

Original Research

Estimation Of Low Birth Weight Risk In Indonesia: What Is The Most Appropriate Intervention?

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ABSTRACT

Background: The prevalence of low birth weight (LBW) in the world (20%) and in Indonesia is still high (12.4%). The importance of efforts to reduce the incidence of LBW is written in the global nutrition targets for 2025.

Methods: The study design in this study was quantitative using the data set 'Indonesian Demographic and Health Survey (IDHS) of 2017. The samples included in the research process were 13,269 samples with probability proportional to size (PPS) sampling technique. The research instrument was based on a modified DHS VII questionnaire. Data were analyzed by chi-square test, binary logistic regression, and Receiver Operating Characteristics (ROC).

Results: The prevalence of LBW in Indonesia is 7% [95% CI: 6.6, 7.5]. The final model for determining low birth weight after controlling for confounding was gemelli $P < 0.001$ [OR: 22,428; 95% CI: 14,145, 35,561], history of pregnancy complications $P < 0.001$ [OR: 1,906; 95% CI: 1.569, 2.315], education level $P = 0.002$ [OR: 1.581; 95% CI: 1.180, 2.117], economic status $P < 0.001$ [OR: 1.509; 95% CI: 1.225, 1.859], and gestational interval $P = 0.016$ [OR: 1.401; 95% CI: 1,066, 1,842]. The minimum probability of the prediction model is 2.8%-80.5% [AUC = 0.638; Sensitivity = 0.074; Specificity = 0.996].

Conclusion: Diagnostic performance with ROC evaluation on a predictive model of LBW determinant has very high specificity power. Mothers with gemelli status need to be the focus to reduce the risk of low birth weight.

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INTRODUCTION

Low birth weight (LBW) is still a public health problem and is a major global concern (Getaneh et al., 2020). Almost all countries experience low birth weight (World Health Organization, 2014a). Based on data from the World Health Organization (WHO), the incidence of low birth weight has an estimated birth weight range of 15% to 25%, or more than 20 million babies in the world experience low birth weight events.

The prevalence of low birth weight in Indonesia is 12.4% (Kementerian Kesehatan RI, 2018). When considering cases that have not been reported, there is a possibility of a higher prevalence compared to the reported data (World Health Organization, 2019).

The importance of efforts to reduce the incidence of low birth weight is reflected in the 2025 global nutrition targets in policies for comprehensive implementation plans for mothers, infants, and children (World Health Organization, 2014a). One of these policies is to reduce the incidence of low birth weight by 30% in 2025 (World Health Organization, 2018). The purpose of the policy is to increase attention, investment, and intervention actions that are effective and efficient. Thus, further studies are needed to reduce the 14 million to 20 million cases of low birth weight (World Health Organization, 2014b).

Birth weight is also a significant predictor determining a person's health status in the future (Mahumud et al., 2017). The quality of life of a nation will be indirectly determined by the quality of life of a baby. Babies who do not meet the normal estimation criteria are a vulnerable group that affects their health status (Farida, 2018). So, birth weight becomes an important indicator of infant health, both in terms of physical and cognitive development (Kusumawati, 2017). Babies with low birth weight status will be physically more susceptible to metabolic disorders in the future (Saragih & Yovsyah, 2017).

The determinants of the incidence of low birth weight in Indonesia are still being studied. Furthermore, research that estimates prediction models in Indonesia has not yet been formulated, and world research still has low sensitivity and specificity, so it is still unclear which risk factors are most appropriate to control. Several studies say the incidence of low birth weight is caused by multiple factors (Hasriyani et al., 2018) (Kusumawati, 2017) (Mahumud et al., 2017) (Rahfiludin & Dharmawan, 2018) (Siramaneerat et al., 2018) (Sunarseh & Wahtini, 2018).

Diagnostic performance on determinants of low birth weight in India has a high sensitivity but moderate specificity (sensitivity = 80.6%; specificity = 70.4%) (Metgud et al., 2013). In Malaysia also has a high sensitivity value but a moderate specificity based on maternal factors (sensitivity = 80%; specificity = 75%) (Yadav & Lee, 2013). Formulation of diagnostic performance on determinants of low birth weight is important to identify dominant risk factors and predict the accuracy of low birth weight.

Therefore, it is necessary to conduct research on the determinants of the incidence of low birth weight in Indonesia with the diagnostic performance of predictive models to determine the most appropriate intervention. The purpose of this study was to determine diagnostic performance by evaluating ROC on an LBW prediction model to determine the most appropriate intervention strategy in Indonesia.

MATERIALS AND METHOD

This study uses the latest data from the Indonesian Demographic and Health Survey (IDHS) of 2017. This type of research is an observational analytic study using a cross-sectional study design. The use of the design in this study aims to determine the prevalence of low birth weight (LBW) in a population, and then the exposure and effects are studied at the same time.

The research locations covered in the IDHS were 34 provinces, or all provinces in Indonesia. Data utilization and further analysis by researchers were carried out in Medan City, North Sumatra Province, Indonesia. The research carried out by the researchers began in February 2020 and ended in August 2022.

The population in this study were women of childbearing age (WUS) aged 15 to 49 years who had children aged 0–59 months in all provinces in Indonesia. The sample in the IDHS consists of 1,970 census blocks in urban and rural areas with a household sample size of 49,250 households. In all the household samples, 59,100 female respondents of childbearing age aged 15 to 49 years were obtained.

The sample in this study were women of childbearing age who had been selected and met the inclusion and exclusion criteria of the study. Based on the results of data cleaning that has been done, there are 13269 samples included in the study. The following is the flow of sampling carried out by the researcher (Figure 1).

The sampling technique used is determined by two stratified levels, the first stage is a systematic probability proportional to size (PPS) sampling technique based on the number of census blocks contained in each regency/city. Size refers to the number of households based on the 2010 Population Census (SP) listing results that are not included in special households (barracks, orphanages, prisons, and boarding houses with >10 people). Then the implicit stratification process is carried out by sorting the census blocks based on the category of rural, urban, and welfare index from the results of the complete enumeration of the 2010 Population Census

In the second stage, 25 ordinary households are selected (the sample size is calculated by considering the relative standard error (RSE) systematically in each census block based on the updated household output. Women of childbearing age in households that were selected as research samples and met the requirements were interviewed with a list of women of childbearing age in the age range of 15 years to 49 years. The inclusion criteria in this study are women of childbearing age with an age range of 15 years to 49 years, having children aged 0 months to 59 months living with their mothers in the selected sample, and having the baby weighed at birth. The exclusion criteria in this study are respondents who answered "don't know" during the interview and incomplete data on research variables.

The data collection was carried out on the Indonesian Demographic and Health Survey (IDHS) data collected through interviews using a research instrument in the form of a questionnaire based on the modification of the Demographic Health Surveys phase 7 (DHS VII) questionnaire and the signing of informed consent by respondents during interviews by field officers. The researcher obtained the data set by downloading it from a registered account.

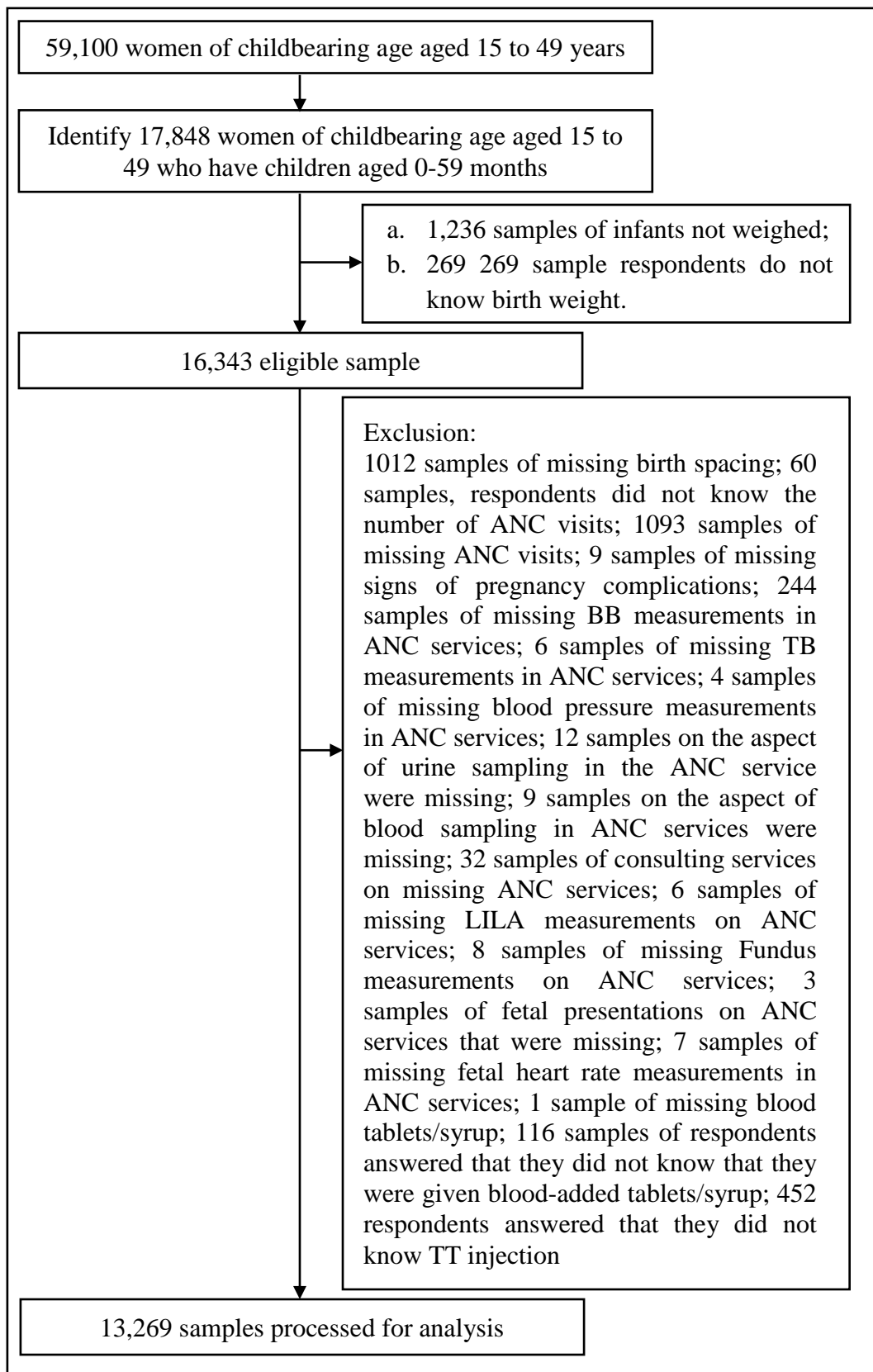


Figure 1. Sampling Flow

In this study, the univariate analysis aims to see the central distribution as well as the distribution for numerical variables and frequency distributions on categorical scale variables. Bivariate analysis using the chi-square test to determine the relationship between variables is then used for the selection or selection of candidates as predictive variables. The variable has a significant relationship if $p < 0.05$.

In the multivariate analysis using the binary logistic regression test, the analysis of the diagnostic performance of the prediction model was carried out by analyzing the Receiver Operating Characteristics (ROC) on the predicted output probabilities with the output sensitivity and specificity of the prediction model. In addition, analysis of the Area Under the ROC Curve (AUC) value is used to determine the level of accuracy of the predicted probabilities interpretation of the level of strength, namely: 50%-60% (very weak), 61%-70% (weak), 71%-80% (moderate), 81%-90% (strong), and 91%-100% (very strong).

In the dominant factor, there are terms of sensitivity and specificity as the outcome of diagnostic performance as a predictor for the occurrence of a topic under study. Sensitivity is the percentage of true positive cases whose observations are correctly predicted by the model. Specificity is the percentage of observations that are also correctly predicted and do not have true negative results from the model. The sensitivity and specificity estimates are obtained by defining the dependent variable (Y) to be a dichotomous result, $Y = 1$ if a disease occurs, and $Y = 0$ otherwise.

The presence or absence of a disease is defined as the "gold standard," and comparing it with a binary explanatory variable (X1), as long as the variables used are Predicted Probability is the probability of prediction for the occurrence of a point of interest (category 1) in subjects with certain characteristics. Epidemiological research usually estimates the risk of an outcome in a group of people compared to a reference group. The calculated effect measurement of the predicted probability is in line with the generalization of the standardization technique.

RESULTS

The prevalence of low birth weight in Indonesia is 7%, in the actual range of 6.6% to 7.5% (Table 1). The majority of mothers still have an optimal number of children, safe birth spacing, a good quantity of antenatal care (ANC), do not have multiple births, and have no history of pregnancy complications. However, the mother's education level is still low, her economic status is low, and the quality of antenatal care services is poor.

The average maternal age, parity, gestational interval, and quantity of antenatal care services are in the optimal category. Nevertheless, these variables are in the aspect of the lowest value, and the highest value is in the very risky category. Among all the risks, only abortion history and quality of ANC services were not associated with LBW.

The diagnostic performance of the prediction model is adequate in categories with the best specificity, where Gemelli, history of pregnancy complications, education level, economic status, and distance from pregnancy are risk factors that must be controlled.

Table 1. This is a table. Tables should be placed in the main text near the first time they are cited
Characteristics of LBW Risk Factors in Indonesia

Characteristic	Frequency	Percentage	95% CI
Variable			
LBW	934	7.0	6.6-7.5
Normal	12335	93.0	92.5-93.4
Mother's Age			

Characteristic	Frequency	Percentage	95% CI
At risk (<20 and >35 Years)	3027	22.8	22.1-23.5
No Risk (20-35 Years Old)	10242	77.2	76.5-77.9
Mother's Education Level			
Low	10813	81.5	80.8-82.2
High	2456	18.5	17.8-19.2
Economic Status			
Low	5873	44.3	43.4-45.1
Moderate	2653	20.0	19.3-20.7
High	4743	35.7	34.9-36.6
Parity			
At risk (1 and >3 children)	6286	47.4	46.5-48.2
No Risk (2-3 children)	6983	52.6	51.8-53.5
Gestational Interval			
At risk (<2 years)	801	8.9	8.3-9.5
No Risk (\geq 2 years)	8202	91.1	90.5-91.7
Gemelli			
Yes	81	0.6	0.5-0.7
No	13188	99.4	99.3-99.5
Abortion History			
Ever Aborted	2026	15.3	14.7-15.9
Never Abort	11243	84.7	84.1-85.3
History of Pregnancy Complications			
Yes	2355	17.7	17.1-18.4
No	10914	82.3	81.6-82.9
Quality of ANC Service			
Bad	10928	82.4	81.7-83.0
Good	2341	17.6	17.0-18.3
Quantity of ANC Service			
Bad (<4 times)	970	7.3	6.9-7.8
Good (\geq 4 times)	12299	92.7	92.2-93.1

Average of mother age is 29.8 years old, and mother was check to antenatal care 8.24 times during pregnancy (Table 2).

Table 2. Characteristics of Mother During Pregnancy

Variable	Mean	SD	Min	Max	95% CI
Mother's Age	29.08	6.314	15	48	28.97-29.19
Parity	2.29	1.346	1	12	2.27-2.32
Gestational Interval	5.77	3.358	0.75	28.42	5.70-5.84
Quantity of ANC Service	8.24	3.313	1	40	8.19-8.30

Based on research analysis, only the history of abortion ($P = 0.183$) and quality of antenatal care ($P = 0.190$) did not have a significant relationship with the occurrence of LBW. The other variables were maternal age ($P = 0.021$), maternal education level

($P < 0.001$), economic status ($P < 0.001$), parity ($P < 0.001$), gestational interval ($P = 0.031$), Gemelli ($P < 0.001$), history of complications ($P < 0.001$), and quantity of ANC services ($P < 0.001$) had a significant relationship with the occurrence of LBW (Table 3).

Table 3. Determinants of Low Birth Weight

Variable	LBW Status				Total n	OR	95% CI	P- Value
	LBW		Normal					
	n	%	n	%				
Mother's Age								
At risk	242	8.0	2785	92.0	3027	1.199	1.030-1.397	0.021
No Risk	692	6.8	9550	93.2	10242			
Mother's Education Level								
Low	806	7.5	10007	92.5	10813	1.465	1.209-1.775	<0.001
High	128	5.2	2328	94.8	2456			
Economic Status								
Low	495	8.4	5378	91.6	5873	1.593	1.364-1.861	<0.001
Moderate	180	6.8	2473	93.2	2653	1.260	1.035-1.534	
High	259	5.5	4484	94.5	4743			
Parity								
At risk	505	8.0	5781	92.0	6286	1.335	1.168-1.525	<0.001
No Risk	429	6.1	6554	93.9	6983			
Gestational Interval								
At risk	68	8.5	733	91.5	801	1.348	1.036-1.755	0.031
No Risk	528	6.4	7674	93.6	8202			
Gemelli								
Yes	48	59.3	33	40.7	81	20.196	12.898-31.624	<0.001
No	886	6.7	12302	93.3	13188			
Abortion History								
Ever Aborted	128	6.3	1898	93.7	2026	0.873	0.720-1.059	0.183
Never Abort	806	7.2	10437	92.8	11243			
History of Pregnancy Complications								
Yes	261	11.1	2094	88.9	2355	1.897	1.632-2.205	<0.001
No	673	6.2	10241	93.8	10914			
Quality of ANC Service								
Bad	754	6.9	10174	93.1	10928	0.890	0.751-1.054	0.190
Good	180	7.7	2161	92.3	2341			
Quantity of ANC Service								
Bad	108	11.1	862	88.9	970	1.740	1.408-2.152	<0.001
Good	826	6.7	11473	93.3	12299			

Further analysis, the variables suspected as confounding with the order of removing the variables from the largest to the smallest, namely history of abortion, parity, maternal age, quality of ANC services, and lastly, the quantity of ANC services, to obtain a fit model. After the confounding control process, none of the confounding variables were found, so a fit determinant model was obtained (Table 4).

Table 4. Final Model of Determinants of Low Birth Weight After Confounding Control

Variable	B	P	OR	95% CI
Low Education Level	0.458	0.002	1.581	1.180-2.117
High Economic Status (references)		0.001		
Low Economic Status	0.411	<0.001	1.509	1.225-1.859
Medium Economic Status	0.222	0.091	1.248	0.965-1.615
Pregnancy Distance < 2 years	0.337	0.016	1.401	1.066-1.842
Gemelli	3.110	<0.001	22.428	14.145-35.561
Low Education Level	0.645	<0.001	1.906	1.569-2.315
Constant	-3.545	<0.001	0.029	

Note: R² = 6,7%

The probability model of binary logistic regression can be formulated as follows:

$$P(x) = 1/(1+e^{-y})$$

Information:

e = 2,718

y = -3.545 + 3.110 (gemelli) + 0.645 (history of pregnancy complications) + 0.458 (education level) + 0.411 (economic status) + 0.337 (distance of pregnancy).

The probability of the occurrence of low birth weight will be smaller when a person does not have gemelli risk factors. The probability of predicting the occurrence of low birth weight is at its minimum point if a person does not have all the above risk factors of 2.8%. On the other hand, if a person has all the above risk factors, the probability of predicting the occurrence of low birth weight is 80.5% (Figure 2).

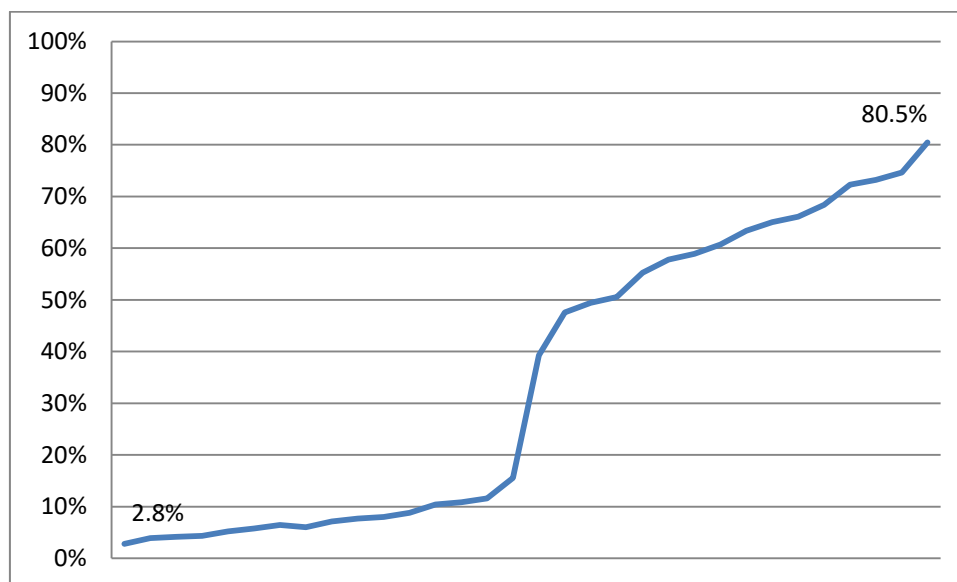


Figure 2. The Probability of Low Birth Weight in Indonesia Based on Dominant Risk Factors

Based on the results of the research, the diagnostic performance with ROC evaluation on the low birth weight determinant prediction model obtained a very high level of specificity (AUC = 0.638; Sensitivity = 0.074; Specificity = 0.996) (Figure 3).

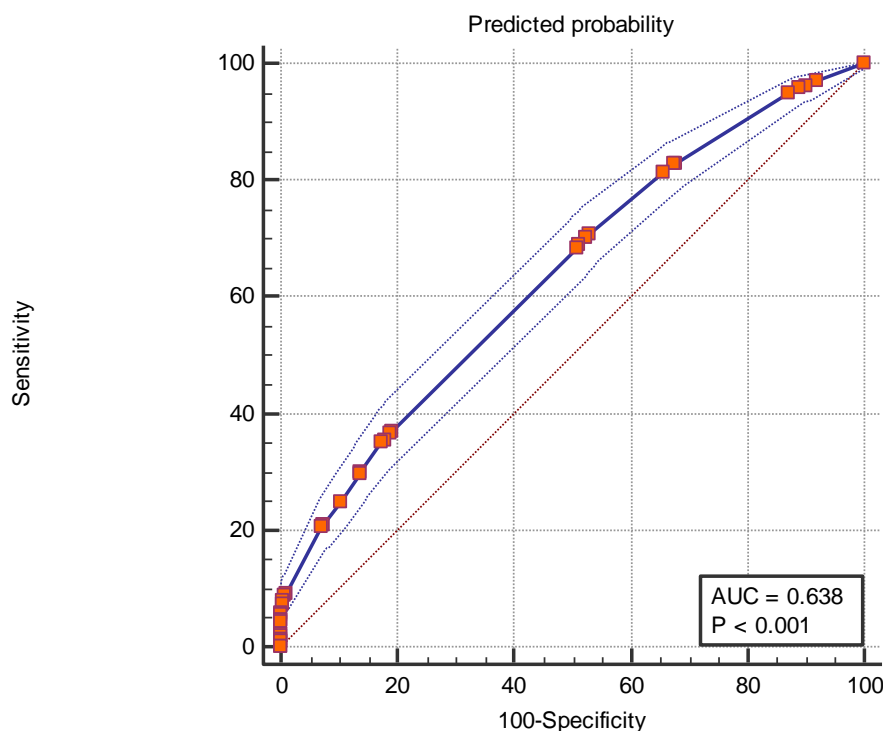


Figure 3. ROC Curve Prediction Model for Low Birth Weight Determinants in Indonesia

DISCUSSION

Based on the multivariate analysis that has been carried out using binary logistic regression, it is found that the Gemelli variable is the dominant variable for the occurrence of low birth weight in Indonesia. Mothers with Gemelli status had a 22.428-times greater risk of giving birth to children with low birth weight than non-Gemelli mothers ($P < 0.001$). Gemelli's status is at risk for low birth weight (Maidartati et al., 2019).

Mothers with Gemelli status are more likely to be implicated in excessive uterine distension. Therefore, it is not uncommon for mothers to experience premature labor and struggle with nutrition (Tonasih & Kumalasary, 2018), increase IUGR, abnormal presentation, congenital abnormalities, and trigger complications (Kesavan & Devaskar, 2019). Simultaneously, mothers with Gemelli status will have an increased incidence of pregnancy complications (Permana & Wijaya, 2019).

Mothers with low education do not have sufficient knowledge about the care of mothers with Gemelli status and preventive behavior for pregnancy complications (Jumhati & Novianti, 2018). This low level of education will lead to a low economic status, so with this low economic status, the fulfillment of nutrition for the mother and fetus is not optimal (Permatasari et al., 2021). The status of Gemelli and pregnancy complications will be exacerbated if you have a close pregnancy distance (< 2 years) because it causes inadequate maternal nutrition and the condition of the uterus has not recovered, thus increasing the risk of low birth weight (Susanti, 2018).

Based on predictive modeling, if the mother has all the risk factors in the form of Gemelli status, has a history of pregnancy complications, low education level, low economic status, and a pregnancy interval of under 2 years, she has a probability of low birth weight of 80.5%. However, the fitted model still has weak diagnostic performance

(AUC = 0.638, sensitivity = 0.074, and specificity = 0.996). A more robust methodological approach as well as the addition of variables to the risk factors for low birth weight will help increase the sensitivity of the predictive model (Hassen et al., 2020).

In the study of Yadav & Lee, (2013), the diagnostic performance of predictive models based on aspects of blood pressure has a sensitivity and specificity of 70%. However, after the addition of maternal factors such as age, ethnicity, monthly family income, and BMI before pregnancy, the diagnostic performance of the model increased with a sensitivity of 80% and specificity of 75%. Many variables have not been studied in this study to improve the diagnostic performance of the predictive model.

In the study of Kitsantas et al., (2006), the sensitivity was at least 63.7% with monitoring of maternal weight during pregnancy, health problems, ethics, smoking status, parity, marital status, and education level as predictors of low birth weight variables. The research of Singh et al., (2014) showed a sensitivity of 65% and a specificity of 84% with a model in the form of inadequate maternal weight during pregnancy, inadequate protein intake, having a history of premature birth, having a history of low birth weight babies, anemic mothers, and passive smoking. However, the incidence of low birth weight can be prevented based on the main risk factors based on aspects of family planning.

Interventions for mothers with Gemelli status and those who have a history of pregnancy complications need to be emphasized by paying attention to the fulfillment of maternal nutrition during pregnancy and strengthening the quality of ANC (Hartiningrum & Fitriyah, 2018). ANC services in China have nutritional fulfillment programs in addition to consuming Fe tablets, namely in the form of consuming folic acid supplements, controlling alcohol, controlling cigarette exposure, and controlling lifestyle (Pei et al., 2016). In terms of maternal nutrition, based on a systematic review study, multiple micronutrient (MMN) supplements can reduce the risk of low birth weight more effectively than folic acid supplements (Lopes et al., 2017).

Therefore, the program in Indonesia needs to be modified, namely, in addition to giving Fe tablets, it is important to give MMN supplements as a mandatory program. MMN supplements meet daily nutrients such as vitamin A, vitamin B1, vitamin B2, niacin, vitamin B6, vitamin B12, folic acid, vitamin C, vitamin D, vitamin E, copper, selenium, and iodine with iron and zinc with reduced LBW in the range of 11%-14% and BBJR in the range of 10%-17% (Lopes et al., 2017). Mothers with a high level of education can improve the economic status of their families.

In addition, mothers with higher education will be able to make decisions about their reproductive health, including visits to health services (Siramaneerat et al., 2018). In the national implementation program in "health and clinical centers of the country under the supervision of the Iranian Ministry of Health", mothers with various levels of education, as well as pregnant women, must know about maternal and child health. The "family physician" program has an important role in face-to-face education to control risk factors for low birth weight (Hajizadeh et al., 2017).

The strengthening of exclusive breastfeeding programs for 2 years or more needs to be strengthened to control the optimal spacing of pregnancies (Tarigan et al., 2017).

CONCLUSION

LBW in Indonesia is still very high. Additionally, the mother's education level is still at low level, her economic status is low, and the quality of antenatal care services is

poor. Diagnostic performance with ROC evaluation on the predictive model of low birth weight determinants obtained a very high specificity power. Mothers with Gemelli status need to be the main focus of program modifications, namely, in addition to giving Fe tablets, it is necessary to provide multiple micronutrient (MMN) supplements and control alcohol, cigarette exposure, and lifestyle during pregnancy to reduce the risk of low birth weight. Subsequent research suggests formulating intervention models based on the risk factors that have been found.

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