AJPMHS GLOBAL RESEARCH NETWORK

**AMERICAN Journal of Pediatric Medicine and Health Sciences**
*Volume 3, Issue 10, 2025 ISSN (E): 2993-2149*

# Effectiveness of Antenatal Corticosteroids in Reducing Neonatal Morbidity in Preterm Birth: A Systematic Review

**Abdulelah Ageel Abdullah Alageel, Saad Saeed Mohammed Alqahtani, Muhannad Khalid Ahmad Alrumayzan, Abdullah Dekhel Abdullah Alraqi**
Family Medicine, Prince Sultan Military Medical City (PSMMC), Riyadh, Saudi Arabia

**Abstract:** Background: The role of preterm birth in contributing to the neonatal's worldwide mortality and morbidity, remains one of the leading causes. The use of antenatal corticosteroids (ACS) greatly enhances the fetal lung maturation and decreases the incidence of these problems in newborns born before 37 weeks of gestation. In spite of the proven efficacy of ACS, there are still unresolved and many debated questions pertaining to the timing, dosing, and merits and risks in certain population subsets, especially in multiple gestations and late preterm births.

Methodology: Including primary research studies like RCTs, cohorts, and observational studies examining the effectiveness of ACS on the reduction of early neonatal morbidity and preterm births, is part of this systematic review. All studies included in this review underwent a detailed search of electronic data bases such as PubMed, Embase and the Cochrane Library. Only the studies published in the English language were incorporated. Based on the predetermined inclusion criteria, the selected data captured study type, the targeted population, the intervention, as well as any significant neonatal outcomes.

Results: Examination of 19 RCTs and numerous big cohort and observational studies showed that in preterm newborns, a single course of ACS significantly lowers the incidence of RDS, IVH, NEC, and neonatal death especially when given within 17 days before birth. The benefit was seen as early as two hours after administration and lasted up to two weeks. Though several courses of ACS did not yield extra benefits and were linked to lower birth weight and head circumference, a single course was still successful among varied maternal and neonatal subgroups. ACS lowered respiratory morbidity but raised the risk of newborn hypoglycemia in late preterm and early term populations. ACS was effective across several gestations and unaffected by maternal BMI.

Conclusion: Antenatal corticosteroids are quite successful in lowering neonatal morbidity and mortality in preterm births; the most benefit comes from doses just before delivery. The data favors the regular application of a single ACS class in women between 24 and 34 weeks gestation who are at danger of preterm birth. Regarding recurring courses and use in late preterm or early term pregnancies, where advantages have to be weighed against possible dangers including hypoglycemia and growth restriction, caution is advised.

## Introduction

One of the main causes of neonatal mortality and morbidity worldwide is preterm birth—that is, delivery before 37 weeks of gestation [1–3]. Complications resulting from preterm birth—including respiratory distress syndrome (RDS), intraventricular hemorrhage (IVH), and necrotizing enterocolitis (NEC)—contribute significantly to both short- and long-term adverse

health outcomes in newborns [4, 5]. With a focus on actions that can increase newborn survival and lower morbidity, the management of pregnancies at risk of preterm delivery is still a key priority in perinatal medicine [6, 7].

Among women at risk of preterm birth, antenatal corticosteroids (ACS) have evolved as one of the most successful therapies [8,9]. ACS quickens fetal lung maturation and lowers the frequency and degree of RDS, IVH, and other consequences related with prematurity when given to pregnant women before expected preterm delivery [10,11]. Evidence from randomized controlled trials and systematic evaluations continually shows that a single course of antenatal steroids dramatically lowers the chance of newborn death, respiratory morbidity, and other severe outcomes in preterm infants [12,13]. Although recent data suggest that decreases in neonatal death and morbidity can occur as early as 2 hours after administration and last for up to two weeks, the advantages of ACS are most pronounced when administered between 24 hours and 7 days before birth [14].

Despite the widespread application of ACS therapy in obstetric practice, there are questions about the best timing, dosage regimens, and long-term safety of corticosteroid exposure, especially for newborns born at the extremes of gestational age or after repeated courses. Considering the evolution of perinatal healthcare efforts and the continuous emergence of fresh research, it is high time and warranted that a systematic review is worked on to consider the relevance of antenatal corticosteroids and their impact on the morbidity rates of neonates suffering from prematurity. Stressing on both immediate and protracted ramifications, the current research intends to assess and amalgamate the existing data on the impact of antenatal corticosteroids on reducing morbidity in neonates born preterm. Such an outcome is useful in determining the growing body of research dedicated to the optimal healthcare approach to pregnancies vulnerable to preterm birth and its clinical implications.

**Methodology**

This research underwent a systematic review while complying with the benchmarking evidence synthesis procedure within the proof-based healthcare model. Upon search of the available electronic databases the Cochrane Library, Embase, and PubMed, and relevant studies were identified. The search strategy applied Medical Subject Headings (MeSH) and the relevant keywords pertaining antenatal corticosteroids, preterm birth, and neonatal mortality, and other relevant combinations. The search strategy was limited to English language publications and the relevant literature within the most recent available date. Inclusion criteria consisted of studies that analyzed the administration of antenatal corticosteroids in women who were deemed to be at risk of preterm birth and who subsequently reported on neonatal morbidity outcomes. Resulted studies had to be either observational studies or randomized controlled trials. Independent of each other, two reviewers examined the titles and abstracts of the studies; for studies that met the criteria for inclusion or were in doubt regarding the eligibility criteria, full-text papers were retrieved.

A standardized form was used to gather data on study design, population features, intervention specifics, control groups, and pertinent neonatal outcomes. Data extraction was done. The incidence of respiratory distress syndrome, intraventricular hemorrhage, necrotizing enterocolitis, and neonatal death were among the main results of interest. When available, secondary outcomes including long-term neurodevelopmental handicap were also kept track of.

Based on study design, appropriate tools were used to evaluate the quality of included studies—the Cochrane Risk of Bias instrument for randomized studies and the Newcastle-Ottawa Scale for observational research. Data synthesis was done qualitatively; quantitative meta-analysis was done when enough uniform data were ready. The findings were condensed to offer a general view of how effective antenatal steroids were in lowering neonatal mortality among premature newborns.

## Results

The current review included 19 studies (Figure 1, [8,9,14-30]), including ten studies which is randomized controlled trials [9,14–22], four large cohort and observational studies [23-26], and five subgroup and special population studies [8,27-30].

## Randomized Controlled Trials

Ten randomized controlled trials (RCTs) [9,14–22] found that antenatal corticosteroids (ACS) consistently lower neonatal respiratory morbidity and mortality throughout a range of preterm groups. A single course of ACS was linked to a major decrease in respiratory distress syndrome (RDS) and neonatal death in women at risk of preterm birth; the most noticeable benefit was seen when the treatment was given within 17 days before delivery. Studies focusing on late preterm infants found that betamethasone reduced the need for respiratory support; though an increased incidence of neonatal hypoglycemia was noted [17,22]. Evidence showing antenatal dexamethasone to be helpful in this group further supported the efficacy of ACS in late preterm birth [9,17].

Findings on successive ACS were conflicting. While another trial showed that multiple doses could lower RDS and severe lung disease without affecting growth at discharge [16], multiple courses did not produce more improvements in composite neonatal morbidity and were linked with lower birth weight, length, and head circumference [15,18,19]. In pregnancies complicated by preterm premature rupture of membranes (PPROM), no significant difference in major neonatal outcomes was seen between single and repeated courses of ACS [18].

Crucially, ACS administration showed quick advantages: reductions in mortality were seen as early as two hours post-administration in very premature newborns [14]. Trials in very preterm and early term cesarean populations likewise verified decreases in neonatal mortality and respiratory morbidity, respectively [21]. These RCTs give strong proof favoring the use of ACS to enhance neonatal outcomes in selected early term births (Table 1).

**Table 1. Randomized Controlled Trials**

| Study (Year) | Design | Population | Sample Size | Key Outcomes | Main Findings |
|---|---|---|---|---|---|
| Murphy et al. (2008) [15] | RCT | Women 25–32 wks, undelivered after 14–21 days of initial ACS | 1858 | Composite neonatal morbidity, growth | Multiple courses of ACS did not improve outcomes; associated with lower birth weight, length, head circumference. |
| Norman et al. (2017) [16] | RCT | Women <34 wks, imminent birth | 2598 | RDS, neonatal death | ACS reduced RDS and neonatal death; optimal benefit when given 1–7 days before birth. |
| Gyamfi-Bannerman et al. (2016) [17] | RCT | Late preterm | 2827 | Respiratory outcomes | Betamethasone reduced respiratory support need; increased hypoglycemia. |
| El-Gawad et al. (2022) [18] | RCT | PPROM, single vs repeated ACS | 200 | Neonatal outcomes | No significant difference in major neonatal outcomes between single and repeated courses. |
| Sultana et al. (2023) [9] | RCT | Late preterm | Not stated | Preterm birth outcomes | Antenatal dexamethasone |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | effective in late preterm birth. |
| Crowther et al. (2006)[19] | RCT | Women <32 wks, repeat doses | 982 | RDS, oxygen use, growth | Repeat doses reduced RDS and severe lung disease; no difference in growth at discharge. |
| Melamed et al. (2025)[14] | RCT | 23–31 wks GA | 7950 | Mortality, neurologic injury | ACS reduced mortality as early as 2 hours post-administration. |
| Shivtej (2018) [20] | RCT | Preterm babies <37 wks | 110 | RDS | Complete course of ACS significantly reduced RDS. |
| Mwansa-kambafwile et al (2010) [21] | RCT | Very preterm | Not stated | Neonatal mortality, RDS | ACS reduced neonatal mortality and RDS. |
| DeBolt et al. (2022)[22] | RCT | Early term cesarean | Not stated | Respiratory morbidity | Betamethasone reduced respiratory morbidity in early term cesarean deliveries. |

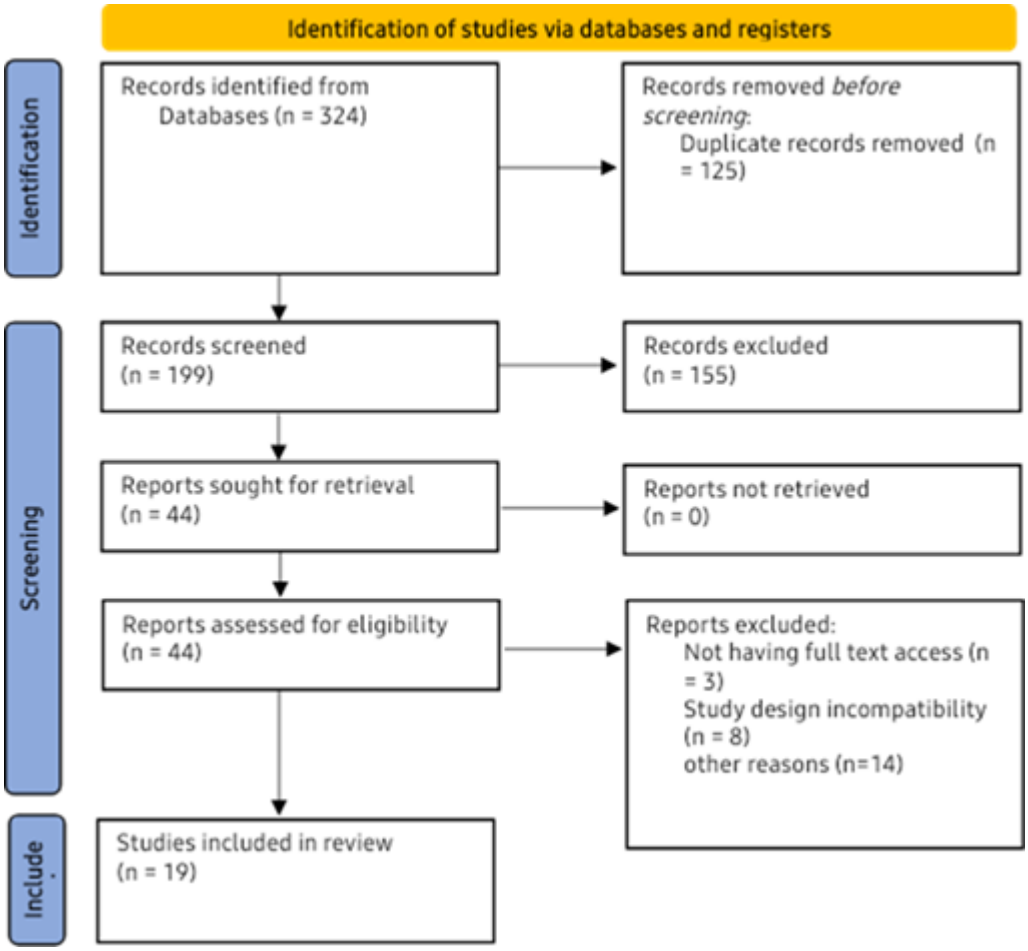


Figure 1: PRISMA flow for including studies

## Large Cohort and Observational Studies

Four large-scale cohort and observational studies [23-26] corroborate the findings of RCTs, indicating that ACS use in women at risk of preterm birth significantly reduces the incidence of RDS and composite neonatal morbidity, regardless of maternal diabetic status [23-26]. In extremely preterm infants (22–25 weeks gestation), ACS exposure was linked to lower rates of death and neurodevelopmental impairment at 18–22 months of age [23,24]. The timing of ACS administration relative to delivery was found to be critical; intervals greater than 14 days, particularly in infants born after 28 weeks, were associated with an increased need for ventilatory support and surfactant use [25]. Additionally, among very low birth weight infants, betamethasone was superior to dexamethasone or no steroids in reducing neonatal death and intraventricular hemorrhage (IVH) [26]. These studies reinforce the substantial benefits of ACS in diverse clinical settings and populations (Table 2).

Table 2. Large Cohort and Observational Studies

| Study (Year) | Design | Population | Sample Size | Key Outcomes | Main Findings |
|---|---|---|---|---|---|
| Battarbee et al. (2022) [23] | Cohort | 23–33 wks, US hospitals | 115,502 | RDS, composite morbidity | ACS reduced RDS and morbidity in both diabetics and non-diabetics. |
| Tyson et al. (2008) [24] | Cohort | 22–25 wks, NICHD Network | 4446 | Death, neurodevelopmental impairment | ACS reduced death and impairment at 18–22 months. |
| Ring et al. (2007) [25] | Cohort | 26–34 wks, singletons | 357 | Ventilatory support, surfactant use | ACS-to-delivery interval >14 days increased need for support, especially >28 wks. |
| Lee et al. (2006) [26] | Cohort | VLBW infants, US | 11,022 | Neonatal death, IVH | Betamethasone reduced neonatal death compared to dexamethasone or no steroids. |

## Subgroup and Special Population Studies

Subgroup analyses and studies [8,27-30] in special populations reveal that the effectiveness of ACS extends to multiple gestations and various maternal characteristics. ACS reduced the incidence of RDS in both twins and triplets, although the magnitude of effect varied by plurality [27]. Maternal body mass index (BMI) did not significantly influence the effectiveness of ACS, suggesting broad applicability across weight categories [28]. However, accurately predicting the timing of delivery after ACS administration remains challenging, with a substantial proportion of women delivering more than seven days after treatment [29].

Further, no significant differences were observed in the efficacy of ACS between twins and singletons in terms of morbidity and mortality [30]. In general preterm populations, a single course of ACS was associated with reductions in mortality, RDS, IVH, and necrotizing enterocolitis (NEC) [8]. These findings highlight the versatility and consistent benefit of ACS across various subgroups and clinical scenarios (Table 3).

Table 3. Subgroup and Special Population Studies

| Study (Year) | Design | Population | Sample Size | Key Outcomes | Main Findings |
|---|---|---|---|---|---|
| Blickstein et al. (2005) [27] | Observational | Twins, triplets vs singletons | 167 twins, 157 | RDS | ACS reduced RDS in twins and triplets, |

| | | | | | |
|---|---|---|---|---|---|
| | | | controls | | though effect size varied by plurality. |
| Hashima et al. (2004) [28] | Observational | Obese vs non-obese women | 243 | Neonatal outcomes | BMI did not influence ACS effectiveness. |
| McLaughlin et al. (2003) [29] | Observational | Women <34 wks, Ireland | 400 | Timing of delivery after ACS | Many women delivered >7 days after ACS; timing accuracy is challenging. |
| Bae et al. (2023) [30] | Cohort | Twins/singletons, Korea | 9531 | Morbidity, mortality | No significant difference in ACS effect by plurality. |
| Bonanno et al. (2012) [8] | Cohort | Preterm infants | 3885 | Mortality, RDS, IVH, NEC | Single ACS course reduced all adverse outcomes. |

**Discussion**

Among preterm babies born before 34 weeks of gestation, the findings from this review confirm the well-known function of antenatal corticosteroids (ACS) in enhancing neonatal results [31–33]. Numerous randomized controlled trials and observational studies constantly show that a single course of ACS substantially lowers the risk of respiratory distress syndrome (RDS), intraventricular hemorrhage (IVH), necrotizing enterocolitis (NEC), and newborn mortality. With evidence suggesting that decreases in neonatal mortality and serious neurological damage may be seen as early as two hours after administration and persist for up to two weeks, the advantages of ACS are most clear when given 17 days before to delivery.

Still a major element, ACS should be given at the right time. Studies suggest that the maximum advantage is realized between 12 hours and 14 days, same with some earlier studies [34,35]. ACS exposure to birth gap Delays past this period can lessen the protective effects, especially on respiratory results. This stresses the need of exact prediction of preterm birth to maximize the effectiveness of ACS treatment.

Concerning several ACS courses, the data is contradictory. Although some studies show that repeat dosing may help to lower the frequency of RDS and the length of mechanical ventilation, questions remain regarding possible negative consequences on brain development and fetal growth. Animal research reveal that multiple courses may influence myelination in the developing brain, and clinical data point to links with lower birth weight, length, and head circumference [36,37]. Therefore, present guidelines advise limiting repeat courses to specifically chosen situations where the risk of preterm birth stays high following an initial course [38].

Rising focus has been on the administration of ACS in early term and late preterm (34–36 weeks). Randomized studies show that ACS can lower short-term respiratory morbidity in late preterm babies; but, this benefit is balanced by a higher incidence of neonatal hypoglycemia. Significantly, recent long-term follow-up research reveal that at six years of age, late preterm ACS exposure has no negative impact on neurodevelopmental results [39]. Still, when thinking about ACS in these gestational windows, close observation and clinical judgment are required given the risk of hypoglycemia, especially within the first 12 hours of life.

ACS's efficacy in many gestations, including twins and triplets, has been questioned.

While previous meta-analyses did not reach a conclusion, cohort studies and clinical practice guidelines, more recently, endorse the use of ACS for multiples, showing comparable reductions in neonatal mortality and morbidity as seen in singletons [40–42]. Factors such as body mass index (BMI) do not seem to substantially change the effectiveness of ACS, thus confirming its broad applicability across other regions.

Unlike cohorts, long-term follow up data ACS gives peace of mind due to evidence suggesting reduced rates of neurodevelopmental impairment in very preterm infants, and no increase in adverse neurocognitive or behavioral outcomes in childhood for those who underwent single course exposure to ACS [39]. However, ACS is cautionary in settings of use in pregnancies likely to end in term birth, as some studies suggest higher rates of neurocognitive deficits in this population.

**Conclusion**

To summarize, the evidence continues to support the case for offering one course of ACS to women in the 24 to 34 weeks of gestation period at risk for preterm birth—along with the targeted timing of administration to shift the advantage as far forward as possible. The administration of repeat courses and timing of administration to late preterm or early term pregnancies should be individualized to minimize the tradeoffs between possible benefits and risks such as newborn hypoglycemia and likely developmental and neurodevelopmental impacts. Future inquiries should focus on improving the definition of optimal dosage, timing, and the long term safety of diverse populations and clinical settings.

**References:**


1. Manuck TA, Rice MM, Bailit JL, et al. Preterm neonatal morbidity and mortality by gestational age: a contemporary cohort. *American Journal of Obstetrics and Gynecology*. 2016;215(1):103.e1-103.e14. doi:10.1016/j.ajog.2016.01.004
2. Quinn JA, Munoz FM, Gonik B, et al. Preterm birth: Case definition & guidelines for data collection, analysis, and presentation of immunisation safety data. *Vaccine*. 2016;34(49):6047-6056. doi:10.1016/j.vaccine.2016.03.045
3. Mohamed H, Mesabah M, Haroun H, Mousa S. Evaluation of the Incidence, Possible Risk Factors and Maternal & Neonatal Morbidity & Mortality in Cases of Preterm Labour at El Minya Maternity University Hospital. *El-Minia Medical Bulletin*. 2022;0(0):1-10. doi:10.21608/mjmr.2022.258231
4. Zivaljevic J, Jovandaric MZ, Babic S, Raus M. Complications of Preterm Birth—The Importance of Care for the Outcome: A Narrative review. *Medicina*. 2024;60(6):1014. doi:10.3390/medicina60061014
5. Supriya N, Singh SN, Tripathi S, Kumar M. Outcome of preterm neonates born to women of a developing country at risk of preterm birth exposed to varying doses of antenatal corticosteroid: A prospective observational study. *Clinical Epidemiology and Global Health*. 2019;8(2):623-627. doi:10.1016/j.cegh.2019.12.015
6. Wastnedge E, Waters D, Murray SR, et al. Interventions to reduce preterm birth and stillbirth, and improve outcomes for babies born preterm in low- and middle-income countries: A systematic review. *Journal of Global Health*. 2021;11. doi:10.7189/jogh.11.04050
7. Ross GN, Ridout AE, Shennan AH. Promising recent advances in preterm birth management. *Frontiers in Women's Health*. 2016;1(2). doi:10.15761/fwh.1000108
8. Bonanno C, Wapner RJ. Antenatal corticosteroids in the management of preterm birth: Are we back where we started? *Obstetrics and Gynecology Clinics of North America*. 2012;39(1):47-63. doi:10.1016/j.ogc.2011.12.006

9. Sultana S, Vogel JP, Oladapo OT. The efficacy of antenatal corticosteroids to improve preterm newborn outcomes in low-resource countries: Are we there yet? *BJOG an International Journal of Obstetrics & Gynaecology*. 2023;130(S3):84-91. doi:10.1111/1471-0528.17611

10. McGoldrick E, Stewart F, Parker R, Dalziel SR. Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. *Cochrane Library*. 2020;2021(2). doi:10.1002/14651858.cd004454.pub4

11. Morhart P, Gärtner J, Weiss C, et al. Influence of timing of antenatal corticosteroid administration on morbidity of preterm neonates. *In Vivo*. 2022;36(4):1777-1784. doi:10.21873/invivo.12891

12. Zullo F, Gulersen M, Di Mascio D, et al. Antenatal corticosteroids for patients at risk of late preterm birth: a systematic review and meta-analysis of randomized controlled trials. *American Journal of Obstetrics & Gynecology MFM*. May 2025:101709. doi:10.1016/j.ajogmf.2025.101709

13. Adegboyega TA, Adejuyigbe EA, Adesina OA, et al. The World Health Organization Antenatal CorTicosteroids for Improving Outcomes in preterm Newborns (ACTION-III) Trial: study protocol for a multi-country, multi-centre, double-blind, three-arm, placebo-controlled, individually randomized trial of antenatal corticosteroids for women at high probability of late preterm birth in hospitals in low- resource countries. *Trials*. 2024;25(1). doi:10.1186/s13063-024-07941-0

14. Melamed N, Murphy KE, Pylypjuk C, et al. Timing of antenatal corticosteroid administration and neonatal outcomes. *JAMA Network Open*. 2025;8(5):e2511315. doi:10.1001/jamanetworkopen.2025.11315

15. Murphy KE, Hannah ME, Willan AR, et al. Multiple courses of antenatal corticosteroids for preterm birth (MACS): a randomised controlled trial. *The Lancet*. 2008;372(9656):2143-2151. doi:10.1016/s0140-6736(08)61929-7

16. Norman M, Piedvache A, Børch K, et al. Association of short antenatal corticosteroid Administration-to-Birth intervals with survival and morbidity among very preterm infants. *JAMA Pediatrics*. 2017;171(7):678. doi:10.1001/jamapediatrics.2017.0602

17. Antenatal betamethasone for women at risk for late preterm delivery. *New England Journal of Medicine*. 2023;388(18):1728. doi:10.1056/nejmx220010

18. Gawad MAE, Elsewafy A, Farid L. Effect of single course versus repeated single course of antenatal corticosteroid (Dexamethasone) in preterm premature rupture of membranes on neonatal respiratory outcome "Randomized Control Trials." *Evidence Based Women S Health Journal*. 2022;12(3):295-303. doi:10.21608/ebwhj.2022.143871.1180

19. Crowther CA, Haslam RR, Hiller JE, Doyle LW, Robinson JS. Neonatal respiratory distress syndrome after repeat exposure to antenatal corticosteroids: a randomised controlled trial. *The Lancet*. 2006;367(9526):1913-1919. doi:10.1016/s0140-6736(06)68846-6

20. N S, R P, Naidu A, S AB, Mehta VB. Effect of single dose and double dose antenatal corticosteroids on respiratory distress syndrome among preterm babies. *International Journal of Contemporary Pediatrics*. 2018;6(1):82. doi:10.18203/2349-3291.ijcp20185152

21. Mwansa-Kambafwile J, Cousens S, Hansen T, Lawn JE. Antenatal steroids in preterm labour for the prevention of neonatal deaths due to complications of preterm birth. *International Journal of Epidemiology*. 2010;39(Supplement 1):i122-i133. doi:10.1093/ije/dyq029

22. DeBolt CA, Johnson S, Harishankar K, et al. Antenatal corticosteroids decrease the risk of composite neonatal respiratory morbidity in planned early term cesarean deliveries. *American Journal of Perinatology*. 2021;39(09):0915-0920. doi:10.1055/a-1674-6198

23. Battarbee AN, Sandoval G, Grobman WA, et al. Antenatal Corticosteroids and Preterm Neonatal Morbidity and Mortality among Women with and without Diabetes in Pregnancy. *American Journal of Perinatology*. 2020;39(01):067-074. doi:10.1055/s-0040-1714391

24. Tyson JE, Parikh NA, Langer J, Green C, Higgins RD. Intensive Care for Extreme Prematurity — Moving beyond Gestational Age. *New England Journal of Medicine*. 2008;358(16):1672-1681. doi:10.1056/nejmoa073059

25. Ring AM, Garland JS, Stafeil BR, Carr MH, Peckman GS, Pircon RA. The effect of a prolonged time interval between antenatal corticosteroid administration and delivery on outcomes in preterm neonates: a cohort study. *American Journal of Obstetrics and Gynecology*. 2007;196(5):457.e1-457.e6. doi:10.1016/j.ajog.2006.12.018

26. Lee BH, Stoll BJ, McDonald SA, Higgins RD. Adverse neonatal outcomes associated with antenatal dexamethasone versus antenatal betamethasone. *PEDIATRICS*. 2006;117(5):1503-1510. doi:10.1542/peds.2005-1749

27. Blickstein I, Shinwell ES, Lusky A, Reichman B. Plurality-dependent risk of respiratory distress syndrome among very-low-birth-weight infants and antepartum corticosteroid treatment. *American Journal of Obstetrics and Gynecology*. 2005;192(2):360-364. doi:10.1016/j.ajog.2004.10.604

28. Hashima JN, Lai Y, Wapner RJ, et al. The effect of maternal body mass index on neonatal outcome in women receiving a single course of antenatal corticosteroids. *American Journal of Obstetrics and Gynecology*. 2009;202(3):263.e1-263.e5. doi:10.1016/j.ajog.2009.10.859

29. McLaughlin K, Crowther C, Vigneswaran P, Hancock E, Willson K. Who remains undelivered more than seven days after a single course of prenatal corticosteroids and gives birth at less than 34 weeks? *Australian and New Zealand Journal of Obstetrics and Gynaecology*. 2002;42(4):353-357. doi:10.1111/j.0004-8666.2002.00353.x

30. Bae SP, Hahn WH, Park S, et al. Effects of antenatal corticosteroids on neonatal outcomes in twin and singleton pregnancies: a Korean national cohort study. *BMJ Paediatrics Open*. 2023;7(1):e001754. doi:10.1136/bmjpo-2022-001754

31. Chung HW, Yu CH, Huang CY, Liang FW. Antenatal corticosteroid exposure and neonatal outcomes in term infants. *Early Human Development*. 2025;208:106325. doi:10.1016/j.earlhumdev.2025.106325

32. McDougall ARA, Aboud L, Lavin T, et al. Effect of antenatal corticosteroid administration-to-birth interval on maternal and newborn outcomes: a systematic review. *EClinicalMedicine*. 2023;58:101916. doi:10.1016/j.eclinm.2023.101916

33. Fuma K, Ushida T, Kawaguchi M, et al. Impact of antenatal corticosteroids on subcortical volumes in preterm infants at term-equivalent age: A retrospective observational study. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 2024;302:7-14. doi:10.1016/j.ejogrb.2024.08.034

34. Oladapo OT, Vogel JP, Piaggio G, et al. Effect of dexamethasone on newborn survival at different administration-to-birth intervals: A secondary analysis of the WHO ACTION (Antenatal CorticosTeroids for Improving Outcomes in Preterm Newborn)-I trial. *EClinicalMedicine*. 2022;53:101744. doi:10.1016/j.eclinm.2022.101744

35. Wynne K, Rowe C, Delbridge M, et al. Antenatal corticosteroid administration for foetal lung maturation. *F1000Research*. 2020;9:219. doi:10.12688/f1000research.20550.1

36. Shields A, Thomson M, Winter V, Coalson J, Rees S. Repeated courses of antenatal corticosteroids have adverse effects on aspects of brain development in naturally delivered baboon infants. *Pediatric Research*. 2012;71(6):661-667. doi:10.1038/pr.2012.18

37. Chang YP. Evidence for adverse effect of perinatal glucocorticoid use on the developing brain. *Korean Journal of Pediatrics*. 2014;57(3):101. doi:10.3345/kjp.2014.57.3.101

38. Crowther CA, McKinlay CJ, Middleton P, Harding JE. Repeat doses of prenatal corticosteroids for women at risk of preterm birth for improving neonatal health outcomes. *Cochrane Library*. July 2015. doi:10.1002/14651858.cd003935.pub4

39. Sultana S, Bruinsma F, Fisher Z, Homer CSE, Vogel JP. Long-term outcomes of antenatal corticosteroids for preterm birth: An overview of systematic reviews. *PLOS Global Public Health*. 2025;5(5):e0004575. doi:10.1371/journal.pgph.0004575

40. Saito K, Nishimura E, Ota E, et al. Antenatal corticosteroids in specific groups at risk of preterm birth: a systematic review. *BMJ Open*. 2023;13(9):e065070. doi:10.1136/bmjopen-2022-065070

41. Socha P, McGee A, Bhattacharya S, Young C, Wang R. Antenatal corticosteroids and neonatal outcomes in twins. *Obstetrics and Gynecology*. June 2022. doi:10.1097/aog.0000000000004835

42. Amiya RM, Mlunde LB, Ota E, Swa T, Oladapo OT, Mori R. Antenatal corticosteroids for reducing adverse maternal and child outcomes in special populations of women at risk of imminent preterm birth: A Systematic Review and Meta-Analysis. *PLoS ONE*. 2016;11(2):e0147604. doi:10.1371/journal.pone.0147604