Jurnal Jaminan Kesehatan Nasional
Volume 5. Number 2, (Dec, 2025). Page 169 - 183
DOI: 10.53756/jjkn.v5i2.377
ISSN : 2798-6705 (online) | 2798-7183 (print)

Research Paper

Hospitalization Costs and Duration for Preterm and Low Birth Weight Infants under National Health Insurance

Farhan Kurniawan[1*], Vetty Yulianty Permanasari[1], Mardiati Nadjib[1], Erfan Chandra Nugraha[2]

[1]Universitas Indonesia, Depok, Indonesia
[2]BPJS Kesehatan, Jakarta, Indonesia

Abstract: Preterm birth and low birth weight are major contributors to neonatal morbidity, mortality, and healthcare costs in Indonesia. This study investigates how maternal risk factors and hospital characteristics jointly influence length of stay and inpatient costs for preterm and low birth weight infants covered by the national health insurance program (JKN) in 2022–2023. Using a retrospective cohort of administrative claims data and multilevel generalized linear models, we find that younger maternal age, neonatal complications, and concurrent diagnoses of prematurity and low birth weight significantly increase both length of stay and costs. Infants from non-government-subsidized members group (PBI – Penerima Bantuan Iuran) and those admitted to referral or public hospitals experience longer stays, while regional tariff differences and hospital ownership shape cost variations. By linking maternal risk, facility capacity, and financial burden under Indonesia's case-based payment system (INA-CBGs – Indonesia Case-Based Groups), this study highlights pathways to improve neonatal care efficiency. Strengthening antenatal services and referral systems may help reduce avoidable admissions and optimize resource use.

Keywords: Inpatient Costs; Length of Stay; Low Birth Weight; National Health Insurance; Preterm Birth

Introduction

Preterm birth (delivery before 37 weeks of gestation) and low birth weight (birth weight below 2,500 grams) are among the most prevalent global public health concerns, affecting approximately 15 milions and over 20 million newborns annually (WHO, 2022; Darmstadt et al., 2023; Krasevec et al., 2022). In Indonesia, 11.1% of births in 2023 were preterm and 6.1% were LBW–both higher than in the previous year (Kemenkes RI, 2023). These conditions are frequently linked to underdeveloped vital organs, rendering affected neonates highly vulnerable to environmental stressors in the early days of life and increasing the risk of early mortality.

Corresponding author name can be contacted at: farhankurniawan.research@gmail.com

Globally, prematurity and LBW are among the leading causes of neonatal deaths, with neonatal mortality accounting for nearly half of all under-five deaths (WHO, 2020; UNICEF, 2024). In Indonesia, the neonatal mortality rate reached 15 per 1,000 live births in 2017, which remains above the Sustainable Development Goal target of fewer than 12 deaths by 2030 (BPS et al, 2017).

Beyond reducing mortality, it is essential to recognize that preterm and LBW infants are at heightened risk of impaired physical and cognitive development. Disrupted fetal growth and limited nutritional reserves can delay organ maturation and neurodevelopment, both of which are critical for early life functioning. These developmental challenges may hinder long-term growth, learning, and overall well-being if not addressed early (Nainggolan & Sitompul, 2019; Novianti et al., 2020).

Managing preterm and LBW infants often requires specialized treatment in neonatal intensive care units (NICUs), resulting in substantial healthcare costs (Rolnitsky et al., 2023). NICUs serve as the final line of care for neonates with severe complications, involving advanced medical technologies and prolonged hospital stays. Prior studies report NICU treatment costs ranging from USD 90,7 per day (Sharma & Murki, 2021). These expenditures burden hospital resources and increase the final strain on patients.

To ensure equitable access to healthcare, Indonesia has implemented the National Health Insurance (JKN) program through the Social Security Administrative Body for Health (BPJS Kesehatan). The program supports Universal Health Coverage by expanding access, offering financial protection, and ensuring affordable, quality services. JKN also promotes prevention of adverse neonatal outcomes through antenatal care (ANC), encouraging six visits across pregnancy (Kemenkes RI, 2023). However, only 17.6% of pregnant women completed the recommended ANC visits in 2023, highlighting critical gaps in maternal health service utilization (Kemenkes RI, 2023).

Insufficient ANC visits have been strongly associated with higher risk of preterm and LBW births. Women with fewer than four ANC visits are 6,7 times more likely to deliver LBW infants compared to those who complete the full schedule (Anggondowati et al., 2017). ANC visits offer critical opportunities for early risk detection, health promotion, nutritional interventions, and delivery planning with skilled professionals, all of which are essential to improving neonatal outcomes (Doku & Neupane, 2017).

Maternal age also plays a critical role in pregnancy outcomes. In 2023, 25.3% of pregnancies in Indonesia occurred among adolescents (Kemenkes RI, 2023). Additionally, women aged 35 and older are at greater risk of delivering preterm or LBW infants than those in the 25–29 age group (Goisis et al., 2017). Maternal complications and comorbidities–such as premature rupture of membranes, prolonged labor, hypertension, and hemorrhage–further increase these risks. Hypertension can restrict placental blood flow, while uncontrolled maternal diabetes may impair placental nutrient transfer, both contributing to fetal growth restriction (Ardissino et al., 2022; Persson et al., 2018).

While these maternal risk factors are well-documented, few studies in low- and middle-income countries (LMICs) have examined how they intersect with hospital-level characteristics to influence both clinical outcomes and costs. This gap is particularly relevant in Indonesia, where hospitals are reimbursed through a case-based payment system (INA-CBGs).

Given these vulnerabilities, this study aims to examine both individual- and facility-level determinants of length of stay and inpatient costs among preterm and low birth weight infants covered by the National Health Insurance (*JKN*) program at Indonesian hospitals during 2022–2023.

Method

This quantitative study used a retrospective cohort design to examine factors associated with length of stay and treatment costs for preterm and LBW neonates at hospitals among JKN beneficiaries in Indonesia during 2022–2023. The retrospective cohort design allows the investigation of the relationship between exposures (maternal health service utilization and complications) and outcomes (length of stay and inpatient costs) by tracing health service records retrospectively from point of birth back through maternal health service history. This approach was chosen for its efficiency in analyzing large-scale administrative data and its ability to establish temporal associations between maternal risks and neonatal outcomes.

Secondary data were drawn from the BPJS Kesehatan Sample Dataset 2021–2024, specifically the General and Contextual Maternal and Child Health sample, which integrates JKN membership, primary care utilization, hospital (INA-CBGs) services, covering both maternal and neonatal health service use. The dataset is publicly available at https://data.bpjs-kesehatan.go.id/ with authorized access.

The BPJS Kesehatan Sample Dataset was conducted using stratified random sampling based on household categories and PHC facilities (Ariawan et al., 2022). Households were classified into three groups: (1) accessed PHC services, (2) accessed hospital services, and (3) had not accessed any health services.

Each stratum combined a PHC facility with one of the household categories. From each stratum, up to 10 households were randomly selected. Participant data from selected households were then linked with service records from PHC and hospital databases.

The target population comprised all neonates aged 0–1 month and their mothers who were JKN participants between 2021 and 2023. The final sample consisted of 1,851 mother-infant dyads that met specific inclusion criteria (neonates diagnosed with ICD-10 codes P070 to P073). Cases with incomplete claim data or mothers whose care did not fall within the defined maternal period were excluded.

The primary outcome variables were neonatal length of stay (in days) and inpatient treatment costs (in Indonesian Rupiah). Independent variables included mother's age,

grouped into <20 years (younger at-risk), 20–35 years (ideal), and >35 years (older at-risk); infant's sex (male, female); *JKN* membership segment (PBI, non-PBI); diagnosis at birth (preterm and LBW, preterm only, LBW only); neonatal complication status (without complications, with complications); ANC visit completeness (≥4 visits, <4 visits); maternal complication status (without complications, with complications); maternal comorbidity history (without comorbidities, with comorbidities); hospital ownership status (public, private), INA-CBGs tariff regionalization (regions 1–5).

Data were analyzed using STATA 16. A multilevel analytical framework was employed: individual-level factors (maternal age, neonatal diagnosis, antenatal care visit completeness, maternal comorbidities) and facility-level characteristics based on the hospital type (hospital ownership status, and INA-CBGs tariff regionalization). Generalized linear models with a gamma distribution and log link were applied to model length of stay, as this approach is well-suited for continuous outcomes with right-skewed distributions. In contrast, negative binomial regression was used for inpatient costs, which are count-like data prone to overdispersion (Espinoza et al., 2021). Sampling weights were not applied because weight variables were unavailable.

Ethical approval and informed consent were not required. The investigation adhered to all relevant ethical standards for secondary data analysis. Potential selection bias may arise because the dataset includes only registered Social Security Administrative Body for Health (BPJS Kesehatan) members, potentially underrepresenting individuals without access to health services or insurance registration. However, the use of stratified random sampling across household service utilization categories helped mitigate this bias and improve the representativeness of the sample.

Results

To provide a comprehensive overview of the study population, Table 1 presents the sociodemographic, clinical, and hospital characteristics of the neonates and their mothers included in the analysis. These characteristics are essential for understanding the context of maternal and neonatal health outcomes in relation to hospital treatment patterns and costs.

Table 1. Characteristics of Neonates and Mothers (*n*=1,851)

Variables	Category	Obs. Freq	Obs. (%)
	Individual Characteristics		
Mother's Age	Ideal Age (20–35 years)	1,388	74.99
	Younger At-Risk Age (<20 years)	94	5.08
	Older At-Risk Age (>35 years)	369	19.94
Sex	Male	950	51.32
	Female	901	48.68
JKN Membership Segmentation	Contribution Assistance Recipients (PBI)	1,048	56.62
	Non-PBI	803	43.38
	Clinical Characteristics		
Infant Diagnosis Group at Birth	Preterm and Low Birth Weight	186	10.05
	Low Birth Weight Only	1,591	85.95

Variables	Category	Obs. Freq	Obs. (%)
Neonatal Complication Status (ICD-10: P220, P221, P228, P229, Q250, P36, P77, P102)	Preterm Only	74	4.00
	Without Complications	1,207	65.21
	With Complications	644	34.79
ANC Visit Completeness (ICD-10: Z34, Z35, Z36)	≥4 visits	350	18.91
	<4 visits	1,501	81.09
Maternal Complication History (ICD-10: O14, O15, O244, O249, O42, O411, O43, O44, O46, O63, O64, O65, O66, O67, O68, O69)	Without Complications	1,052	56.83
	With Complications	799	43.17
Maternal Comorbidity History (ICD-10: I10, E10, E11)	Without Comorbidities	1,821	98.38
	With Comorbidities	30	1.62
	Hospital Characteristics		
Hospital Ownership Status	Public	1,207	65.21
	Private	644	34.79
Hospital Type	Type A	87	4.70
	Type B	510	27.55
	Type C	894	48.30
	Type D	198	10.70
	Specialized Hospital	162	8.75
INA-CBGs Tariff Regionalization	Region 1	808	43.65
	Region 2	309	16.69
	Region 3	262	14.15
	Region 4	177	9.56
	Region 5	295	15.94

As shown in Table 1, the majority of mothers were within the ideal reproductive age range (20–35 years), accounting for 74.99% of the total sample. A smaller proportion were classified as younger at-risk (<20 years) and older at-risk (>35 years) mothers, representing 5.08% and 19.94%, respectively. The distribution of infant sex was nearly equal, with 51.32% male and 48.68% female neonates.

In terms of health insurance segmentation under the National Health Insurance (JKN), 56.62% of participants were registered as Contribution Assistance Recipients (Penerima Bantuan Iuran, PBI), while 43.38% were non-PBI members, indicating a substantial proportion of beneficiaries from lower socioeconomic backgrounds.

Regarding clinical characteristics, low birth weight only was the predominant diagnosis at birth (85.95%), followed by preterm and low birth weight (10.05%) and preterm only (4.00%). Approximately 34.79% of neonates experienced complications (e.g., respiratory distress, infections), while 65.21% did not. For antenatal care (ANC) visits, the majority of mothers (81.09%) had fewer than four visits, reflecting suboptimal ANC coverage, whereas only 18.91% achieved the recommended ≥4 visits.

Maternal clinical conditions showed that 43.17% had a history of complications (such as hypertension or gestational diabetes), and 1.62% had comorbidities recorded under ICD-10 codes I10, E10, or E11.

Hospital characteristics indicate that most deliveries occurred in public hospitals (65.21%), and the most common facility type was Type C (48.30%), followed by Type B (27.55%). The regional distribution under INA-CBGs tariff regionalization shows the highest

proportion in Region 3 (40.46%), suggesting concentration in moderately resourced healthcare zones.

Overall, these findings describe a predominantly low-risk maternal population accessing care primarily through the national insurance scheme in public hospitals, yet with notable clinical and service variability that may influence neonatal outcomes and associated healthcare costs.

To provide a clearer understanding of hospital resource utilization and the economic burden associated with neonatal care, Table 2 summarizes the distribution of hospital length of stay and direct treatment costs among preterm and low birth weight infants included in this study.

Table 2. Summary of Hospital Length of Stay and Direct Treatment Costs among Preterm and Low Birth Weight Infants

Variables	n	Median	IQR	Mean	SD	Min.	Max.
Length of Stay (Days)	1,851	4	2–8	6.23	5.94	0	31
Direct Treatment Costs (Rp)							
Per Episode	1.918	7,029,500	5,289,000–10,000,200	9,207,074	9,500,195	1,273,300	188,855,904
Per Individual	1.851	7,242,600	5,323,800–10,208,400	9,493,310	9,751,797	1,273,300	188,855,904

The findings presented in Table 2 reveal substantial variation in both hospital stay duration and treatment expenditures among preterm and low birth weight infants. The median length of stay was 4 days (IQR: 2–8 days), indicating that most infants required short to moderate hospitalization. However, the range extended up to 31 days, suggesting that a subset of patients experienced prolonged admissions, likely reflecting greater clinical complexity or complications.

Regarding the economic outcomes, the mean direct treatment cost per episode was approximately Rp 9,207,074 (SD: Rp 9,500,195), while the mean cost per individual was slightly higher at Rp 9,493,310 (SD: Rp 9,751,797). The wide range of costs—from Rp 1,273,300 to Rp 188,855,904—highlights the significant variability in healthcare expenditures within this population. This cost heterogeneity may be attributed to differences in clinical severity, comorbidities, treatment intensity, and resource utilization patterns across cases.

Overall, these results underscore the considerable healthcare burden posed by preterm and LBW infants, emphasizing the need for targeted strategies to optimize care efficiency and reduce unnecessary variation in hospital costs and length of stay.

To further explore the determinants influencing hospital utilization among preterm and low birth weight infants, a multivariable regression analysis was performed. Table 3 presents the results of this analysis, identifying factors independently associated with the length of hospital stay after adjusting for individual, clinical, and institutional characteristics.

Table 3. Multivariable Analysis for Identifying Factors Associated with the Length of Stay among Preterm and Low Birth Weight Infants

Variables	Category	Coef.	95% CI		p-value
			Lower	Upper	
Mother's Age	Ideal Age		*Reference*		
	Younger At-Risk Age	0.247	0.085	0.409	0.003
	Older At-Risk Age	-0.023	-0.115	0.069	0.624
Sex	Male		*Reference*		
	Female	-0.024	-0.096	0.049	0.522
JKN Membership Segmentation	PBI		*Reference*		
	Non-PBI	0.104	0.028	0.179	0.007
Infant Diagnosis Group at Birth	Preterm and Low Birth Weight		*Reference*		
	Low Birth Weight Only	-0.201	-0.319	-0.082	0.001
	Preterm Only	-0.501	-0.718	-0.283	<0.001
Neonatal Complication Status	Without Complications		*Reference*		
	With Complications	0.443	0.367	0.519	<0.001
ANC Visit Completeness	≥4 visits		*Reference*		
	<4 visits	0.022	-0.072	0.116	0.645
Maternal Complication History	Without Complications		*Reference*		
	With Complications	0.043	-0.032	0.119	0.261
Maternal Comorbidity History	Without Comorbidities		*Reference*		
	With Comorbidities	0.051	-0.234	0.337	0.725
Hospital Ownership Status	Public		*Reference*		
	Private	-0.279	-0.376	-0.182	<0.001
INA-CBGs Tariff Regionalization	Region 1		*Reference*		
	Region 2	-0.174	-0.283	-0.064	0.002
	Region 3	-0.122	-0.239	-0.005	0.040
	Region 4	-0.029	-0.161	0.103	0.668
	Region 5	-0.140	-0.254	-0.025	0.017
Wald chi2(15)		226.52			
Observations		1,851			

As shown in Table 3. The multivariable analysis revealed several significant predictors of hospital length of stay among preterm and low birth weight infants.

Infants born to younger at-risk mothers (<20 years) had a significantly longer hospital stay compared to those born to mothers within the ideal reproductive age (Coef = 0.247, 95% CI: 0.085–0.409, p = 0.003). In contrast, maternal age >35 years showed no significant association.

Regarding health insurance segmentation, infants covered under non-PBI (non-contribution assistance recipients) JKN membership experienced longer hospitalization (Coef = 0.104, 95% CI: 0.028–0.179, p = 0.007) compared to those under PBI coverage. This finding may reflect differences in hospital type or access to higher-level facilities among different socioeconomic groups.

For clinical characteristics, both diagnosis group and complication status demonstrated strong associations. Infants diagnosed as low birth weight only had significantly shorter hospital stays (Coef = −0.201, 95% CI: −0.319 to −0.082, $p < 0.001$) compared with those with both preterm and low birth weight conditions. Similarly, preterm-only infants had the shortest stays (Coef = −0.501, 95% CI: −0.718 to −0.283, $p < 0.001$). Conversely, neonates with complications were hospitalized for longer durations (Coef = 0.443, 95% CI: 0.367–0.519, $p < 0.001$), confirming the substantial impact of clinical severity on healthcare utilization.

Other maternal and clinical variables, including ANC visit completeness, maternal complication history, and maternal comorbidities, did not show statistically significant associations ($p > 0.05$).

At the institutional level, hospital ownership and regional tariff classification were also significant factors. Infants treated in private hospitals had shorter lengths of stay than those in public hospitals (Coef = −0.279, 95% CI: −0.376 to −0.182, $p < 0.001$). Furthermore, facilities in Regions 2 and 5 exhibited slightly shorter stays compared to Region 1 ($p = 0.002$ and $p = 0.017$, respectively), suggesting possible differences in hospital capacity, efficiency, or clinical management practices across regions.

To assess the hierarchical structure and model fit in explaining variations in hospital length of stay, a multilevel negative binomial regression analysis was conducted. Table 4 presents the comparison of successive models, incorporating both individual- and hospital-level predictors as well as selected interaction effects among preterm and low birth weight infants.

Table 4. Comparison of Multilevel Negative Binomial Models for Determinants of Length of Stay among Preterm and Low Birth Weight Infants

Model	Log Likelihood	AIC	BIC	Var (Intercept)	PCV (%)	No. of Parameter
Model 0: Empty Model	-5,230.996	10,467.99	10,484.56	0.115	-	3
Model 1: Level-1 Predictors	-5,141.649	10,309.3	10,381.1	0.079	31.2	13
Model 2: Level-2 Predictors	-5,121.065	10,278.13	10,377.55	0.035	56.0	18
Model 3: Interaction by Mother's Age	-5,119.063	10,292.13	10,441.26	0.035	55.0	27
Model 4: Interaction by *JKN* Membership Segment	-5,117.638	10,277.28	10,393.27	0.035	54.7	21

As shown in Table 4, model performance improved progressively with the inclusion of additional predictors and interaction terms. The empty model (Model 0), which included no explanatory variables, demonstrated a log-likelihood of −5,230.996 and a variance (intercept) of 0.115, serving as the baseline for comparison.

When individual-level predictors were added (Model 1), model fit improved substantially, as indicated by the decrease in AIC (10,309.3) and BIC (10,381.1) values. The

proportion of variance explained (PCV) increased to 31.2%, suggesting that individual-level factors accounted for nearly one-third of the variability in hospital stay duration.

The inclusion of hospital-level predictors (Model 2) further enhanced model performance, reducing the AIC and BIC values to 10,278.13 and 10,377.55, respectively, and increasing the PCV to 56.0%. This indicates that hospital characteristics contributed substantially to explaining between-hospital differences in the length of stay.

In Model 3, the interaction between mother's age and clinical factors slightly improved the model fit (AIC = 10,292.13; PCV = 55.0%), though the improvement over Model 2 was modest. Finally, Model 4, which incorporated an interaction between JKN membership segmentation and hospital characteristics, achieved the best overall fit, reflected by the lowest AIC (10,277.28) and BIC (10,393.27) among all models, with a PCV of 54.7%.

These results suggest that both individual and institutional determinants—particularly the interplay between insurance segmentation and hospital factors—play a crucial role in explaining variations in the length of hospital stay among preterm and low birth weight infants. The declining variance at the intercept across models also indicates that the inclusion of contextual (hospital-level) variables successfully captured much of the unexplained heterogeneity observed in the empty model.

To further identify the determinants influencing hospital expenditure, a multivariable regression analysis was conducted to examine the factors associated with direct inpatient treatment costs among preterm and low birth weight infants. Table 5 summarizes the estimated coefficients, confidence intervals, and significance levels for the key predictors included in the model.

Table 5. Multivariable Analysis for Identifying Factors Associated with the Direct Inpatient Costs Among Preterm and Low Birth Weight Infants

Variables	Category	Coef.	95% CI		p-value
			Lower	Upper	
Mother's Age	Ideal Age		*Reference*		
	Younger At-Risk Age	0.124	0.031	0.217	0.009
	Older At-Risk Age	-0.041	-0.092	0.010	0.113
Sex	Male		*Reference*		
	Female	-0.046	-0.086	-0.005	0.027
JKN Membership Segmentation	PBI		*Reference*		
	Non-PBI	0.088	0.046	0.130	<0.001
Infant Diagnosis Group at Birth	Preterm and Low Birth Weight		*Reference*		
	Low Birth Weight Only	-0.216	-0.285	-0.147	<0.001
	Preterm Only	-0.277	-0.400	-0.157	<0.001
Neonatal Complication Status	Without Complications		*Reference*		
	With Complications	0.287	0.243	0.330	<0.001
Maternal Comorbidity History	Without Comorbidities		*Reference*		
	With Comorbidities	-0.038	-0.198	0.122	0.643
Hospital Ownership Status	Public		*Reference*		

Variables	Category	Coef.	95% CI		p-value
			Lower	Upper	
INA-CBGs Tariff Regionalization	Private	-0.091	-0.144	-0.039	0.001
	Region 1	*Reference*			
	Region 2	-0.092	-0.152	-0.032	0.003
	Region 3	-0.098	-0.162	-0.034	0.003
	Region 4	0.070	-0.004	0.144	0.065
	Region 5	-0.011	-0.075	0.051	0.719
Wald chi2(13)		305.61			
Observations		1,851			

Table 5 shown that, several factors were found to significantly affect direct inpatient treatment costs among preterm and low birth weight infants. Infants born to younger mothers (<20 years), those experiencing neonatal complications, and those treated in hospitals located in INA-CBGs Regions 2 and 3 incurred higher treatment costs. In contrast, preterm-only or low birth weight–only cases tended to have lower costs.

All models for determinants of inpatient cost among preterm and LBW infants improved over the null model, as indicated by decreasing log-likelihood, AIC, and BIC values. Adding individual-level predictors (Model 1) and contextual-level predictors (Model 2) sequentially enhanced model fit. Model 2 achieved the lowest AIC, indicating optimal balance between fit and parsimony. Although Model 3 and 4 included interaction terms and slightly improved log-likelihood, they increased BIC, suggesting possible overfitting relative to Model 2. The random intercept variance at the hospital type level decreased across models, implying that added covariates explained part of the between-hospital variation.

To further validate these findings and assess the contribution of individual- and facility-level predictors, multilevel gamma models were subsequently employed. The comparison of these models and their performance is presented in Table 6.

Table 6. Comparison of Multilevel Gamma Models for Determinants of Inpatient Cost among Preterm and Low Birth Weight Infants

Model	Log Likelihood	AIC	BIC	Var (Intercept)	PCV (%)	No. of Parameter
Model 0: Empty Model	-30,735.704	6,147.41	61,493.98	0.274	-	3
Model 1: Level-1 Predictors	-30,607.463	61,236.93	61,297.68	0.205	25.2	11
Model 2: Level-2 Predictors	-30,589.267	61,210.53	61,298.91	0.184	32.8	16
Model 3: Interaction by Mother's Age	-30,584.977	61,215.95	61,342.99	0.182	33.6	23
Model 4: Interaction by *JKN* Membership Segment	-30,588.518	61,213.04	61,312.46	0.183	33.2	18

As presented in Table 6, the multilevel gamma model incorporating both individual- and facility-level predictors (Model 2) provided the best overall fit, indicating that variations in inpatient costs were influenced not only by individual characteristics but also by hospital-level factors. Models that included interaction terms offered only marginal

improvement, suggesting that the main effects sufficiently explained most of the observed variability.

Discussion

Variation in length of stay and inpatient costs among preterm and LBW infants reflects differences in clinical severity and patterns of care utilization. The higher mean compared to the median indicates a right-skewed distribution, suggesting that a subset of neonates required prolonged and costly treatment, suggesting increased clinical severity among this subgroup. The discrepancy between the number of episodes (*n*=1,918) and individuals (*n*=1,851) indicates repeated admissions, pointing to multiple care episodes within a short period.

Maternal age showed a significant association with neonatal outcomes. Preterm and LBW neonates of mothers under 20 years old had longer length of stay and incurred higher inpatient costs, a finding consistent with prior studies linking adolescent pregnancies to biological immaturity, inadequate ANC visits, and increased neonatal complications (Atinuke et al., 2015; Fitri Subagja et al., 2024; Liznindya, 2023). In contrast, although older maternal age (>35 years) is biologically considered high-risk, no significant effect was observed–possibly due to better health literacy, ANC compliance, and timely interventions (Thalib & Abdullah, 2024; Wahyuni et al., 2021). These findings point to the need for targeted maternal health policies, such as subsidized or conditional ANC programs for adolescent mothers, to mitigate preventable complications and reduce downstream neonatal costs.

Socioeconomic disparities also emerged through segmentation of *JKN* membership. Preterm and LBW infants from non-PBI households exhibited longer length of stay and higher costs, suggesting a differentiated access pattern or care-seeking behavior based on ability to navigate and utilize services. Interestingly, while male preterm and LBW infants showed no significant difference in length of stay, female infants incurred lower inpatient costs, consistent with biological evidence suggesting that male neonates are more prone to complications such as respiratory distress (Su et al., 2022). This highlights the intersection of biological risk and socioeconomic stratification, underscoring the importance of ensuring equitable neonatal care access across membership groups in *JKN*.

Diagnostic classification at birth played a crucial role in determining healthcare utilization. Infants diagnosed with both preterm and LBW conditions experienced significantly longer length of stay and greater costs than those with either condition alone. This supports existing evidence that dual diagnoses amplify physiological immaturity, increasing the likelihood of NICU admission, respiratory support, and prolonged hospitalization (Beam et al., 2020; de Melo et al., 2022).

The most influential factors across both outcomes was the presence of neonatal complications such as sepsis or respiratory distress. These complications substantially increased healthcare demands, resulting in more intensive and prolonged care (Beam et

al., 2020; de Melo et al., 2022). Their impact reflects the clinical severity and intensive care needs often associated with high-risk neonatal conditions. Policy efforts should therefore strengthen early detection and referral mechanisms within primary health care to prevent complications from escalating to resource-intensive hospital care.

Although incomplete ANC visits (<4) and maternal complications were not statistically significant in multivariable models, their indirect impact remains important. Literature suggests that inadequate ANC reduces early detection of fetal risks, contributing to adverse neonatal outcomes (Prashanti et al., 2023; Sámano et al., 2024). Likewise, maternal complications such as preeclampsia elevate neonatal morbidity. However, timely referral and hospital-based management may mitigate their measurable impact. Maternal comorbidities (hypertension and diabetes) were also non-significant in this study, possibly due to early diagnosis and clinical stabilization (Fu et al., 2023; Mahovo & Velaphi, 2020; Sámano et al., 2024).

Hospital ownership status emerged as a significant determinant of both hospitalization costs and length of stay for preterm and LBW infants. Specifically, treatment in public hospitals was associated with longer inpatient durations and higher costs compared to private facilities. This pattern likely reflects the functional role of public hospital within the *JKN* referral system, where they often serve as higher-tier or tertiary referral centers managing more severe and complex neonatal cases. In line with previous studies, delays in emergency referrals or late-stage presentations may further exacerbate infants conditions upon arrival at public facilities, thereby intensifying resource use (Chafik et al., 2023; Deressa & Desta, 2023). These findings support tariff reform within Indonesia Case-Based Groups (INA-CBGs) to ensure reimbursement structures adequately reflect the higher resource demands of referral hospitals, preventing underfunding and supporting quality neonatal care.

Regional variations in the INA-CBGs payment system also shaped cost patterns. Hospital in Regions 2 and 3 were associated with shorter length of stay and lower costs compared to Region 1, which hosts major referral centres with greater clinical burden. These patterns align with INA-CBGs adjustment for hospital class, location, and teaching status (Nurwahyuni, 2015; Nurwahyuni & Setiawan, 2019). Such disparities mirror experiences in other low- and middle-income countries implementing DRG-based financing, where regional and institutional heterogeneity has produced inequities unless tariffs are explicitly adjusted. Positioning Indonesia's experience in this global context underscores the need for equity-oriented strategic purchasing reforms.

Overall, these findings contribute to a deeper understanding of how health financing structures intersect with service delivery context to shape the cost dynamics of neonatal care. Policymakers should leverage these insights to balance financial sustainability with equitable access, by integrating maternal risk targeting, strengthening ANC coverage for vulnerable groups, and revising hospital tariffs within the *JKN* framework.

Despite these findings, this study has several limitations. The use of secondary data from the Social Security Administrative Body for Health (BPJS Kesehatan) Sample Dataset, while efficient, limited the availability of important variables such as parity, maternal knowledge, NICU or PICU identification, and maternal nutritional status during pregnancy. The analysis of maternal complications and comorbidities was also restricted to certain conditions recorded administratively, which may not capture more clinically nuanced diagnoses. Furthermore, the dataset only covered services within the *JKN* benefit package, excluding care paid out-of-pocket or through other schemes. Due to the absence of sampling weights in the neonatal subset, the findings cannot be generalized to the entire JKN population but only represent approximately 1% of active JKN users during 2021–2023. These limitations suggest the need for cautious interpretation and highlight opportunities for future research using more comprehensive data sources.

Conclusion

This study demonstrates that maternal age, neonatal diagnosis at birth, national health insurance (JKN) membership segmentation, and hospital ownership are significant determinants of length of stay and inpatient costs among preterm and low birth weight infants. The findings contribute to a deeper understanding of healthcare utilization and cost drivers in Indonesia's referral hospital system and add to the broader evidence on neonatal health financing in low- and middle-income country contexts. Policymakers should consider enhancing antenatal care coverage and risk-based subsidies for vulnerable mothers, as well as reforming the Indonesia Case-Based Groups (INA-CBGs) payment mechanism to ensure equitable reimbursement for severe neonatal cases. Hospital administrators, in turn, are encouraged to strengthen early risk detection, optimize referral systems, and expand neonatal intensive care capacity, thereby improving efficiency while reducing avoidable costs and adverse outcomes.

Acknowledgement

The authors would like to express their gratitude to BPJS Kesehatan for providing access to the dataset, and to ThinkWell Institute Indonesia for their valuable guidance in deepening the understanding of policy context and statistical analysis methods.

References

Anggondowati, T., et al. (2017). Maternal characteristics and obstetrical complications impact neonatal outcomes in Indonesia: A prospective study. BMC Pregnancy and Childbirth, 17(1).

Ardissino, M., et al. (2022). Maternal Hypertension Increases Risk of Preeclampsia and Low Fetal Birthweight: Genetic Evidence from a Mendelian Randomization Study. Hypertension, 79(3), 588–598.

Ariawan, I., et al. (2022). Data Sampel BPJS Kesehatan. BPJS Kesehatan.

Thalib, A.L., Abdullah, M.N.A. (2024). Dampak Tingginya Early-Age Marriage Terhadap Kelahiran Prematur dan Bayi Berat Badan Lahir Rendah (BBLR). SABANA: Jurnal Sosiologi, Antropologi, dan Budaya Nusantara, 3(3), 249–257.

Atinuke, A., Shola, A., & Mark, G. (2015). Empirical analysis of factors associated with neonatal length of stay in Sunyani, Ghana. Journal of Public Health and Epidemiology, 7(3), 59–64.

Beam, A.L., et al. (2020). Estimates of healthcare spending for preterm and low-birthweight infants in a commercially insured population: 2008–2016. Journal of Perinatology, 40(7), 1091–1099.

Chafik, K., et al. (2023). Factors associated with neonatal near miss: Case of the University Hospital Center IbnSina of Rabat Morocco 2021. Journal of Neonatal-Perinatal Medicine, 16(1), 105–110.

Darmstadt, G.L., et al. (2023). New World Health Organization recommendations for care of preterm or low birth weight infants: health policy. eClinicalMedicine, 63.

de Melo, T.F.M., et al. (2022). Direct costs of prematurity and factors associated with birth and maternal conditions. Revista de Saude Publica, 56.

BPS, Kemenkes RI, USAID, et al. (2017). Survei Demografi dan Kesehatan Indonesia. BPS.

Deressa, A.T., & Desta, M.S. (2023). Prevalence and Determinants of Neonatal Near Miss in Ethiopia: A Systematic Review and Meta-Analysis. PLoS ONE, 18.

Doku, D.T., & Neupane, S. (2017). Survival analysis of the association between antenatal care attendance and neonatal mortality in 57 low- And middle-income countries. International Journal of Epidemiology, 46(5), 1668–1677.

Espinoza, E., et al. (2021). Modeling the Count Data of Public Health Service Visits with Overdispersion Problem by Using Negative Binomial Regression. Journal of Physics: Conference Series.

Subagja, S.F., et al. (2024). Hubungan Usia Ibu Hamil dengan Kejadian Berat Bayi Lahir Rendah di Ruang Bersalin RSUD Kabupaten Sumedang. Jurnal Ners, 8(2).

Fu, M., et al. (2023). Risk factors for length of NICU stay of newborns: A systematic review. Frontiers in Pediatrics, 11.

Goisis, A., et al. (2017). Advanced Maternal Age and the Risk of Low Birth Weight and Preterm Delivery: A Within-Family Analysis Using Finnish Population Registers. American Journal of Epidemiology, 186(11), 1219–1226.

Kemenkes RI. (2023). Survei Kesehatan Indonesia 2023. Kemenkes RI.

Krasevec, J., et al. (2022). Study protocol for UNICEF and WHO estimates of global, regional, and national low birthweight prevalence for 2000 to 2020. Gates Open Research, 6.

Liznindya. (2023). Hubungan Usia Ibu Hamil dengan Kejadian Bayi Berat Lahir Rendah (BBLR) di Desa Serangmekar Ciparay Kab. Bandung Tahun 2021. Jurnal Ilmiah Indonesia, 3(1).

Mahovo, R., & Velaphi, S. (2020). Duration of Hospital Stay and Factors Associated with Prolonged Hospital Stay in Very Low Birth Weight Infants Surviving to Hospital Discharge. Journal of Pediatrics, Perinatology and Child Health, 3(4).

Nainggolan B.C., Sitompul M. (2019). Hubungan Berat Badan Lahir Rendah (BBLR) dengan Kejadian Stunting pada Anak Usia 1-3 Tahun. Nutrix Journal, 3(1).

Novianti, I., Mardianti, D., Safitri Muchtar, A. (2020). Pemberian ASI dan BBLR Berhubungan dengan Kejadian Stunting pada Balita Usia 12-36 Bulan. Jurnal Kebidanan, 6(3).

Nurwahyuni, A. (2015). Pengembangan Model Penetapan Tarif Rawat Inap di Rumah Sakit Berdasarkan INA-CBG (Studi Kasus CMG O). Universitas Indonesia.

Nurwahyuni, A., Setiawan, E. (2019). Kinerja Rumah Sakit Swasta dengan Pembayaran INA-CBGs di Era Jaminan Kesehatan Nasional: Casemix, Casemix Index, Hospital Base Rate. Jurnal Ekonomi Kesehatan, 4(2).

Persson, M., et al. (2018). Association of Maternal Diabetes With Neonatal Outcomes of Very Preterm and Very Low-Birth-Weight Infants An International Cohort Study. JAMA Pediatrics, 172(9), 867–875.

Prashanti, N.A.P., et al. (2023). Risk Factors Affecting Length of Stay in Preterm Infants at Wangaya Regional General Hospital, Indonesia. Bioscientia Medicina: Journal of Biomedicine and Translational Research, 8(1), 3892–3901.

Rolnitsky, A., et al. (2023). The price of neonatal intensive care outcomes – in-hospital costs of morbidities related to preterm birth. Frontiers in Pediatrics, 11.

Sámano, R., et al. (2024). Low Antenatal Care Number of Consultations Is Associated with Gestational Weight Gain and Birth Weight of Offspring of Teenage Mothers: A Study Based on Colombian and Mexican Cohorts. Nutrients, 16(21).

Sharma, D., & Murki, S. (2021). Making neonatal intensive care: cost effective. Journal of Maternal-Fetal and Neonatal Medicine, 34(14).

Su, Z., et al. (2022). Increased Risk for Respiratory Complications in Male Extremely Preterm Infants: A Propensity Score Matching Study. Frontiers in Endocrinology, 13.

UNICEF. (2024). Neonatal mortality. UNICEF.

Wahyuni, W., et al. (2021). Hubungan Usia Ibu, Paritas dan Kadar Hemoglobin dengan Kejadian Bayi Berat Lahir Rendah (BBLR) di RSUD Siti Fatimah Provinsi Sumatera Selatan Tahun 2020. Jurnal Keperawatan Sriwijaya, 8(2).

WHO. (2020). Newborns: Improving Survival and Well-Being. WHO.

WHO. (2022). WHO recommendations for care of the preterm or low-birth-weight infant. WHO.

Zhou, J., et al. (2023). Estimating Costs Associated with Disease Model Stages Using Generalized Linear Models: A Tutorial. Pharmacoeconomics, 42(3), 261–273.