

Maternal Sexually Transmitted Infections as an Independent Risk Factor for Childhood Stunting in Makassar, Indonesia: A Case–Control Study

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ABSTRACT

Introduction: Stunting remains a major public health challenge in Indonesia. Maternal factors, including sexually transmitted infections (STIs), may contribute to impaired child growth; however, empirical evidence remains limited, particularly in urban settings.

Objective: This study aimed to assess the association between maternal sexually transmitted infections during pregnancy and the incidence of stunting among infants in Makassar, Indonesia.

Methods: A case–control study was conducted at the Kassi-Kassi Primary Health Center in Makassar between October 2023 and January 2024. A total of 30 mother–infant pairs were included, comprising 15 stunted infants (cases) and 15 non-stunted infants (controls). Maternal STI status, including hepatitis B virus, HIV, and syphilis, was determined using laboratory-confirmed antenatal screening records. Logistic regression analysis was performed to evaluate the association between maternal STIs and stunting.

Results: Maternal STIs were significantly more prevalent among mothers of stunted infants than among controls. Infants born to mothers with STIs had a significantly higher risk of stunting (odds ratio = 7.56; 95% confidence interval: 1.50–36.15; $p = 0.014$). This association remained significant after adjustment for maternal age and parity (adjusted odds ratio = 7.12; 95% confidence interval: 1.38–36.72; $p = 0.018$).

Conclusion: Maternal sexually transmitted infections during pregnancy are independently associated with an increased risk of stunting among infants. These findings highlight the importance of integrating routine STI screening and timely management into antenatal care as part of comprehensive stunting prevention strategies.

KEYWORD

Stunting, sexually transmitted infections, pregnancy, maternal health

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INTRODUCTION

Stunting, defined as impaired linear growth indicated by a height-for-age measurement below -2 standard deviations of the WHO Child Growth Standards, remains a major global public health concern with substantial economic and developmental consequences (Vaivada et al., 2020). In 2022, an estimated 148 million children under five years of age were affected by stunting worldwide. The highest burden is concentrated in low- and middle-income countries (LMICs), particularly in Sub-Saharan Africa, South Asia, and Southeast Asia. Long-term consequences of stunting include impaired cognitive development, increased vulnerability to chronic diseases, reduced educational attainment, and lower economic productivity in adulthood (Elsa Octa Aditia et al., 2023).

In Indonesia, national survey data indicate a moderate decline in stunting prevalence from 24.4% in 2021 to 21.6% in 2022. Although this trend reflects progress, the prevalence remains above national and global targets, underscoring the need to address the diverse and interrelated determinants of stunting (Hamid, 2023; Permana et al., 2023).

Stunting prevention and monitoring are closely linked to growth and development during the first 1,000 days of life, from conception to a child's second birthday. During this critical period, nutritional deficiencies, recurrent infections, and adverse intrauterine conditions may result in irreversible growth impairment. Maternal health plays a central role in shaping these early-life exposures (Vaivada et al., 2020). Restricted intrauterine growth, low birth weight, and subsequent stunting have been consistently associated with maternal anemia, chronic infections, and malnutrition. This intergenerational cycle of undernutrition highlights how poor maternal health can perpetuate growth failure across generations (Mate et al., 2021).

Among maternal health conditions, sexually transmitted infections (STIs), including syphilis, hepatitis B virus (HBV), and human immunodeficiency virus (HIV), remain major global health challenges. The World Health Organization estimates that more than one million new STI cases occur daily worldwide (CDS 2021, n.d.). These infections are frequently asymptomatic, leading to delayed diagnosis and treatment. During pregnancy, STIs are strongly associated with miscarriage, stillbirth, congenital anomalies, preterm birth, and low birth weight. Syphilis can directly infect the placenta, resulting in congenital syphilis and fetal growth restriction. HIV impairs placental function, while chronic HBV infection increases the risk of preterm delivery and neonatal complications, thereby creating biological conditions that predispose infants to growth faltering and stunting (WHO, 2021b).

Despite substantial evidence linking maternal infections to adverse pregnancy outcomes, the specific contribution of maternal STIs to childhood stunting has not been fully elucidated. Current stunting prevention strategies primarily focus on nutritional interventions, micronutrient supplementation, exclusive breastfeeding, and improvements in water, sanitation, and hygiene (WASH). However, preventing and treating infections during pregnancy is equally critical for ensuring optimal fetal growth and early childhood development (Laksono et al., 2022).

Several biological mechanisms support the association between maternal STIs and stunting. Chronic infections induce systemic inflammation, characterized by elevated levels of pro-inflammatory cytokines such as interleukin-6 and tumor necrosis factor- α (Deshmukh & Way, 2019). These inflammatory mediators disrupt placental angiogenesis, impair nutrient and oxygen transport, and increase the risk of intrauterine growth restriction. Direct placental infection may lead to congenital transmission and neonatal illness, further compromising postnatal growth. In addition, maternal infections often coexist with undernutrition, producing synergistic effects that exacerbate fetal growth impairment (Gamberini et al., 2023; Hussain et al., 2022).

Socioeconomic and environmental factors further modify this relationship. Poverty, adolescent pregnancy, limited access to antenatal care, and inadequate sexual and reproductive health education increase the risk of both STIs and stunting. Cultural stigma surrounding sexual health and gender inequality may delay diagnosis and treatment. Moreover, poor sanitation and exposure to enteric pathogens contribute to recurrent childhood infections, which further aggravate growth deficits (CDS 2021, n.d.).

Evidence linking maternal STIs to childhood stunting remains limited but is gradually emerging. Studies conducted in Kenya, Malawi, India, and Bangladesh have reported associations between maternal HIV or syphilis infection and intrauterine growth restriction, low birth weight, and impaired postnatal growth. In Indonesia, national data indicate variable prevalence rates of HIV, syphilis, and HBV among pregnant women, with higher rates reported in urban centers such as Makassar. Although local studies have linked reproductive tract infections to adverse birth outcomes, few have specifically examined the contribution of maternal STIs to childhood stunting, leaving a substantial evidence gap (Dionne-Odom et al., 2016; Kumarasinghe et al., 2021; Tukei et al., 2021).

To address stunting, the World Health Organization and UNICEF promote integrated intervention programs encompassing maternal nutrition, appropriate complementary feeding, and improvements in WASH. Indonesia's National Strategy for Accelerating Stunting Prevention prioritizes the first 1,000 days of life, emphasizing nutritional supplementation and sanitation. However, these strategies largely overlook maternal infectious diseases. The WHO Triple Elimination initiative, which aims to eliminate mother-to-child transmission of HIV, syphilis, and hepatitis B (Azhali et al., 2023; Israel et al., 2023), represents a critical yet underutilized opportunity to integrate infection control with stunting prevention efforts (Isara & Baldeh, 2021; Teasdale et al., 2018).

Although notable progress has been made in maternal and child health, the association between maternal STIs and stunting remains insufficiently explored, particularly in Southeast Asia. Epidemiological studies examining this relationship are essential to inform integrated public health policies that combine nutrition, infection prevention, and high-quality antenatal care (WHO, 2021a).

In response to this gap, the present study investigates the association between maternal sexually transmitted infections and the incidence of stunting among infants in Makassar, Indonesia. Using a case–control design and data derived from structured interviews and clinical records, this study provides evidence on an often-overlooked determinant of childhood stunting. The findings are expected to inform comprehensive maternal and child health strategies that integrate nutritional support, infectious disease control, and strengthened antenatal care to reduce stunting prevalence and improve long-term health outcomes.

METHODS

This observational analytical study employed a case–control design to examine the association between maternal sexually transmitted infections (STIs) and the incidence of stunting among infants. The study was conducted at Kassi-Kassi Primary Health Center (Puskesmas Kassi-Kassi) in Makassar, Indonesia, between October 2023 and January 2024. This health facility serves an urban population and provides routine antenatal and postnatal care, including maternal infection screening and child growth monitoring.

The study population consisted of pregnant women and their infants who attended the health center for antenatal or postnatal services during the study period. All participants were permanent residents of Makassar and had accessible maternal and child health records.

Eligible mother–infant pairs were identified through clinic registers and medical records to ensure the availability of relevant clinical and anthropometric data.

A total of 30 mother–infant pairs were included in the analysis, comprising 15 cases (mothers of stunted infants) and 15 controls (mothers of non-stunted infants). The sample size was determined using total sampling of all eligible participants who met the inclusion criteria during the study period. A 1:1 case-to-control ratio was applied to enhance statistical comparability between groups. Cases were defined as infants with a length-for-age Z-score below -2 standard deviations according to WHO Child Growth Standards, while controls were infants with normal linear growth.

Inclusion criteria were mothers who delivered a live-born infant between January and December 2023, had complete maternal and infant medical records—including birth weight and birth length—and provided informed consent to participate in structured interviews. Exclusion criteria included infants with congenital anomalies or known genetic disorders affecting growth, multiple births due to differing growth trajectories, and mothers with incomplete or missing antenatal STI screening records.

The primary exposure variable was maternal STI status during pregnancy. Maternal STIs were identified through the routine antenatal “triple elimination” screening program, which includes serological testing for HIV, syphilis (*Treponema pallidum*), and hepatitis B virus (HBV). Maternal infection was defined as a positive result for at least one of these infections at any point during pregnancy. The triple elimination screening protocol follows national guidelines and World Health Organization recommendations for the prevention of vertical transmission. All laboratory results were verified through medical records and cross-checked with antenatal care documentation to ensure data accuracy.

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics were used to summarize maternal and infant characteristics, including frequencies, percentages, means, and standard deviations for both case and control groups. Bivariate analyses were conducted using the chi-square test to assess associations between maternal STI status and stunting, as well as between potential confounding variables and stunting. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength of associations.

Variables with a p -value < 0.25 in bivariate analyses were considered for inclusion in multivariable logistic regression models to control for confounding. Adjusted odds ratios (aORs) with 95% CIs were reported, and statistical significance was set at $p < 0.05$. Confounding variables were selected based on biological plausibility, epidemiological relevance, and completeness of available data. Maternal age and parity were included in the multivariable model due to their known associations with maternal infection risk and fetal growth. Other potential confounders, such as socioeconomic status, maternal nutritional intake, and educational level, were not included because of inconsistent data availability across medical records and interviews.

This study was conducted in accordance with ethical principles for research involving human participants. Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Islam Negeri Alauddin Makassar (Approval No. E039/KEPK/FKIK/I/2023). Written informed consent was obtained from all participating mothers prior to data collection.

RESULTS

A total of 30 mother–infant pairs were included in the study, comprising 15 cases (infants with stunting) and 15 controls (infants without stunting). The baseline maternal characteristics of the two groups are summarized in Table 1. Most mothers were aged 16–30 years (76.7%), followed by those aged 31–40 years (20.0%), with only one participant aged over 40 years. The distribution of maternal age categories

was comparable between the case and control groups. Regarding parity, 43.3% of mothers were primiparous and 56.7% were multiparous, with no meaningful differences observed between groups. The majority of participants identified as Muslim (96.7%), reflecting the local population profile. Overall, half of the mothers (50.0%) tested positive for at least one sexually transmitted infection (STI) during pregnancy (Table 2). Among these infections, hepatitis B virus (HBsAg positive) was the most prevalent (30.0%), followed by syphilis (13.3%) and HIV (6.7%). The remaining 50.0% of participants tested negative for all screened STIs.

Table 1. Maternal characteristics of study participants

Characteristic	Case (n = 15)	Control (n = 15)	Total (n = 30)
Maternal age (years)			
16–30	12 (80.0%)	11 (73.3%)	23 (76.7%)
31–40	3 (20.0%)	3 (20.0%)	6 (20.0%)
41–50	0 (0.0%)	1 (6.7%)	1 (3.3%)
Parity			
Primiparous	6 (40.0%)	7 (46.7%)	13 (43.3%)
Multiparous	9 (60.0%)	8 (53.3%)	17 (56.7%)
Religion			
Islam	14 (93.3%)	15 (100.0%)	29 (96.7%)
Christian	1 (6.7%)	0 (0.0%)	1 (3.3%)

Table 2. Prevalence of maternal sexually transmitted infections (STI) during pregnancy (n = 30)

Maternal STI Status	n (%)
STI positive	15 (50.0%)
Hepatitis B (HBsAg positive)	9 (30.0%)
HIV positive	2 (6.7%)
Syphilis positive	4 (13.3%)
STI negative	15 (50.0%)

Bivariate analysis demonstrated a statistically significant association between maternal STI status and stunting (Table 3). Among mothers of stunted infants, 11 out of 15 (73.3%) were positive for at least one STI, compared with only 4 out of 15 (26.7%) mothers in the control group. Infants born to mothers with a positive STI status had a significantly higher likelihood of stunting (odds ratio [OR] = 7.56; 95% confidence interval [CI]: 1.50–36.15; $p = 0.014$).

Table 3. Association between maternal sexually transmitted infection status and stunting

Maternal STI Status	Case (n = 15)	Control (n = 15)	OR (95% CI)	p-value
STI positive	11 (73.3%)	4 (26.7%)	7.56 (1.50–36.15)	0.014
STI negative	4 (26.7%)	11 (73.3%)	Ref	—

This association remained robust after adjustment for potential confounding variables in multivariable logistic regression analysis. After controlling for maternal age and parity, maternal STI

positivity remained independently associated with stunting (adjusted odds ratio [aOR] = 7.12; 95% CI: 1.38–36.72; $p = 0.018$), confirming maternal STI status as an independent predictor of stunting in this population.

Descriptive analyses indicated that most mothers attended at least four antenatal care (ANC) visits during pregnancy. No statistically significant differences were observed between the case and control groups with respect to ANC attendance, maternal age category, or parity ($p > 0.05$). Although not statistically significant, mothers of stunted infants more frequently reported inadequate dietary diversity and had lower pre-pregnancy body mass index (BMI), suggesting potential additive effects of nutritional status and maternal infection on child growth outcomes.

Taken together, these findings indicate that maternal sexually transmitted infections were more prevalent among mothers of stunted infants and were strongly associated with an increased risk of stunting. Infants born to mothers with STIs were more than seven times as likely to experience stunting compared with those born to uninfected mothers, even after adjustment for key maternal factors. These results highlight the importance of integrating routine STI screening and treatment for pregnant women into national and regional stunting prevention programs. In particular, antenatal triple elimination screening may serve as a critical entry point for early detection and intervention to reduce the burden of stunting.

DISCUSSION

This study demonstrates a significant association between maternal sexually transmitted infections (STIs) specifically hepatitis B virus (HBV), human immunodeficiency virus (HIV), and syphilis and the occurrence of stunting among infants in Makassar, Indonesia. Using a case–control design, we found that infants born to mothers with laboratory-confirmed STIs had more than a sevenfold increased risk of stunting compared with those born to uninfected mothers. These findings highlight an underrecognized determinant of childhood stunting and underscore the importance of integrating maternal infection control into maternal and child health strategies.

Maternal Sexually Transmitted Infection and Stunting

Our findings are consistent with a growing body of global evidence linking maternal infections to impaired fetal growth and subsequent childhood stunting. Previous studies have shown that maternal HIV infection increases the risk of intrauterine growth restriction (IUGR) and low birth weight, both of which are well-established risk factors for stunting (Asferie et al., 2025; Ruck & Smolen, 2022; Warr et al., 2019). Similarly, syphilis during pregnancy has been associated with stillbirth, preterm birth, and fetal growth impairment (Ikumi & Matjila, 2022; Mengesha & Dangisso, 2020), while chronic HBV infection has been linked to preterm delivery and neonatal growth failure (Ruan et al., 2023; Yuan et al., 2024).

The magnitude of the association observed in our study supports these findings and extends the evidence to the urban Indonesian context, where integrated monitoring of maternal infections and nutritional status remains limited. Several biological mechanisms may explain the observed relationship. Chronic maternal infections induce systemic inflammation, characterized by elevated pro-inflammatory cytokines such as interleukin-6 and tumor necrosis factor- α , which disrupt placental angiogenesis and impair nutrient transfer (Barfield, 2018; Moseholm et al., 2024). Infections such as syphilis may directly damage placental tissue and compromise fetal oxygenation (Gamberini et al., 2023; Lara-Escandell et al., 2024). In addition, maternal infections can increase oxidative stress and alter the maternal gut microbiota, indirectly affecting fetal nutrient availability and growth (Amir et al., 2020). Together, these mechanisms create a suboptimal intrauterine environment that increases the risk of growth faltering in

infancy.

Interaction with Nutritional and Environmental Factors

Our findings support a multi-etiological model of stunting in which maternal infections interact with nutritional and environmental factors. While inadequate dietary intake and poor sanitation remain dominant contributors to stunting in Indonesia (Elsa Octa Aditia et al., 2023; Laksono et al., 2022), our results indicate that maternal STIs independently increase the risk of stunting, even after adjustment for maternal age and parity. This suggests that infection control should be considered a core component of stunting prevention strategies, alongside nutritional interventions and improvements in water and sanitation.

Maternal STIs often coexist with poor nutritional status, as reflected by lower pre-pregnancy body mass index (BMI) among infected mothers in our study. Infection-related anorexia, impaired nutrient absorption, and increased metabolic demands may exacerbate the effects of maternal undernutrition on fetal growth (Ibrahim et al., 2017; Morales et al., 2023). Addressing these interrelated risk factors requires an integrated antenatal care approach that combines infection screening, nutritional counseling, and social support.

Public Health and Policy Implications

Globally, the World Health Organization has promoted the triple elimination initiative to prevent mother-to-child transmission of HIV, syphilis, and HBV (Azhali et al., 2023). Although Indonesia has adopted elements of this strategy, routine integration with stunting prevention programs remains limited. Our findings suggest that comprehensive implementation of triple elimination screening and timely treatment during pregnancy could provide dual benefits by preventing vertical transmission of STIs and reducing the risk of childhood stunting. Such interventions are likely to be cost-effective and align with the Sustainable Development Goals (SDGs) targeting the elimination of malnutrition and communicable diseases.

Furthermore, our results emphasize the importance of early antenatal care. Women who seek care during the first trimester have greater opportunities for STI screening, nutritional assessment, and infection treatment before the critical window of fetal growth closes. Health education targeting adolescents and young women is equally important, as early sexual debut and limited sexual health knowledge increase the risk of STIs, unplanned pregnancy, and maternal undernutrition.

Evidence on the relationship between maternal STIs and stunting in Indonesia remains scarce, with previous studies primarily focusing on nutrition, exclusive breastfeeding, and household sanitation (Demétrio et al., 2020). By demonstrating a strong association between maternal STIs and stunting, this study fills an important gap in the literature (Osama Abel Azim Elgamal et al., 2024). These findings are particularly relevant for urban centers such as Makassar, where HIV and syphilis prevalence has increased due to migration and changing sexual behaviors.

Strengths and Limitations

The main strengths of this study include the use of laboratory-confirmed maternal STI diagnoses, the integration of medical record data with structured interviews, and the case–control design, which allows efficient estimation of risk. However, several limitations should be acknowledged. First, the relatively small sample size ($n = 30$) limits statistical power and results in wide confidence intervals; therefore, effect estimates should be interpreted with caution. Second, the single-site design restricts the generalizability of findings to populations with different sociodemographic and epidemiological characteristics. Third, although multivariable analysis was performed, adjustment was limited to maternal age and parity due to

incomplete data on other potential confounders, such as socioeconomic status, maternal dietary intake, and educational level. Nevertheless, the use of laboratory-confirmed maternal STI data provides strong internal validity.

While biological plausibility and consistency with prior studies support a potential causal relationship, longitudinal studies are needed to confirm temporal pathways and elucidate underlying mechanisms. In addition, reliance on retrospective medical records introduces the possibility of incomplete data, although this risk was mitigated through cross-verification with structured interviews.

Future research should involve larger, multicenter studies to confirm these findings across diverse settings in Indonesia. Prospective cohort designs incorporating detailed nutritional assessments, longitudinal infection monitoring, and molecular analyses of placental and infant biomarkers would further clarify causal pathways. Implementation research is also needed to evaluate how integrating triple elimination programs into national stunting prevention initiatives can improve population-level outcomes.

CONCLUSION

This study demonstrates that maternal sexually transmitted infections during pregnancy are independently associated with an increased risk of stunting among infants in Makassar, Indonesia. The association remained significant after multivariable adjustment for maternal age and parity, highlighting maternal STIs as an important but often overlooked determinant of childhood stunting.

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