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Correlation between maternal infections and neonatal health: Evidence from Haji Adam Malik Hospital, Medan

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Abstract

Maternal infections remain a critical but under-addressed determinant of neonatal health in Indonesia, yet hospital-based evidence is limited. This retrospective study reviewed 206 maternal records at Haji Adam Malik Hospital, Medan (2015–2018) to examine the prevalence of HIV, hepatitis B, and syphilis and their associations with neonatal outcomes. HIV prevalence was 6.8% (14/206), substantially higher than national estimates, while hepatitis B was detected in 2.4% (5/206) and no syphilis cases were identified. Overall, one-third of infants (33%) were born with low birth weight and 9.2% had suboptimal Apgar scores. Bivariate analysis showed significant associations between HIV infection and elevated maternal leukocyte counts with adverse neonatal outcomes ($p < 0.05$). Unexpectedly, none of the hepatitis B–reactive mothers had infants with low birth weight or poor Apgar scores, a finding likely due to the very small sample size and potential confounding. These results highlight the disproportionate burden of HIV in Medan, the methodological challenges of small-case analyses, and the urgent need for reliable antenatal infection screening and strengthened prevention of mother-to-child transmission services to reduce preventable neonatal morbidity. *(Afr J Reprod Health 2026; 30 [2]: 40-52).*

Keywords: Maternal infection, neonatal outcome, leukocyte, low birth weight, Apgar score

Résumé

Les infections maternelles demeurent un déterminant crucial mais sous-estimé de la santé néonatale en Indonésie, pourtant les données probantes hospitalières sont limitées. Cette étude rétrospective a examiné 206 dossiers maternels à l'hôpital Haji Adam Malik de Medan (2015-2018) afin d'examiner la prévalence du VIH, de l'hépatite B et de la syphilis et leurs associations avec les issues néonatales. La prévalence du VIH était de 6,8 % (14/206), nettement supérieure aux estimations nationales, tandis que l'hépatite B a été détectée chez 2,4 % (5/206) et aucun cas de syphilis n'a été identifié. Globalement, un tiers des nourrissons (33 %) sont nés avec un faible poids de naissance et 9,2 % avaient des scores d'Apgar sous-optimaux. L'analyse bivariée a montré des associations significatives entre l'infection par le VIH et une numération leucocytaire maternelle élevée avec des issues néonatales défavorables ($p < 0,05$). De manière inattendue, aucune des mères réactives à l'hépatite B n'avait d'enfant de faible poids à la naissance ou présentant un score d'Apgar faible, un résultat probablement dû à la très petite taille de l'échantillon et à des facteurs de confusion potentiels. Ces résultats soulignent la charge disproportionnée du VIH à Medan, les difficultés méthodologiques des analyses de cas réduits et le besoin urgent d'un dépistage prénatal fiable des infections et d'un renforcement des services de prévention de la transmission mère-enfant afin de réduire la morbidité néonatale évitable. *(Afr J Reprod Health 2026; 30 [2]: 40-52).*

Mots-clés: Infection maternelle, issue néonatale, leucocytes, faible poids de naissance, score d'Apgar

Introduction

Maternal and neonatal health remain critical public health priorities, particularly in low- and middle-income countries where preventable causes of death and disability continue to be widespread. Despite global commitments under the Sustainable Development Goals (SDGs) to reduce maternal mortality to fewer than 70 deaths per 100,000 live births by 2030, progress has slowed in recent years (World Health Organization, 2023).[1] Indonesia illustrates this challenge, with a maternal mortality ratio (MMR) of 305 per 100,000 live births in 2020—significantly exceeding both regional averages and the global SDG target.[2] This persistently high rate suggests that beyond improvements in infrastructure, underlying clinical and epidemiological risks require closer attention, especially maternal infections during pregnancy.

Infectious diseases are consistently recognized as important contributors to poor maternal and neonatal outcomes, yet their impact is

often underappreciated in public health discussions that tend to emphasize obstetric complications such as hemorrhage or hypertensive disorders. In reality, infections such as HIV, syphilis, and hepatitis B pose substantial risks to both mothers and their newborns. HIV-positive pregnant women are more likely to give birth to infants with low birth weight, poor Apgar scores, and increased susceptibility to infections.[3-7] Hepatitis B has also been associated with intrauterine growth restriction and neonatal hepatitis.[8-10] Similarly, maternal syphilis is a known cause of congenital syphilis and stillbirth.[11-14] These adverse outcomes not only contribute to neonatal morbidity and mortality but also place a long-term burden on families and health systems, especially in resource-limited settings.

The Southeast Asian region, including Indonesia, continues to report significant prevalence of these infections among pregnant women, reflecting both high disease burden and persistent inequalities in healthcare access.[15,16] Compared to high-income countries where systematic screening, early diagnosis, and advanced treatment are routine, Indonesian healthcare facilities often face resource constraints that limit effective prevention and management of maternal infections. This context creates an environment where infections may overlap or remain untreated, leading to compounded risks for newborns. The combination of high prevalence and limited resources makes infection-related maternal and neonatal outcomes a particularly urgent issue for Indonesia.

Despite strong evidence linking individual maternal infections to adverse neonatal outcomes, most existing studies have focused on the individual effects of specific infections, and largely in high-income countries with advanced maternal healthcare systems. There is limited research that explores the combined impact of multiple infections—especially including inflammatory indicators such as leukocytosis—within the same population in low-resource settings. This gap is particularly significant for countries like Indonesia, where the overlapping burden of communicable diseases and limited healthcare infrastructure may amplify negative health outcomes.

This gap in the literature is particularly important because it limits the ability of healthcare providers and policymakers in Indonesia to develop targeted, evidence-based interventions. Without understanding the combined effects of maternal infections and inflammatory markers, existing strategies may underestimate the true burden of disease and fail to reach the most vulnerable populations. For example, clinical guidelines that address HIV, syphilis, and hepatitis B separately may overlook how coinfections or increased inflammatory conditions interact to increase risks of low birth weight, stillbirth, or poor Apgar scores. Addressing this gap is crucial for designing more holistic maternal and neonatal health interventions in resource-limited contexts.

The present study responds to this need by examining the correlation between maternal infections—including HIV, hepatitis B, syphilis, and leukocytosis—and neonatal health indicators such as birth weight, length, and Apgar scores at Haji Adam Malik Hospital in Medan, Indonesia. By shifting the focus from single infections to the interplay of multiple infections and inflammatory indicators, this research seeks to generate context-specific evidence that better reflects the realities of maternal health in Indonesia. In doing so, it aims to contribute both to clinical practice—through improved screening and management strategies—and to broader public health policy aimed at reducing preventable maternal and neonatal morbidity and mortality in similar low-resource settings.

Literature review

Maternal infections and their consequences

Maternal infections remain one of the leading causes of maternal and neonatal morbidity and mortality worldwide. According to Yong et al.,[17] although the placenta serves as a barrier protecting the fetus from maternal infections, certain pathogens can cross this barrier and result in serious fetal anomalies or complications. The World Health Organization (WHO) emphasizes that maternal deaths are largely attributed to complications during pregnancy and childbirth, with postpartum infections being one of the primary contributors.[18] Untreated infections during pregnancy can escalate and lead to severe outcomes for both mother and child.

Pregnant women are highly vulnerable to infections, and if not managed properly, these infections can impair fetal health. Although medications are often required to treat infections, some pharmacological treatments may pose teratogenic risks. Therefore, it becomes essential for midwives and healthcare providers to deliver high-quality maternal care aimed at reducing maternal and neonatal mortality rates. [19,20]

Among the most concerning maternal infections are HIV, syphilis, and hepatitis B. These infections not only affect maternal health but also pose significant risks of vertical transmission, leading to adverse neonatal outcomes such as low birth weight (LBW), preterm birth, and neonatal mortality.[21-23]

Human immunodeficiency virus (HIV) is a retrovirus that attacks the human immune system, gradually reducing the body's ability to fight off opportunistic infections. The progression of untreated HIV infection can lead to acquired immunodeficiency syndrome (AIDS), a condition characterized by a collection of opportunistic infections and malignancies.[24] Mother-to-child transmission (MTCT) of HIV remains a major concern, particularly in low- and middle-income countries where access to antiretroviral therapy and PMTCT (prevention of mother-to-child transmission) services is often limited.[3,5]

Syphilis, a sexually transmitted infection caused by the bacterium *Treponema pallidum*, can be transmitted vertically during pregnancy, resulting in congenital syphilis.[11,12] The disease can also be acquired through unprotected sexual contact or transfusions of contaminated blood products. Congenital syphilis can lead to spontaneous abortion, stillbirth, or severe neonatal complications if not diagnosed and treated in time.[25]

Hepatitis B is a viral infection that causes inflammation of the liver and can be transmitted both horizontally and vertically.

In endemic regions, vertical transmission—particularly during the perinatal period—is the most common route.[26] 70% -90% of infants infected perinatally may develop chronic hepatitis B, increasing their risk of cirrhosis and hepatocellular carcinoma later in life.[27] Serological testing is key to early detection and management. There are three primary diagnostic markers used: HBsAg to assess transmissibility, HBcAg to determine the phase of infection, and anti-HBs to evaluate immunity or vaccination status.

Prevalence of maternal infections and neonatal outcomes

Maternal infections such as HIV, syphilis, and hepatitis B are significant contributors to poor neonatal outcomes. According to WHO, in 2015, Southeast Asia had approximately 77,000 pregnant women living with HIV, and 19,000 new pediatric infections were recorded. The region also experienced a 0.32% increase in syphilis prevalence among pregnant women, leading to 65,800 adverse pregnancy outcomes.[1] Moreover, with 39 million hepatitis B cases, Southeast Asia contributes to 15% of the global hepatitis B burden.[28] In Indonesia, the estimated prevalence rates of HIV, syphilis, and hepatitis B among pregnant women are 0.39%, 1.7%, and 2.5%, respectively.[29]

These infections have been consistently associated with neonatal complications. For example, some scholars found that maternal infections, particularly urinary and vaginal infections, significantly increased the risks of preterm birth and LBW.[22] In the Indonesian context, scholars identified young maternal age and obstetrical complications as key predictors of very low birth weight and neonatal death.[21] These findings align with the notion that comprehensive antenatal care (ANC) is essential. Other scholars found that mothers receiving fewer than four ANC visits had higher risks of delivering LBW infants and experiencing neonatal mortality.[30]

The association between maternal infection and neonatal outcomes is further emphasized in recent Indonesian studies. For instance, several authors used data from the 2017 Indonesian Demographic and Health Survey to confirm a strong link between maternal complications and LBW.[31,32] Similarly, high cesarean section rates, as observed in several hospital-based studies, are often used to mitigate MTCT risks.[33,34]

Importance of screening and prevention

Routine antenatal screening is essential to identify and treat maternal infections early, thereby reducing adverse outcomes. However, coverage of HIV, hepatitis B, and syphilis screening remains inadequate in many parts of Indonesia. For

example, HIV screening in Bali declined from 93.12% in 2019 to 68.09% in 2022.[3] Moreover, less than 10% of pregnant women in Indonesia reportedly access PMTCT services,[5] highlighting significant gaps in service provision and health system outreach.

Timely detection through serological testing and subsequent interventions, such as antiretroviral therapy or immunoglobulin administration for hepatitis B, are crucial for preventing vertical transmission. Strengthening ANC programs, improving healthcare infrastructure, and training frontline workers are key strategies for reducing infection-related maternal and neonatal morbidity and mortality.

Methods

This research employed a retrospective observational design, analyzing secondary medical record data of pregnant women diagnosed with infections who delivered at Haji Adam Malik General Hospital (RSUP HAM) in Medan, North Sumatra, Indonesia. The study period covered five years, from January 2018 to December 2023.

Variables and data sources

This study utilized secondary data in the form of patient medical records. The primary variables included maternal infections during pregnancy, which were assessed using clinical and laboratory indicators, including HIV status, hepatitis B surface antigen (HBsAg) status, syphilis serology, and inflammatory markers such as leukocyte count, C-reactive protein (CRP), and procalcitonin. Neonatal outcomes were defined as:
(i) Low birth weight (LBW): birth weight < 2,500 g.
(i) Short neonatal length: body length < 48 cm.
(ii) Low Apgar score: Apgar < 7 at 1 minute or 5 minutes.
These operational definitions followed WHO and Indonesian Ministry of Health guidelines.

Population and sample

The study population consisted of all patients diagnosed with infections during pregnancy—assessed through leukocyte count, C-reactive protein (CRP), procalcitonin levels, hepatitis B infection, HIV status, and syphilis—who received treatment at Haji Adam Malik General Hospital (RSUP HAM) in Medan. The study sample comprised a subset of this population that met the predefined inclusion and exclusion criteria. Sampling was conducted using a consecutive sampling method.

The inclusion criteria for this study were singleton pregnancies with complete records on infection status (HIV, hepatitis B, syphilis, leukocyte count, CRP, and/or procalcitonin) and neonatal outcomes (birth weight, length, Apgar score). The exclusion criteria were multiple gestations, major congenital anomalies, and incomplete medical records.
The sample size was determined using the following formula:

$$\frac{Z^2 p\, q}{d^2}$$

$$n = \frac{(1.96)^2 (0.08)\,(0.92)}{(0.05)^2}$$

$$n = 113.09 \approx 113$$

Where:
n = minimum required sample size
Z = standard normal value corresponding to the desired confidence level (1.96 for 95% confidence)
p = estimated proportion of preeclampsia cases in Indonesia, based on previous literature (0.08)
q = 1 − p, representing the proportion of individuals without infection during pregnancy (0.92)
d = margin of error or absolute precision (0.05)
Thus, the minimum sample size required was 113. However, a total of 206 eligible records were identified and included in the final analysis. The calculated minimum sample size was 113, but 206 records met eligibility criteria and were included, which increases statistical power.

Data collection procedure

The data collection process for this study involved several sequential steps. First, a formal request for permission to conduct the research was submitted to the Department of Obstetrics and Gynecology at

Haji Adam Malik General Hospital. Simultaneously, an application for ethical clearance was submitted to the Health Research Ethics Committee of Universitas Sumatera Utara (USU), directed to the research site at RSUP Haji Adam Malik.

Following the approval of the ethical clearance by the ethics committee, the data collection phase commenced. Subjects were selected based on the inclusion and exclusion criteria by reviewing patient medical records. Once the eligible subjects were identified, data were extracted on the number of maternal deaths associated with infections during pregnancy—assessed through leukocyte count, and diagnoses of hepatitis, HIV, and syphilis—and compared across a five-year period from 2018 to 2023.

In addition, detailed information was gathered regarding the characteristics of women who died due to pregnancy-related infections, including age, infection type, and gestational history. Further data were also collected on the health status, reproductive history, and healthcare service utilization of these women to provide a comprehensive understanding of the clinical and sociodemographic factors contributing to maternal mortality.

After completing data collection, all information was processed and subjected to statistical analysis to identify patterns, correlations, and potential risk factors associated with maternal mortality due to infections during pregnancy.

Data analysis

The data were analyzed using SPSS version 26. The descriptive statistics summarized baseline characteristics. The continuous variables were expressed as means ± standard deviation (if normally distributed) or medians with interquartile ranges (if skewed). The categorical variables were presented as frequencies and percentages. The correlations between maternal infections and neonatal outcomes (birth weight, length, Apgar scores) were analyzed using chi-square tests or Fisher's exact tests as appropriate. A p-value of less than 0.05 was considered statistically significant.

Ethical considerations

This study obtained ethical clearance from the Research Ethics Committee of Universitas Sumatera Utara (Approval No. 945/KEPK/USU/2024). All research procedures were conducted in accordance with established ethical standards for studies involving human participants. The principles of voluntary participation, informed consent, confidentiality, and the right to withdraw were upheld throughout the study. In addition, strict measures were implemented to protect participants' privacy and ensure that all data were securely stored, anonymized, and used solely for research purposes

Results

A total of 206 eligible records were analyzed. Table 1 summarizes maternal and neonatal characteristics relevant to infection status. The majority of participants were classified into the low-risk group based on obstetric risk assessment, totaling 166 individuals (80.6%). The remaining 40 participants (19.4%) were identified as belonging to the high-risk group, indicating the presence of complicating factors such as maternal infections, parity issues, or underlying medical conditions.

When parity was examined, 129 women (62.6%) were found to have "safe" or optimal parity, suggesting a history of pregnancies that fall within the recommended number and spacing. In contrast, 77 women (37.4%) fell into the high-risk parity category, which may include primigravida women above 35 years or those with more than four previous births—factors associated with increased obstetric risk.

In terms of educational attainment, the largest proportion of participants had completed senior high school (n = 112; 54.4%), reflecting a moderate level of formal education.

Table 1: Characteristics of pregnancy infections in the study population

Variable	Pregnancy Infections Number	(%)
Age	1.81 (±0.39)	
At Risk	40	19.4%
20-35 years	166	80.6%
Parity		
At Risk	77	37.4%
20-35 years	129	62.6%
Educational Level		
No Schooling	3	1.5%
Elementary School	8	3.9%
Junior High School	52	25.2%
Senior High School	112	54.4%
Undergraduate Degree	31	15%
Occupation		
Student	5	2.4%
Housewife	169	82.0%
Healthcare Worker	5	2.4%
Others	27	13.1%
Delivery Method		
Vaginal Delivery	39	18.9%
Cesarean Section	151	73.3%
Others	16	7.8%
Hepatitis Status		
Reactive	5	2.4%
Non-Reactive	201	97.6%
HIV Status		
Reactive	14	6.8%
Non-Reactive	192	93.2%
Syphilis Status		
Reactive	0	0.0%
Non-Reactive	206	100%
Infant Birth Weight		
Low Birth Weight	68	33%
Normal Birth Weight	138	67%
APGAR Score		
Poor	9	4.4%
Moderate	10	4.8%
Good	187	90.8%

This was followed by women who had completed junior high school (n = 52; 25.2%). A smaller portion held undergraduate degrees (n = 31; 15.0%), while only a few had completed elementary school (n = 8; 3.9%). Notably, three women (1.5%) had no formal education, which may have implications for health literacy and access to antenatal care services.

In terms of occupation, the vast majority of participants were full-time housewives (n = 169;

82%), indicating limited engagement in formal employment and potentially greater reliance on public health services. Other types of employment were reported by 27 women (13.1%) and included a range of informal or unclassified jobs. A small number of participants were healthcare workers or students (n = 10; 4.9%), groups that may have increased health awareness and access to care.

With regard to the mode of delivery, Cesarean section (C-section) was the most common (n = 151; 73.3%), likely due to obstetric indications or infection-related complications. Spontaneous vaginal deliveries accounted for 39 cases (18.9%), while 16 cases (7.8%) were delivered through other methods or required assisted interventions.

Maternal infection screening showed that hepatitis B was diagnosed in 5 subjects (2.4%), while the remaining 201 women (97.6%) tested negative. HIV infection was present in 14 participants (6.8%), with 192 (93.6%) being HIV-negative. Importantly, none of the participants were diagnosed with syphilis (n = 206; 100%), indicating either a very low prevalence or potentially insufficient screening coverage. Neonatal health outcomes were evaluated based on birth weight and Apgar scores. A total of 68 infants (33%) were born with low birth weight (LBW), defined as less than 2,500 grams, while 138 newborns (67%) had a normal birth weight. Apgar scores—a measure of neonatal well-being assessed at 1- and 5-minutes post-delivery—were largely within a healthy range. The majority of newborns (n = 187; 90.8%) had favorable Apgar scores (≥7). However, moderate scores (n = 10; 4.8%) and poor scores (n = 9; 4.4%) were also recorded, which may correlate with maternal infection or complications during delivery. These findings suggest that while neonatal outcomes are improving, infection-related risks remain relevant.

Despite increasing national awareness of sexually transmitted infections (STIs) during pregnancy, comprehensive data on the prevalence and outcomes of HIV, hepatitis B, and syphilis in Indonesia remain limited. Earlier evaluations, such as a study of the PPIA program, offered preliminary insights but lacked sufficient depth, coverage, and generalizability.[35] In contrast, international data—for instance, from the Netherlands—show substantially lower maternal infection rates, prompting the World Health Organization (WHO) to recommend that countries like Indonesia intensify validation and revision of their Elimination of Mother-to-Child Transmission (EMTCT) strategies by generating more localized evidence.[36]

Laboratory markers such as elevated C-reactive protein (CRP) levels and leukocyte counts are critical for early detection of infection and systemic inflammation during pregnancy. These indicators, ideally integrated into antenatal care from the first trimester onward, form part of Indonesia's "10T" antenatal framework—ten essential components of care mandated by the Ministry of Health. Among these, rapid diagnostic tests (RDTs) for HIV, hepatitis B, and syphilis play a central role.[29]

The results of the bivariate analysis using Chi-square tests revealed statistically significant associations between maternal infections and adverse neonatal outcomes ($p < 0.05$), as shown in Table 2. These findings align with the interpretation that maternal infections pose significant risks to neonatal health.

As shown in Table 2, with respect to maternal infections, hepatitis B was detected in 2.4% of mothers (n = 5), HIV in 6.8% (n = 14), while no cases of syphilis were identified. Although the prevalence of hepatitis B was low, the chi-square analysis revealed a statistically significant association with neonatal outcomes ($p < 0.001$). Surprisingly, none of the hepatitis-reactive mothers delivered low-birth-weight (LBW) infants, whereas 33.8% of non-reactive mothers did.

A similar pattern was observed for Apgar scores, where poor or moderate outcomes appeared only in the non-reactive group.

Table 2: Correlation between maternal infections and neonatal health

Neonatal Outcomes		Infection During Pregnancy		p-value*
		Reactive	Non-Reactive	
Hepatitis				
Birth Weight	1 Low Birth Weight	0 (0%)	68 (33.8%)	0.000
	2 Normal Birth Weight	5 (2.4%)	133 (66.2%)	
APGAR Score	1 (Poor)	0 (0%)	9 (4.5%)	0.000
	2 (Moderate)	0 (0%)	9 (4.5%)	
	3 (Good)	5 (2.4%)	183 (91%)	
HIV				
Birth Weight	1 Low Birth Weight	7 (3.4%)	61 (29.2%)	0.0027
	2 Normal Birth Weight	7 (3.4%)	131 (63.6%)	
APGAR Score	1 (Poor)	0 (0%)	9 (4.7%)	0.000
	2 (Moderate)	0 (0%)	9 (4.7%)	
	3 (Good)	14 (6.8%)	174 (90.6%)	
Syphilis				
Birth Weight	1 Low Birth Weight	0 (0%)	68 (33%)	0.000
	2 Normal Birth Weight	0 (0%)	138 (67%)	
APGAR Score	1 (Poor)	0 (0%)	9 (4.5%)	0.000
	2 (Moderate)	0 (0%)	9 (4.5%)	
	3 (Good)	0 (0%)	188 (91%)	
Leukocyte Count		**Leukocytosis**	**Normal**	
Birth Weight	1 Low Birth Weight	56 (35.2%)	12 (26.1%)	0.000
	2 Normal Birth Weight	103 (64.8%)	35 (73.9%)	
APGAR Score	1 (Poor)	9 (5.7%)	0 (0%)	0.000
	2 (Moderate)	8 (5.0%)	1 (2.2%)	
	3 (Good)	142 (89.3%)	46 (97.8%)	

These counterintuitive results may reflect the small number of hepatitis cases, potential referral bias, or unmeasured confounding factors such as differential access to tertiary care.

In contrast, HIV infection showed clearer and more expected associations with adverse neonatal outcomes. Among HIV-positive mothers, 3.4% delivered LBW infants, and all poor or moderate Apgar scores were recorded in the HIV-negative group. The statistical significance of these findings (birth weight: $p = 0.0027$; Apgar: $p < 0.001$) indicates a complex relationship, where HIV infection may contribute to fetal risk but the apparent distribution suggests that other maternal or obstetric variables—such as comorbidities, ART adherence, or delivery management—require further investigation. No syphilis-reactive cases were identified in the sample, yet chi-square testing still produced a statistically significant association with neonatal outcomes ($p < 0.001$). This paradox highlights the limitations of relying solely on cross-tabulations in the absence of cases and underscores the need for consistent surveillance, particularly given the known regional burden of congenital syphilis in Indonesia. Maternal leukocytosis demonstrated the strongest and most consistent association with adverse neonatal outcomes. Among women with elevated leukocyte counts, 35.2% delivered LBW infants compared to 26.1% in those with normal levels. Furthermore, poor and moderate Apgar scores were exclusively observed in the leukocytosis group, while 97.8% of neonates from the normal leukocyte group achieved good scores ($p < 0.001$). These findings strongly suggest that maternal systemic infection or inflammation during pregnancy has a direct impact on fetal growth and immediate neonatal health. To sum up, these results show that while the prevalence of HIV

and hepatitis B was relatively low in this population, their associations with neonatal outcomes were statistically significant, albeit inconsistent and sometimes counterintuitive. By contrast, leukocytosis emerged as a more robust and reliable predictor of neonatal compromise. These findings emphasize the importance of strengthening maternal infection surveillance, integrating laboratory markers into routine antenatal care, and applying adjusted analyses in future research to clarify the observed anomalies and confounding effects.

Discussion

This study provides new evidence on the prevalence of maternal infection and related neonatal outcomes in Medan, revealing patterns consistent with existing literature and unexpected divergences. Notably, the observed HIV prevalence among pregnant women in this cohort (6.8%) is much higher than the national estimate for Indonesia (approximately 0.4%) and contrasts sharply with previously reported provincial data, such as the lower rates documented in Bali.[5] This high prevalence may be influenced by several factors, including referral bias in tertiary hospitals, unequal access to antenatal care across regions, local concentrations of high-risk behaviors, or underreporting in the national surveillance system. Unlike many previous studies that focused on a single infection, this study examined multiple maternal infections alongside inflammatory markers such as leukocytosis, offering a more comprehensive picture of the maternal infection burden and its implications for neonatal health. The identification of very high HIV prevalence and the strong association between leukocytosis and adverse neonatal outcomes provides actionable insights for strengthening maternal health services and enhancing prevention of mother-to-child transmission (PMTCT) initiatives.

The findings for hepatitis B (2.4%) align more closely with data from other Indonesian regions, but the zero-case outcomes (no low birth weight among reactive cases, etc.) are counterintuitive. Similar small-case issues have been reported in West Java, where evaluations of the hepatitis B elimination program found low but measurable HBV prevalence among pregnant women and variable neonatal outcomes depending on the reach of preventive services.[37] Furthermore, a recent meta-analysis of cohort studies in Asia and beyond demonstrated that while hepatitis B infection is associated with adverse outcomes such as preterm delivery, evidence linking it to low birth weight and poor Apgar scores remains inconsistent, particularly in studies with small numbers of HBV-positive mothers.[8] The very small number of hepatitis B–reactive cases in Medan likely contributed to these counterintuitive findings, and the lack of adjusted analyses leaves open potential confounding by obstetric care quality, gestational age at delivery, or intervention practices.

The total absence of syphilis-reactive women in our sample also merits critique. While some Indonesian studies report low but non-zero syphilis prevalence among antenatal women, coverage of testing remains inconsistent. For example, a health systems analysis in Cianjur district, West Java, found that in 2015 there were no recorded syphilis test results for pregnant women in village or community health center (*Puskesmas*) registers, despite syphilis being part of national antenatal care guidelines.[38] That we observed none in our Medan sample could reflect under-screening, low diagnostic sensitivity, or selection bias in the hospital-based population. Bivariate associations that show significance in the absence of any reactive cases underscore a methodological problem: when expected cell counts are zero, chi-square tests can be misleading. For future work, exact tests or logistic regression with appropriate handling of sparse data should be used.

Leukocytosis (or elevated leukocyte counts) emerged here as possibly the most consistent marker of risk because its association with low birth weight and poor Apgar scores was strong. That aligns with smaller Indonesian work on newborn infection risk and leukocyte levels—for example, a thesis in Malang found that elevated neonatal leukocyte counts are associated with early detection of infection among infants admitted for suspected neonatal sepsis.[39] This supports the idea that inflammatory or infection proxies can be clinically useful in low-resource settings where full

pathogen screening is not feasible. These findings have practical implications for ANC (antenatal care) and PMTCT strategies in Medan. Given the high HIV prevalence, the gaps in screening and treatment coverage reported nationally (only a modest proportion of HIV-positive pregnant women receive antiretroviral therapy) are unacceptable.[40] Hospitals in Medan might need targeted interventions: more sensitive and routine screening (including multiple markers), ensuring early ART initiation, and strengthening data systems to detect syphilis and hepatitis B reliably. Furthermore, since leukocytosis appears to be a good risk predictor, integrating simple inflammatory marker tests into routine ANC could help in early risk stratification.

From a policy standpoint, maternal infection and inflammation screening should be more strongly embedded into antenatal guidelines. Given that many low- and middle-income countries (including Indonesia) already promote frequent antenatal care visits,[41-43] policies should expand those visits' laboratory scope to include infection-inflammatory markers. Integrating these markers into standard packages could allow earlier detection of subclinical or systemic maternal inflammation, thereby guiding timely referral, intensified monitoring, or targeted interventions.

This study has several limitations. First, the hospital-based sampling strategy may have resulted in an overrepresentation of complicated or high-risk pregnancies, thus limiting the generalizability of the findings to the broader population. Second, the very small number of hepatitis B cases (n = 5) and the absence of syphilis cases limited meaningful subgroup analyses and may explain some of the counterintuitive associations. Third, the analysis relied primarily on bivariate associations without adjustment for important confounding factors such as gestational age, mode of delivery, quality of antenatal care, and socioeconomic status; omission of these variables may have biased the observed associations. Finally, limitations in diagnostic sensitivity, particularly for syphilis screening, may have contributed to an underestimation of the true prevalence of maternal infection.

In conclusion, the data from Medan reinforce the existing picture: HIV remains a critical infection in pregnancy with adverse neonatal consequences; inflammatory markers (e.g., leukocytosis) may provide additional predictive value; and findings for hepatitis B and syphilis highlight gaps in detection and possibly in outcome management. To improve neonatal health outcomes, Medan should push for (1) expanded coverage and quality of PMTCT services, (2) routine screening for not just HIV but also hepatitis B and syphilis with quality diagnostics, (3) integration of inflammatory marker testing as an adjunct risk stratifier, and (4) collection of larger and adjusted datasets to clarify anomalies and improve policy relevance.

Conclusion and recommendation

This study reveals a disproportionate burden of maternal infections in Medan, most notably an HIV prevalence of 6.8% among pregnant women—well above national estimates of <1%. While hepatitis B prevalence (2.4%) was within the intermediate range reported elsewhere in Indonesia, the counterintuitive finding of no adverse neonatal outcomes among reactive cases highlights the limitations of small subgroup sizes and the need for cautious interpretation. Equally striking was the complete absence of syphilis cases, which could reflect either effective local prevention or potential underdiagnosis due to limited screening sensitivity. Neonatal risks remained substantial, with one-third of newborns classified as low birth weight and nearly 10% with suboptimal Apgar scores, both strongly associated with maternal infections and elevated leukocyte counts.

These results underscore the urgent need for region-specific strategies, i.e., expanding reliable HIV and hepatitis B screening within antenatal care, ensuring consistent provision of PMTCT services, and strengthening laboratory capacity for syphilis detection. For Medan in particular, targeted public health education and provider training should be prioritized to close screening and treatment gaps. This study's retrospective design, reliance on secondary records, and absence of adjusted analyses limit causal inference and may explain paradoxical associations. Nonetheless, by documenting both the high HIV prevalence and methodological challenges in infection-related outcomes research,

the study provides critical evidence to inform Indonesia's EMTCT agenda. Future research using longitudinal designs and larger, multi-site datasets will be essential to validate these findings and guide stronger maternal–child health policies

Authors' contributions

Muara P. Lubis – Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft; Melvin N .G. Barus - Conceptualization, Organizing data collection, Resources, Supervision, Writing –review and editing.

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