BAREKENG: Journal of Mathematics and Its Applications
December 2023 Volume 17 Issue 4 Page 1825–1834
P-ISSN: 1978-7227 E-ISSN: 2615-3017
https://doi.org/10.30598/barekengvol17iss4pp1825-1834

LOGISTIC REGRESSION APPROACH TO STUDY PREGNANT WOMEN CASES AS A RISK FACTOR OF LBW AT THE BATAKTE PUBLIC HEALTH CENTER, KUPANG BARAT DISTRICT

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ABSTRACT

Article History:

Received: 7th January 2023
Revised: 10th August 2023
Accepted: 5th September 2023

Keywords:

ANC;
CED;
LBW;
Logistic regression.

The research examines the influencing factors of low birth weight (LBW) in the work area of the Batakte Public Health Center, Kupang Regency. The specific objective of this study is to identify the risk factors associated with the LBW. In parallel with the research objective, the hypothesis of this study is that there is a relationship among several maternal factors: age, education, number of children, birth spacing, chronic energy deficiency (CED), low hemoglobin in pregnant women, and the practice of antenatal care (ANC) during pregnancy. The sample in this study was some mothers who gave birth in 2020 and 2021, whose data were recorded. The results of the study show that the logistic models of the dominant parameters causing LBW cases are: 1. Pregnant women who experience CED have a risk of 31% giving birth to babies with LBW: 2. The risk opportunities for pregnant women with low hemoglobin (below 11g/dl) is 57% will give birth to a LBW baby: and 3. The risk of pregnant women who never or do not routinely perform ANC is about 85% will give birth to a LBW baby. The results of parameter interpretation show that the dominant factor causing LBW cases in the work area of the Batakte Public Health Center is pregnant women who experience chronic energy deficiency conditions, low hemoglobin, and pregnant women who have never or only once done Antenatal care (ANC) in the work area of the Batakte Public Health Center.

How to cite this article:

K. Ginting and G. L. Putra, "MATHEMATICAL STUDY OF PREGNANT WOMEN CASES AS A RISK FACTOR OF LBW AT THE BATAKTE PUBLIC HEALTH CENTER, KUPANG BARAT DISTRICT," *BAREKENG: J. Math. & App.*, vol. 17, iss. 4, pp. 1825-1834, December, 2023.

Journal homepage: *https://ojs3.unpatti.ac.id/index.php/barekeng/*
Journal e-mail: *barekeng.math@yahoo.com; barekeng.journal@mail.unpatti.ac.id*

Research Article • Open Access

1. INTRODUCTION

Birth weight is the baby's weight that is measured within the first hour after birth [1]. Low birth weight (LBW) is one of the main causes of infant mortality in the world, especially in developing countries. Based on data from the Indonesian Demographic and Health Survey, 7.1% of cases in Indonesia in 2017 were LBW, which is a relatively high rate [2], [3]. If LBW is not treated properly, it can lead to death and stunted growth and development in children [4], [5], [6].One of the regions in Indonesia that is still facing various challenges to improve the quality of children's health and education is East Nusa Tenggara Province [7]. One indicator to describe this situation is the percentage of LBW in this province which is the highest percentage in Indonesia for around 13.43% in 2017 [8].

There are 22 regencies and cities in East Nusa Tenggara. In 2020, a total of 88.740 babies were delivered alive, of which 5.615 were born with a low birth weight. Based on the available data, it is evident that there are four regions exhibiting the highest prevalence of low birth weight (LBW) cases. These regions include Timor Tengah Selatan regency, which recorded 1,150 cases, followed by Sikka regency with 560 cases, Kupang regency with 452 cases, and Kupang city with 409 cases [9]. Based on the given information, the researchers analyzed the influencing factors that cause of LBW in West Kupang Regency. We collect the main causes of LBW from other researchers in Indonesia [2] and overseas countries like India [10], [11], Ethiopia [12], South Africa [13], and Eastern Nepal [5]. They use different methods, such as the Oaxaca decomposition method, survey for the change every 10 years, but most of them use the logistic regression method. In this paper, we use the logistic regression method.

As we know, the logistic regression is used to predict the dependent variable with a nominal scale of two categories. The purpose of this method is to test whether the probability of the dependent variable can be predicted using the independent variables. We can also abandon the assumption of homoscedasticity, the moltivariate normality assumption for the independent variables and a lot more [14]. With that explanation, we see that this method is suitable to solve the LBW cases. We then identify the phenomena that cause LBW cases, both direct and indirect. Furthermore, the data is analyzed by doing the fit test of the logistic model, and then we interpret the logistic model to conclude or explain the most dominant cause of the LBW case and forecast the probability model of the cause of LBW cases in the work area of the Batakte Public Health Center. Ferinawati et al [15] give the result about the relation between LBW with number of children (p-value $= 0.01$) and mother's age (p-value $= 0.017$) when they did the research in Jeumpa Heatlh Center, Bireuen regency. Jayanti et al [4] also support the result about the relation between the number of children and health problems with children, especially LBW cases [4]. Anuja et al. also give a result about the existence of a relation between LBW with maternal age and low nutrition during pregnancy [10]. Sielu et al. identified that a lack of the antenatal care or ANC and a history of medical illness were significant factors in LBW [12].

According to these results, we consider the variables that already identified by previous researcher and also we consider some cases related to low hemoglobin in pregnant women. So, the dependent variables that we analyzed is the probability of LBW in the Batakte Public Health Center and the independent variables are maternal age during pregnancy (X_1), mother's education (X_2), number of children (X_3), birth spacing (X_4), pregnant women who experience chronic energy deficiency or CED (X_5), pregnant women who experience hemoglobin below 12 (X_6), and ANC check to health care for pregnant women (X_7). Out of all the variables, the difference with others is the low hemoglobin for pregnant women due to the geographical situation and the condition of the patient visiting the Batakte Public Health Center.

2. RESEARCH METHODS

The data that has been collected was analyzed through the following steps:

1. Identifying risk factors that influence LBW cases

$$Z(x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 \quad (1)$$

2. Analyzing of the logit function

$$Z(x) = \ln \frac{p}{(1-p)} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 \quad (2)$$

3. Testing the compatibility of the logistic model simultaneously (G test)

$$G = -2\ln \left[\frac{likelihood(Model\ B)}{likelihood(Model\ A)}\right] \quad (3)$$

4. Testing the compatibility of the logistic model (Wald test)

$$W_i = \left[\frac{\hat{\beta}_i}{SE(\hat{\beta}_i)}\right]^2 \quad ; i = 1,2,\dots,7 \quad (4)$$

5. Determine the potential risk that cause LBW

$$P = \Pr(Y = 0|x) = \frac{1}{1+e^z} v \quad (5)$$

3. RESULTS AND DISCUSSION

3.1 Phenomenon of Low Birth Weight Cases

In **Figure 1**, the data pertaining to the percentage of cases of LBW in all regencies and cities within East Nusa Tenggara for the years 2020 and 2021 is presented. According to the data provided, there were 5.615 cases of LBW in 2020, and this number increased to 7.784 cases in 2021 [17].

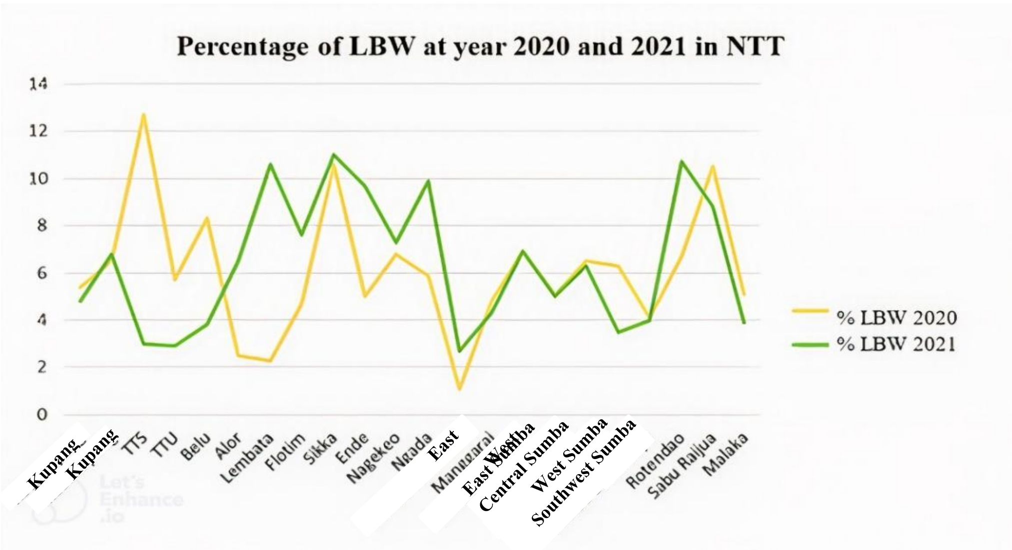

Figure 1. The Graph of LBW Cases in NTT at 2020 and 2021

3.2 Analysis of the Causes of Low Birth Weight (LBW)

The findings of the descriptive analysis conducted on a sample of 121 participants from various branches of the Batakte Public Health Center reveal the percentage distribution of the association between the causes of low birth weight (LBW) and the influencing factors. According to the findings presented in **Table 1**, the descriptive analysis indicates that about 53.1% of pregnant women between the ages of 20 and 30 gave birth to kids with low birth weight (LBW). Conversely, for pregnant women under the age of 20 or above the age of 30, the proportion of newborns with LBW was around 46.9%.

Table 1. Percentage of Mother's Age Affects LBW

			Mother's age		Total
			Between 20-30 years	**Less than 20 or more than 30 years**	
LBW	Normal Birth Weight	Count % within LBW	56 77.8%	16 22.2%	72 100%
	Birth Weight under 2000 gr	Count % within LBW	26 53.1%	23 46.9%	49 100%
	Total	Count % within LBW	82 67.8%	39 32.2%	121 100%

Data Source: *BPS, 2021* [18]

Based on the results of the chi-square analysis, it shows that the chi-squared value is 0.004. So, $\chi^2_{value} < \chi^2_{table}$, H_0 is accepted, means that there is no direct relationship between maternal age and LBW cases.

Table 2. Percentage of Mother's Education Affects LBW

			Mother's Education		Total
			High School or Higher	**Elementary School or Lower**	
LBW	Normal Birth Weight	Count % within LBW	22 30.6%	50 69.4%	72 100%
	Birth Weight under 2000 gr	Count % within LBW	15 30.6%	34 69.4%	49 100%
	Total	Count % within LBW	37 30.6%	39 69.4%	121 100%

Data Source: *BPS, 2021* [18]

Based on Table 2, the results of the descriptive analysis of pregnant women who will give birth with LBW cases for and education level of elementary school or lower were 69.4% and those who educated in junior high school and above were only 30.6%. The value of the chi-square analysis is 0.995 while the chi-square table is 3.84. So, $\chi^2_{value} < \chi^2_{table}$ which means that there is no direct relationship between mother's education and LBW cases.

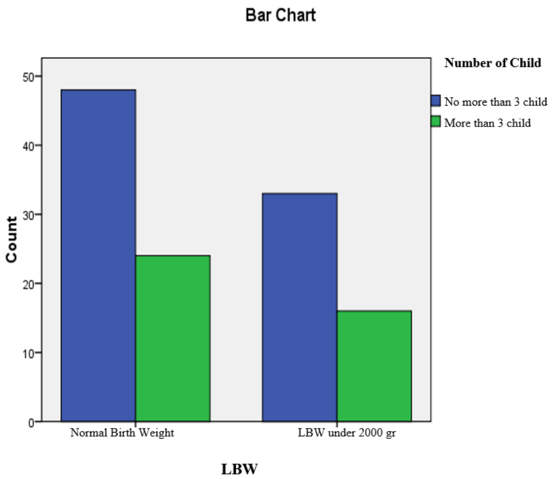

Figure 2. Graph of The Relationship Between The Number Of Children and LBW cases

The findings from the descriptive analysis indicate that 67.3% of families with LBW infants had less than three children, whereas 32.7% of families had more than three children. In addition, the chi-square analysis was employed to derive the chi-square value which was found to be 0.93. Given that the Chi-square table value is 3.84, it can be observed that $\chi^2_{value} < \chi^2_{table}$. Consequently, H_0 is accepted, indicating that there is no significant association between the number of children in a family and the occurrence of LBW instances.

Table 3. **Percentage of Birth Distance to LBW**

			Birth Space		Total
			At least 2 years	Less than 2 years	
LBW	Normal Birth Weight	Count % within LBW	60 83.3%	12 16.7%	72 100%
	Birth Weight Under 2000 gr	Count % within LBW	35 71.4%	14 28.6%	49 100%
	Total	Count % within LBW	95 78.5%	26 21.5%	121 100%

Data Source: *BPS, 2021* **[18]**

The data presented in **Table 3** provides a study of the distribution of children based on their birth spacing. Approximately 71.4% of children were born with a birth spacing of more than 2 years, while the remaining 28.6% were born with a birth spacing of less than 2 years. The chi-square value derived from the table ($\chi^2_{table} = 3.84$) exceeds the calculated chi-square value ($\chi^2_{value} = 0.12$), leading to the rejection of the H_1. This indicates that there is no significant association between the distance between pregnancies and the occurrence of LBW cases.

Table 4. **Percentage of Chronic Energy Deficiency (CED) to LBW**

			Chronic Energy Deficiency		Total
			UAC $\geq$ 23.5	UAC $<$ 23.5	
LBW	Normal Birth Weight	Count % within LBW	44 61.1%	28 38.9%	72 100%
	Birth Weight under 2000 gr	Count % within LBW	9 18.4%	40 81.6%	49 100%
	Total	Count % within LBW	53 43.8%	68 56.2%	121 100%

Data Source: *BPS, 2021* **[18]**

Based on the findings presented in **Table 4**, it can be shown that pregnant women who suffer from chronic energy shortage and have an upper arm circumference (UAC) measurement of less than 23.5 are associated with a significant 81.6% probability of giving birth to infants with LBW. In the case of pregnant women who do not exhibit CED, the likelihood of delivering an LBW infant is approximately 18.4%, whereas the proportion of infants with a normal birth weight is estimated to be approximately 61.1%. Moreover, the findings of the chi-square analysis indicate that the calculated chi-square value ($\chi^2_{value} = 21.64$), while the chi-square value from the table ($\chi^2_{table} = 3.84$). It is evident that the $\chi^2_{value} > \chi^2_{table}$. Consequently, H_1 is accepted, indicating a statistically significant association between the situations of pregnant women who experience CED and cases of LBW. According to a study conducted by **[7]**, there is a correlation between maternal malnutrition during pregnancy and the occurrence of low birth weight in newborns.

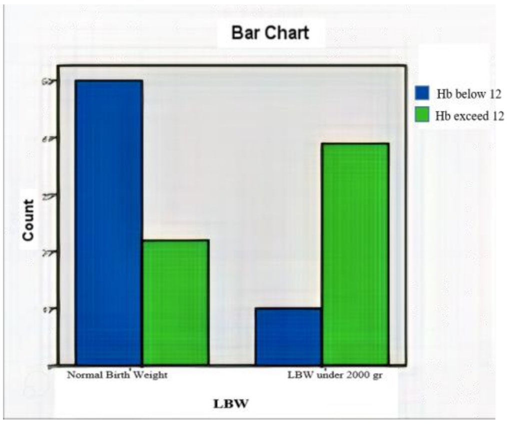

Figure 3. **The Graph Of Hemoglobin Health Condition And Its Relation With LBW**

The chi-square analysis yielded a $\chi^2_{value} = 28.05$, which exceeds the and $\chi^2_{table} = 3.84$. Consequently, we can conclude that $\chi^2_{value} > \chi^2_{table}$. In order to reject the H_0, it can be concluded that the hemoglobin levels below 11 in pregnant women have a significant impact on the occurrence of LBW) instances. It can be inferred that pregnant women with hemoglobin levels below 11 have heightened fatigue and susceptibility to illnesses, hence impacting the fetal development within the maternal womb. Consequently, this may lead to the birth of infants with low birth weight.

Table 5. Percentage of Relationship Between ANC and LBW

			Antenatal Care (ANC)		Total
			Complete ANC	ANC no more than once	
LBW	Normal Birth Weight	Count % within LBW	36 50%	36 50%	72 100%
	Birth Weight under 2000 gr	Count % within LBW	3 6.1%	46 93.9%	49 100%
	Total	Count % within LBW	39 32.2%	82 67.8%	121 100%

Data Source: *BPS, 2021* **[18]**

According to the data shown in **Table 5**, it is evident that pregnant women participants who have either never or only once attended antenatal care (ANC) at the health center faced a 93.9% likelihood of delivering babies with low birth weight (LBW). In contrast, the likelihood of delivering a low birth weight (LBW) infant is significantly reduced to 6.1% among those who have received comprehensive antenatal care (ANC). This outcome can be attributed to the diligent efforts made by expectant mothers who consistently engage in ANC, as it plays a crucial role in monitoring the well-being of both the mother and the developing fetus. The chi-square analysis yielded a $\chi^2_{value} = 25.7$, indicating statistical significance. As a result, the H_0 was rejected. This finding indicates a notable correlation between pregnant women who received comprehensive prenatal care and instances of low birth weight (LBW). The findings of this study align with the Aruben study, which posited that regular prenatal examinations or Antenatal Care (ANC) serve as a preventive measure against the occurrence of infants with low birth weight (LBW). Antenatal care tests are typically conducted a minimum of four times throughout the duration of pregnancy **[4]**.

3.3 Logit Model Factors Affecting LBW Cases

This study aims to examine the association between many factors, including maternal age, education level, number of children, birth spacing, chronic energy deficiency (CED), hemoglobin levels in pregnant women, and the utilization of antenatal care (ANC) during pregnancy, with the incidence of low birth weight (LBW). The objective is to develop a Logit iteration factor model for analyzing these relationships. The factors contributing to cases of low birth weight (LBW) can be elucidated as follows:

$$Z = -4.95 + 1.22X_1 - 0.22X_2 + 0.18X_3 + 1.02X_4 + 1.35X_5 - 1.77X_6 + 2.35X_7 \quad (6)$$

Hence,

$$p = \frac{1}{1+e^{-4.95+1.22X_1-0.22X_2+0.18X_3+1.02X_4+1.35X_5-1.77X_6+2.35X_7}} \quad (7)$$

3.4 Simultaneous Logistics Model Fit Test (G-Test)

The suitability test of all models with significant independent variables on LBW cases are using the G-Test Statistics:

$$G = -2\ln\left[\frac{L(Model\ B)}{L(Model\ A)}\right] = 100{,}37 \quad (8)$$

Table 6. Suitability Test of All Model with LBW Case

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
100.74[a]	0.406	0.548

Data Source: *SPSS, 2022*

The simultaneous test analysis, as indicated in **Table 6**, provides an explanation of the coefficients of the chi-square distribution parameters, namely $\chi^2_{table} = 14.07$ and $\chi^2_{value} = 26.059$. The results obtained, where $\chi^2_{value} > \chi^2_{table}$, signify the rejection of the H_0. This rejection implies that all independent variables hold significance in the context of low birth weight (LBW). Hence, it may be inferred that the aforementioned model can be employed for subsequent investigation.

3.5 Logistics Model Compatibility Test (Wald's Test)

Based on the results presented in above, each parameter was analyzed partially by using the Wald test, namely: Partial fit test of the model using the Wald test so that the values can be obtained:

$$W_j = \left[\frac{\widehat{\beta_j}}{SE(\widehat{\beta_j})}\right]^2, j = 1,2,3,4,5,6,7 \quad (9)$$

$$W_1 = \left[\frac{\widehat{\beta_1}}{SE(\widehat{\beta_1})}\right]^2 = \left[\frac{1.216}{0.624}\right]^2 = 3.8 \quad (10)$$

The suitability test of the multinomial logistics model. The factors that most influence the LBW cases are the variables X_1 with $df = 1, \alpha = 0.05$. We get that $\chi^2_{table} = 3.84$ and $W_1 = 3.8$, then $W_1 < \chi^2_{table}$. So, H_0 is accepted, means that there is no significant effect of maternal age during pregnancy on LBW cases.

$$W_2 = \left[\frac{\widehat{\beta_2}}{SE(\widehat{\beta_2})}\right]^2 = \left[\frac{0.22}{0.58}\right]^2 = 0.137 \quad (11)$$

The variable X_2 with $df = 1, \alpha = 0.05$, resulting $\chi^2_{table} = 3.84$ and $W_2 = 0.137$, then $W_2 < \chi^2_{table}$. So, H_0 is accepted, which means there is no significant relationship between the influence of mother's education on LBW cases.

$$W_3 = \left[\frac{\widehat{\beta_3}}{SE(\widehat{\beta_3})}\right]^2 = \left[\frac{0.182}{0.644}\right]^2 = 0.08 \quad (12)$$

Furthermore, the wald test with variable X_3 and $\chi^2_{table} = 3.84$, $W_3 = 0.08$. So, $W_3 < \chi^2_{table}$ and H_0 is accepted, meaning that there is no significant relationship between the number of children and LBW cases.

$$W_4 = \left[\frac{\widehat{\beta_4}}{SE(\widehat{\beta_4})}\right]^2 = \left[\frac{1.015}{0.621}\right]^2 = 2.67 \quad (13)$$

The variable X_4 with $df = 1, \alpha = 0.05$ giving $\chi^2_{table} = 3.84$ and $W_4 = 2.67$. As a result, $W_4 < \chi^2_{table}$. So, H_0 is accepted, means that there is no direct significant effect of birth spacing on LBW cases.

$$W_5 = \left[\frac{\widehat{\beta_5}}{SE(\widehat{\beta_5})}\right]^2 = \left[\frac{1.361}{0.054}\right]^2 = 6.35 \quad (14)$$

The variable X_5 with $df = 1, \alpha = 0.05$ where $\chi^2_{table} = 3.84$ and $W_5 = 6.35$. Consequently, $W_5 > \chi^2_{table}$. So, H_0 is rejected, which means there is a significant relationship of pregnant women who experience chronic energy deficiency to the cause of LBW.

$$W_6 = \left[\frac{\widehat{\beta_6}}{SE(\widehat{\beta_6})}\right]^2 = \left[\frac{1.767}{0.532}\right]^2 = 11.029 \quad (15)$$

The variable X_6 with $df = 1, \alpha = 0.05$ where $\chi^2_{table} = 3.84$ and $W_6 = 11.029$. Consequently, $W_6 > \chi^2_{table}$. So, H_0 is rejected, means that there is a significant relationship between pregnant women who experience hemoglobin below 12 causes of LBW cases.

$$W_7 = \left[\frac{\widehat{\beta_7}}{SE(\widehat{\beta_7})}\right]^2 = \left[\frac{2.345}{0.727}\right]^2 = 10.41 \quad (16)$$

The variable X_7 with $df = 1, \alpha = 0.05$, $\chi^2_{table} = 3.84$ and $W_7 = 10.41$. As a result, $W_7 > \chi^2_{table}$. So, H_0 is rejected, indicating a statistically significant association between pregnant women who regularly attend antenatal care (ANC) check-ups at health centers and cases of low birth weight (LBW).

According to the findings of the Wald test analysis, the variables that exhibit statistical significance in their association with cases of low birth weight (LBW) under the jurisdiction of Batakte Public Health Center are: The logistic model for pregnant women who exhibit chronic energy deficiency, low hemoglobin, and have either only undergone one antenatal care (ANC) visit or have never received ANC at the Batakte Public Health Center is as follows:

$$Z = -4.951 + 1.36X_5 + 1.77X_6 + 2.35X_7 \tag{17}$$

The logistic model yields the following result:

$$p = \frac{1}{1+e^{(-4.951+1.36X_5+01.77X_6+2.35X_7)}} \tag{18}$$

3.6 Interpretation of the Logistics Model of the Cause of LBW

The interpretation of the logistic model of cases causing LBW in the Batakte Public Health Center work area:

$$Z = -4.951 + 1.36X_5 + 1.77X_6 + 2.35X_7 \tag{19}$$

with parameters $\beta_0 = -4.951$. If all independent variables are set to 0, indicating their absence, the probability of pregnant women with low hemoglobin, chronic energy deficiency (CED), and lack of routine antenatal care (ANC) giving birth to babies with a low birth weight (LBW) risk is 0.69 or 69%. This is in comparison to mothers who have normal hemoglobin levels, do not experience CED, and receive routine ANC during pregnancy. The influence of pregnant women with CED (X_5) conditions with parameter $\beta_5 = 1.36$, then the value of the odds ratio $\ln\left(\frac{p_1}{p_0}\right) = 1.36$.

Additionally, the acquired data can be represented as $p_1 = 0.31\, p_0$. Therefore, pregnant women who have chronic energy deficiency (CED) have a 31% probability of giving birth to a low birth weight (LBW) infant, in contrast to adequately nourished pregnant women without CED. The impact of pregnant women who have low hemoglobin levels (X_6), with the parameter $\beta_6 = 1.77$, and an odds ratio value of $\ln\left(\frac{p_1}{p_0}\right) = 0.57$, results in the calculation of $p_1 = 0.57\, p_0$. The probability of pregnant women with low hemoglobin giving birth to a low birth weight (LBW) baby is 0.57, or 57%. The impact of pregnant women who do not consistently or regularly undergo antenatal care (ANC) tests is represented by the parameter $\beta_7 = 2.35$ which corresponds to an odds ratio $\ln\left(\frac{p_1}{p_0}\right) = 0.85$. This indicates that $p_1 = 0.85\, p_0$.

The likelihood of pregnant women who do not consistently engage in antenatal care (ANC) having low birth weight (LBW) babies is estimated to be 0.85 or 85%. Based on the findings of parameter interpretation, it has been determined that the primary factors contributing to cases of low birth weight (LBW) in the Batakte Public Health Center's jurisdiction are pregnant women who suffer from chronic energy deficiency, pregnant women with low hemoglobin levels, and those who have either never received or only received Antenatal care (ANC) once in the Batakte Public Health Center's jurisdiction.

4. CONCLUSIONS

Based on the results of this study, the logistic model of the parameters of the dominant factors causing LBW cases was the chances of risk of pregnant women with low hemoglobin, CED, and do not receive regular ANC will give birth to babies with LBW risk of 0,69 or 69% compared to mothers who have normal hemoglobin, do not experience CED, and receive routine having ANC during pregnancy. From the results of parameter interpretation, it is found that the dominant factors causing LBW cases in the Batakte Public Health Center are: 1. pregnant women who experience CED conditions have a risk of 31% giving birth to babies with LBW; 2. pregnant women with low hemoglobin levels below 11g/dl face a risk of approximately 57% in terms of giving birth to a baby with LBW; 3. the likelihood of pregnant women who do not engage in regular or consistent antenatal care (ANC) having a low birth weight (LBW) infant is estimated to be 85%.

ACKNOWLEDGMENT

The Research of this article was funded by DIPA of Public Service Agency of the University of Nusa Cendana 2022, Number: SP. DIPA.023.17.2.077528 /2022, on March 21, 2022, In accordance with the Rector Decree, Number: 4471.DBA.004.051B MAK 525119.

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