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The Correlation between Low Birth Weight and the Degree of Neonatal's Kidney Function Impairment in RSUDZA

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Abstract: *Low birth weight (LBW) is often found in premature birth or because of early gestational age. Several studies have evaluated the impact of Acute Kidney Injury (AKI) on neonates. Birth weight is an important predictor of the nephron and glomerular mass. Mortality in infants with AKI is significantly higher than in those without AKI. Objectives: To analyze the correlation between birth weight and the degree of kidney function disorders. Methods: This study uses an observational analytic approach with a cross-sectional research design. Eighty-nine patients from patients treated from January 2019 to December 2020 were obtained using total sampling. Patient demographic data were collected, and Spearman's test was performed to see the relationship between LBW and the level of impaired renal function in neonates. Results: During the study, 89 samples were obtained, where the mean body length of the neonates was 44.46 ± 2.22 cm, the ureum range was 6-189 mg/dL, the creatinine range was 0.20 -4.03 mg/dL, mean GFR was known to be 19.01+8.96 ml/min/1.73 m2. The highest number of neonates was in the 34–36-week gestational age group. The average birth weight was 1,964.94 ± 274 g, with a range of 1,500-2,400 g. Most neonates had kidney function of risk (31.5%) and injury (30.3%). Only 15 (16.9%) neonates were not affected. Conclusion: There is a significant relationship between birth weight and the level of impaired kidney function (p < 0.05). The correlation coefficient of 0.217 indicates a weak correlation. There was no relationship (p= 0.061) and no significant correlation between gestational age, low GFR (r= 0.189).*

Keywords: *neonate, low birth weight, acute kidney injury*

I. Introduction

Birth weight is an essential predictor of the nephron and glomerular mass. Low birth weight (LBW) is associated with the development of end-stage renal failure, chronic kidney disease (CKD), and a more rapid decline in kidney function.1–3 Premature birth is estimated to reach 80% of the LBW population. The hypotheses underlying why LBW is associated with CKD vary depending on the etiology (Dyson, A. 2019; Das SK, 2017).

Three extensive single-center studies have evaluated the incidence of AKI in low-birth-weight neonates. Koralkar et al. followed 229 LBW infants who were followed prospectively from birth to 36 weeks postmenstrual. The incidence of AKI using the modified neonatal KDIGO criteria was 18%. Mortality in infants with AKI was significantly higher than in those without AKI (42% and 5%) (Koralkar, R. 2011)

Viswanathan et al. reported similar findings in a one-center retrospective study in which 12.5% (59/472) of all infants with SGA had AKI, and mortality among those with AKI was significantly higher than controls (70% and 22%).6 Carmody et al. examined 455 LBW infants and found an AKI incidence of 39.8%. In that study, AKI was independently associated with increased mortality and length of stay (11.7 days in hospital) (Carmody, 2014).

The Nickavar study (2018) showed that infants with AKI mean age was 5.41 ± 3.29 days, and most patients had non-oliguric renal failure. Birth weight, systolic blood pressure, blood urea nitrogen (BUN), calcium, and pH at hospital admission were significantly associated with AKI. Birth weight was observed as a relatively accurate predictor of AKI, with a sensitivity of 73.5% and specificity of 80%. This study was conducted to analyze the correlation between birth weight and the degree of kidney function disorders.

II. Research Methods

This retrospective cross sectional observational analytic study was conducted in NICU at dr. Zainoel Abidin Hospital, Banda Aceh from May-June 2021. Data were collected from patients treated in the period January 2019 to December 2020. The target population was all NICU patients treated at dr. Zainoel Abidin Hospital, Banda Aceh from January 2019-December 2020.

Neonates with low birth weight (1500 - 2500 g) were included in the study, whereas those with incomplete medical records, hyperfiltration, and congenital abnormalities were excluded. The baby's birth weight was weighed using a balance and expressed on a ratio scale, while the level of impaired kidney function was described on an ordinal scale where there was no disturbance (1), risk (2), injury (3), and failure (4).

Data obtained were recorded in the research form and processed and presented, and analyzed. The analysis carried out is univariate and bivariate analysis. Bivariate analysis using Spearman's used to analyze the relationship between birth weight and the level of impaired kidney function in neonates with low birth weight. The research has received ethical approval from the Health Research Ethics Committee, Faculty of Medicine, Syiah Kuala University, or/and dr. Zainoel Abidin Hospital, Banda Aceh with decree number: 119/EA/FK-RSUDZA/2021.

III. Results and Discussion

3.1 Results

a. Characteristics of Study Sample

325 LBW patients were treated during this period, and only 89 neonates met the inclusion and exclusion criteria (see Table 1). Neonates are more male than female. Most neonates were in the 1–6-day group, 67.4% of the total sample (range 1-28 days). All neonates were included in the preterm criteria, with the highest number in the 34–36-week gestational age group. Overall, neonates tend to be short (60.7%).

Body length in neonates with a gestational age of 28-30 weeks is 38.5-40 cm, while the results showed that the body length of neonates in this gestational age group was higher. In the 32-34 weeks and 34-36 weeks gestational age groups, the median body length was within normal limits, although there were babies with low body length.

Based on the standard in the gestational age range of 32-34 weeks, the ideal body length is above 43-45 cm and at 34-36 weeks above 45-47 cm. There is a tendency for neonates to be preterm, with most neonates having a gestational age of 34-36 weeks (50.6%) and 32-34 weeks (34.8%). The mean neonatal body length and GFR were 44.46+2.22 cm and 19.01+8.96 ml/min/1.73 m2, respectively.

b. Neonate Birth Weight

Birth weight has an average value of 1,964.94 ± 274 g, with a range from 1,500 to

2,400 g and weight data appears to be normally distributed ($p > 0.050$) (see Table 3). Based on these values, if grouped into two criteria for birth weight, above and below 2,000 g (see Table 4). Those weighing less than 2,000 g were slightly more than neonates who weighed more than 2,000 g.

c. Level of Kidney Function Disorder

Most of the neonates had kidney function risk (31.5%) and injury (30.3%). The criteria for no disturbance were found to be the least, i.e., only in 15 neonates or 16.9% (see Table 5).

d. The Relationship of Respondents Characteristics with the Level of Kidney Function Disorders

Male and female sexes showed relatively equal proportions at each level of impaired kidney function. As a group, it can be observed that neonates aged 1-6 days tend to be more dominant in the criteria for nRIFLE risk and injury, while the group 7-12 days are more likely to be found in the criteria for injury and failure. Two-thirds of neonates >21 days of age met the nRIFLE risk criteria (see Table 6).

The weight group also showed relatively similar results with the previous two characteristics. Neonates with short and normal body lengths have relatively the same level of impaired renal function. The older the gestational age, the lower the number of failed nRIFLE criteria, but this result did not occur in the other criteria groups. The relationship between characteristic variables and nRIFLE criteria have a p-value >0.050, so it can be concluded that they are not correlated to the level of impaired kidney function.

e. Relationship between Birth Weight and Kidney Function Impairment

The analysis results showed a significant relationship between birth weight and the level of impaired kidney function ($p < 0.05$). The study correlation coefficient is 0.217, which can be concluded as the strength of the relationship formed is low (see Table 7).

Table 1. Characteristics of Study Subjects

Variable	N	%
Sex		
Male	47	52,8%
Female	42	47,2%
Age (Day)		
1-6	60	67,4%
7-21	20	22,5%
> 21	9	10,1%
Body Length		
Short	54	60,7%
Normal	35	39,3%
Gestation Age (Week)		
28-30	12	13,5%
32-34	31	34,8%
34-36	45	50,6%
36-38	1	1,1%

Table 2. Description of Age, Body Length, and GFR (n=89)

Variable	n	*Mean*	SD	Median	Min.	Maks.	p*
Age	89	6,11	7,57	3,00	1,00	28,00	0,001
Body Length (cm)	89	44,46	2,22	45,00	36,00	48,00	0,001
GFR (ml/min/1,73 m^2)	89	19,01	8,96	17,36	3,01	62,10	0,014

Description: * *One-Sample Kolmogorov-Smirnov Test*

Table 3. Description of Study Subjects Birth Weight (n=89)

Variable	N	*Mean*	SD	Min.	Maks.	p*
Birth Weight (gr)	89	1.964,94	274,10	1.500,00	2.400,00	0,585

Description: * *One-Sample Kolmogorov-Smirnov Test*

Table 4. Distribution of Birth Weight of Study Subjects (n=89)

Variable	Jumlah (n)	Percentage (%)
<2.000 gr	45	50,6%
≥2.000 gr	44	49,4%

Table 5. Distribution of nRIFLE Criteria for Research Subjects (n=89)

Variable	N	%
Normal	15	16,9%
Risk	28	31,5%
Injury	27	30,3%
Failure	19	21,3%

Table 6. Frequency Distribution of Kidney Function Disorders by Sex, Age, Body Length, Gestational Age

Variable	nRIFLE								Total		P
	Normal		*Risk*		*Injury*		*Failure*				
	n	%	n	%	n	%	n	%	n	%	
Sex											
Male	8	17.0%	14	29.8%	15	31.9%	10	21.3%	47	100.0%	0,982
Female	7	16.7%	14	33.3%	12	28.6%	9	21.4%	42	100.0%	
Age (Day)											
1-6	13	21.7%	19	31.7%	20	33.3%	8	13.3%	60	100.0%	
7-21	1	5.0%	3	15.0%	7	35.0%	9	45.0%	20	100.0%	0,060
> 21	1	11.1%	6	66.7%	0	0.0%	2	22.2%	9	100.0%	
Body Length											
Short	11	20.4%	17	31.5%	18	33.3%	8	14.8%	54	100.0%	0,245
Normal	4	11.4%	11	31.4%	9	25.7%	11	31.4%	35	100.0%	
Gestation Age (Week)											
28-30	2	16.7%	0	0.0%	4	33.3%	6	50.0%	12	100.0%	
32-34	5	16.1%	13	41.9%	6	19.4%	7	22.6%	31	100.0%	0,114
34-36	8	17.8%	14	31.1%	17	37.8%	6	13.3%	45	100.0%	
36-38	0	0.0%	1	100.0%	0	0.0%	0	0.0%	1	100.0%	

Table 7. Relationship between Birth Weight and Level of Kidney Function Disorders of Research Subjects (n=89)

Independent variable	Dependent variable	r	p*
Body Weight (gr)	nRIFLE Criteria	0,217	0,041

Description: * *Spearman's rho*

3.2 Discussion

This study involved 89 infants who met the inclusion and exclusion criteria of this study. There are more males than females. A similar study conducted by Mahayana et al. (2015) reported that of 72 LBW neonates, the male sex was 44 (61.1%) more than the female sex 28 (38.9%).9 This is different from the research by Pramono et al. (2014), who reported that LBW was more common in women than men. This is because naturally, for the same gestation period, female baby weights are smaller than male babies, so they have a greater risk for LBW. Therefore, it is necessary to pay more attention to nutritional intake during pregnancy (Pramono. 2015).

The majority of neonates aged 1-6 days with 67.4% and 7-21 days with 22.5%. Most neonates were in the short category with 60.7%, while the normal category was 39.3%. The body length of neonates in this study with a gestational age group of 28-30 weeks was higher than the normal range of 38.5-40 cm. There is a tendency for neonates to be preterm, with most neonates having a gestational age of 34-36 weeks (50.6%) and 32-34 weeks (34.8%).

Sulistyorini et al. (2014), analyzing the risk factors for LBW at the Banjarnegara Health Center, reported that of 68 babies belonging to LBW (1500-2500 grams), there were 59 babies (86.8%), and there were nine babies (13.2%) who included in the non-LBW category. LBW (LBW and LBW i.e. BB <1500 grams).11 One of the factors that influence the level of LBW is the hemoglobin level of the mother during pregnancy. When the mother's hemoglobin level during pregnancy is low, it can inhibit the delivery of nutrients and oxygen from the mother to the baby through the placenta. So that it can affect the weight of the baby at birth (Perwiraningtyas, 2020).

In general, LBW clinical features have a body length at birth of 46 cm, a chest circumference of 30 cm, and a head circumference of 33 cm. Permana et al. (2019) reported that 24.5% were premature and 75.5% were term. Babies born prematurely (gestational age <35) increase the likelihood of LBW. The risk analysis results also showed a significant relationship between babies born prematurely and the incidence of LBW, where the risk was 3.1 times greater than that of babies born at term.

Research by Sulistyorini et al. (2014) also analyzed the risk factors for LBW at the Banjarnegara Health Center found that 77.9% of babies were born at low risk (>37 weeks), and the rest were born at high risk (<37 weeks). The results of statistical tests showed a relationship between gestational age and LBW (p=0.009) where p-value <0.05. Generally, LBW is caused by premature birth and delayed fetal growth. Birth at the age of fewer than 37 weeks is premature birth.

A study by Septiani et al. (2018) in Bireuen with a sample of 30 neonates found that gestational age >37 weeks was greater with 19 neonates and <37 weeks with 11 neonates. The study stated that gestational age was associated with the incidence of LBW due to term pregnancy caused by several factors such as pre-eclampsia, chronic energy deficiency, history of shortness of breath, placental insufficiency, moderate anemia, placenta previa, hydramnios and premature rupture of membranes.

Another study by Purwanto et al. (2016) in East Java reported that the most LBW was at 37-42 weeks gestation (58.3%) compared to 28-36 weeks (41.7%). This study, stated that the high risk of gestational age on the incidence of LBW in this study was due to biologically the baby's weight was increasing according to gestational age.

Gestational age affects the incidence of LBW because the lower the gestational age of the mother, the less perfect the development of the baby's organs. It also affects the baby's weight. Babies born prematurely have organs and organs that have not functioned normally to survive outside the womb. This LBW group often has complications or complications due to the immaturity of the organs due to insufficient gestational age.

The level of impaired renal function was assessed using the RIFLE16 neonatal criteria using the value of the glomerular filtration rate; the results showed that most of the neonates had AKI stage risk 28 (31.46%), injury 27 (30.33%), failure 19 (21.34%). There was no impaired renal function as many as 15 neonates (16.85%), while the criteria for loss and end-stage in this study were not obtained because the neonatal care period in the NICU was 28 days (Hasanah, 2020).

A study conducted by Hasanah et al. (2020) in Semarang reported that prenatal risk factors were statistically significant for the incidence of chronic kidney disease in children, namely low birth weight and premature birth. The increased risk of LBW to CKD incidence is 7.33 times, while the risk of prematurity to the incidence of CKD is 10.56 times. In the study subjects with CKD, a history of LBW was found in 22 (28.9%) and premature in 23 (30.3%) children.

Birth weight of 1500-2000 grams as many as four children, with the lowest of 1500 grams. While birth weight >2000-<2500gram as many as 18 children. The average gestational age is between 31-36 weeks (some parents only mention months, not weeks). Most of the children who had a history of prematurity were diagnosed with congenital nephrotic syndrome, namely eight children. All LBW subjects were according to gestational age (Hasanah, 2020).

Low birth weight (400-2499 g) is associated with the risk of developing CKD. This study supports previous studies that stated that LBW had a lower number of nephrons, which was a risk factor for CKD in childhood and adulthood. A cohort study with 38 years of observation conducted by Vikse et al. also stated that compared to LBW, LBW had a 1.7 times risk of end-stage renal disease, as did small infants during pregnancy with a 1.5 times risk (Hasanah, 2020).

IV. Conclusion

There is a significant relationship between birth weight and the level of impaired kidney function ($p < 0.05$). The correlation coefficient of 0.217 indicates a weak correlation. There was no relationship (p= 0.061) and no significant correlation between gestational age and low GFR (r= 0.189).

References

Carmody JB, Swanson JR, Rhone ET, et al. Recognition and reporting of AKI in very low birth weight infants. Clin J Am Soc Nephrol. 2014;9(12):2036–43.

Das SK; Choupoo NS; Saikia P; et al. Incidence proportion of acute cor pulmonale in patients with acute respiratory distress syndrome subjected to lung-protective ventilation: a systematic review and meta-analysis. Indian J Crit Care Med. 2017;21(6):364–75.

Dyson A, Kent AL. The Effect of Preterm Birth on Renal Development and Renal Health Outcome. No reviews. 2019;20(12):725–36.

Gomella TL; Cuningham MD; Eyal FG; et al. Neonatology: Management, procedure, On-Call Problems, Disease, and Drug. New York: McGraw-Hill Education; 2013.

Hasanah K, Widajat RR, Mellyana O. Faktor Risiko Prenatal Terhadap Kejadian Penyakit Ginjal Kronik derajat III-V di RSUP Dr. Kariadi Semarang. Sari Pediatr. 2020;22(2):76–82.

Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. New York; 2013.

Koralkar R, Ambalavanan N, Levitan EB, et al. Acute kidney injury reduces survival in very low birth weight infants. Pediatr Res. 2011;69(4):354–8.

Mahayana SAS. Faktor Risiko yang Berpengaruh terhadap Kejadian Berat Badan Lahir Rendah di RSUP Dr. M. Djamil Padang. J Kesehat Andalas. 2015;4(3):664–72.

Nickavar A, Choobdar FA, Mazouri A, et al. Predictive Factors of Acute Renal Failure in the Neonates with Respiratory Distress Syndrome. Iran J Neonatol. 2018;9(1):1–6.

Perwiraningtyas P, Arini NL, Anggraini CY. Analisis Faktor Risiko Tingkat Berat Bayi Lahir Rendah. J Nurs Care. 2020;3(3):212–9.

Permana P, Gede BRW. Analisis Faktor Risiko Bayi Berat Badan Lahir Rendah (BBLR) Di Unit Pelayanan Terpadu (UPT) Kesehatan Masyarakat (Kesmas) Gianyar I Tahun 2016-2017. Intisari Sains Medis. 2019;10(3):674–8.

Pramono MS, Paramita A. Pola Kejadian Dan Determinan Bayi Dengan Berat Badan Lahir Rendah (BBLR) Di Indonesia Tahun 2013. Bul Penelit Sist Kesehat. 2015;18(1):1–10.

Purwanto AD, Chatarina UW. Hubungan Antara Umur Kehamilan, Kehamilan Ganda, Hipertensi Dan Anemia Dengan Kejadian Bayi Berat Lahir Rendah (BBLR). J Berk Epidemiol. 2016;4(3):349–59.

Ruggajo P, Skrunes R, Svarstad E, et al. Familial factors, low birth weight, and development of ESRD: A Nationwide Registry Study. Am J Kidney Dis. 2016;67(4):601–8.

Septiani M, Maria U. Faktor-Faktor yang Berhubungan dengan Kejadian BBLR di Wilayah Kerja Puskesmas Peudada Kabupaten Bireuen. J Berk Epidemiol. 2016;4(2):158–74.

Sulistyorini D, Shinta S. Analisis Faktor-Faktor Yang Memengaruhi Kejadian BBLR Di Puskesmas Perkotaan Kabupaten Banjarnegara. In Semarang: Universitas Muhammadiyah Semarang; 2014.

Viswanathan S, Manyam B, Azhibekov T, et al. Risk factors associated with acute kidney injury in extremely low birth weight (ELBW) infants. Pediatr Nephrol. 2012;27(2):303–11.