Research Article

Maternal Risk Factors Associated with Neonatal Stunting: A Case–Control Study

Anita Rohmah[1], Yasmini Fitriyati[2], Afifah Az Zahra[3], Isna Arifah Rahmawati[3], Muhtia Mahderina Cahyani[3]

[1]*Department of Obstetrics and Gynecology Wonosari Hospital*
[2]*Department of Obstetrics and Gynecology*
[3]*Faculty of Medicine, Universitas Islam Indonesia*
Yogyakarta

Abstract

Objective: To identify maternal risk factors associated with neonatal stunting at Wonosari Hospital.

Methods: A case–control study was conducted involving mothers who gave birth at Wonosari Hospital in 2023. Maternal sociodemographic characteristics (age, education, and occupation), nutritional status (body mass index and mid-upper arm circumference), and pregnancy-related factors (gestational age, gestational status, hemoglobin levels, blood pressure, pregnancy complications, and mode of delivery), as well as newborn length at birth, were obtained from medical records. Neonatal stunting was defined as a length-for-age z-score < −2 SD according to World Health Organization (WHO) standards. Statistical analysis was performed using chi-square tests and multiple logistic regression.

Results: A total of 154 participants were included, equally divided into case (stunted newborns) and control (non-stunted newborns) groups. Mothers with a lower educational level had significantly higher odds of delivering a stunted newborn (p = 0.010; aOR = 2.845; 95% CI = 1.286–6.293). Preterm birth was also associated with an increased risk of neonatal stunting (p = 0.033; aOR = 9.847; 95% CI = 1.210–80.152). In addition, pregnancy complications were significantly associated with higher odds of neonatal stunting (p = 0.020; aOR = 2.728; 95% CI = 1.171–6.352).

Conclusion: Maternal factors, including low educational level, preterm birth, and pregnancy complications, were significantly associated with neonatal stunting at Wonosari Hospital. These findings underscore the importance of maternal education in neonatal health outcomes. Furthermore, close monitoring of fetal growth and nutritional status, along with appropriate management of pregnancy complications, may help reduce the risk of neonatal stunting. However, larger-scale studies are needed to assess the population-level impact of these factors.

Keywords: neonatal, pregnancy complication, stunting.

Correspondence author. Afifah Az Zahra. Universitas Islam Indonesia. Yogyakarta,
Email: 217110403@uii.ac.id Telp : +6285729222530

INTRODUCTION

During the first 1000 days of life, the period from conception to the first two years of a child's life, maternal nutrition plays a crucial role in determining fetal health and future well-being. During pregnancy, the fetus undergoes rapid development and requires adequate nutrient intake from the mother. The increased nutritional needs of pregnant women are influenced by age, pre-pregnancy nutritional status, and any underlying medical conditions[1].

Pregnant women with malnutrition, undernutrition, or poor nutritional status during pregnancy are more likely to give birth to infants with low birth weight or small for gestational age[2]. Basic Health Research (Riskesdas), 48.9% of pregnant women were anemic, 17.3% experienced Chronic Energy Deficiency (CED), and 28% had a risk of life-threatening obstetric complicatiions. Several studies have shown that deficiencies in specific nutrients during pregnancy can negatively impact fetal growth and contribute to low birth weight[3]. For high-risk pregnant women, preventive measures and nutritional interventions become increasingly important to prevent complications and fetal developmental problems[4].

Neonatal stunting is a growth disorder that characterized by a birth length-for-age z-score of <-2 Standard Deviations (SD)[5]. This condition is a serious global public health issue, particularly in developing countries like Indonesia. Global Nutrition Report, the prevalence of neonatal stunting reached 21.9% in low- and middle-income countries[6]. Stunting has long-term impacts on health, cognitive development, and quality of life, even into adulthood[7].

Malnutrition in Indonesia remains one of the highest in the world, with 1 in 10 children under five experiencing wasting and 3 in 10 children experiencing stunting (short stature). Based on the results of the Indonesian Nutrition Status Survey (SSGI), the prevalence of stunting in Indonesia decreased by 2.8%, from 24.4% in 2021 to 21.6% in 2022. This achievement is in line with the target set by the Ministry of Health, which is approximately 2.7% annually. This study aims to examine the characteristics of pregnant women associated with neonatal stunting at a referral hospital in the Special Region of Yogyakarta, Wonosari Hospital.

METHODS

This observational analytical study employed a case-control design to investigate maternal characteristics associated with neonatal stunting. The study population consisted of pregnant women who delivered at Wonosari Hospital among March and September 2023.

The sample size was calculated using the Lemeshow formula, with subjects distributed into two groups at a 1:1 ratio. The case group comprised mothers who delivered stunted newborns, while the control group comprised mothers who delivered newborns with normal birth length. Subjects were selected using purposive sampling to minimize selection bias. To control for information bias inherent in secondary data usage, strict inclusion and exclusion criteria were applied. Only medical records with complete documentation were included. Records with missing data on key variables, were excluded from the study.

The dependent variable was the incidence of neonatal stunting. In accordance with WHO growth standards and current clinical references, neonatal stunting was operationally defined as a birth length-for-age z-score of <-2 SD relative to the WHO child growth standards. Data were collected retrospectively using secondary data from patient medical records. Data validity and reliability were ensured, as all anthropometric measurements (birth length, maternal Mid-Upper Arm Circumference/MUAC) and vital signs (blood pressure) were performed by certified healthcare professionals (midwives and nurses) using calibrated, hospital-standard instruments (infantometers for newborns and digital sphygmomanometers for mothers).

Independent variables encompassed maternal characteristics and health status, specifically: maternal age, educational attainment, employment status, parity, gestational age (preterm <37 weeks vs term ≥37 weeks), nutritional status (BMI and MUAC <23,5 cm for Chronic Energy Deficiency/CED), hemoglobin levels (anemia defined as <11 g/dL), blood pressure (hypertension defined as ≥140/90 mmHg), and other concurrent pregnancy complications.

Statistical analysis was performed using IBM SPSS Statistics software version 25. Univariate analysis was utilized to describe the demographic characteristics of the subjects. Associations between variables were assessed using bivariate analysis (chi-square test). Variables meeting the inclusion criteria ($p<0.25$) were subsequently entered into a multivariate analysis using multiple logistic regression to identify dominant risk factors. This study received ethical clearance from the Medical Research Ethics Committee of the Faculty of Medicine, Universitas Islam Indonesia with the registered number: 18/Ka.Kom.Et/70/KE/XII/2023).

RESULTS

This study enrolled 154 participants, equally distributed into case and control groups (n=77 each). The majority of subjects (Table 1) fell within the healthy reproductive age range of 20–34 years (n=121, 78.6%) and exhibited normal nutritional status (n=117, 76%). High prevalence of pregnancy complications (74.7%) reflects the study setting at Wonosari Hospital as a referral center, where cases were predominantly characterized by severe preeclampsia (n=50, 32.5%) and premature rupture of membranes (PROM) (n=27, 17.5%), alongside other conditions such as oligohydramnios and gestational diabetes.

Table 1. Baseline Characteristics of Mothers at Wonosari Hospital

Characteristic	N	(%)
Age (y o)		
<20	5	3.2
20 – 35	121	78.6
≥35	28	18.2
Education		
Elementary	46	29.9
Secondary	104	67.5
High	4	2.6
Working Status		
Yes	50	32.5
No	104	67.5
Nutritional Status		
Underweight	5	3.2
Normal	117	76
Overweight	27	17.5
Obesity	5	3.2
History of PEM		
Yes	11	7.1
No	143	92.9
Anemia		
Yes	30	19.5
No	124	80.5
Gestational Hypertension		
Yes	72	46.8
No	82	53.2
Gestational Age		
Preterm	13	8.4
Aterm	141	91.6
Number of Pregnancies		
Primigravida	56	36.4
Multigravida	98	63.6
Complications		
Yes	115	74.7
No	39	25.3
Childbirth		
Normal	81	52.6
C-section	73	47.4

The association between maternal characteristics and neonatal stunting was assessed using the chi-square test (Table 2). Preterm birth (<37 weeks) significantly increased the risk of neonatal stunting (p=0.012; OR=14.031; 95%CI:1.776–110.824). Mothers experiencing pregnancy complications had a fourfold greater risk of delivering a stunted newborn compared to those without complications (p=0.001; OR=4.048; 95%CI:1.803–9.087). Additionally, mothers with a basic education level demonstrated a significantly higher proportion of stunted newborns compared to those with a secondary education (p=0.001).

Other variables, including maternal age, employment status, nutritional status (BMI), history of Chronic Energy Deficiency (CED), anemia, parity, and history of hypertension, did not show statistically significant associations with neonatal stunting. Although maternal anemia appeared to nearly double the risk of stunting, statistical analysis indicated that this association was not significant (p=0.107; OR=1.966; 95%CI:0.864–4.472).

Table 2. Bivariate Analysis of Maternal Risk Factors Associated with Neonatal Stunting

Characteristic	Neonatal				OR (CI 95%)	*P-value*
	Stunted		Normal			
Age (y o)	N	%	N	%		
<25 and >35	20	60.6	13	39.4	0935	0.851
20-34	57	47.1	64	52.9	(0.454-1.922)	
Education						
Elementary	20	60.6	16	39.4	Reff	
Secondary	57	47.1	64	52.9	3.601 (1.70-7.63)	0.001
High	1	25	3	75	7.615 (0.73-80.05)	0.091
Working status						
Yes	22	44	28	56	0.700 (0.355-2.379)	0.302
No	55	53	49	47		
Nutrional status						
Underweight	4	80	1	20	0.238 (0.26-2.189)	0.205

Normal	57	48.7	60	51.3	Reff	
Overweight	14	52	13	48	0.882 (0.382-2.038)	0.769
Obesity	2	40	3	60	1.425 (0.230-8.844)	0.704
History of PEM						
Yes	6	54.5	5	45.5	1.217 (0.355-4.169)	0.755
No	71	49.7	72	50.3		
Anemia						
Yes	19	63.3	11	36.7	1.966 (0.864-4.472)	0.107
No	58	46.8	66	53.2		
Gestational Hypertension						
Yes	37	51.4	35	48.6	0.901(0.478-1.697)	0.747
No	40	48.8	42	51.2		
Gestational Age						
Preterm	12	92.3	1	7.7	14.031 (1.776-110.824)	0.012
Aterm	65	46.1	76	53.9		
Number of pregnancy						
Primigravida	27	48.2	29	51.8	0.894 (0.463-1.724)	0.738
Multigravida	50	51	48	49		
Complication						
Yes	67	58.3	48	41.7	4.048 (1.803-9.087)	0.001
No	10	25.6	29	74.4		

Multiple logistic regression analysis was performed on maternal risk factors including gestational age, pregnancy complications, maternal education level, and anemia ($p<0.25$). As detailed in Table 3, the final model identified three primary predictors. Gestational Age emerged as the strongest risk factor, where preterm birth increased the risk of neonatal stunting by 9.8 times (p=0.033; aOR=9.847; 95%CI:1.210–80.152). Maternal Education was a significant predictor (p=0.010), with basic education associated with a higher risk compared to secondary education (aOR=2.845; 95%CI:1.286–6.293). Pregnancy Complications independently increased the risk of neonatal stunting by 2.7 times (p=0.020; aOR=2.728; 95%CI:1.171–6.352).

Table 2. Bivariate Analysis of Maternal Risk Factors Associated with Neonatal Stunting

Variabel	B	S.E	Wald	df	aOR (aCI 95%)	*P-value*
Education Level			7.422	2		0.024
Secondary	1.046	0.405	6.666	1	2.845 (1.286-6.293)	0.010
High	1.767	1.218	2.103	1	5.851 (0.537-63.698)	0.147
Gestational Age	2.287	1.070	4.571	1	9.847 (1.210-80.152)	0.033
Maternal Complication	1.003	0.431	5.413	1	2.728 (1.171-6.352)	0.020
Constant	-6.449	2.146	9.029	1	0.002	0.003

The analysis confirms that all three variables gestational age, maternal education, and pregnancy complications are significant independent risk factors for neonatal stunting. This is evidenced by adjusted odds ratio (aOR) values greater than 1 for each variable. Gestational age shows the highest point estimate (aOR = 9.85), although its wide confidence interval reflects considerable uncertainty, likely due to the limited number of preterm cases. In contrast, maternal education and pregnancy complications present narrower confidence intervals, indicating more precise and stable risk estimates within the studied population.

DISCUSSION

This study confirms that maternal education is a critical determinant of neonatal health. We found that lower maternal education is significantly associated with an increased risk of delivering stunted infants (p=0.010; aOR=2.845; 95%CI=1.286-6.293). This results is consistent with a study on stunting determinants which highlighted that limited health literacy and delayed healthcare seeking among mother with lower education directly compromise maternal nutrient intake[8]. Higher maternal education and literacy correlate with improved socioeconomic status and household income, thereby facilitating access to essential resources such as nutritious food, healthcare, and sanitation while enhancing the understanding of child care practices required for optimal growth.[9,10].

Therefore, preventing neonatal stunting requires more than clinical intervention; it necessitates targeted educational empowerment for mothers with lower formal education, specifically regarding the first 1000 days of life. This approach is supported by recent findings demonstrating that nutritional education significantly enhances maternal understanding of adequate nutrition from preconception through pregnancy, a factor proven to reduce stunting risks[11].

In this study, the majority of stunted newborns in this study were born prematurely (<37 weeks), establishing lower gestational age as a significant predictor of neonatal stunting (p=0.033; aOR 9.847; 95%CI 1.210-80.152). This finding is consist with previous observations demonstrating that premature newborns tend to have lower birth weight and length compared to full-term counterparts[12]. Growth impairment initiating at birth often persist through the first two years of life, predisposing the child to permanent short stature and a heightened risk of chronic comorbidities in adulthood[13].

Underlying this growth restriction is the fact that bone mineralization is critically dependent on the third trimester of gestation, during which approximately 80% of fetal mineral accretion primarily calcium and phosphate occurs via active placental transport[14]. Consequently, preterm birth abruptly interrupts this vital supply, leaving the infant with significant mineral deficits. Furthermore, at the molecular level, this growth restriction is exacerbated by disruptions in the Growth Hormone (GH) axis, characterized by suppressed Insulin-like Growth Factor 1 (IGF-1) concentrations[15]. Systemic inflammation significantly worsens this deficiency, as proinflammatory cytokines drive the upregulation of IGFBP-1, which sequesters free IGF-1 and limits its bioavailability for linear bone mineralization[16]. Concurrently, nutritional deficits and intrauterine growth restriction are linked to elevated IGFBP-2 levels, providing a distinct pathway of growth inhibition that compounds the effects of inflammation[17].

This study demonstrates that pregnancy complications, particularly severe preeclampsia and premature rupture of membranes (PROM), significantly increase the risk of neonatal stunting (p=0.020; aOR=2.728; CI=1.171-6.352). The mechanism linking these complications to stunting likely involves placental insufficiency and inflammation. Preeclampsia and gestational hypertension induce systemic vasoconstriction and placental hypoperfusion, restricting the transfer of oxygen and nutrients essential for fetal skeletal growth[18–20].

Similarly, PROM is often precipitated by ascending urinary tract infections or systemic inflammation, which can trigger preterm labor and interrupt the fetal development timeline[21,22]. While other studies have linked factors sleep disturbances[23], HIV[24], and gestational diabetes[25,26] to adverse outcomes, our findings specifically underscore that in this population, aggressive management of hypertension and infection control is the direct preventive strategy for neonatal stunting. Consequently, stratified antenatal care focusing on these specific pathological drivers is essential to mitigate the risk of neonatal growth failure.

Several sociodemographic variables traditionally cited as risk factors did not demonstrate statistical significance in this study. In contrast to previous findings linking reproductive extremes (<20 or >35 years) to stunting[12], our analysis revealed no such association. While these age groups are recognized as high-risk for pregnancy complications[27,28], our results align with other studies suggesting that stunting is driven more by modifiable determinants such as maternal education and access to prenatal care rather than biological age alone[29].

Similarly, the lack of association with gravidity in our study is consistent with research suggesting that maternal nutritional reserves and socioeconomic status are more critical predictors than the number of pregnancies[30], although short inter-pregnancy intervals (<24 months) remain a potential risk factor[31]. Furthermore, employment status was not a significant differentiator. While excessive workload (>40-hour shifts) is a known stressor[32,33], occupation itself is likely a secondary factor that can be modified to reduce morbidity rather than a primary cause of stunting[34].

Maternal nutritional status (BMI and MUAC) was not significantly associated with neonatal stunting, a finding that contradicts established evidence linking maternal underweight status to fetal growth restriction and micronutrient deficiencies (iron, folate, zinc)[35,36]. Previous studies emphasize that maternal height (<150 cm) and weight (<43 kg) are strong predictors of stunting[37]. Nutrition imparment such as malnutrition hinders fetal growth through nutrient deprivation[36,38], while obesity impairs placental perfusion with inflammatory pathways[19,39]. The lack of significance in our data may be attributed to sample limitations or the influence of unmeasured confounders often linked to low socioeconomic status, such as poor sanitation and low per capita income[40,41] or behavioral factors like smoking, alcohol, caffeine intake and substance exposure[42,43].

Maternal anemia did not reach statistical significance (p=0.107). However the analysis revealed a clinically relevant trend, with anemic mothers having nearly twice the risk of delivering stunted newborns (OR=1.966). This contradicts findings where anemia showed a stronger statistical impact on birth length[44,45]. Anemia induces chronic fetal hypoxia and restricts the oxygen supply essential for development, often resulting in congenital malformations or growth restriction[46,47]. However, the absence of statistical significance in our dataset aligns with recent studies in developing countries, which suggest that neonatal stunting may be more strongly correlated with maternal short stature and chronic deprivation rather than acute anemia levels during pregnancy alone[12,48].

This study is limited by its retrospective design and reliance on secondary data, which may introduce selection bias and reduce the accuracy of some measurements. The single-hospital setting restricts generalizability, while the small sample size limited statistical power, particularly in the underweight subgroup. Finally, unmeasured confounders like paternal height and daily nutritional intake were not included in the analysis.

CONCLUSION

This study concludes that low maternal education, preterm birth, and pregnancy complications significantly increase the risk of neonatal stunting. However, maternal nutritional status and anemia did not demonstrate statistical significance in this study. Strengthening maternal education and improving antenatal care services are essential in reducing stunting risk, particularly through stratified monitoring of maternal comorbidities and targeted health literacy programs. Further longitudinal studies are required to explore long-term child outcomes and causal mechanisms to inform public health policies.

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