LUMEN ET VIRTUS
ISSN: 2177-2789

# IMPACT OF ADEQUATE ANTENATAL CARE ON THE REDUCTION OF NEONATAL INFECTIONS: A SYSTEMATIC REVIEW

# IMPACTO DA ASSISTÊNCIA PRÉ-NATAL ADEQUADA NA REDUÇÃO DAS INFECÇÕES NEONATAIS: UMA REVISÃO SISTEMÁTICA

# IMPACTO DE LA ATENCIÓN PRENATAL ADECUADA EN LA REDUCCIÓN DE LAS INFECCIONES NEONATALES: UNA REVISIÓN SISTEMÁTICA

https://doi.org/10.56238/levv16n55-104

**Submitted on:** 11/19/2025 **Publication date:** 12/19/2025

**Maria Luiza Leme Camargo[1], Miriam Damares Oliveira Sousa[2], Luciano Custódio dos Santos Lima[3], Ingrid Pinheiro Feijó[4], Yasmin Maria Della Torre Tavares[5], Igor José Moreira Montanher[6]**

## ABSTRACT

**Introduction:** Neonatal infections remain a leading cause of morbidity and mortality worldwide, particularly in low- and middle-income countries, and many of these events are preventable through high-quality antenatal care. Adequate antenatal follow-up creates opportunities for early identification and management of maternal comorbidities and infectious diseases, thereby interrupting vertical transmission pathways and improving neonatal outcomes.

**Objective:** To systematically evaluate the impact of adequate antenatal care on the reduction of neonatal infections and infection-related mortality, and to identify the specific antenatal interventions most strongly associated with improved neonatal infectious outcomes across different health system contexts.

**Methods:** This systematic review followed PRISMA guidelines. Searches were conducted in PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov, and the International Clinical Trials Registry Platform, using controlled vocabulary and keywords related to antenatal care, maternal infections, and neonatal infections, without language restriction. Human studies published in the last five years were prioritized, with potential extension to ten years if fewer than ten eligible studies were available. Two independent reviewers performed study selection, data extraction, and risk-of-bias assessment using RoB 2, ROBINS-I, and QUADAS-2 as appropriate. Certainty of evidence was graded using GRADE, and results were synthesized narratively.

**Results:** 22 studies met the inclusion criteria, encompassing randomized controlled trials, cohort studies, population-based analyses, and meta-analyses from diverse geographic

[1] Universidade Nove de Julho. E-mail: marialuizalemecamargo@gmail.com
[2] Universidade Nove de Julho. E-mail: damares.miriam@uni9.edu.br
[3] Faculdade de Ciências Médicas da Santa Casa de São Paulo. E-mail: lucianofisio@yahoo.com.br
[4] CESUPA. E-mail: ingrid.pf0673@gmail.com
[5] UNIARA. E-mail: ymdttavares@uniara.edu.br
[6] Universidad internacional Três Fronteras. E-mail: igorjmontanher@gmail.com

regions. Adequate or intensified antenatal care was consistently associated with reduced neonatal mortality and infection-related complications. Targeted interventions such as timely syphilis screening and treatment, systematic Group B Streptococcus screening with intrapartum prophylaxis, and maternal pertussis vaccination showed robust reductions in congenital and early-onset infections. Antenatal corticosteroids improved survival and respiratory outcomes among preterm infants when used according to guidelines, although some large observational cohorts suggested potential increases in infection risk when used outside recommended indications. Heterogeneity in implementation fidelity, health-system capacity, and population risk profiles contributed to variability in effect magnitude.

**Conclusion:** Adequate antenatal care, particularly when it integrates structured infectious disease screening, maternal vaccination, and guideline-based pharmacologic interventions, plays a decisive role in reducing neonatal infections and infection-related mortality. Strengthening the coverage, quality, and continuity of antenatal services—especially in resource-limited settings—should be a central component of strategies aimed at improving neonatal survival and reducing the global burden of preventable infectious disease in early life.

**Keywords:** Antenatal Care. Neonatal Infections. Maternal Health Services. Perinatal Outcomes.

## RESUMO

**Introdução:** As infecções neonatais permanecem como uma das principais causas de morbimortalidade em todo o mundo, particularmente em países de baixa e média renda, sendo que muitos desses eventos são evitáveis por meio de uma assistência pré-natal de alta qualidade. O acompanhamento pré-natal adequado cria oportunidades para a identificação precoce e o manejo de comorbidades maternas e doenças infecciosas, interrompendo vias de transmissão vertical e melhorando os desfechos neonatais.

**Objetivo:** Avaliar sistematicamente o impacto da assistência pré-natal adequada na redução das infecções neonatais e da mortalidade relacionada a infecções, bem como identificar as intervenções pré-natais específicas mais fortemente associadas à melhora dos desfechos infecciosos neonatais em diferentes contextos de sistemas de saúde.

**Métodos:** Esta revisão sistemática seguiu as diretrizes PRISMA. As buscas foram realizadas nas bases PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov e na International Clinical Trials Registry Platform, utilizando vocabulário controlado e palavras-chave relacionadas à assistência pré-natal, infecções maternas e infecções neonatais, sem restrição de idioma. Foram priorizados estudos em humanos publicados nos últimos cinco anos, com possível extensão para dez anos caso menos de dez estudos elegíveis estivessem disponíveis. Dois revisores independentes realizaram a seleção dos estudos, a extração dos dados e a avaliação do risco de viés utilizando as ferramentas RoB 2, ROBINS-I e QUADAS-2, conforme apropriado. A certeza da evidência foi graduada pelo método GRADE, e os resultados foram sintetizados de forma narrativa.

**Resultados:** Vinte e dois estudos atenderam aos critérios de inclusão, abrangendo ensaios clínicos randomizados, estudos de coorte, análises populacionais e meta-análises de diversas regiões geográficas. A assistência pré-natal adequada ou intensificada foi consistentemente associada à redução da mortalidade neonatal e das complicações relacionadas a infecções. Intervenções direcionadas, como a triagem e o tratamento oportunos da sífilis, a triagem sistemática para Streptococcus do grupo B com profilaxia intraparto e a vacinação materna contra coqueluche, demonstraram reduções robustas de infecções congênitas e de início precoce. O uso de corticosteroides antenatais melhorou a

sobrevida e os desfechos respiratórios entre recém-nascidos pré-termo quando utilizados conforme as diretrizes; contudo, alguns grandes estudos observacionais sugeriram possível aumento do risco de infecção quando utilizados fora das indicações recomendadas. A heterogeneidade na fidelidade de implementação, na capacidade dos sistemas de saúde e nos perfis de risco populacional contribuiu para a variabilidade na magnitude dos efeitos observados.

**Conclusão:** A assistência pré-natal adequada, especialmente quando integra triagem estruturada de doenças infecciosas, vacinação materna e intervenções farmacológicas baseadas em diretrizes, desempenha um papel decisivo na redução das infecções neonatais e da mortalidade relacionada a infecções. O fortalecimento da cobertura, da qualidade e da continuidade dos serviços de pré-natal — particularmente em contextos com recursos limitados — deve ser um componente central das estratégias voltadas à melhoria da sobrevida neonatal e à redução da carga global de doenças infecciosas evitáveis no início da vida.

**Palavras-chave:** Atenção Pré-natal. Infecções Neonatais. Serviços de Saúde Materna. Desfechos Perinatais.

## RESUMEN

**Introducción:** Las infecciones neonatales continúan siendo una de las principales causas de morbilidad y mortalidad a nivel mundial, especialmente en países de ingresos bajos y medianos, y muchos de estos eventos son prevenibles mediante una atención prenatal de alta calidad. El seguimiento prenatal adecuado crea oportunidades para la identificación temprana y el manejo de comorbilidades maternas y enfermedades infecciosas, interrumpiendo las vías de transmisión vertical y mejorando los resultados neonatales.

**Objetivo:** Evaluar sistemáticamente el impacto de una atención prenatal adecuada en la reducción de las infecciones neonatales y de la mortalidad relacionada con infecciones, así como identificar las intervenciones prenatales específicas más fuertemente asociadas con la mejora de los resultados infecciosos neonatales en diferentes contextos de sistemas de salud.

**Métodos:** Esta revisión sistemática siguió las directrices PRISMA. Las búsquedas se realizaron en PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov y la International Clinical Trials Registry Platform, utilizando vocabulario controlado y palabras clave relacionadas con la atención prenatal, las infecciones maternas y las infecciones neonatales, sin restricción de idioma. Se priorizaron estudios en humanos publicados en los últimos cinco años, con posible extensión a diez años si se disponía de menos de diez estudios elegibles. Dos revisores independientes realizaron la selección de los estudios, la extracción de los datos y la evaluación del riesgo de sesgo utilizando las herramientas RoB 2, ROBINS-I y QUADAS-2, según correspondiera. La certeza de la evidencia se graduó mediante el enfoque GRADE, y los resultados se sintetizaron de forma narrativa.

**Resultados:** Veintidós estudios cumplieron con los criterios de inclusión, abarcando ensayos clínicos aleatorizados, estudios de cohorte, análisis poblacionales y meta-análisis de diversas regiones geográficas. La atención prenatal adecuada o intensificada se asoció de manera consistente con una reducción de la mortalidad neonatal y de las complicaciones relacionadas con infecciones. Intervenciones específicas, como la detección y el tratamiento oportunos de la sífilis, el cribado sistemático del Streptococcus del grupo B con profilaxis intraparto y la vacunación materna contra la tos ferina, mostraron reducciones robustas de las infecciones congénitas y de inicio temprano. El uso de corticosteroides antenatales

mejoró la supervivencia y los resultados respiratorios en recién nacidos pretérmino cuando se utilizaron conforme a las guías clínicas; sin embargo, algunos grandes estudios observacionales sugirieron un posible aumento del riesgo de infección cuando se emplearon fuera de las indicaciones recomendadas. La heterogeneidad en la fidelidad de la implementación, la capacidad de los sistemas de salud y los perfiles de riesgo poblacional contribuyó a la variabilidad en la magnitud de los efectos observados.

**Conclusión:** La atención prenatal adecuada, especialmente cuando integra un cribado estructurado de enfermedades infecciosas, la vacunación materna y las intervenciones farmacológicas basadas en guías, desempeña un papel decisivo en la reducción de las infecciones neonatales y de la mortalidad relacionada con infecciones. El fortalecimiento de la cobertura, la calidad y la continuidad de los servicios de atención prenatal —especialmente en entornos con recursos limitados— debe ser un componente central de las estrategias destinadas a mejorar la supervivencia neonatal y a reducir la carga global de enfermedades infecciosas prevenibles en las primeras etapas de la vida.

**Palabras clave:** Atención Prenatal. Infecciones Neonatales. Servicios de Salud Materna. Resultados Perinatales.

## 1 INTRODUCTION

Adequate antenatal care is widely recognized as a cornerstone of maternal and neonatal health, particularly in preventing serious infectious complications in the early postnatal period[1]. Early engagement with antenatal services enables timely identification of maternal comorbidities that can predispose newborns to infection, such as diabetes, hypertensive disorders, and asymptomatic bacteriuria[1]. The integration of evidence-based screening protocols during pregnancy further contributes to reducing neonatal morbidity by enabling targeted interventions against infectious risks[1]. These components collectively highlight the essential role of structured antenatal care in optimizing neonatal outcomes[2].

Neonatal infections remain a leading cause of mortality worldwide, disproportionately affecting low-resource settings where inadequate antenatal care is more prevalent[2]. The majority of early-onset neonatal infections originate from maternal transmission, underscoring the critical need for systematic prenatal screening and prophylactic strategies[2]. Contemporary guidelines emphasize the importance of timely detection and treatment of maternal infectious diseases such as HIV, syphilis, hepatitis B, and Group B Streptococcus, all of which significantly influence neonatal health[3]. Ensuring appropriate antenatal interventions therefore represents a pivotal determinant in disrupting vertical transmission pathways[3].

The global burden of neonatal sepsis illustrates substantial geographic variation, driven partly by differences in access to and quality of antenatal care[3]. In regions where antenatal services are limited or inconsistent, neonates are more likely to develop severe infections due to undetected maternal colonization or untreated perinatal complications[4]. Strengthening antenatal care programs, including laboratory infrastructure and trained personnel, has been shown to reduce neonatal mortality attributable to preventable infections[4]. These disparities highlight the urgent need for consolidating evidence on which antenatal strategies offer the greatest impact across diverse health systems[4].

Preventive components of antenatal care, such as maternal vaccination, infection screening, nutritional supplementation, and education on hygiene practices, represent critical measures in reducing the incidence of neonatal infections[5]. Studies have demonstrated that maternal immunization against influenza, pertussis, and tetanus can confer substantial protection to newborns who are otherwise vulnerable during the first months of life[5]. Moreover, the identification of risk factors such as preterm premature rupture of membranes and intra-amniotic infection allows clinicians to implement timely obstetric interventions that

directly impact neonatal outcomes[5]. Understanding how these elements interact within the broader continuum of maternal-child health underscores the value of systematic antenatal frameworks[6].

Emerging research has focused on the integration of standardized antenatal care packages that combine screening, prophylaxis, and structured follow-up to minimize infectious risks for newborns[6]. Such models have been shown to improve maternal adherence to recommended visits and enhance the timeliness of clinical decision-making[6]. Additionally, digitized health systems and telemedicine platforms have demonstrated potential in expanding antenatal coverage, particularly in remote areas where infectious disease surveillance is inconsistent[7]. These innovations suggest that improving antenatal care delivery may offer scalable solutions to prevent neonatal infections globally[7].

Despite advancements, gaps remain in understanding which specific components of antenatal care yield the most substantial reductions in neonatal infections[7]. Variability in implementation fidelity, resource allocation, and patient engagement limits the consistency of outcomes across different populations[8]. Furthermore, the influence of social determinants of health, including socioeconomic status, education, and geographic accessibility, introduces additional complexity in assessing antenatal effectiveness[8]. A systematic evaluation of available evidence is therefore necessary to clarify the magnitude of benefit associated with diverse antenatal interventions[8].

Given the rapid evolution of global maternal-child health guidelines, an updated synthesis of high-quality studies is essential to inform clinical decision-making and public health policies[9]. Previous reviews have not fully accounted for recent advancements in diagnostic technologies, prophylactic strategies, and structured antenatal care programs[9]. Moreover, heterogeneity in study designs and outcomes poses challenges to deriving unified recommendations regarding infection prevention in neonates[9]. By systematically reviewing contemporary literature, this study aims to close existing knowledge gaps and provide a comprehensive understanding of how adequate antenatal care influences neonatal infectious outcomes[10].

## 2 OBJECTIVES

The main objective of this systematic review is to evaluate the impact of adequate antenatal care on the reduction of neonatal infections, synthesizing contemporary evidence on preventive strategies implemented during pregnancy. Secondary objectives include identifying which specific antenatal interventions most effectively reduce neonatal infectious morbidity; assessing the influence of maternal screening programs on early-onset neonatal

infection rates; comparing outcomes across different healthcare settings to understand contextual variability; examining the role of maternal vaccination and prophylaxis in preventing neonatal infections; and evaluating the extent to which structured antenatal follow-up contributes to improved neonatal health outcomes.

## 3 METHODOLOGY

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure methodological rigor and transparency. A comprehensive search strategy was applied across major databases, including PubMed, Scopus, Web of Science, Cochrane Library, LILACS, ClinicalTrials.gov, and the International Clinical Trials Registry Platform. Search terms combined controlled vocabulary and keywords related to antenatal care, prenatal screening, maternal infections, neonatal infections, and infection prevention. No language restrictions were applied. The primary inclusion criteria were studies involving human participants, published within the last five years; however, if fewer than ten eligible studies were identified, the time window would be expanded to ten years. Animal or in vitro studies were only included in separate descriptive tables when relevant to mechanistic interpretation. Studies with small samples were accepted but treated as methodological limitations.

Study selection occurred in two stages, with titles/abstracts and full texts screened independently by two reviewers. Disagreements were resolved by a third reviewer. Duplicates were removed using automated and manual verification. Extraction fields included study design, population, antenatal intervention or exposure, comparison groups, outcomes related to neonatal infection, effect measures, and methodological characteristics. A PRISMA flow process documented all steps of identification, screening, eligibility assessment, and inclusion.

Risk of bias was evaluated independently by two reviewers using validated tools: RoB 2 for randomized controlled trials, ROBINS-I for non-randomized studies, and QUADAS-2 for diagnostic accuracy studies when applicable. The certainty of evidence was assessed using GRADE, considering study limitations, inconsistency, indirectness, imprecision, and publication bias. The synthesis strategy included narrative integration of findings and structured comparison of interventions, populations, and outcomes. When appropriate, heterogeneity and methodological differences were highlighted to contextualize effect variability.

This systematic review was justified by the need to consolidate recent and rapidly evolving evidence regarding antenatal care strategies that contribute to preventing neonatal

infections. By adhering to PRISMA guidelines and applying standardized assessment tools, the review ensures reproducibility, minimizes bias, and supports high-quality evidence synthesis to inform policy and clinical practice.

## 4 RESULTS

Twenty-two studies met all inclusion criteria and were incorporated into the qualitative synthesis. The included studies comprised randomized controlled trials, prospective and retrospective cohort studies, population-based investigations, and meta-analyses published within the last five years.

Sample sizes varied from fewer than 200 high-risk pregnancies in hospital-based cohorts to large national databases with tens of thousands of mother–infant pairs. Studies originated from diverse regions including sub-Saharan Africa, Europe, Asia, North America, and Latin America, reflecting heterogeneous antenatal care systems and infection burdens. Interventions and exposures included overall antenatal care adequacy, maternal screening for infectious diseases (syphilis, HIV, hepatitis B), Group B Streptococcus (GBS) screening strategies, maternal pertussis vaccination, and the use of antenatal corticosteroids or dexamethasone in preterm birth settings. Neonatal outcomes included early-onset neonatal sepsis, congenital syphilis, GBS early-onset disease, laboratory-confirmed pertussis, and broader infection-related morbidity and mortality.

Across nearly all studies assessing general antenatal care adequacy, higher-quality or more frequent antenatal visits were strongly associated with reduced neonatal mortality and infection-related complications. Studies focusing on maternal syphilis management consistently demonstrated that timely diagnosis and complete antenatal treatment significantly lowered rates of congenital syphilis and neonatal death. Investigations on GBS screening and maternal pertussis vaccination showed reductions in early-onset GBS disease and pertussis-related hospitalizations, respectively. Antenatal corticosteroid studies presented mixed findings: while corticosteroids clearly improved survival and respiratory outcomes among preterm infants, some large cohort studies suggested a possible increased risk of neonatal infections when corticosteroids were used outside guideline-recommended indications.

Overall, the evidence indicates that adequate antenatal care—especially when incorporating systematic infectious disease screening, maternal vaccination, and guideline-based pharmacologic interventions—substantially contributes to the prevention of neonatal infections. However, effect estimates varied according to context, population characteristics, and methodological design.

**Table 1**

| Reference | Population / Intervention / Comparison | Outcomes | Main Conclusions |
|---|---|---|---|
| Tekelab et al., 2019 | Women in sub-Saharan Africa; at least one skilled antenatal care visit vs none | Neonatal mortality (including infection-related deaths) | Antenatal care attendance associated with significant reduction in neonatal mortality. |
| Tolossa et al., 2020 | Ethiopian mothers; any antenatal care vs none; number of visits | Neonatal mortality | More antenatal visits correlated with lower neonatal mortality. |
| WHO ACTION Trial, 2020 | Preterm birth risk; dexamethasone vs placebo | Neonatal death, early neonatal infection | Dexamethasone reduced neonatal mortality without increasing early neonatal sepsis under controlled conditions. |
| Shiferaw et al., 2021 | Facility births in Ethiopia; adequate vs inadequate antenatal care | Early neonatal mortality, suspected sepsis | Adequate antenatal care reduced early mortality and infection-related complications. |
| Mwita et al., 2021 | Preterm infants; antenatal corticosteroids vs none | Neonatal sepsis, mortality | Corticosteroids improved survival but showed mixed effects on neonatal sepsis. |
| Stock et al., 2022 | Late preterm and term pregnancies | Neonatal hypoglycemia, infection | Corticosteroids improved respiratory outcomes but did not consistently reduce infections. |
| Torres et al., 2022 | Pregnant women with syphilis in Brazil | Congenital syphilis, neonatal death | Adequate antenatal treatment markedly reduced congenital infection. |
| Skoff et al., 2023 | Infants <1 year; maternal Tdap vaccination vs none | Laboratory-confirmed pertussis | Maternal vaccination significantly reduced infant pertussis. |
| Yao et al., 2023 | Nationwide cohort | Serious infections including sepsis | Antenatal corticosteroids associated with increased long-term infection risk when used outside guidelines. |
| Cramez et al., 2024 | Pregnant women with syphilis | Congenital syphilis, neonatal mortality | Early diagnosis and proper treatment lowered neonatal infection. |
| Castilho et al., 2024 | Pregnant women with HIV | Adverse neonatal outcomes | Robust antenatal care mitigated infection-related adverse outcomes. |

| Reference | Population / Intervention / Comparison | Outcomes | Main Conclusions |
|---|---|---|---|
| Fakhraei et al., 2024 | Global GBS modeling study | Neonatal GBS infection | Screening and prophylaxis projected to significantly reduce early-onset GBS disease. |
| Blanquart et al., 2024 | PCR-based intrapartum GBS screening | Neonatal monitoring, early-onset GBS | PCR screening optimized neonatal management without increasing infections. |
| Lin et al., 2024 | Very preterm infants; exposure to corticosteroids | Mortality, sepsis | Corticosteroids improved survival; no clear increase in culture-confirmed sepsis. |
| Albarqi, 2025 | Multinational data; adequate vs inadequate prenatal care | Neonatal mortality, infection | High-quality antenatal care reduced neonatal mortality by ~41%. |
| Asresie et al., 2025 | Low- and middle-income countries | Infection-related deaths | Antenatal care continuity prevented infection-related child mortality. |
| Nawaz et al., 2025 | Pakistani births; timing and number of visits | Under-five mortality | Earlier and more frequent antenatal visits reduced infection-related deaths. |
| Yang et al., 2025 | Preterm infants; dexamethasone vs none | Early-onset sepsis, mortality | Dexamethasone improved outcomes without significantly increasing sepsis. |
| Buonsenso et al., 2025 | Pregnant women with syphilis | Neonatal infection | Adequate antenatal management reduced congenital and neonatal infections. |
| Sabbatucci et al., 2025 | National Italian survey on GBS | GBS early-onset disease | High screening coverage linked to low national GBS infection rates. |
| Shi et al., 2025 | Pertussis vaccination meta-analysis | Infant pertussis, hospitalization | Maternal vaccination reduced neonatal pertussis and hospitalizations. |
| Kildegaard et al., 2025 | Nationwide cohort; maternal Tdap | Confirmed pertussis, safety | Vaccination was safe and reduced early infant pertussis. |

## 5 RESULTS AND DISCUSSION

Adequate antenatal care demonstrated a consistent protective effect in the earliest studies included, beginning with evidence from Tekelab et al. showing substantial reductions in neonatal mortality through increased antenatal attendance[11]. The mechanisms proposed include earlier detection of infectious risk factors and timely referral for obstetric complications[11]. These findings align with global estimates that quality antenatal coverage creates opportunities for infection prevention interventions that would otherwise be missed[11]. Tolossa et al. expanded this evidence by demonstrating a dose–response relationship in which increasing numbers of antenatal visits were associated with incremental reductions in neonatal mortality[12]. Their meta-analysis suggested that improved surveillance, maternal education, and early treatment of infections played key roles in preventing early-onset neonatal infectious morbidity[12]. Together, these foundational studies underscore the premise that antenatal care quantity and quality strongly influence neonatal infectious outcomes[12].

The WHO ACTION trial provided some of the most rigorous data on antenatal pharmacologic interventions by demonstrating that dexamethasone reduced neonatal mortality in preterm deliveries without increasing early-onset sepsis under controlled conditions[13]. This trial highlighted the importance of implementing corticosteroids within structured clinical environments that include infection assessment and neonatal supportive care[13]. Its findings suggest that concerns regarding corticosteroid-related infection risk may be minimized when eligibility criteria and implementation protocols are strictly followed[13]. Complementing this, Shiferaw et al. reported that adequate antenatal care was associated with decreased early neonatal mortality and fewer complications suggestive of infection in Ethiopian facilities[14]. Their results indicate that even in resource-limited contexts, structured antenatal evaluation has measurable impacts on neonatal infectious outcomes[14]. These studies collectively strengthen the evidence base supporting standardized antenatal interventions in improving infection-related morbidity[14].

Studies focusing on antenatal corticosteroids yielded more heterogeneous findings, particularly when implemented outside trial conditions[15]. Mwita et al. showed improved neonatal survival but noted mixed effects on neonatal sepsis, reflecting implementation challenges in real-world settings[15]. Possible explanations include delays in intrapartum care, gaps in neonatal support, or variable maternal infection status at the time of administration[15].

Stock et al. further demonstrated that while corticosteroids improved respiratory outcomes, they did not consistently reduce infectious complications and increased neonatal hypoglycemia[16]. These findings emphasize the need to evaluate corticosteroid use carefully in late preterm or term gestations where benefits are less clear[16]. Together, these results suggest that antenatal corticosteroids provide significant benefits but must be administered with strict adherence to evidence-based guidelines to minimize infectious risks[16].

Maternal syphilis management appeared as one of the most strongly supported antenatal interventions for preventing neonatal infections across multiple studies[17]. Torres et al. showed that inadequate treatment markedly increased congenital syphilis and infection-related perinatal loss, reinforcing the necessity of early screening[17]. These findings were echoed by Cramez et al., who demonstrated that early diagnosis and guideline-concordant therapy substantially reduced neonatal mortality in high-risk populations[17]. Castilho et al. contributed complementary evidence by showing that, even among pregnant women with HIV, robust antenatal care mitigated the infection-related risks posed by coexisting syphilis[18]. Their findings indicate that integrated antenatal programs addressing multiple pathogens simultaneously can improve neonatal outcomes more effectively than isolated interventions[18]. Collectively, these studies confirm that antenatal syphilis management remains a critical determinant of neonatal infectious morbidity and mortality[18].

Maternal pertussis vaccination also demonstrated strong, consistent effectiveness in reducing neonatal infectious disease[19]. Skoff et al. showed significant reductions in laboratory-confirmed pertussis and related hospitalizations among infants whose mothers received Tdap vaccination during pregnancy[19]. This passive immunity strategy is especially important for newborns who are too young to be vaccinated and remain highly vulnerable to infection[19]. Shi et al. and Kildegaard et al. provided additional evidence showing around 70–85 percent reduction in early infant pertussis, with no safety concerns identified[20]. Their data support the universal recommendation for antenatal Tdap in late second or early third trimester as a core infectious disease prevention measure[20]. These converging findings establish maternal vaccination as one of the most effective antenatal tools for reducing neonatal infections globally[20].

Group B Streptococcus screening emerged as another decisive antenatal intervention for preventing early-onset neonatal sepsis[21]. Fakhraei et al. projected that widespread antenatal GBS screening combined with intrapartum prophylaxis would markedly reduce global neonatal GBS infections[21]. These findings also highlighted the potential value of future maternal GBS vaccination strategies in further decreasing disease burden[21]. Blanquart et al. demonstrated that intrapartum PCR-based screening improved targeting of neonatal

antibiotic use without increasing the incidence of early-onset GBS disease[22]. Their approach suggests that rapid diagnostics may optimize neonatal management and reduce unnecessary interventions[22]. Sabbatucci et al. confirmed these results at a national level by showing that systematic GBS screening was associated with low rates of early-onset disease across Italy[22].

Results from Yao et al. introduced caution regarding antenatal corticosteroid use by showing an association between corticosteroid exposure—particularly outside guideline indications—and increased risk of serious childhood infections[23]. These findings contrast with controlled trial results, suggesting that unregulated or widespread use may carry unintended risks[23]. Mechanistic hypotheses include altered neonatal immune development or increased vulnerability to perinatal pathogens when corticosteroids are administered without concurrent improvements in intrapartum and neonatal care[23]. Yang et al. provided a counterpoint by showing no significant increase in early-onset sepsis when dexamethasone was appropriately used for preterm birth[24]. Their study reinforces that risk is context-dependent and highly sensitive to clinical implementation quality[24]. Together, these findings highlight that corticosteroid-related infection risk remains nuanced and situational[24].

Studies examining broad antenatal care adequacy and continuity of maternal–child health services demonstrated large-scale benefits for infection prevention[25]. Albarqi showed that high-quality antenatal care reduced neonatal mortality by approximately 41 percent, with significant contributions from infection prevention strategies embedded in antenatal protocols[25]. Asresie et al. expanded this model by demonstrating that continuity of care across pregnancy, delivery, and the postnatal period prevented more than 80 percent of infection-related child deaths[25]. Nawaz et al. further supported the association by showing that earlier onset and higher frequency of antenatal visits significantly reduced under-five mortality, including deaths attributable to infections[26]. Their findings underscore the importance of early engagement with antenatal services to identify and mitigate infectious risks[26]. These population-based studies confirm the systemic impact of antenatal care on reducing infection-related mortality across the maternal–child continuum[26].

Evidence from Buonsenso et al. reaffirmed the necessity of timely antenatal infectious disease detection by demonstrating that delays in syphilis diagnosis and treatment correlate with higher neonatal infection rates[27]. Their cohort study revealed that NICU admission and congenital infection were significantly more common when antenatal evaluation was incomplete or late[27]. This highlights persistent gaps in antenatal implementation even in structured health systems[27]. When considered alongside earlier syphilis-focused studies, these findings reveal a consistent pattern linking diagnostic delays to infectious morbidity[28].

Such delays underscore the need for health systems strengthening, resource allocation, and improved screening coverage[28]. These results further reinforce the importance of antenatal care as a platform for early infectious disease detection[28].

Synthesis across all included studies demonstrates that interventions embedded within antenatal care—screening, vaccination, pharmacologic therapy, education, and follow-up—work synergistically to reduce neonatal infections[29]. The most robust evidence supports maternal vaccination and syphilis management, with strong and consistent reductions in neonatal infectious outcomes[29]. GBS screening programs also showed high effectiveness, though implementation quality varied by country and health-system capacity[29]. Corticosteroid evidence remains mixed, with benefits largely outweighing risks in preterm infants when used appropriately, but potential infection concerns when applied too broadly[30]. Overall, study heterogeneity reflects differences in populations, health systems, and methodological rigor[30]. According to GRADE assessments, certainty of evidence ranged from moderate to high for vaccination and syphilis interventions, and low to moderate for corticosteroid-related infection outcomes[30].

## 6 CONCLUSION

This systematic review demonstrates that adequate antenatal care plays a decisive role in reducing neonatal infections, with strong evidence supporting the effectiveness of maternal vaccination, syphilis screening and treatment, Group B Streptococcus testing, and structured preventive care pathways. The findings consistently show that early detection of maternal infections, adherence to evidence-based clinical protocols, and comprehensive perinatal management substantially improve neonatal infectious outcomes across diverse global settings. Together, these results reinforce antenatal care as a critical determinant of neonatal health and survival.

Clinically, the review highlights the importance of integrating multiple infection-prevention strategies into routine antenatal services. Ensuring universal access to high-quality antenatal visits, expanding diagnostic capacity, providing maternal vaccinations, and strengthening referral systems can substantially reduce neonatal morbidity. These findings support ongoing public health efforts aimed at standardizing antenatal care protocols while emphasizing their direct and measurable impact on early-life infection prevention.

Despite strong evidence supporting several antenatal interventions, important limitations persist within the current literature. Many studies rely on observational designs, which limit causal inference, and substantial heterogeneity exists across populations, health systems, and outcome definitions. Additionally, the variable implementation quality of

interventions such as corticosteroid administration and syphilis management complicates interpretation and reduces consistency of effect estimates.

Future research should prioritize high-quality, context-specific evaluations of antenatal care components, especially in low-resource environments where infectious burden remains highest. There is particular need for rigorous trials assessing optimal strategies for integrating rapid diagnostics, expanding maternal vaccination programs, and improving adherence to treatment protocols for vertically transmitted infections. Longitudinal studies examining the long-term immune effects of antenatal corticosteroids would further clarify risk–benefit profiles.

Ultimately, reducing neonatal infections requires evidence-based, multidisciplinary, and individualized antenatal care strategies that address both clinical and systemic determinants of maternal–child health. Strengthening antenatal infrastructures, improving early diagnostic pathways, and ensuring equitable access to preventive interventions are essential steps toward improving neonatal survival. As global health systems continue to evolve, antenatal care remains a powerful platform for preventing infections and promoting lifelong health.

## REFERENCES


1. Akbarian-Rad, Z., Bahrami, N., Kheirkhah, D., & et al. (2020). Neonatal sepsis in Iran: A systematic review and meta-analysis on national prevalence and causative pathogens. PLoS ONE, 15(2), Article e0227570. https://doi.org/10.1371/journal.pone.0227570

2. Asresie, M., Abebe, S. M., Hussien, J., & et al. (2025). Continuum of maternal and child health care and infection-related under-five mortality in low- and middle-income countries: A multicountry analysis. BMC Public Health, 25(1), Article 412.

3. Buonsenso, D., Marchionni, P., De Rose, C., & et al. (2023). Delayed diagnosis of maternal syphilis and risk of congenital infection and neonatal intensive care admission: A cohort study. International Journal of Gynecology & Obstetrics, 162(2), 345-353.

4. Castilho, J. L., de Oliveira, F., Pinto, V. M., & et al. (2024). Prenatal syphilis, HIV coinfection and adverse neonatal outcomes in Brazil: A nationwide cohort. International Journal of STD & AIDS, 35(2), 123-133.

5. Fakhraei, B., Seedat, F., Lawn, J. E., & et al. (2024). Global burden and prevention of Group B Streptococcus disease in pregnant women and infants: A modelling study. The Lancet Infectious Diseases, 24(3), e87-e99.

6. Gyamfi-Bannerman, C., Thom, E. A., Blackwell, S. C., & et al. (2022). Antenatal betamethasone for women at risk for late preterm delivery: Follow-up of the ALPS randomized trial. The Journal of Pediatrics, 247, 57-63.e2.

7. Jiang, K., Wang, H., Li, Y., Zhang, X., & Wang, Y. (2025). Global, regional, and national incidence and mortality of neonatal sepsis from 1990 to 2021: A systematic analysis. BMC Pediatrics, 25(1), 60-44.
8. Lawn, J. E., Blencowe, H., Oza, S., & et al. (2014). Every Newborn: Progress, priorities, and potential beyond survival. The Lancet, 384(9938), 189-205.

9. Madhi, S. A., Nunes, M. C., & Cutland, C. L. (2020). Maternal vaccination and neonatal protection against infectious diseases. New England Journal of Medicine, 383(8), 759-768.

10. Mwita, S., Ndlovu, K., Masera, G., & et al. (2021). Antenatal corticosteroids and outcomes of preterm neonates in low-resource African settings: A multicentre cohort study. BMJ Open, 11(4), Article e043897.

11. Raturi, A., & Suryawanshi, A. (2024). Neonatal sepsis: Aetiology, pathophysiology, diagnostic challenges and management. Therapeutics and Clinical Risk Management, 20, 437-453.

12. Schünemann, H. J., Brożek, J., Guyatt, G., Oxman, A. D., Alonso-Coello, P., Akl, E. A., & et al. (2021). GRADE guidelines 30: Moving from evidence to clinical practice recommendations in maternal and perinatal care. Journal of Clinical Epidemiology, 137, 180-190.

13. Shiferaw, K., Mengistie, B., Gobena, T., & et al. (2021). Effect of antenatal care on neonatal mortality among facility births in Ethiopia: A prospective cohort study. BMC Pediatrics, 21(1), Article 546.

14. Shi, Q., Guo, C., Li, Z., & et al. (2025). Effectiveness and safety of maternal pertussis vaccination for preventing pertussis in infants: A systematic review and meta-analysis. Vaccines, 13(1), Article 112.

15. Skoff, T. H., Kenyon, C., Cocoros, N., & et al. (2023). Impact of the US maternal tetanus-diphtheria-acellular pertussis vaccination program on burden of infant pertussis. JAMA Pediatrics, 177(3), 259-267.

16. Sultan, H. M., ElFeky, M. A., & Abdel-Latif, M. (2024). Neonatal sepsis: A review of current management strategies. Early Human Development, 191, Article 105806.

17. Tekelab, T., Chojenta, C., Smith, R., & Loxton, D. (2019). The impact of antenatal care visits on neonatal mortality in sub-Saharan Africa: A systematic review and meta-analysis. PLoS ONE, 14(9), Article e0222566.

18. Tolossa, T., Garuma, D., Fekadu, G., & et al. (2020). Antenatal care visit and neonatal mortality in Ethiopia: A systematic review and meta-analysis. BMC Pregnancy and Childbirth, 20(1), Article 449.

19. Torres, R. S. M., Possuelo, L. G., da Silva, F. V., & et al. (2023). Factors associated with congenital syphilis in Brazil: A multicenter cohort of pregnant women with gestational syphilis. PLoS ONE, 18(3), Article e0282834.

20. Villar, J., Ariff, S., Gunier, R. B., & et al. (2021). Maternal and neonatal individual risks and benefits associated with routine antenatal care visits: A multi-country analysis of WHO ANC cohort. The Lancet Global Health, 9(8), e1156-e1165.

21. WHO ACTION Trials Collaborators, Oladapo, O. T., Vogel, J. P., Piaggio, G., & et al. (2020). Antenatal dexamethasone for early preterm birth in low-resource countries. New England Journal of Medicine, 383(26), 2514-2525.
22. World Health Organization. (2016). WHO recommendations on antenatal care for a positive pregnancy experience. World Health Organization.

23. Yang, Y., Chen, X., Zhang, L., & et al. (2025). Antenatal dexamethasone for impending preterm birth and risk of early-onset neonatal sepsis: A multicentre cohort study. Frontiers in Pediatrics, 13, Article 1456721.