to problems in nutritional status.

Based on preliminary observations, 10 out of 25 students in Elementary School 24 of Gorontalo were stunted. From the results of data collection in the Tomulabutao Selatan sub-district - where the Elementary School 24 is located - regarding socio-economic conditions, as many as 35% of the residents do not have jobs which affect the family's economic condition. From the interviews of eating habits of Elementary School 24 students, 19 of the 25 students had high energy consumption habits and 15 students consumed moderate protein.

The total number of students in this school from grade 1 to grade 6 is 185 students. Determination of class samples considering students who have been able to be interviewed, so that students who are the sample of the study are students in grades 4, 5 and 6. The total number of students in these classes is 75 students and all of them are used as research samples.

Data collection methods used were observation, questionnaires and interviews. Observations were made to directly measure the height, weight and age of students who became the study sample. Height was measured by a microtoise tool and a height-for-age 5 to 19 years table. The microtoise tool is generally used for children who can stand with 0.1 cm accuracy. In addition, observations were also made to assess the nutritional status of students using anthropometric measurements. Anthropometry is a simple tool for assessing nutritional status in individuals and communities and offers the advantages of objective evidence with relatively low technology [13]. The anthropometric index used is height according to age because height is an anthropometry that describes skeletal development. This index describes the nutrition of the past

and is closely related to socio-economic status [14]. The questionnaire and interview methods were used to determine family income, socio-economic, and food consumption habits by using 24-hour food recall and food frequency forms.

The research analysis methods consisted of univariate, bivariate and multivariate analysis. Univariate analysis was used to describe the characteristics of elementary school students. Bivariate analysis was used to select each independent variable with the dependent variable through a simple logistic regression test. If the results of the bivariate test have a value of p <0.25 then the variable can be included in the multivariate model. But it is possible for the p value> 0.25 to remain multivariate if the variable is substantially important. Multivariate analysis is used to analyze many variables simultaneously. In this study, multivariate analysis used a logistic regression test to predict the value of the dependent variable. The purpose of logistic regression analysis is to get the best and simplest model that can describe the relationship of the independent variable with the dependent variable [12].

The symbolic model of logistic regression is formulated as follows:

$$ln\left(\frac{P_i}{1-P_i}\right) = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n$$

Where P is the probability of someone included in the stunting category or not. X_1 is family income, X_2 is the level of energy sufficiency, X_3 is the level of protein sufficiency, X_4 is maternal education level, X_5 is the energy consumption habit, and X_6 is the protein consumption habit. In the case of a stunting event P is the probability of a stunting child and 1 - P is the probability of a normal child.

The estimation of logit model is done by using the Maximum Likelihood (ML) method. The Maximum Likelihood (ML) method is used to find the regression coefficient so that the probability of occurrence of the dependent variable can be as high as possible or as much as possible. The criteria are the smaller the value of -2LL, the better the model and vice versa the greater the value of -2LL then the less the model.

Results

Characteristics of students in this study include energy consumption habits, protein consumption habits, maternal education level, and family income. Based on energy consumption habits, 43 respondents or 57.33% had high habits, while those with moderate habits were 32

respondents or 42.66% of the overall study sample. For the characteristics of protein consumption habits, 44 respondents or 58.66% had high protein consumption habits while those with moderate protein consumption habits were 31 respondents or 41.33%. On the educational characteristics of mothers, respondents who were highly educated were 54 respondents or 72% while those with low education were 21 or 28%. For the family income characteristics, respondents who have a high-income family are 49 respondents or 65.33% while those with low income are 26 respondents or 34.66% of the total study sample.

In this study, all student characteristics were used as variables that influenced the incidence of stunting. In addition there are 2 main variables, namely the level of energy sufficiency and the level of protein sufficiency. Thus 6 independent variables that influence the incidence of stunting include X_1 = family income, X_2 = energy adequacy level, X_3 = protein adequacy level, X_4 = maternal education level, X_5 = energy consumption habits, and X_6 = protein consumption habits. The six variables were selected using bivariate analysis through a simple logistic regression test. The test result of each variable show a value of p value <0.25.

Bivariate analysis of family income factors with stunting event has p value = 0,000 (p value <0.25), energy adequacy level with stunting event has a value of p value = 0,000 (p value <0.25), protein adequacy level with stunting event has p value = 0.000 (p value <0.25), maternal education level with stunting events has a p value = 0.000 (p value <0.25), energy consumption habits with stunting events have a p value = 0,000 (p value <0.25), and proteins consumption habits factors with stunting events have a p value = 0.022 (p value <0.25). Thus the six variables can be included in the multivariate model.

The modeling process of stunting events is done through the logistic regression statistical test using the SPSS program. Table 1 displayed information about predictive accuracy of 56%. Predictive accuracy is obtained based on previously determined independent and dependent variable data. Thus there is an independent variable that affects the dependent variable of the stunting event[15]. The value of the stunting event consists of 2 categories, namely stunting and normal.

In this study, 6 independent variables were determined, namely X_1 = family income, X_2 = energy adequacy level, X_3 = protein adequacy level, X_4 = maternal education level, X_5 = energy consumption habits, and X_6 = protein consumption habits. Table 2 displayed statistical information about the estimated model. By using the stepwise method, in the third step 3

independent variables are produced which significantly influence the dependent variable with each sig value (0.021), sig (0.000) and sig (0.000).

Table 3 gave information about the model's goodness of fit. The value of Cox &Snel R Square is 0.507. This means that the three independent variables in the logit model can explain the incidence of stunting by 50.7%. Whereas based on Nagelkerke R square the size is 0.68. This figure showed that the three independent variables in the logistic model can explain the incidence of stunting by 68%. The Chi Square test on the Hosmer and Lemeshow test showed that it is not significant so the predicted probability is in accordance with the observed probability.

Table 4 described the overall prediction accuracy of 88%. While the accuracy of predictions of normal students and stunting is 85.7% and 90.9% respectively. Table 5 presents the results of the process of selecting independent variables included in the equation through the Stepwise method.

There are 3 independent variables in the equation that influence the decision of the student in the stunting category, namely the Protein Consumption Level (PCL) with the level of sig. (0.001), Maternal Education Level (MEL) sig. (0.002) and Energy Consumption Habits (ECH) sig. (0.023). Protein Consumption Habits (PCH), Energy Adequacy (EA), and Family Income (FI) variables were not included in the logistic regression equation because they were not significant.

The logistic regression model produced is $Z = 10,081-2,494X_3-2.343X_4-1.794X_5$, where the number 10,081 is a constant, the X_3 coefficient -2,292, the coefficient of X_4 -2,343, and the coefficient X5 -1,794. Pi = 1 / (1 + e-z) is the probability for each individual stunting child and the probability for a normal child 1-Pi.

Discussion

Based on the results of data collection through observation, interviews, and questionnaires as well as measuring the nutritional status of energy and protein consumption habits, 6 variables were determined to influence the incidence of stunting. These variables are X_1 = family income, X_2 = energy adequacy level, X_3 = protein adequacy level, X_4 = maternal education level, X_5 = energy consumption habits, and X_6 = protein consumption habits.

Based on the processed data, the mathematical model of stunting is $Z = 10,081 - 2,494X_3 - 2,343X_4 - 1,794X_5$ where, 10,081 are constants, X_3 = Protein Adequacy Level, X_4 = Maternal Education Level, X_5 = Energy Consumption Habits.

The first variable that affects is the level of protein adequacy. Protein needs of children aged 6-15 years are increasing because it is widely used for new cell growth, tissue maintenance and replacement of damaged cells including brain cells, bones, muscles, then the formation of important body components such as enzymes, hormones, red blood cells[16]. Children with the level of protein adequacy less can be caused by protein intake into the body <60gr, the frequency of eating in a day is only twice. Children who have enough are good with a protein intake>= 60gr per day and the frequency of eating children three times a day. Most types of food from protein sources consumed by Elementary School 24 students are fish, tofu, fermented soybean and eggs with a frequency of 1-3 times a day. The limitation of this unbalanced food intake causes the child to get sick often, his motor and intellectual abilities are low compared to normal children. In accordance with observations around 34.66% of children are less agile and responsive in answering simple questions given.

The level of education is very influential on changes in attitudes and healthy behavior, because it makes it easier for someone to absorb information and implement behavior in daily life. The level of maternal education is related to the level of care given to children. Parenting practices are closely related to maternal education is the practice of choosing family food especially for children[17].

The variable energy consumption habits influence the incidence of stunting of elementary school students. The habit of consuming staple foods such as rice is an energy source. Nutrients are important part of the health and growth[18]. Generally children consume food according to their own preferences without regard to what nutrients are contained in these foods. The results of this study indicate that there is a relationship between energy consumption habits and the incidence of stunting. Children rarely consume energy sources of food such as corn, cassava and potatoes while eating frequently are rice, noodles, bread and biscuits. The main function of carbohydrates is to provide body energy[19]. Sources of carbohydrates are whole grains or cereals, tubers, dried beans and sugar.

Conclusion

The variables that can affect the incidence of stunting are family income, energy adequacy level, protein adequacy level, maternal education level, energy consumption habits, and energy consumption habits. The logistic regression equation model as a result of the findings can be used for decision making in determining whether a child includes the stunting or normal category. The probability of stunting in Gorontalo elementary school students is significantly influenced by factors such as protein adequacy level, maternal education and food consumption habits.

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Conflict of interest statement

The authors have no conflicts of interest to declare for this study.

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Tables

Table 1.Accuracy of Constant Predictions

Observed			Predicted		
			Decision of stunting events		
			Stunting	Normal	Percentage Correct (%)
Step 0	**Decision on the incidence of stunting**	Stunting	0	33	0
		Normal	0	42	100
	Overall Percentage				56

Table 2.Omnibus Tests of Model Coefficients

Step	Chi-square	df	Sig.
	34.605	1	.000
1	34.605	1	.000
	34.605	1	.000
	16.617	1	.000
2	51.222	2	.000
	51.222	2	.000
	5.329	1	.021
3	56.551	3	.000
	56.551	3	.000

Table 3.Goodness of Fit Model, Hosmer and Lemeshow Test

Step	-2Log likelihood	Cox & Snell R Square	Nagelkerke R Square	Chi-square	df	Sig.
1	69.092	.363	.486	.000	0	
2	55.284	.470	.630	2.534	2	.282
3	49.882	.507	.680	2.542	4	.637

Table 4.Accuracy classification of stunting events

	Observed		Predicted		
			Decision of stunting events		
			Stunting	Normal	Percentage Correct (%)
Step 1	Stunting	Normal	26	7	78.8
			6	36	85.7
	Overall Percentage				82.7
Step 2	Stunting	Normal	26	7	78.8
			6	36	85.7
	Overall Percentage				82.7
Step 3	Stunting	Normal	30	3	90.9
			6	36	85.7
	Overall Percentage				88.0

Table 5.Variables in the Equation

		B	Df	Sig.
Step 1	PCL	-310	1	0.00
	Constant	4.74	1	0.00
Step 2	PCL	-3.14	1	0.00
	MEL	-2.48	1	0.00
	Constant	8.31	1	0.00
Step 3	PCL	-2.49	1	0.01
	MEL	-2.34	1	0.00
	PCH	-179	1	0.04
	Constant	10.08	1	0.00

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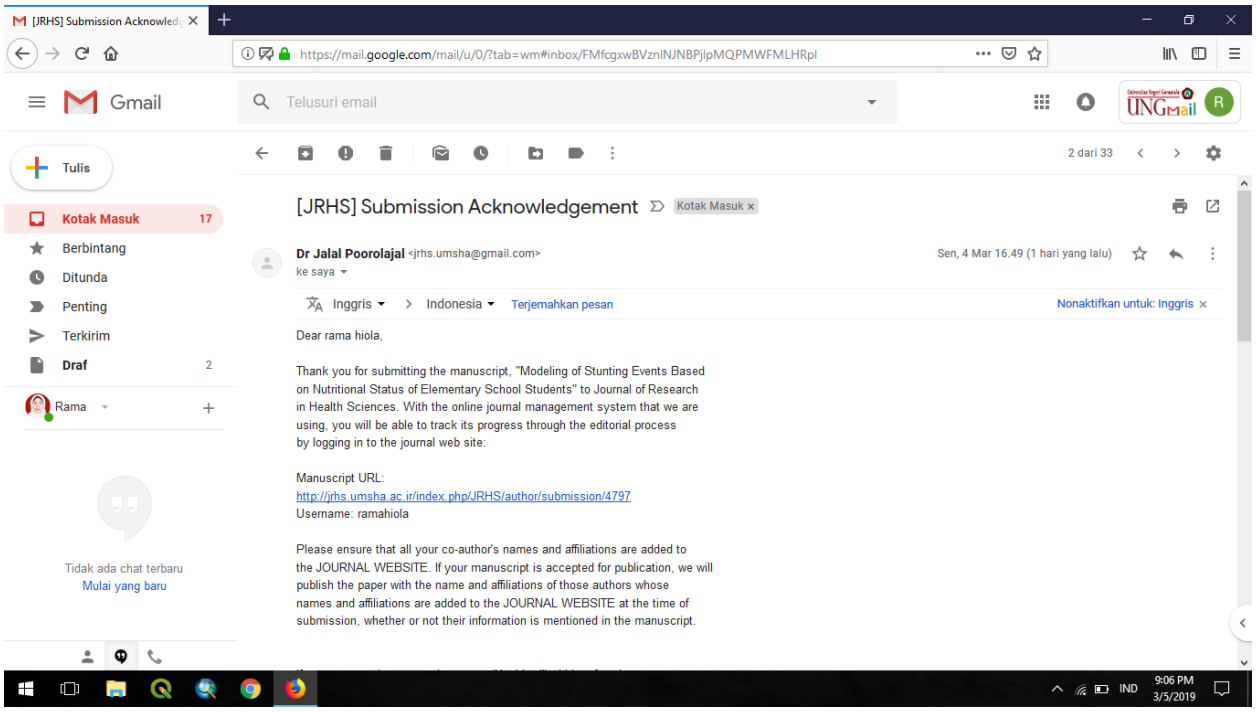
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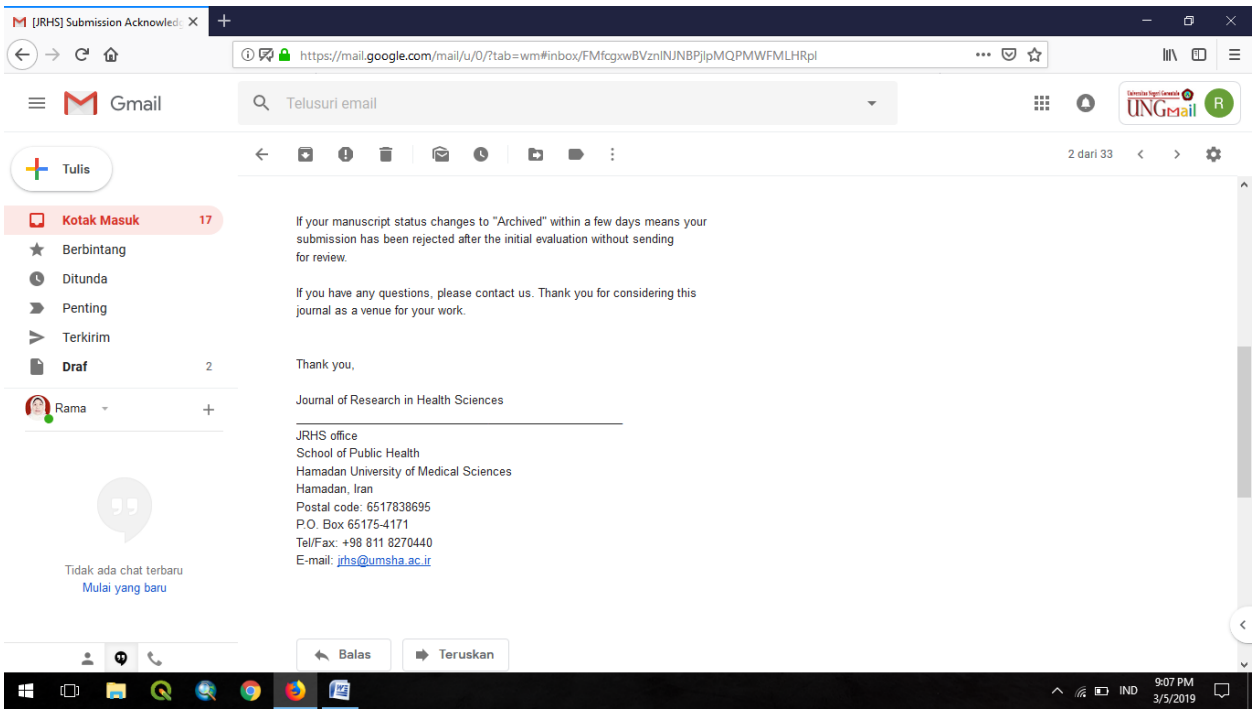
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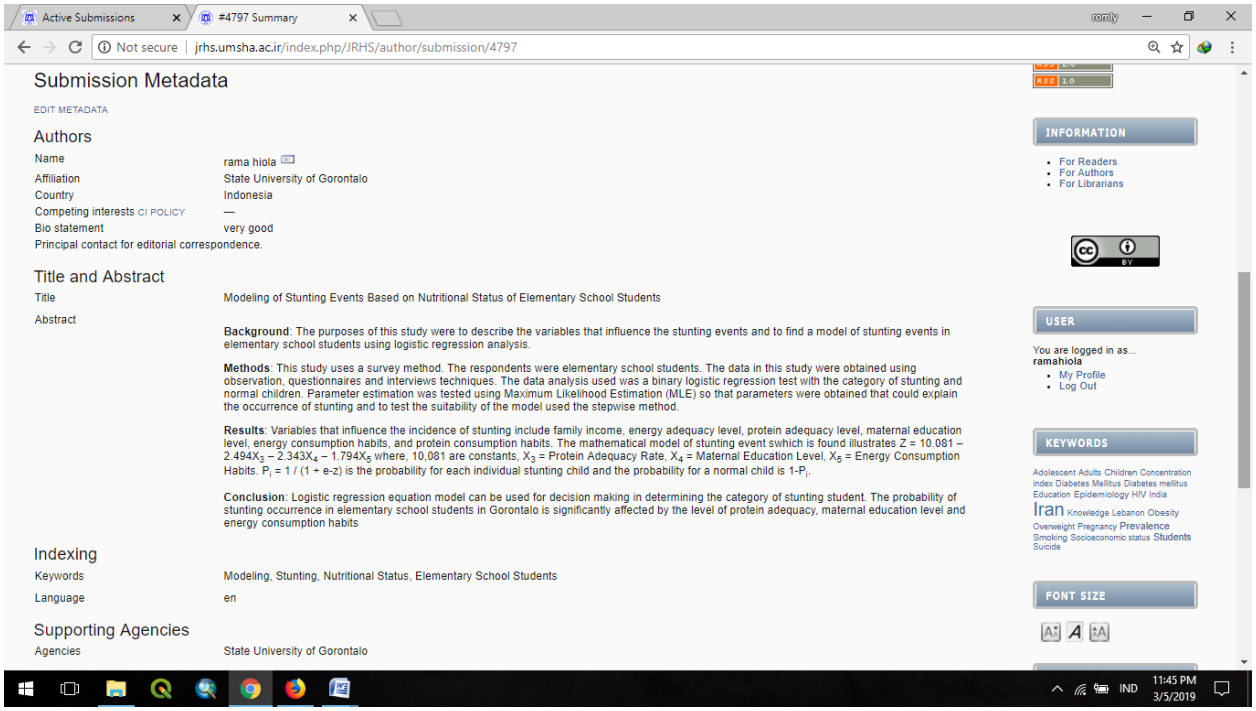
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Title and Abstract
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Indexing
Keywords
Modeling, Stunting, Nutritional Status, Elementary School Students
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