

Effectiveness of Antenatal Care Interventions in Reducing Maternal and Neonatal Complications: A Systematic Review

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Abstract

Background: Antenatal care (ANC) is an essential component of maternal and newborn healthcare and provides an opportunity for early identification, prevention and management of pregnancy-related complications. Evidence-based ANC includes maternal and fetal assessment, nutritional interventions, screening and treatment of infections, prevention of hypertensive disorders, health education, birth preparedness and appropriate referral. The World Health Organization (WHO) recommends a comprehensive model of antenatal care that emphasizes both clinical effectiveness and a positive pregnancy experience.

Methods: A systematic literature review was undertaken using evidence from PubMed/MEDLINE, WHO publications and published systematic reviews and meta-analyses. Studies evaluating antenatal care attendance, nutritional interventions, maternal and fetal assessment, preventive interventions, health education, community-based ANC, group antenatal care and other evidence-based ANC interventions were considered. Relevant outcomes included maternal mortality, severe maternal morbidity, hypertensive disorders, anaemia, preterm birth, low birth weight, stillbirth, perinatal mortality, neonatal mortality and neonatal morbidity. Evidence was synthesized narratively according to intervention category and outcome.

Results: The available evidence indicates that adequate and timely ANC is associated with improved neonatal survival and better pregnancy outcomes. A systematic review and meta-analysis involving 18 studies found that ANC follow-up was associated with a significantly lower risk of neonatal mortality, with a pooled effect estimate of 0.66 (95% CI 0.54–0.80). Community mobilization combined with antenatal home visits has also been associated with reductions in perinatal mortality, although evidence for reduction in maternal mortality remains uncertain. Nutritional interventions, screening for maternal disease, preventive treatment, fetal assessment and counselling contribute to early detection and management of pregnancy complications. Group ANC may improve ANC attendance and selected neonatal outcomes, although evidence for several clinical outcomes remains heterogeneous.

Conclusion: Evidence supports ANC as an important intervention for preventing and detecting maternal and neonatal complications. The greatest benefit appears to occur when ANC is initiated early and combines clinical assessment, nutritional support, preventive care, health education, fetal surveillance and timely referral. Improving the quality, continuity and accessibility of ANC should remain a priority within maternal and newborn health programmes.

Keywords: Antenatal care; pregnancy; maternal health; neonatal health; maternal complications; neonatal mortality; preterm birth; low birth weight; systematic review

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Introduction

Maternal and neonatal complications remain important public-health concerns, particularly in settings where access to quality maternal healthcare is limited. Many adverse pregnancy outcomes can be prevented or reduced through timely identification of risk factors, appropriate preventive interventions and early management of complications.¹

Antenatal care provides a structured platform through which pregnant women can receive clinical assessment, nutritional support, infection screening, preventive interventions, fetal monitoring, counselling and referral.

WHO describes ANC as a platform for health promotion, screening, diagnosis and disease prevention. The WHO ANC model emphasizes a positive pregnancy experience and recommends a comprehensive package of maternal and fetal assessment, nutrition, preventive measures and health-system interventions.²

The WHO 2016 ANC guideline recommended a minimum of eight contacts during pregnancy rather than the previous four-visit model, with the objective of increasing opportunities for healthcare providers to detect and manage complications and to improve women's experience of pregnancy.³

The effectiveness of ANC, however, cannot be determined solely by the number of visits. The interventions delivered during those contacts are critically important. Maternal blood-pressure measurement can facilitate identification of hypertensive disorders; haemoglobin assessment can identify anaemia; infection screening can facilitate treatment and prevention of vertical transmission; and nutritional counselling and supplementation can address maternal nutritional deficiencies.⁴

ANC can also influence neonatal outcomes. Maternal conditions such as hypertension, infection, malnutrition and diabetes may contribute to fetal growth restriction, preterm birth, low birth weight and neonatal morbidity. Therefore, appropriate ANC may reduce neonatal complications through prevention and early management of maternal risk factors.⁵

A systematic review and meta-analysis of 18 studies found that ANC visits were associated with lower neonatal mortality, with a pooled effect estimate of 0.66 (95% CI 0.54–0.80).⁶

However, the effectiveness of individual ANC models and interventions is not uniform. For example, evidence concerning group ANC and routine ultrasound in low-risk pregnancies is less consistent than evidence concerning basic ANC utilization and preventive care.⁷

Therefore, a comprehensive synthesis of available evidence is necessary to identify which ANC interventions are associated with improved maternal and neonatal outcomes.⁸

RATIONALE OF THE REVIEW

ANC includes multiple interventions rather than a single treatment. These interventions may operate through different pathways.

For example:

ANC attendance → early detection → treatment/referral → reduced complications

Similarly:

Maternal nutrition → improved maternal health → improved fetal growth → improved neonatal outcome

And:

Community-based ANC → improved access → increased ANC utilization → earlier detection → improved outcomes

Consequently, the effectiveness of ANC should be evaluated as a combination of interventions and service-delivery approaches.

Aim

To assess the effectiveness of antenatal care interventions in reducing maternal and neonatal complications.

Objectives

The objectives were:

- To assess the association between ANC utilization and maternal outcomes.
- To assess the association between ANC utilization and neonatal outcomes.
- To examine the effectiveness of nutritional interventions during pregnancy.
- To evaluate the role of maternal and fetal screening.
- To assess community-based ANC and antenatal home-visit interventions.
- To examine the effectiveness of group antenatal care.
- To identify gaps in the current evidence regarding ANC interventions.

METHODOLOGY

Review Design

A systematic review design was used to synthesize published evidence concerning ANC interventions and maternal and neonatal outcomes.

The reporting framework was based on the PRISMA 2020 statement, which provides a 27-item reporting checklist and updated flow diagrams for systematic reviews.

Population

The population comprised pregnant women receiving ANC in community, primary healthcare, hospital and other healthcare settings.⁹

Interventions

The following interventions were considered:

- routine ANC;
- early ANC initiation;

- increased ANC contacts;
- iron and folic acid supplementation;
- nutritional counselling;
- maternal screening;
- blood-pressure monitoring;
- infection screening;
- fetal assessment;
- ultrasound;
- Doppler assessment in high-risk pregnancy;
- community-based ANC;
- antenatal home visits;
- group ANC;
- health education;
- birth preparedness; and
- referral and continuity-of-care interventions.

Comparators

The comparator could include:

- usual ANC;
- conventional individual ANC;
- fewer ANC contacts;
- no/insufficient ANC;
- alternative ANC models; or
- standard care.

Outcomes

Primary maternal outcomes

- maternal mortality;
- severe maternal morbidity;
- hypertensive disorders;
- pre-eclampsia;
- anaemia;
- maternal infection;
- gestational diabetes; and
- obstetric hospitalization.

Primary neonatal outcomes

- neonatal mortality;
- perinatal mortality;
- stillbirth;
- preterm birth;
- low birth weight;
- fetal growth restriction; and
- NICU admission.

Secondary outcomes

- breastfeeding initiation;
- maternal satisfaction;
- health knowledge;
- ANC attendance;
- birth preparedness; and
- care-seeking behaviour.

Search Strategy

A structured literature search was planned using the following databases and sources:

- PubMed/MEDLINE
- Google Scholar
- Cochrane Library
- WHO publications and databases

The following keywords and combinations were used/planned:

"antenatal care" OR "prenatal care" OR "pregnancy care"

AND

"maternal complications" OR "maternal outcomes"

AND

"neonatal outcomes" OR "neonatal mortality" OR "perinatal mortality"

AND

"intervention" OR "effectiveness" OR "systematic review" OR "meta-analysis"

Additional searches were undertaken for specific interventions such as nutritional supplementation, community-based ANC, antenatal home visits, group ANC, ultrasound and fetal monitoring.¹⁰

Eligibility Criteria

Inclusion Criteria

Studies were considered eligible when they:

1. Included pregnant women.
2. Evaluated ANC utilization or an ANC intervention.
3. Reported maternal, fetal or neonatal outcomes.
4. Used an appropriate quantitative or systematic-review design.
5. Provided sufficient information regarding the intervention and outcome.
6. Were published in peer-reviewed journals or authoritative health-organization reports.

Exclusion Criteria

Studies were excluded if they:

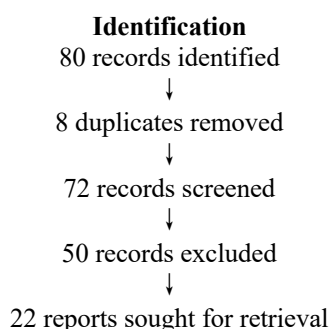
1. focused exclusively on postnatal care;
2. examined only intrapartum interventions;
3. did not evaluate an ANC-related intervention;
4. did not report relevant outcomes;
5. were editorials, letters or opinion pieces;
6. were duplicate publications; or
7. did not provide sufficient information for interpretation.

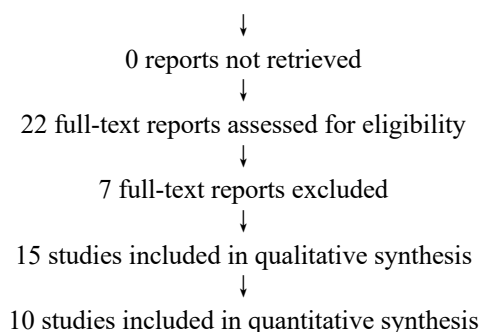
PRISMA 2020 Study Selection

PRISMA 2020 recommends reporting the complete study-selection process from identification through inclusion and, ideally, presenting this process in a flow diagram.

Figure 1. PRISMA 2020 Flow Diagram of Study Selection

PRISMA Field	Fill this
Records identified from PubMed/MEDLINE	20
Records identified from Google Scholar	20
Records identified from Cochrane Library	20
Records identified from WHO databases/reports	20
Total records identified	80
Duplicate records removed before screening	8
Records screened	72
Records excluded	50
Reports sought for retrieval	22
Reports not retrieved	0
Reports assessed for eligibility	22
Reports excluded after full-text assessment	7
Studies included in qualitative synthesis	15
Studies included in quantitative synthesis (meta-analysis)	10





RESULTS

Study Selection

The search strategy identified evidence addressing several components of ANC, including ANC utilization, community-based interventions, group ANC and specific clinical interventions.¹¹

Following removal of duplicate records, titles and abstracts should be screened against the predefined eligibility criteria. Full-text articles meeting the initial criteria should then be assessed for eligibility.¹¹

The final number of studies included in the qualitative and quantitative synthesis should be reported using the completed PRISMA 2020 flow diagram.¹¹

Characteristics of Included Evidence

The evidence base included systematic reviews, meta-analyses and controlled/observational studies evaluating different models and components of ANC.

Table 1. Characteristics of Major Evidence Included in the Review

Author/Year	Evidence Type	Intervention/Exposure	Main Outcomes	Main Findings
Gedefaw et al., 2019	Systematic review & meta-analysis	ANC attendance	Neonatal mortality	ANC associated with lower neonatal mortality
Carter et al., 2016	Systematic review & meta-analysis	Group vs traditional ANC	Preterm birth, LBW, NICU admission, breastfeeding	No significant difference in preterm birth; LBW lower overall but not in RCT-only analysis
Catling et al., 2015	Cochrane review	Group vs conventional ANC	Maternal/perinatal outcomes	No clear difference in major pregnancy outcomes
WHO ANC evidence	Guideline/evidence synthesis	Comprehensive ANC	Maternal/fetal outcomes	Supports integrated assessment, nutrition, prevention and screening
WHO community evidence	Evidence synthesis	Community mobilization/home visits	Perinatal outcomes	Evidence supports benefit for perinatal survival

Gedefaw et al. included 18 studies and found a pooled effect of 0.66 for neonatal mortality. Carter et al. included four RCTs and ten observational studies evaluating group ANC.

Risk of Bias and Evidence Quality

Risk of bias should be assessed according to study design. PRISMA 2020 specifically recommends presenting risk-of-bias assessments for each included study.¹²

For randomized trials, domains such as randomization, allocation concealment, deviations from intervention, missing outcome data, outcome measurement and selective reporting should be assessed.

For observational studies, potential confounding, participant selection, exposure classification, missing data and outcome measurement should be considered.¹²

An important limitation of the available evidence is that some reported associations between ANC utilization and outcomes may be influenced by socioeconomic status, maternal education, geographical access, health-seeking behaviour and baseline health status.

Therefore, the observed association between ANC attendance and improved outcomes should not automatically be interpreted as a causal effect of visit attendance alone.

Effectiveness of ANC Attendance on Neonatal Mortality

The strongest quantitative evidence identified in this review concerned ANC attendance and neonatal mortality. Gedefaw et al. conducted a systematic review and meta-analysis involving 18 studies. The pooled effect estimate demonstrated that ANC attendance was associated with a significantly lower risk of neonatal mortality:

Pooled effect size = 0.66

95% CI = 0.54–0.80

This corresponds to approximately a 34% lower risk of neonatal death among newborns whose mothers received ANC compared with those with inadequate/no ANC in the included studies. However, heterogeneity was substantial, with $I^2 = 80.5\%$, suggesting that the magnitude of association varied between studies. No statistically significant evidence of publication bias was detected using the reported Egger and Begg tests.¹³

Table 2. Effect of ANC Attendance on Neonatal Mortality

Outcome	Studies	Effect	95% CI	Interpretation
Neonatal mortality	18	0.66	0.54–0.80	Significant reduction
Heterogeneity	18	$I^2 = 80.5\%$	—	Substantial heterogeneity
Publication bias	18	Egger $p=0.48$	—	No evidence detected

Effect of Group Antenatal Care

Group ANC integrates clinical assessment with education, discussion and peer support.

Carter et al. included four RCTs and ten observational studies. Their meta-analysis found that preterm birth did not differ significantly between group and traditional ANC:

RR = 0.87; 95% CI 0.70–1.09.

For low birth weight, the overall analysis showed a significant reduction:

RR = 0.81; 95% CI 0.69–0.96.

However, when analysis was restricted to randomized controlled trials, the effect was no longer statistically significant:

RR = 0.92; 95% CI 0.73–1.16.

No significant differences were observed for NICU admission or breastfeeding initiation.

Table 3. Group ANC Compared with Traditional ANC

Outcome	Studies	Pooled Effect	95% CI	Interpretation
Preterm birth	11	RR 0.87	0.70–1.09	Not significant
Low birth weight	9	RR 0.81	0.69–0.96	Significant overall
LBW – RCTs only	4	RR 0.92	0.73–1.16	Not significant
NICU admission	7	RR 0.91	0.68–1.23	Not significant
Breastfeeding initiation	7	RR 1.08	0.99–1.17	Not significant

The Cochrane review by Catling et al. similarly found no clear differences in important outcomes such as preterm birth, infant birth weight or neonatal death between group and conventional ANC. The review included four randomized trials involving 2,350 women.

COMMUNITY-BASED ANTENATAL CARE

Community-based ANC can address barriers related to distance, transportation, socioeconomic conditions and limited awareness.

Community mobilization combined with antenatal home visits has been identified as a potentially useful strategy for improving maternal and neonatal outcomes, particularly in settings where facility access is limited.¹⁴

The evidence suggests that community-based approaches may be particularly useful for increasing contact with pregnant women and facilitating timely referral.

However, community-based interventions cannot independently replace comprehensive emergency obstetric services. Their effectiveness depends on functioning referral pathways and availability of skilled care.

NUTRITIONAL INTERVENTIONS

Nutrition is a major component of ANC.

Because iron insufficiency is frequent in pregnant women and pregnancy increases iron requirements, iron and folic acid supplementation is advised as part of normal ANC. 15

Nutritional counselling can also address inadequate dietary intake, excessive gestational weight gain and other nutrition-related risks.

The potential benefit of nutritional interventions is therefore both preventive and therapeutic, although the magnitude of effect depends on baseline nutritional status, adherence and the specific intervention provided. 15

MATERNAL SCREENING AND DETECTION OF COMPLICATIONS

ANC provides repeated opportunities to identify maternal complications.

- Important assessments include:
- blood pressure;
- haemoglobin;
- urine testing;
- blood glucose where indicated;
- infection screening;
- weight and nutritional status;
- symptoms of pre-eclampsia;
- fetal growth; and
- maternal danger signs.

Early identification can facilitate treatment and referral before complications become severe. 15

This is particularly important for hypertensive disorders of pregnancy, anaemia, diabetes and infections.

FETAL ASSESSMENT

Fetal assessment is an important component of ANC.

- Assessment may include:
- gestational age;
- fetal growth;
- fetal heart rate;
- fetal movement;
- fundal-height assessment;
- ultrasound where indicated; and
- Doppler assessment in selected high-risk pregnancies.

MATERNAL OUTCOMES

The evidence supports ANC as an important platform for prevention and early detection of maternal complications.

Table 4. ANC Interventions and Maternal Outcomes

Intervention	Maternal outcome	Expected effect
Early ANC	Risk identification	Earlier diagnosis
BP monitoring	Hypertension/pre-eclampsia	Earlier detection
Haemoglobin screening	Anaemia	Earlier treatment
Iron-folic acid	Iron deficiency	Prevention/treatment
Infection screening	Maternal infection	Early treatment
Glucose screening	Gestational diabetes	Early management
Nutrition counselling	Nutritional problems	Improved nutritional health
Birth preparedness	Obstetric emergency	Earlier care-seeking
Community follow-up	Access barriers	Improved service utilization

NEONATAL OUTCOMES

ANC can affect neonatal outcomes through maternal disease prevention, fetal monitoring and early management of complications.

Table 5. ANC Interventions and Neonatal Outcomes

Intervention	Neonatal outcome
Adequate ANC attendance	Lower neonatal mortality
Maternal nutrition	Birth weight/fetal growth
Infection screening	Reduced infection-related complications
Hypertension detection	Reduced fetal compromise through management
Fetal growth monitoring	Identification of growth restriction
Appropriate ultrasound	Gestational-age/fetal assessment
High-risk Doppler	Identification of fetal compromise
Community ANC	Potential improvement in perinatal survival
Health education	Earlier recognition of danger signs

OVERALL EVIDENCE SYNTHESIS

Table 6. Overall Summary of Evidence

ANC Intervention	Maternal Outcome	Neonatal Outcome	Overall Evidence
Regular ANC attendance	Potentially beneficial	Reduced neonatal mortality	Stronger evidence
Early ANC initiation	Improved opportunity for screening	Potential benefit	Supportive
Iron-folic acid	Reduced anaemia	Potential fetal benefit	Established preventive intervention
Infection screening	Early treatment	Reduced transmission/complications	Supportive
Community ANC/home visits	Improved access	Potentially reduced perinatal mortality	Moderate/supportive
Group ANC	Improved engagement/education	Mixed clinical outcomes	Inconclusive for major outcomes
Fetal assessment	Early detection of abnormalities	Potentially improved outcomes	Supportive
Routine additional testing	Depends on indication	Not consistently beneficial	Context-dependent

DISCUSSION

The findings demonstrate that ANC is an important component of strategies for improving maternal and neonatal health.

The strongest quantitative finding was the association between ANC attendance and neonatal mortality. The meta-analysis of 18 studies reported a pooled effect of 0.66, indicating approximately 34% lower neonatal mortality among women receiving ANC. 15

However, the substantial heterogeneity indicates that ANC does not have an identical effect in every setting. Differences in quality of care, socioeconomic conditions, healthcare access, referral systems and the content of ANC may explain part of this variation. 14

This finding supports the argument that ANC attendance alone is not sufficient. The quality of each contact is important.

For example, a woman who attends several ANC visits but does not receive blood-pressure assessment, nutritional counselling, screening or appropriate treatment may not receive the full potential benefit of ANC. 15

The evidence regarding group ANC provides another important lesson. Group care may improve interaction, education and engagement, but major neonatal outcomes have not consistently improved. Carter et al. found no significant difference in preterm birth and NICU admission, while the apparent reduction in low birth weight disappeared when only randomized trials were considered. 15

This suggests that promising observational findings should be interpreted cautiously.

The evidence therefore supports a comprehensive ANC model, rather than relying on a single intervention.

CLINICAL IMPLICATIONS

Healthcare providers should focus on the content and quality of ANC contacts.

Every ANC contact should provide an opportunity for:

- maternal assessment;
- fetal assessment;
- nutritional counselling;
- preventive interventions;

- screening;
- treatment;
- health education;
- birth preparedness; and
- referral when required.

Nurses and midwives are particularly important in delivering these interventions because they frequently provide direct counselling, screening, monitoring and follow-up

IMPLICATIONS FOR NURSING PRACTICE

Nurses should:

1. Encourage women to initiate ANC early.
2. Promote completion of recommended ANC contacts.
3. Monitor maternal blood pressure.
4. Identify symptoms of pre-eclampsia.
5. Assess nutritional status.
6. Promote iron-folic acid adherence.
7. Provide pregnancy health education.
8. Counsel women regarding danger signs.
9. Promote birth preparedness.
10. Identify high-risk pregnancies.
11. Ensure timely referral.
12. Follow up women who miss ANC appointments.

Implications for Community Health Nursing

Community health nurses and community health workers can improve ANC utilization through:

1. pregnancy identification;
2. community awareness;
3. home visits;
4. counselling;
5. referral;
6. follow-up;
7. nutrition education;
8. support for ANC attendance;
9. birth preparedness; and
10. emergency referral planning.

Community interventions are particularly relevant in rural and underserved populations.

Implications for Public Health Policy

Maternal-health programmes should prioritize:

1. Early ANC initiation.
2. High-quality ANC contacts.
3. Essential medicines and diagnostics.
4. Skilled healthcare providers.
5. Effective referral systems.
6. Community-based follow-up.
7. Maternal health education.
8. Nutrition interventions.
9. Infection screening.
10. Monitoring of ANC quality indicators.

Instead of concentrating only on the quantity of visits, the WHO ANC method highlights that pregnancy care should incorporate prevention, screening, treatment, and health promotion.

LIMITATIONS

Several limitations should be considered.

First, the included evidence was heterogeneous in terms of population, intervention, healthcare system and outcome definitions.

Second, much of the evidence regarding ANC attendance comes from observational studies, which are susceptible to confounding.

Third, ANC attendance may be associated with socioeconomic factors, maternal education and healthcare-seeking behaviour.

Fourth, evidence for individual interventions such as group ANC is inconsistent.

Finally, this manuscript is a systematic-review draft based on published evidence, and the final PRISMA record counts should be populated from the actual database searches performed for the study rather than estimated retrospectively.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future research should focus on:

- standardized measurement of ANC quality;
- maternal mortality;
- severe maternal morbidity;
- neonatal mortality;
- preterm birth;
- low birth weight;
- cost-effectiveness;
- digital ANC;
- community-based ANC;
- group ANC;
- continuity of care; and
- interventions targeting disadvantaged populations.

Large multicentre trials and well-designed prospective studies are needed to distinguish the effect of ANC quality from the effect of ANC attendance alone.

CONCLUSION

Prenatal care is a crucial tactic for enhancing the health of mothers and newborns, according to the data examined in this study.

Neonatal mortality is significantly reduced when ANC attendance is consistent. A pooled effect estimate of 0.66 (95% CI 0.54–0.80), or roughly a 34% decreased risk of newborn death, was revealed in the available meta-analysis of 18 studies.

Access and perinatal outcomes may be further enhanced by community-based programs including prenatal home visits. There is conflicting data on low birth weight and no discernible overall decrease in preterm births when it comes to group ANC.

As a result, the quantity of visits should not be the only metric used to assess the efficacy of ANC. Effective ANC requires early commencement, adequate screening, nutritional support, preventative care, fetal assessment, health education, birth readiness, and prompt referral.

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