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Risk Factors Associated with Low Birth Weight

Faktor-faktor Risiko Bayi dengan Berat Badan Lahir Rendah

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Abstract

Neonatal deaths are associated with preterm birth complications. The aim of this study was to analyze risk factors associated with LBW. This was a cross-sectional study held in Bulu Primary Health Care, Temanggung, Central Java, Indonesia. The sample size required for this study was 69 based on the Slovin formula. Data were collected using questionnaires and semi-quantitative Food Frequency Questionnaire forms. Data on infant birth weight was taken from midwives' delivery cohort records. Mid upper arm circumference (MUAC), hemoglobin level, blood pressure, maternal age, parity, nutritional intake, and serum transferrin receptor data were taken from the infant's mother using a MUAC tape, automatic blood pressure monitor and blood laboratory analysis by Prodia. Data analysis procedures were carried out with quantitative methods. Descriptive statistics were analyzed as means and standard deviations. Inferential statistics used the chi-square test for bivariate analysis and binary logistic regression for multivariate analysis. The results of this study showed that mean infant birth weight was 2917.68 ± 374.673 kg. Inferential analysis showed that MUAC and pregnancy at a risky age were significant risk factors associated with LBW, while serum transferrin receptor levels, anemia, parity, energy and protein consumption levels, and systolic and diastolic blood pressure were nonsignificant risk factors. The probability of LBW in pregnant women with LILA under 23.5 cm and pregnancy at a risky age was 68.9%.

Keywords: Low birth weight, risk factors, Central Java

Abstrak

Kematian neonatal terkait dengan komplikasi kelahiran prematur. Penelitian ini bertujuan menganalisis faktor risiko bayi dengan berat badan lahir rendah (BBLR). Penelitian ini merupakan penelitian potong lintang dan dilakukan di Puskesmas Bulu, Temanggung, Jawa Tengah, Indonesia. Sampel penelitian berjumlah 69 sampel berdasarkan rumus perhitungan sampel Slovin. Data dikumpulkan dengan menggunakan kuesioner dan formulir semi kuantitatif *Food Frequency Questionnaire*. Data berat lahir bayi diambil dari rekaman kohort persalinan bidan. Lingkar lengan atas (LILA), kadar hemoglobin, tekanan darah, usia ibu, paritas, asupan gizi dan data reseptor transferrin serum diambil dari ibu bayi menggunakan pita LILA, Monitor Tekanan Darah Otomatis dan analisis laboratorium darah oleh Prodia. Prosedur analisis data dilakukan dengan metode kuantitatif. Statistik deskriptif dianalisis dengan mean dan standar deviasi. Statistik inferensial menggunakan uji kai kuadrat untuk analisis bivariat dan regresi logistik biner untuk analisis multivariat. Hasil penelitian menunjukkan bahwa berat lahir bayi rata-rata 2917,68 ± 374.673 kg. Analisis inferensial menunjukkan LILA dan usia kehamilan berisiko secara signifikan sebagai faktor risiko yang menyebabkan BBLR, sedangkan reseptor serum transferin, anemia, paritas, tingkat konsumsi energi dan protein, tekanan darah sistolik dan diastolik bukanlah faktor risiko yang signifikan. Kemungkinan ibu hamil BBLR dengan LILA di bawah 23,5 cm dan kehamilan pada usia berisiko sebesar 68,9%.

Kata kunci: Berat bayi lahir rendah, faktor risiko, Jawa Tengah

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Introduction

Child mortality is a core indicator of child health and well-being. The proposed Sustainable Development Goals target for child mortality represents a renewed commitment to the world's children under 5 years of all age, with all countries aiming to reduce neonatal mortality to 12 deaths per 1000 live births or lower and under-5 mortality to 25 deaths per 1000 live births or lower. The worldwide neonatal mortality rate in 2015 was 19 deaths per 1000 live births.[1] This number shows that the worldwide neonatal mortality rate is still high. Among the top 10 countries that contribute 67% of neonatal deaths in the world, Indonesia contributes 2%.[2]

Neonatal deaths are caused by intrapartum complications and severe infections, and the leading cause of death in all regions of the world is preterm birth complications.[3] Preterm birth is also related to low birth weight (LBW). LBW is defined as a weight at birth of less than 2500 gram. Not only is LBW a major predictor of prenatal mortality and morbidity, but recent studies have found that low birth weight also increases the risk of noncommunicable diseases, such as diabetes and cardiovascular disease, later in life.[4] There are multiple causes of LBW, including low income, maternal age under 20 years or over 35 years, heavy physical work, low maternal education, maternal complications (placenta previa, pregnancy-induced hypertension, premature rupture of membranes), anemia, malaria, inadequate antenatal care, and maternal nutritional factors.[5-6]

National Basic Health Research in 2013 showed that LBW occurs in Indonesia at a rate of 10.2%. In Central Java, the rate of LBW was 9.7%.[7] In Temanggung, specifically in the working area of Bulu Primary Health Care, the incidence of LBW in 2013, 2014, and 2015 was 6.94%, 7.09%, and 7.88%, respectively.[8]

The aim of this study was to analyze risk factors of LBW, including mid upper arm circumference (MUAC), hemoglobin levels, blood pressure, maternal age, parity, nutritional intake, and serum transferrin receptor levels. There have been many studies on risk factors associated with LBW, but only a few studies have examined the relation between the serum transferrin receptor and LBW. The transferrin receptor is the best indicator of iron deficiency in pregnant woman. The serum level of this receptor can be measured easily by conventional techniques and presents a large distinction between iron deficiency anemia and chronic anemia disease.[9]

Method

This was a cross-sectional study held in Bulu Primary Health Care, Temanggung, Central Java, Indonesia. The study population consisted of 114 pregnant women in the second and the third trimesters. The required sample size for this study was 69 samples based on the Slovin formula.[10] A random sampling technique was applied. MUAC, maternal age, serum transferrin receptor, hemoglobin, parity, and systolic and diastolic blood pressure data were collected using a questionnaire, while energy and protein consumption data were collected using semi-quantitative food frequency questionnaire forms. MUAC was measured using a MUAC Tape accurate to 1 mm. Blood samples were taken for measurement of hemoglobin and serum transferrin receptor levels according to standard protocols in the Prodia Laboratory. Hemoglobin was measured using cyanmethemoglobin, and serum transferrin receptor was measured using the Quantikine IV D, human sTfR Immunoassay, R&D systems, Minneapolis, MN, USA.[11-12] Anemia is defined as a hemoglobin level of less than 11 gram/dl or a transferrin receptor level of more than 21 nmol/l. Data on the infant's birth weight was taken from the midwives in Bulu Primary Health Care, by copying the infant's weight recorded by the midwives in a baby cohort. The data were collected a week after delivery. Data analysis procedures were carried out with quantitative methods. Descriptive statistics were analyzed by mean and standard deviation. Categorical data were analyzed by cross tabulation. Inferential statistics used the chi-square test for bivariate analysis and binary logistic regression for multivariate analysis. A significant correlation between independent and dependent variables was shown at p value = 0.05. Ethical clearance was obtained from the Commission of Ethics of Medical and Public Health Research, Faculty of Public Health, Diponegoro University (approval no. 252/EC/FKM/2016).

Results

The mean (SD) birth weight was 2917.68 (374.673) kg, and the mean age of the pregnant women was 26.71 (5.806) years; furthermore, the mean and standard deviation of each variable are presented in Table 1. The results of this study, shown in Table 2, indicated that MUAC and pregnancy at a risky age were significant risk factors causing LBW, while serum transferrin receptor, anemia, parity, energy and protein consumption levels, and systolic and diastolic blood pressure were nonsignificant risk factors.

Multivariate analysis with multiple logistic regression showed a significance of 0.905 for the Hosmer and Lemeshow Test, indicating an acceptable goodness of fit to the model tested. A Nagelkerke R Square of 0.328 showed that risky age and MUAC variable models are risk factors for LBW at 32.8%. The values of B and the exponential B, along with their significance, can be seen in Table 3.

The odds ratio for maternal age was 3.7 and that of MUAC was 15.38 for the incidence of LBW. Based on the table above, Exp(B) can be used to construct a logistic

Table 1. Infant Birth Weight According to Selected Maternal Factors

Variable	Category	Birth Weight		Mean	SD
		Low	Normal		
Anemia	Anemia (<11 gr/dl)	4 (11.4%)	31 (88.6%)	10.90	1.02
	Normal (11 gr/dl)	3 (8.8%)	31 (91.2%)		
Mid upper arm circumference	Chronic Energy Deficiency (< 23.5 cm)	4 (50%)	4 (50%)	26.84	2.98
	Normal (23.5cm)	3 (4.9%)	58 (54.8%)		
Serum transferrin receptor	Iron Deficiency (21 nmol/l)	6 (12.5%)	42 (87.5%)	24.80	7.29
	Normal (<21 nmol/l)	1 (4.8%)	20 (95.2%)		
Maternal age at pregnancy	Risky Age (<19 years or >35 years)	3 (30%)	7 (70%)	26.71	5.80
	Normal Age (19-35 years)	4 (6.8%)	55 (89.9%)		
Parity	Multipara (2 live births)	5 (9.6%)	47 (90.4%)	2.14	0.93
	Primipara (1 live birth)	2 (11.8%)	15 (88.2%)		
Level of energy consumption	Less (<80%)	1 (7.7%)	12 (92.3%)	96.09	12.66
	Normal (80%)	6 (10.7%)	50 (89.3%)		
Level of protein consumption	Less (<80%)	2 (7.4%)	25 (92.6%)	90.34	26.77
	Normal (80%)	5 (11.9%)	37 (88.1%)		
Systolic blood pressure	Prehypertension (>120 mmHg)	1 (3.6%)	27 (96.4%)	114.51	12.66
	Normal (120 mmHg)	6 (14.6%)	35 (85.4%)		
Diastolic blood pressure	Prehypertension (>80 mmHg)	1 (6.7%)	14 (93.3%)	72.68	10.30
	Normal (80 mmHg)	6 (11.1%)	48 (88.9%)		

Notes:
SD = Standard Deviation

Table 2. Prevalence Risk of Maternal Factors (n = 69)

Variable	PR	95% CI		p Value
		Lower	Upper	
Anemia	1.333	0.275	6.457	0.72
Mid upper arm circumference	19.333*	3.172	117.853	0.0001*
Serum transferrin receptor	2.857	0.322	25.350	0.327
Maternal age at pregnancy	5.893*	1.806	31.698	0.025*
Parity	0.798	0.140	4.545	0.799
Level of energy consumption	0.684	0.076	6.323	0.745
Systolic blood pressure	0.216	0.025	1.903	0.135
Diastolic blood pressure	0.571	0.063	5.153	0.614

Notes:
PR = Prevalence Risk, CI = Confidence Interval, Significant < 0.05

Table 3. Variables in the Equation

Variable	B	S.E.	Wald	df	p Value	Exp(B)
Maternal Age at Pregnancy	1.312	1.010	1.687	1	0.194	3.713
MUAC	2.732	.955	8.176	1	0.004	15.358
Constant	-3.212	.662	23.531	1	0.000	0.040

Equation 1. Probability of LBW

$$\text{Probability of LBW: } \frac{1}{1 + e^{-(-3{,}2+1{,}3\,MaternalAge\,Pregnancy+2{,}7\,MUAC<23{,}5)}}$$

regression equation to determine the probability of occurrence of LBW if pregnancy occurred at a risky age and MUAC was <23.5 cm, as follows Equation 1.

Based on this model, if there was a mother with a risky age at pregnancy (<19 or >35 years old) and she had MUAC less than 23.5 cm, the probability of LBW was 68.2%.

Discussion

Anemia is the most common nutritional deficiency in the world. The World Health Organization has estimated that the prevalence of anemia is 51% in developing countries.[13] In Southeast Asia, anemia during pregnancy has a 48.2% prevalence, equal to 18.1 million cases. In Indonesia, the prevalence of anemia during pregnancy is 50.9%.[14] In this study, anemia in pregnant women was nonsignificant as a risk factor for having a LBW infant. Anemia in pregnant mothers associated with adverse outcomes may be related to other maternal complications, such as hemoglobinopathy, malnutrition, chronic infection, and inadequate access to prenatal care, and anemia itself may be a marker of these underlying conditions. A study by Xiong, *et al.*[15] also showed that anemia was not statistically significantly associated with infant LBW.

MUAC is another anthropometric measure used to evaluate adult nutritional status that has been found to be particularly effective in determining malnutrition in adults in developing countries.[16] This study used an MUAC measure threshold of 23.5 for pregnancy outcome, infant morbidity, and mortality.[17] The results showed that a MUAC of less than 23.5 cm increased the risk of LBW by a factor of 19. Women with MUAC less than 23.5 cm had more LBW infants than those with MUAC of 23 cm and more. A study by Assefa,[18] also showed a statistically significant association between LBW and MUAC less than 23 cm.

Serum transferrin receptor was a nonsignificant as a risk factor in LBW. Transferrin is the main iron transport protein found in the blood and plays a role in maintaining cellular iron homeostasis through regulation of cellular

iron intake. Serum transferrin receptor is largely derived from developing red blood cells. Assessment of serum transferrin receptor levels has been used to distinguish iron deficiency anemia from anemia of chronic disease because the receptors are generally unaffected by concurrent infection or inflammation.[19] The results of the present study showed that the serum transferrin receptor was not significant as risk factor in LBW. Although many studies found an association between iron deficiency and pregnancy outcomes.[20–22] A previous study by Khambalia *et al,*[23] did not detect a significant association between iron deficiency and preterm birth. the inconsistencies may have been caused by study population differences and confounders.

Maternal age affects fertility. Fertility starts to decrease at the age of 20 years and decreases rapidly after the age of 35 years. Getting pregnant at a young age is also a risk factor, as the endometrium has not yet matured, whereas the endometrium is less fertile after the age of 35 years. This will increase the likelihood of having congenital syndrome and affecting maternal and child health during pregnancy.[24] A previous study indicated that mothers at the younger and older ends of the childbearing age range are at increased risk for LBW. This study showed that maternal age increase the risk of LBW by a factor of 5. A study by Fraser,[25] found that adolescent mothers aged 13 to 17 years had a significantly higher risk (p value < 0.001) than mothers aged 20 to 24 years of delivering an infant with LBW (relative risk, 1.7; 95% CI, 1.5 to 2.0). Kartasurya,[26] also found that pregnancy at a risky age (<20 or >35 years) was also a risk factor associated with LBW (<20 or >35 years; OR = 1.95 with CI = 1.16–3.36) in Batang District, Central Java Province.

Based on the result, parity was nonsignificant as a risk factor in LBW. Parity and maternal age have been shown to increase the risk of adverse neonatal outcomes, such as intrauterine growth restriction, prematurity, and mortality.[22, 27, 28] Nulliparity may confer risk through complications during childbirth, such as obstructed labor, whereas high parity has been linked to an increased risk of hypertension, placenta previa, and uterine rupture.[29] A meta-analysis by Shah,[30] concludes that multiparity, although it is associated with reduced birth weight, is not associated with LBW or preterm birth, in which multiparity is often confounded by socioeconomic status. Higher complications in terms of birth outcome associated with multiparity are valid for communities with poor socioeconomic status, low levels of education, and inadequate access to health care.

In this study, energy consumption was found to be nonsignificant as a risk factor in LBW. It should be that deficient energy consumption or weight during pregnancy can cause impaired fetal growth and increase the risk of LBW in newborns.[31] Furthermore, LBW infants have serious health problems, such as cerebral palsy, mental retardation, and even cardiovascular disease, when they become adults.[32] In study by Karima,[33] pre-pregnancy weight, weight gain during pregnancy, maternal age, and birth order were factors affecting birth weight significantly, with pre-pregnancy weight as the dominant factor (OR = 6.643, CI: 2.3–18.8). Therefore, it is important to pay more attention to undernourished women who are planning a pregnancy.[33] Pre-pregnancy weight and maternal weight gain in the first, second, and third trimesters have a moderate power relation and positive pattern.[34]

Protein is important for fetal development because one of its roles is to form fetal cells and tissues. Protein consumption is increased during pregnancy to prevent protein deficiency and malnutrition.[35] In this study, the level of protein consumption was nonsignificant as risk factor in LBW. Even though a previous study by Ramakrishnan,[36] stated that poor nutrition is one of factors associated with LBW babies, this inconsistency may be due to the limitation of sample size in this study (n = 69) with only seven infants with LBW.

The maternal cardiovascular system undergoes progressive adaptations throughout pregnancy, including decreased vascular resistance, increased blood volume, and other metabolic changes. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) decreased from the first to second trimester and then increased up to the postpartum period.[37] The causes of LBW are multifactorial, and one such factor is blood pressure. This study showed that SBP and DBP were nonsignificant as risk factors in LBW infants. A study by Walker *et al,*[38] indicated an association between blood pressure and infants with LBW. This inconsistency may be due to the inclusion of subjects with pre-hypertension, whose blood pressures were not very high (<120 mmHg for SBP and <80 mmHg for DBP).

LBW is one of the risk factors for perinatal death. LBW has a PAR value of 14.90. This means that if the focus of the intervention program is on decreasing the perinatal mortality rate by decreasing the prevalence of LBW infants, there will be a 15% reduction in the risk of perinatal death out of all live births in the population.[39] Interventions for pregnancy at a risky age and mothers with MUAC less than 23.5 cm are indispensable for reducing LBW occurrence, as confirmed in a study by Kartasurya.[26]

Conclusion

It can be concluded that MUAC and age are risk factors associated with LBW in newborns, with a probability of 68.2%. It is suggested that public education on the importance of nutrition during pregnancy be increased to increase MUAC and avoid pregnancy under the age of

19 years or above the age of 35 years to reduce the incidence of infants with LBW.

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