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The Maternal Sociodemographic Determinants of Low Birth Weight in Indonesia

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Abstract

LBW is one of the highest predictors of infant and child mortality. In Indonesia, more than 100 thousand newborns experience LBW cases. In addition to birth intervals, there are maternal sociodemographic factors can explain cases of LBW, such as age, parity, location of residence, marital status, education, and level of maternal welfare. For this reason, this study aims to analyze the association between birth intervals and maternal sociodemographic factors in LBW cases using the 2017 IDHS data. The study results show that 1 in 10 babies is born with LBW. More than half are found in rural areas, with secondary education of the mother, and in the poorest conditions. SRS results show that birth interval has no significant association with LBW. However, from the results of MLR, birth interval, parity, mother's age, residency, education, and the interaction between education and birth interval are significant determinants of LBW. Mothers who have children with short (<24 months) or long (>48 months) birth intervals, live in urban areas, have a lower level of education, and are under 20 or over 35 years old have a greater chance of giving birth to LBW babies. Meanwhile, mothers with more children have a slight chance of giving birth to LBW babies. These findings show the critical role of family planners in educating partners and parents in Indonesia regarding the potential risks of LBW babies according to the mother's sociodemographic condition.

Introduction

Low birth weight (LBW), defined as a baby weighing less than 2.5 kilograms at birth, is the strongest predictor of infant and toddler death (WHO, 2005). Because of this LBW syndrome, babies are at a higher risk of stunting and acquiring noncommunicable diseases like diabetes, hypertension, and heart disease as adults, as well as having a shorter life expectancy (Brumana et al., 2017; Mwabu, 2009). The birth interval, defined as the time between a live birth and the conception of a subsequent fetus by Merklinger-Gruchala et al. (2015) is one factor affecting LBW. The birth interval is associated with a more than fifty percent rise in LBW (Shah et al., 2022; Zhu, 2005).

According to data from the 2019 Directorate of Community Nutrition, 111,827 infants in Indonesia have low birth weights (Ministry of Health, 2020). Furthermore, according to data from the Ministry of Health of the Republic of Indonesia in 2019, 69% of the fatalities of children under the age of five happened during the neonatal period. LBW was the leading cause of death in all recorded newborn deaths, accounting for 7,150 instances (35.3%). The pregnancy interval, which produces low maternal nutritional status, is one of the reasons that can explain LBW instances, according to (Guevara-Romero et al., 2021). The time between births is critical in determining the baby's health. The WHO (2006) recommends a minimum of 24 months between births. Furthermore, the risk of LBW is increases during the first child's birth (Kyozuka et al., 2019).

The prevalence of LBW varies significantly according to the country's socioeconomic situation, healthcare system, maternal variables, and other empirical criteria (Habibov & Fan, 2011). In a Nepal study, Anil et al. (2020) discovered that maternal

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variables such as maternal age, LBW history, smoking during pregnancy, and health problems all enhance the risk of LBW. Bird et al. (2000) found that the mother's marital status influences LBW, with married moms having a lower likelihood of producing LBW babies than unmarried mothers (pregnant outside of marriage). Furthermore, Auger et al. (2008) claim that short birth intervals (less than 12 months) and unmarried pregnancies increase the chance of LBW newborns. Wubetu et al. (2021) found that the prevalence of LBW was highest among mothers under the age of 20 who were low-income, single, alcoholic, uneducated, and multigravida. According to these studies, researchers typically employ two to three maternal factors as model predictors, even though using maternal factors in a more sophisticated manner may result in a superior model for evaluating the incidence of LBW in Indonesia.

Several rigorous research has been done to determine the precise cause of LBW. However, the results have yet to be resolved. As a result, the primary goal of this research is to examine the relationship between birth intervals and LBW in Indonesia, a low-middle-income country with a relatively high LBW rate in the world (10th position) (Haksari, 2019). The second goal is to examine the maternal characteristics that influence the condition of LBW, specifically the mother's age, parity, education, marital status, welfare index, and home area (Habibov & Fan, 2011; Momeni et al., 2017; Ngwira, 2019; Sharma et al., 2015; Yanuar et al., 2019). The study's premise is that increasing the level of poverty, education, mother's age, and birth interval will positively improve prenatal health care utilization, increasing the likelihood of normal birth weight kids. On the other hand, parity, married status, and home location will negatively impact LBW.

Method

This paper is a quantitative study based on secondary data. The dataset utilized in this study was derived from the Indonesian Demographic and Health Survey (IDHS), which was conducted in 2017 by the National Family Planning Coordinating Board (BKKBN), the Central Statistics Agency (BPS), and the Ministry of Health (IDHS, 2017). The dataset used was 9,527 samples; the variables are listed in Table 1 below. The sample exclusively included mothers who had live-born children. Some of the literature examines the determinants of LBW using various analytical methods such as binary logistic regression, regression quintile, and two-stage least squares (2SLS) (Anil et al., 2020; Geraci, 2016; Habibov & Fan, 2011).

TABLE 1. Research Variables

Variable Name	Unit/Level of Variable	Range/Categories	Data Scale
Dependent Variable			
- Child Birth Weight (CBW)	In grams (most recent birth)	200-7.500 grams	Numeric/Ratio
Independent Variable			
- Mother's Age	Mother's age at the most recent birth	15-48 years old	Numeric/Ratio
- Parity	Number of live births of the mother	2-12 children	Numeric/Ratio
- Residence	Type of residence place of the mater	1: Urban 2: Rural	Categoric/Nominal
- Marital Status	Marital status of a mother	0: Never in union 1: In union 2: Divorced/widowed	Categoric/Nominal
- Birth Interval	Preceding birth interval (most recent birth)	0: Short <25months 1: Medium 25-48 months 2: Long ≥49months	Categoric/Ordinal
- Education	The highest educational level of the mother	0: No education 1: Primary 2: Secondary 3: Higher	Categoric/Ordinal
- Wealth	Wealth quintile of the mother	1: Poorest 2: Poorer 3: Middle 4: Richer 5: Richest	Categoric/Ordinal

Source: IDHS, 2017

This essay will estimate the socio-demographic effect of mothers on LBW cases using multiple linear regression (MLR). MLR is used to determine the effect of socio-demographic variables on birth weight to distinguish the characteristics of mothers who give birth to normal and LBW kids to prevent and avoid future cases of LBW. An interaction is generated in the regression model between the birth interval and the mother's education because, according to Howard et al. (2013), the birth interval is a risk factor that mothers can alter through educational measures. We also include the quadratic maternal age variable in the model because, according to Habibov & Fan (2011) and McGovern (2013) there is a quadratic trend in the maternal age variable, with birth weight being higher in mothers aged 20-35 years and lower in mothers aged under 20 years and over 35 years. Furthermore, this variable is employed to overcome the model's cases of heteroscedasticity (Christensen, 2019). In addition to MLR, we employ descriptive statistics and correlation analysis to summarize the data and assess the response distribution (Cleff, 2019).

Result and Discussion

The research begins by cross-tabulating the association between LBW and maternal sociodemographic determinants. Table 2 shows the distribution of LBW in each determining group. The average maternal age and number of live births among the 9,527 moms were 31.542 years (SD=5.432) and three children (SD=1.249). In general, the frequency of LBW is nearly comparable in rural and urban areas, with a 3.5% difference (Table 2). Almost two-thirds of newborns have long birth intervals (49 months). Meanwhile, the sample was dominated by mothers who were in a relationship/married (95%) and had secondary education (55.8%) based on maternal variables.

TABLE 2. Summary Statistics of Child Birth Weigth on Socio-demographic Determinants of Mothers

Variables	Frequency	%	Mean of Birth Weight	Standard Deviation	95% Confidence Interval		LBW
Birth weight	9,527	100.0	3,187.24	548.40			1,024 (10.75)
Residence							
- Urban	4,927	51.72	3,176.98	527.86	3,162.24	3,191.72	473 (46.19)
- Rural	4,600	48.28	3,198.22	569.43	3,181.77	3,214.68	551 (53.81)
Marital Status							
- Never in union	4	0.04	2,975.00	512.35	2,472.85	3,477.15	1 (0.10)
- In union	9,305	97.67	3,188.61	546.70	3,177.50	3,199.72	992 (96.88)
- Divorced/widowed	218	2.29	3,132.59	616.30	3,050.77	3,214.41	31 (3.03)
Birth Interval							
- Short <25m	965	10.13	3,171.50	558.12	3,136.28	3,206.72	117 (11.43)
- Medium 25-48m	2,441	25.62	3,217.44	549.20	3,195.65	3,239.23	238 (23.24)
- Long ≥49m	6,121	64.25	3,177.68	546.17	3,163.99	3,191.36	669 (65.33)
Education							
- No education	96	1.01	3,000.66	643.43	2,871.93	3,129.38	23 (2.25)
- Primary	2,604	27.33	3,143.28	593.12	3,120.49	3,166.06	378 (36.91)
- Secondary	5,316	55.80	3,200.29	534.75	3,185.91	3,214.67	514 (50.20)
- Higher	1,511	15.86	3,228.94	500.35	3,203.72	3,254.18	109 10.64)
Wealth							
- Poorest	2,235	23.46	3,162.50	615.02	3,137.00	3,188.00	347 (33.89)
- Poorer	1,916	20.11	3,179.20	557.16	3,154.25	3,204.15	221 (21.58)
- Middle	1,850	19.42	3,201.62	522.73	3,177.80	3,225.45	174 (16.99)
- Richer	1,784	18.73	3,203.89	519.53	3,179.78	3,228.00	144 (14.06)
- Richest	1,742	18.28	3,195.50	500.66	3,171.98	3,219.01	138 (13.48)

Source: primary data analysis from the IDHS 2017

Table 2 further shows that the average birth weight in all variables is higher than 2,500, indicating normal conditions. However, there are still many incidences of LBW in Indonesia, where one out of every ten kids is born with LBW. More than half of the LBW cases were in rural regions with lengthy birth intervals (64.33%) and moms with secondary education (50.2%). One-third of LBW instances are seen in the most vulnerable women. Then we identify the association between LBW and the maternal sociodemographic determinants. According to Cleff (2019), explanatory variables must have a high correlation with the response variable to be relevant and sufficient for identifying the model. The Pearson correlation for interval/ratio scale variables, ANOVA (F-test) for nominal scale variables, and Spearman's Rank for ordinal scale variables are employed to examine the relationship between birth weight and its statistical determinants (Cleff, 2019). Table 3 shows the results of the correlation. The test results demonstrate that although the link is very weak, the variables parity, level of education, and maternal welfare have a positive and significant correlation with birth weight. Birth weight has a negative and substantial relationship with the birth interval variable. Other variables, such as the mother's age and marital status, exhibit no significant link with birth weight. However, the residency variable is significant at the 10% level. Nonetheless, we will attempt to add these variables into the model to investigate their relationship with birth weight.

TABLE 3. Correlation Analysis Between Birth Weight and Mother's Sociodemographic Determinants

Variables	Coefficient	P-value
Pearson Correlation	1	
Parity	0.029	0.025*
Mother's Age	-0.006	0.573
ANOVA (F-test)		
Residence	3.570	0.059**
Marital Status	1.410	0.244
Rank Spearman		
Birth Interval	-0.020	0.050*
Educational Level	0.066	<0.001*
Wealth Index	0.040	<0.001*

Source: primary data analysis from the IDHS 2017

Note: *significant at the 5% level

After identifying the correlation, we construct the simple linear regression model to estimate the relationship between birth interval and LBW, the results of which are shown in Table 4 below. The study's initial hypothesis was that the birth interval had no effect on LBW. Table 4's t-test and p-values show that the relationship between birth interval and birth weight is significant at the 5% level (p=0.01). Babies born at medium birth intervals weighed 45.94 grams more than babies born at short birth intervals (p=0.028). At the same time, there was no statistically significant difference in birth weight between babies with long and short birth intervals (p=0.745). Furthermore, this model has a very low Adjusted R2 (<1%).

TABLE 4. Linear Regreesion of Birth Interval and the Child Birth Weight

Variable	Coefficient	SE	t-value	P-value	95% CI	
Model Parameter						
Birth Interval						
- Short <24 m	Ref					
- Medium 25-48m	45.940	20.844	2.200	0.028*	5.081	8.799
- Long 49+m	6.176	18.986	0.330	0.745	-31.041	43.392
Constanta	3,171.501	17.646	179.730	<0.001*	3,136.910	3,206.091
The goodness of fit model						
- F-test	5.030			0.0065*		
- R-squared	0.0011					
- Adjusted R-squared	0.0008					

Source: primary data analysis from the IDHS 2017

Note: *significant at the 5% level

In this section, we will examine the relationship between birth weight and maternal sociodemographic variables and the interaction between birth weight and the mother's education. According to Muula et al. (2011) and Sharma et al. (2015), mothers with a higher level of education are more likely to develop birth plans for their children, including birth intervals between children, to prevent pregnancy risks such as LBW. The anticipated value of each birth interval to schooling, which forms a parallel line (Figure 1.a), serves as the foundation for this model interaction, with the difference value always being the same (Table 5). The interaction result between birth interval and the mother's education is reported in Table 6.

Table 5. The Difference of Birth Interval Based on Maternal Educational Level

Difference	No Education	Primary	Secondary	Higher
Medium - Short	52.55	52.55	52.55	52.55
Long - Medium	-23.49	-23.49	-23.49	-23.49
Long - Short	29.05	29.05	29.05	29.05

Source: primary data analysis from the IDHS 2017

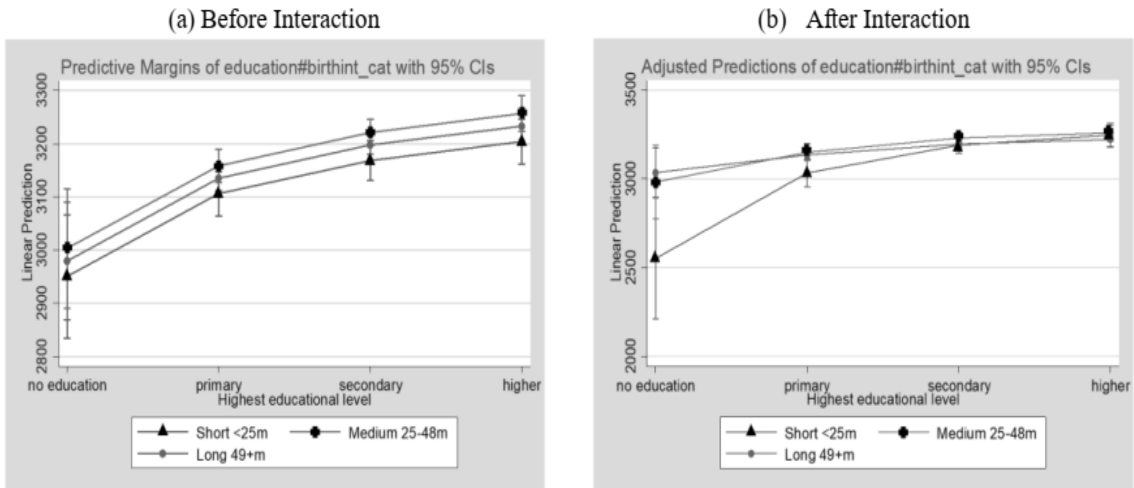

Figure 1. The Predicted Values of Birth Weight Based on Birth Interval and Mother's Education

Figure 1.b depicts MLR results with the interaction between birth interval and the mother's education. The regression line for each birth interval group is no longer parallel. Instead, it creates an interaction in which the birth weight discrepancy between short birth intervals and other categories is most significant in mothers who do not attend school. However, this gap will narrow as mothers' education increases. After equations 3-4, a detailed explanation of this interaction is provided.

The MLR findings of the two models are shown in Table 6. In the first model, we include all predictor factors, although certain variables, such as welfare level and marital status, are insignificant based on the joint F-test results. Except for the interaction parameter between the medium birth interval and elementary school (p=0.122), practically all categories in each birth weight variable were significant at the 5% level in Model 2. Meanwhile, the joint F-test revealed a significant interaction between education and birth interval at the 10% level (p=0.0605). This model's adjusted R2 value is 0.0098, indicating that all predictor variables can explain only 0.98% of the total variation in birth weight in the model.

Table 6. Multiple Linear Regression of Birth Weight and Mother's Sociodemographic Determinants

Variable	Model 1				Model 2			
	B	SE	t	P>t	B	SE	t	P>t
Parity	25.910	5.628	4.600	<0.001*	23.918	5.567	4.300	<0.001*
Mother's Age	24.439	9.946	2.460	0.014*	26.150	9.927	2.630	0.008*
Mother's Age Squared	-0.425	0.155	-2.740	0.006*	-0.446	0.155	-2.880	0.004*
Residence								
- Urban	Ref				Ref			
- Rural	45.858	12.592	3.640	<0.001*	35.992	11.548	3.120	0.002*
Birth Interval								
- Short <25 months	Ref				Ref			
- Medium 25-48 months	443.695	202.396	2.190	0.028*	442.223	202.422	2.180	0.029*
- Long 49+ months	497.413	187.188	2.660	0.008*	499.435	187.173	2.670	0.008*
Educational Level								
- No schooling	Ref				Ref			
- Primary School	482.285	177.538	2.720	0.007*	484.527	177.543	2.730	0.006*
- Secondary School	631.781	174.975	3.610	<0.001*	643.627	174.880	3.680	0.000*
- Higher (diploma or above)	682.852	177.155	3.850	<0.001*	697.644	176.905	3.940	0.000*
Wealth Index								
- Poorest	Ref							
- Poor	17.218	17.475	0.990	0.325				
- Middle	43.081	18.392	2.340	0.019*				
- Rich	43.745	19.389	2.260	0.024*				
- Richest	28.162	21.113	1.330	0.182				
Marital Status								
- Never in union	Ref							
- In union/marriage	196.836	273.585	0.720	0.472				
- Divorced/widowed	157.111	275.949	0.570	0.569				
Interaction Between Birth Interval and Education								
- Medium 25-48m#Primary	-326.590	207.636	-1.570	0.116	-321.187	207.647	-1.550	0.122
- Medium 25-48m#Secondary	-404.022	204.326	-1.980	0.048*	-401.385	204.351	-1.960	0.050*
- Medium 25-48m#Higher	-432.357	206.693	-2.090	0.036*	-429.481	206.720	-2.080	0.038*
- Long 49+m#Primary	-392.605	191.589	-2.050	0.040*	-389.660	191.586	-2.030	0.042*
- Long 49+m#Secondary	-492.032	188.793	-2.610	0.009*	-490.761	188.782	-2.600	0.009*
- Long 49+m#Higher	-515.900	191.388	-2.700	0.007*	-516.416	191.374	-2.700	0.007*
Constant	1902.232	356.145	5.340	<0.001*	2088.556	234.380	8.910	<0.001*
The goodness of Fit Model								
F-test of Model	4.78			<0.001*	6.260			0.000*
R-squared	0.009				0.0098			
Adj R-squared	0.008				0.0082			
Joint F-test								
- Wealth Index	1.84							
- Marital Status	0.82							
- Interaction	1.98			0.0647**	2.01			0.0605**

Source: primary data analysis from the IDHS 2017
Note: *significant at the 5% level, **significant at the 10% level

Equations 1-3 below illustrate the equations for each model. According to these equations, short birth intervals have the lowest slope value of 2,088.56, while medium and long birth intervals have slope values of 2,530.78 and 2587.99, respectively. This result suggests that short birth intervals are one of the factors that contribute to LBW cases.

- Short Birth Interval (Less than 24 months)

$$BW = 2088.56 + 23.92\ Parity + 26.15\ Age - 0.45\ Age^2 + 35.99\ Rural + 484.53\ Primary\ Educ + 643.63\ Seconder\ Educ + 694.64\ Diploma\ or\ above \quad (1)$$

- Medium Birth Interval (24-48 months)

$$BW = 2530.78 + 23.92\ Parity + 26.15\ Age - 0.45\ Age^2 + 35.99\ Rural + 163.34\ Primary\ Educ + 242.24\ Seconder\ Educ + 268.16\ Diploma\ or\ above \quad (2)$$

- Long Birth Interval (More than 48 Months)

$$BW = 2587.99 + 23.92\ Parity + 26.15\ Age - 0.45\ Age^2 + 35.99\ Rural + 94.87\ Primary\ Educ + 152.87\ Seconder\ Educ + 181.22\ Diploma\ or\ above \quad (3)$$

Based on equations 1-3, we know that parity has a positive relationship with birth weight, such that every extra kid held by the mother is connected with an additional birth weight of 23.92 grams, providing the other factors are constant. In their study, Oladeinde et al. (2015) and Thompson et al. (2001) explained that firstborn children had a higher risk of LBW than their siblings. It is because the mother has previously had the experience of nurturing the kid in her womb, including supplying her nutritional needs so that successive births can result in the birth of a normal-weight infant. Meanwhile, we employ prediction margins to assess the influence of the mother's age on birth weight because this variable has a quadratic effect. The margin value shows a growth pattern in birth weight from 3,100 to 3,200 grams from the mother's age of 15-30 years. However, starting at 30 and up, birth weight decreased by up to 3,050 grams at the age of 48. These findings are supported by research from Iran, where risk factors for LBW are more prevalent among young mothers in 1109 hospitals (Roudbari et al., 2007). Ngwira (2019) found that the prevalence of LBW was 37.5% higher in women aged 20 and under and 29.5% higher in moms aged 35 and up. According to Vilanova et al. (2019), adolescents aged 15-20 still need to complete their studies at the secondary and postsecondary levels. Therefore pregnancy literacy remains low. Furthermore, they are regarded as physically and intellectually unprepared (Astone et al., 2007; Liu et al., 2008)

Furthermore, after controlling for other variables, people in rural areas have a 35.99 gram greater average birth weight than people in cities. These findings differ from those of several other studies because moms in urban regions typically have easier access to prenatal healthcare (nutritionists and health experts); therefore, their chances of having LBW kids are lower than mothers in rural areas. According to Mohammed et al. (2019), mothers in rural locations may have better access to fresh agricultural/plantation items, allowing them to boost birth weight. Furthermore, medium and long birth intervals have a greater average birth weight than close birth intervals, with a difference of 442.22 and 499.43 grams. The potential of having a first child in pregnant women with short birth intervals adds stress to the mother and harms the baby's weight at delivery (Auger et al., 2008). Mothers with medium and long birth intervals may have adequate time to recover from the previous pregnancy and prepare for the next.

In terms of education, moms with higher levels of education tend to have kids with standard weights. However, elementary, secondary, and higher education mothers had babies with an average birth weight of 482.29, 631.78, and 682, respectively. This finding is consistent with earlier research that shows that a mother's higher education makes it easier to obtain information from numerous sources, particularly with the supply of nutritional nourishment for the fetus in the womb, to avoid occurrences of LBW. On the other hand, mothers with low education, knowledge, and parenting habits are obtained from parents/neighbors who may have a lower level of education and experience, increasing the likelihood of LBW offspring (Nasution et al., 2014; Ngwira, 2019; Oladeinde et al., 2015)

Based on the interaction between a mother's education and birth interval, other findings show that mothers with short birth intervals who do not attend school have babies with LBW cases. In contrast, mothers with medium and long birth intervals who attend school have babies with an average weight of 2,500 grams. The influence of close birth intervals on birth weight decreases as the mother's education grows, with the intercept birth weight for close birth intervals exceeding 2,500 grams in the primary, secondary, and higher education categories. In all categories of mother education, medium birth intervals had a higher intercept than short and long birth intervals. The findings of this study are consistent with the findings of Kwon et al. (2012), who discovered that women's behavior during pregnancy and childbirth changes as their level of education and expertise increases. They can anticipate problematic pregnancies by increasing the utilization of prenatal health care inputs, thereby minimizing the unfavorable impacts of pregnancy and birth, such as LBW (McGovern, 2013).

In general, the predictors of LBW in developing nations (represented in this study by Indonesia) are nearly identical to those in developed countries. Several studies in industrialized countries have found that parity, education, and birth interval are essential predictors of birth weight (Mohammed et al., 2019; Vilanova et al., 2019). The difference is that the proportion of educated mothers in developed countries is higher than in developing countries; hence cases of LBW in affluent countries are six times lower than in developing ones. Furthermore, in affluent countries, most moms reside in cities, whereas in developing countries, nearly half of mothers live in rural regions. These findings highlight the critical role that family planners have in teaching couples and parents in Indonesia about the dangers of LBW newborns at short birth intervals.

Conclusion

According to our findings, the SLR birth interval model does not affect CBW. However, we discovered that birth interval, parity, mother age, residency, education, and the interaction between education and birth interval were significant drivers of LBW in the first MLR model. This finding is consistent with prior research in both developing and developed countries, indicating maternal factors play a significant impact in lowering LBW cases. LBW instances are more likely in moms with children born at either a short (24 months) or long (>48 months) interval. Mothers with previous reproductive experience (parity > 0), have a higher education level, live in rural areas, and are aged 20-35 years have a lower risk of LBW. As a result, prenatal care must be adjusted based on the mother's education level and reforms to strengthen maternal education programs because maternal education is one of the main elements in reducing the prevalence of LBW in the future. Furthermore, the birth interval must be highlighted as a critical intervention to lower the LBW rate in developing countries such as Indonesia. Of course, many other factors influence the prevalence of LBW that are not included in our models, such as the mother's income, access to prenatal health care, the mother's health condition and infectious diseases, the mother's bad habits during pregnancy, such as smoking, drinking alcohol, and poor diet, and the condition of the premature baby. In the future, researchers studying the determinants of LBW may be able to incorporate these elements to develop a better model.

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