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Review Article

Economic evaluation of maternal healthcare services for Indigenous and rural people: a systematic review

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Abstract

Introduction: Indigenous and rural populations worldwide continue to face persistent maternal health inequities driven by geographic isolation, cultural barriers, socioeconomic constraints, and historical mistrust of healthcare systems. While targeted maternal health programs have been implemented, there remains limited evidence on their economic effectiveness. This systematic review was conducted to assess the cost-effectiveness of antenatal, intrapartum, and postnatal interventions in Indigenous and rural contexts, with the goal of informing resource allocation and policy reform. This is the first comprehensive global synthesis of full economic evaluations in Indigenous and rural maternal health.

Methods: Following PRISMA 2020 guidelines, we searched six major databases (PubMed, Cochrane Library, International Health Technology Assessment Database, ProQuest, Cost-Effective Analysis Registry, and Centre for Reviews and Dissemination) and relevant grey literature for full economic evaluations published between January 2004 and April 2025. Eligible studies had to report both costs and health outcomes for maternal health interventions in Indigenous and/or rural populations. Titles, abstracts, and full texts were screened independently by two reviewers, with disagreements resolved by consensus. Data were extracted using a piloted template and assessed for methodological quality using the CHEC (Consensus Health Economic Criteria)-Extended checklist, while risk of bias was appraised using the Bias in Economic Evaluation tool. Costs were converted to 2024 US dollars and adjusted for purchasing power parity to allow cross-country comparison. Due to heterogeneity in interventions and outcomes, findings were synthesised narratively and grouped by intervention type.

Results: From 1095 records, 42 studies reporting 50 full economic evaluations across 25 countries met inclusion criteria. The majority were cost-effectiveness analyses (n=30) or cost–utility analyses (n=15). Over half of the included evaluations scored ≥95% on the CHEC-Extended tool, indicating strong methodological rigour, although limitations were noted in the frequent use of narrow healthcare payer perspectives and incomplete sensitivity analyses.

Five main categories of intervention emerged: community-based and culturally adapted models, such as participatory women's groups and birthing on Country; clinical and diagnostic innovations, such as misoprostol distribution for postpartum haemorrhage prevention and rapid syphilis screening; health system strengthening strategies, including ambulance services, emergency obstetric referrals, and mentorship programs; digital and mobile health tools; and financial incentives, particularly when integrated with quality improvement measures. Incremental cost-effectiveness ratios ranged from 8.52 to 2001 per disability-adjusted life year averted.
Conclusion: Culturally tailored, community-embedded, and system-integrated maternal health interventions consistently delivered high economic value in Indigenous and rural populations. These findings reinforce the importance of embedding cultural identity, community leadership, and health system linkages into maternal health programming. The evidence suggests that investment in such models not only reduces inequities but also optimises resource use. Future research should address the paucity of evaluations in postpartum care, incorporate broader societal perspectives, extend follow-up periods to capture long-term outcomes, and expand analysis in high-income Indigenous contexts where evidence remains limited.

Keywords

community-based interventions, cost-effectiveness analysis, culturally adapted care, economic evaluation, financial incentives, health system strengthening, Indigenous populations, maternal health care, m-health, rural health services.

Introduction

Indigenous communities and isolated rural populations face a range of health challenges shaped by longstanding social, environmental, and structural conditions. Both groups experience a considerable burden of chronic diseases, infectious illnesses, undernutrition, and mental health conditions, compounded by limited opportunities for preventive care and health promotion[1-3]. These health patterns are linked to shared circumstances, including lower household income, reduced access to education, and limited availability of essential public services[4,5]. Geographic isolation further restricts access to timely health care and reduces engagement with routine services.

Although they share many of these constraints, Indigenous Peoples also encounter challenges that are rooted in historical and cultural contexts. The continuing effects of colonisation, land dispossession, cultural disruption, and experiences of discrimination within health systems contribute to longstanding inequities in health and wellbeing[1,6-8]. These factors influence trust in mainstream services, shape patterns of care-seeking, and deepen barriers to sustained engagement with formal health care[2,9].

These combined circumstances have important implications for maternal health. Maternal healthcare services have a central role in improving maternal and neonatal outcomes, yet Indigenous and rural populations often face heightened barriers to accessing quality care. Obstacles such as geographic remoteness, cultural differences, economic constraints, and historical mistrust of healthcare systems can limit timely antenatal attendance and safe delivery options[10,11]. As a result, these communities continue to exhibit poorer maternal health indicators including higher rates of maternal mortality, preterm birth, and delivery complications compared with more advantaged populations[12-14]. In response, health authorities have introduced maternal healthcare programs as part of priority healthcare systems tailored to the needs of Indigenous and rural communities, seeking to improve access, continuity of care, and cultural safety.

These interventions aim to enhance prenatal care, ensure safe delivery practices, and provide comprehensive postnatal support, all while being culturally sensitive and accessible. For instance, culturally tailored prenatal programs have shown promise in increasing the utilisation of antenatal care, improving birth outcomes, and reducing complications[15,16]. Additionally, community-based birthing centres, staffed with skilled midwives familiar with Indigenous cultural practices, have effectively ensured safe delivery practices by providing accessible and culturally respectful environments for childbirth[17,18]. Postnatally, home-visiting programs that offer breastfeeding support, newborn health monitoring, and maternal mental health services have been instrumental in delivering continuous, culturally appropriate support during the critical postpartum period[19].

Despite the documented clinical benefits of these programs, there is a notable lack of comprehensive economic evaluations. Conducting such evaluations is essential to determine how resources can be allocated efficiently and whether these programs are financially sustainable over time. Economic evaluation is a comparative analysis of the costs and outcomes of two or more health interventions, carried out to determine which option provides better value for the resources used.

In the literature, types of economic evaluation include cost-effectiveness analysis (CEA), cost–utility analysis (CUA), cost–benefit analysis (CBA), and cost–consequence analysis (CCA). CEA compares interventions based on natural units of outcome, such as cases detected or complications avoided. CUA incorporates broader measures of health by translating outcomes into utility-based metrics, most commonly the quality-adjusted life year (QALY). CBA expresses both costs and outcomes in monetary terms to determine whether the net benefits of an intervention justify its investment. CCA presents costs alongside a range of outcomes without aggregating them into a single summary measure, allowing decision-makers to weigh the various consequences according to their priorities.

QALYs provide a combined measure of survival and health-related quality of life, enabling comparisons across diverse health interventions. In contrast, disability-adjusted life years (DALYs) reflect the burden of disease by quantifying years of healthy life lost due to both premature mortality and time lived in less-than-ideal health. Together, these measures support more consistent and transparent comparisons of interventions when conducting CUA or burden-of-disease analysis.

Policymakers and healthcare providers need robust economic evidence to make informed decisions that balance quality, accessibility, and financial feasibility. Without such data, there is a risk of either underfunding effective programs or overinvesting in interventions that may not deliver proportional economic benefits.

Therefore, this systematic review aims to evaluate the current evidence on the economic effectiveness of maternal healthcare services for Indigenous and rural populations. By assessing economic evaluation studies, this review seeks to identify gaps in the literature, provide insights into the most efficient use of

resources, and offer recommendations for future research and policy development in maternal health services tailored to these communities.

Methods

This systematic review adhered to PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) 2020 guidelines, with defined protocols for study selection, data extraction, and quality appraisal.

Eligibility criteria

Included studies were full economic evaluations of maternal health interventions targeting Indigenous and/or rural populations. Eligible populations included those identified as Indigenous, tribal, Aboriginal, First Nations, or rural. Mixed-population studies were included if results were disaggregated or clearly relevant.

Eligible interventions spanned clinical, structural, or financial strategies during antenatal, intrapartum, or postnatal periods. These included direct health services (eg antenatal care, skilled birth attendance), outreach (eg home visits, mobile clinics), and culturally adapted care.

Studies had to compare both costs and outcomes between alternatives. CCA analyses were accepted if cost and health outcome data were clearly reported. Cost-only analyses, return on investment, and budget impact studies were excluded.

Primary outcomes were economic metrics (eg incremental cost-effectiveness ratios (ICERs), cost per QALY / disability-adjusted life year (DALY)). Secondary outcomes included service indicators like antenatal coverage, maternal/neonatal morbidity, and skilled birth attendance.

Only studies published between 1 January 2004 and 30 April 2025 were included. Acceptable study designs included randomised controlled trials, quasi-experiments, observational studies, and model-based economic evaluations.

Search strategy

The following databases were searched: PubMed, Cochrane Library, International Health Technology Assessment (HTA) Database, ProQuest, Cost-Effectiveness Analysis Registry, and the Centre for Reviews and Dissemination. Searches spanned 1 January 2004 to 30 April 2025, using MeSH and free-text terms (Appendix I). Grey literature included unpublished reports and non-government organisation publications. Duplicates were removed using Zotero organisational software v6.0.36 (Digital Scholar; https://www.zotero.org).

Screening and selection

Two authors (AAAN and LSS) screened titles, abstracts, and full text independently. Disagreements were resolved by discussion or by a third author (KI). Reasons for exclusion were recorded and illustrated in the PRISMA diagram.

Data extraction and quality assessment

Two authors (AAAN and KI) extracted data independently using a standardised form to capture study characteristics, population, intervention details, evaluation type, and outcomes. No automation tools were used. Discrepancies were resolved by consensus. If required information was missing or unclear in the published reports, we recorded it as 'not available'. No imputations were made. Unreported variables were excluded from synthesis and flagged in quality appraisal.

Costs were converted to 2024 US dollars (1 USD = 1.45 AUD) using the C-CEMG-EPPI cost converter (EPPI Centre; https://eppi.ioe.ac.uk/costconversion) with purchasing power parity adjustments[20]. For primary outcomes, effect measures included ICERs expressed as cost per QALY or DALY gained. Secondary outcomes were summarised descriptively; no pooled effect measures were calculated due to heterogeneity across studies.

Quality was assessed using the CHEC (Consensus Health Economic Criteria)-Extended checklist[21,22]. This 20-item checklist is applicable to both model-based and trial-based economic evaluations. Each item was scored as 1 for a positive response and 0 for a negative one. The total score was calculated by summing the individual item scores and expressing it as a percentage (total score ÷ 20 × 100%). Based on this percentage, studies were categorised into four quality levels: low (≤50%), moderate (51–75%), good (76–95%), and excellent (>95%). A higher percentage reflects better methodological quality. For the risk of bias, we assessed the included studies using the Bias in Economic Evaluation (ECOBIAS) checklist[23]. This tool comprises two main components. The first addresses overall bias across 11 domains: narrow perspective, inappropriate comparator, omission of relevant costs, sporadic data collection, flawed valuation methods, ordinal ICERs, double-counting, improper discounting, limited sensitivity analysis, funding bias, and selective reporting. The second component focuses on bias in model-based economic evaluations, covering three subdomains: model structure (four items), data inputs (six items), and internal consistency (one item). Each criterion was rated as 'yes', 'no', 'partly', 'unclear', or 'not applicable', with 'yes' indicating high risk of bias and 'no' indicating low risk of bias.

Data synthesis and analysis

A narrative synthesis approach was used due to methodological heterogeneity. Findings are presented in structured summary tables organised by intervention type, population focus and outcome category, and were synthesised descriptively. No subgroup analysis or meta-regression was performed. No statistical methods were used to assess reporting bias. During synthesis, variations in national healthcare systems, financing models, Indigenous health policies, resource availability, and geographic context were considered when interpreting cost-effectiveness findings across countries.

Ethics approval

This study is a systematic review of previously published data. No primary data collection or involvement of human participants occurred. Therefore, institutional review board approval and informed consent were not required.

Results

Study selection and characteristics

From 1095 records and four manually added studies, 1000 were screened. After full-text review, 42 studies met the inclusion criteria, yielding 50 economic evaluations (Fig1). These included 30 CEAs, 15 CUAs, and 5 other formats (eg CCA). Evaluations spanned 25 countries, with India (n=7) and Uganda (n=4) most represented. Summary results of all included evaluations are presented in Appendix II[24-65].

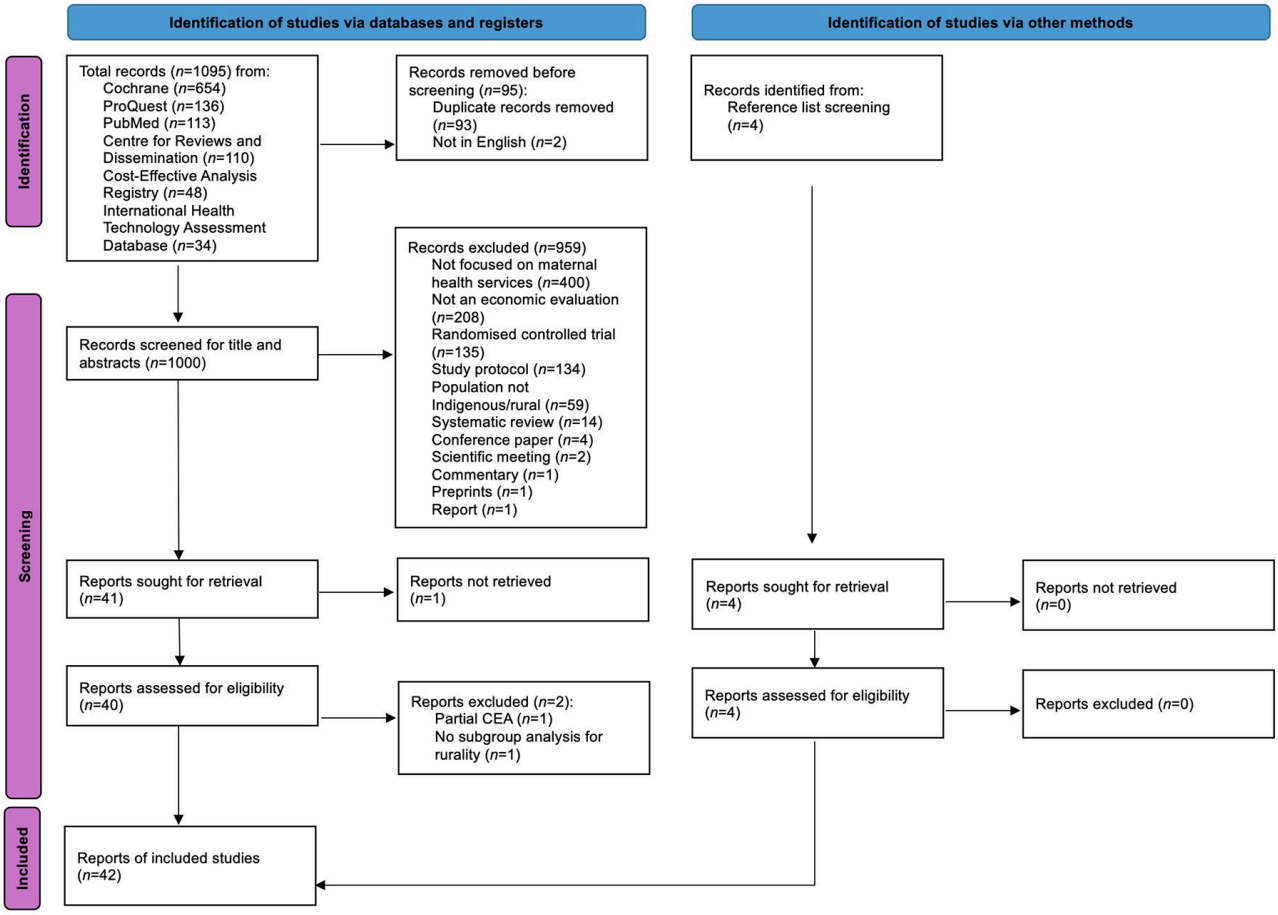

Figure 1: PRISMA 2020 flow diagram for new systematic reviews, which included searches of databases, registers and other sources.

Risk of bias

The ECOBIAS checklist showed that most studies (20/22 criteria) had a low risk of bias (Appendix III[24-65]). Common issues included narrow costing perspective and limited sensitivity analyses. Most studies selected comparators well and reported transparently.

Study quality

Over half of the studies scored ≥95% on the CHEC-Extended checklist (Appendix IV[24-65]). Lower-rated studies lacked clarity on time horizons, modelling methods, discounting, or uncertainty analysis.

Thematic analysis by intervention type

Thematic analysis of the included studies revealed five dominant intervention categories: community-based care (*n*=15), clinical or diagnostic innovations (*n*=9), system strengthening (*n*=8), digital and mobile health tools (*n*=6), and financial incentives (*n*=6).

Community-based interventions

Community-based interventions were the most commonly evaluated, often engaging community health workers (CHWs)[30,34-36,45,49,52,54], women's groups[38,41,45,47,58], midwives[29,32,49], or traditional birth attendants[43] or broader community mobilisation actors[51]. These programs aimed to increase care-seeking behaviours, improve cultural safety, and deliver care in familiar, accessible settings. Studies showed strong cost-effectiveness across diverse contexts. For example, participatory learning and action groups in India and Nepal were associated with reduced neonatal mortality at a cost per DALY averted ranging from US$49 to US$104[45,58]. In Australia, the Birthing in Our Community model, which provided culturally safe midwifery care for First Nations women, was cost-saving and effective, reporting a US$3909 saving per mother–baby pair[32]. CHW home-visit programs in Bolivia, Mali, and Vietnam also demonstrated favourable economic outcomes. For example, the cost per cognitive point gained in a child ranged from US$7 to US$20, as measured using the *Bayley Scales of Infant and Toddler Development*, third edition (Bayley-III)[35,36]. The cost per mother–child pair reached US$381[30], while the ICER per additional antenatal care (ANC) contact compared to standard care was reported as low as US$2.02[52].

A study in Sierra Leone in which the researchers 'rebranded' traditional birth attendants as maternal and newborn health promoters found that combining health promotion with a social enterprise model yielded greater health impact and cost-effectiveness (US$1963 per life year saved) than health promotion alone[43].

Similarly, in rural Burkina Faso, a demand-side intervention involving district-wide community mobilisation and behavioural change communication was positively correlated with a sharp increase in institutional deliveries. The narrow incremental cost per additional delivery attributed to these activities was estimated at US$253, lower than the average facility-based delivery cost of US$331, indicating high cost-effectiveness[51]. However, when program management costs were included in the analysis, the broader estimate rose to US$2013 per delivery.

Notably, studies that focused on Indigenous or marginalised populations emphasised the value of cultural safety, continuity of care, and trusted relationships with health workers. However, some volunteer-based models (eg in Bolivia) faced sustainability challenges due to high fixed costs and limited reach, raising concerns about scalability[30].

Clinical and diagnostic innovations

Clinical or diagnostic interventions such as misoprostol distribution, rapid syphilis screening, and neonatal resuscitation training offered cost-effective solutions for critical periods in maternal and newborn care[37,44,55,57,60-63]. In India, a modelling study estimated 7.5 maternal deaths averted (ICER of US$2001 per death averted) by administering misoprostol after delivery, compared to no intervention[60]. The 7.5 deaths averted occurred over a single delivery episode (per 10,000 home births), with a time horizon of approximately 2 days postpartum. A related study found that administering misoprostol for treatment versus prevention was highly cost-effective, with ICERs of US$8.52 per DALY averted[61]. Similarly, in Senegal, a trial comparing misoprostol and oxytocin against standard care found both strategies to be cost-effective for preventing severe postpartum haemorrhage, with ICERs of US$53 and US$159, respectively[63]. South Africa's rapid syphilis screening using immunochromatographic strip testing averted 82% of congenital syphilis cases at an ICER of US$173 per case averted[37]. In addition, an economic model from Haiti found that integrating rapid syphilis tests into existing prenatal HIV screening programs was effective, with DALY costs of US$10.86 in rural areas[57]. Training traditional birth attendants in Zambia in neonatal resuscitation and infection management reported a 45% reduction in neonatal mortality, with ICERs ranging from US$36 to US$179 per DALY and US$2790 per neonatal death averted[55].

In a nutritional intervention in Bangladesh, an early maternal micronutrient supplementation at 9 weeks of pregnancy had achieved under-five mortality and stunting reductions at a cost of US$30.92 per DALY averted, compared to standard care of 60 mg iron and 400 µg folic acid at 20 weeks[62]. Meanwhile, a model-based evaluation in India found that integrated reproductive health services, including family planning, safe abortion, and stepped-up emergency obstetric care could prevent 150,000 maternal deaths, with ICERs ranging from US$224.31 to US$448.62 per life year saved[44].

Health system strengthening

Health system strengthening interventions targeted various components of the health system, including workforce development, infrastructure upgrades, supervision and mentorship, referral systems, and integration of services across care levels[31,33,39,41,42,46,48,51,56,59,66]. Several interventions demonstrated strong cost-effectiveness. The Ethiopian Millennium Rural Initiative improved the infrastructure, staffing, and referral systems of 30 primary healthcare units was highly cost-effective, with a cost per life saved of US$6968[42]. Emergency obstetric ambulance service in Ethiopia and Uganda had remarkably low costs of US$32.14 and US$22.19 per life year saved, respectively[33,59]. Rwanda's Mentorship, Enhanced Supervision for Healthcare and Quality Improvement program improved antenatal care quality at a cost of US$3.30 per complete clinical assessment[48]. Similarly, Burkina Faso's Skilled Care Initiative, combining facility upgrades with behavioural change strategies, demonstrated incremental cost per delivery between US$253 and US$2013, depending on cost inclusions[51].

Tanzania's implementation of electronic clinical decision-support system within antenatal care and childbirth services improved interpersonal care and history taking, but it yielded limited health gains. The ICERs were high at US$3213 per 1% ANC quality improvement and US$440 per 1% improvement in childbirth care[56].

A study in Malawi evaluated the combination of community mobilisation, facility quality improvement, and both together. Individually, the community component was more cost-effective (at US$104.73 per DALY averted) than the facility-only arm, while the combined arm produced the greatest overall health benefit, with an ICER of USD$194 per DALY[41]. These findings highlight the added value of integrating community demand generation with facility quality improvements.

Digital and mobile health tools

Digital health interventions, particularly mobile-based tools, also showed promising economic returns. These interventions were primarily designed to support care-seeking behaviour, improve quality of care, and strengthen the efficiency of CHW programs and health facilities. Interventions included text or voice message reminders to pregnant and postpartum women[26,28], digital job aids for frontline health workers[27,28,50], and electronic clinical decision-support systems integrated into antenatal and childbirth services[56].

Bangladesh's mCARE program, which used text-message reminders and CHW home visits, reported a cost per DALY averted of just US$40, and US$1149 per newborn death averted[26]. Similarly, the ReMiND program in India, which equipped accredited social health activists with mobile job aids to support maternal and newborn counselling and follow-up, was cost-saving from the societal perspective and cost-effective from the health system perspective, with an ICER of US$116 per DALY averted[27]. These digital interventions demonstrated significant impact through improved preventive care uptake and strengthened referral systems.

Other interventions included large-scale platforms like MOTECH in Ghana, which combined voice messaging and digital records with a cost of only US$27 per DALY averted[28]. The ImTeCHO platform in India, which provided multimedia content, task reminders, and decision-support tools to accredited social health activists in tribal and rural communities, reported a cost per life year saved of US$94 and was considered highly cost-effective[50].

Results were modest for the Tanzania QUALMAT project, where electronic clinical decision-support system improved some quality in ANC and childbirth care but yielded high ICERs per 1% quality gain (US$3273 for ANC and US$448 for childbirth)[56]. These findings suggest that while digital tools can improve service quality, their effectiveness depends on local capacity, infrastructure, and health worker engagement.

Financial incentives

Financial incentive interventions such as conditional cash transfers, vouchers, performance-based financing, and non-monetary incentives such as delivery kits were effective when well implemented and aligned with supply-side capacity[24,40,53,64,65].

In Uganda, a combined voucher and quality improvement program led to a 52% increase in institutional deliveries and had an ICER of US$424 per DALY averted[24]. A results-based financing program in Zambia was also cost-effective, with ICERs ranging from US$1072 to US$1324 per QALY depending on quality adjustments[65]. The Malawi Results-Based Financing for Maternal and Neonatal Health program, combining conditional cash transfers and infrastructure upgrades, achieved health gains but was sensitive to maternal life expectancy and quality assumptions. The ICER was reported as US$1487 per DALY averted and US$34760 per death averted, placing it in the cost-effective range at higher willingness-to-pay thresholds[40]. In contrast, Kenya's Afya trial, which offered mobile

cash transfers of US$9.32 per ANC, delivery, and postnatal visit attended had limited impact and high ICERs (US$1227 per additional ANC visit), mainly due to implementation delays and low transfer amounts[53]. Non-monetary incentive models such as one in Zambia that provides 'mama' kits (consisting of items like diapers, baby wraps, and blankets) increased facility deliveries, but with a higher ICER of US$6871 per death averted[64].

Discussion

The findings of this review offer important insights for policymakers seeking to improve maternal health outcomes in Indigenous and rural populations. At the national level, the evidence can guide ministries of health and Indigenous health authorities in developing equitable funding frameworks and integrating culturally responsive care into universal coverage strategies. At the regional and district levels, the results can assist maternal health managers in prioritising cost-effective models that improve access and outcomes in underserved areas. These findings are also relevant to non-government organisations, philanthropic foundations, and research funders seeking high-impact interventions for Indigenous and rural populations. Interventions that were consistently cost-effective shared common features: they were contextually adapted, community-embedded, and integrated within broader health systems. These characteristics should serve as key guiding principles when designing or scaling programs across different implementation levels. Community-based and culturally tailored care models should be prioritised in regions with high maternal health disparities, especially where trust in formal health services is low[67]. These approaches are actionable for district health offices, community health managers, and non-governmental partners who coordinate grassroots maternal programs. Programs that engaged local actors such as CHWs, midwives, or traditional leaders improved service uptake and maternal and newborn outcomes[68]. For clinicians and midwifery leaders, these findings highlight the importance of maintaining continuity of culturally respectful care. Policy and donor agencies can use this evidence to justify investment in CHW and midwifery capacity-building. Where successful examples already exist, adapting these models for other Indigenous or rural populations with similar sociocultural dynamics could enhance health equity while maintaining cost-efficiency.

Digital health tools represent another area for strategic investment, especially in settings with expanding mobile coverage. These innovations are relevant to health system managers, digital health units within ministries, and philanthropic funders supporting technology-enabled care. However, their deployment should be accompanied by adequate training, human support, and system-level coordination to ensure sustainability. Standalone digital tools are unlikely to succeed unless embedded in functional care systems[69,70]. For clinicians and CHWs, mobile health platforms can improve efficiency and follow-up, while national digital health strategies can use this evidence to strengthen interoperability and accountability frameworks. Policymakers should therefore view mobile health as a complement to human resources rather than a substitute.

Financial incentive programs also merit close consideration, particularly by national financing agencies, development partners, and local implementers designing conditional cash transfers or performance-based schemes[71]. These mechanisms have shown promise but require careful design. Targeting mechanisms, transfer amounts, and alignment with quality improvements all influenced cost-effectiveness[72]. To maximise value, financial incentives should be integrated into quality improvement frameworks that involve both health facility readiness and community uptake, ensuring alignment between national funding priorities and local service delivery capacity.

Beyond community-based approaches, the cost-effectiveness of interventions varied across countries according to health-system structure, financing mechanisms, and geographic context. In high-income, colonisation settings such as Australia and Canada, efficiency gains were often achieved through culturally governed Indigenous health services integrated within publicly funded systems[11,73]. Conversely, in low- and middle-income countries, cost-effectiveness frequently resulted from improvements in basic system components such as ambulance networks, referral pathways, and workforce capacity. For district-level policymakers, these findings reinforce the economic justification for continued investment in basic system capacity. Geographic remoteness also shaped outcomes, as higher implementation costs in remote regions were often offset by improvements in access, continuity of care, and maternal health equity, a key consideration for rural planning divisions and transport-focused donors.

Across Indigenous and rural settings, several other public health interventions have also demonstrated cost-effective outcomes. These include prevention and management strategies for non-communicable diseases such as hypertension and diabetic retinopathy, as well as infectious disease interventions like screening and treatment of hepatitis b and respiratory syncytial virus prophylaxis among high-risk infants[74-76]. Preventive programs have likewise shown cost-effective outcome, including school-based physical activity and nutrition initiatives, road-injury prevention measures, and community-based drowning and suicide prevention programs[77,78]. These examples provide a useful backdrop for interpreting the economic value of maternal health interventions, as maternal health outcomes serve as a critical determinant of long-term community wellbeing and health system performance.

The time span of the included studies (2004–2025) introduces temporal heterogeneity in both maternal health systems and outcomes. Over this period, global maternal mortality declined, health financing models evolved from donor-dependent and fragmented funding structures to more integrated, performance-based, and government-financed systems, and new technologies such as mobile health platforms and point-of-care diagnostics emerged[79]. At the same time, economic evaluations evolved from narrowly scoped analyses with limited costing and shorter time horizons to more comprehensive assessments incorporating system-level costs, broader outcome measures, and real-world implementation constraints. These shifts influenced both intervention costs and effectiveness, explaining some variation in reported ICERs across decades. As a result, cost-effectiveness should not be viewed as a fixed attribute of interventions, but as contingent on evolving health-system contexts and methodological practices. This temporal perspective is relevant for researchers, donors, and policy agencies evaluating long-term trends in the value of maternal health interventions.

Several limitations of this review should be considered when interpreting the findings. First, the inclusion criteria focused strictly on full economic evaluations that compared both costs and health outcomes. As a result, the review excluded partial evaluations, return-on-investment analyses, and budget impact studies. While this approach enhanced methodological consistency, it may have omitted relevant interventions, particularly those implemented by non-government or community-based organisations operating outside formal health systems.

Second, the evidence base was heavily weighted toward studies conducted in low- and middle-income countries. There was limited representation of economic evaluations from high-income settings with Indigenous populations, particularly outside of Australia. This uneven distribution restricts the applicability of findings to contexts with very different health system structures, financing arrangements, or service delivery models.

Third, considerable variation existed in intervention types, costing methods, time horizons, and outcome measures across studies. These differences limited the feasibility of quantitative synthesis and introduced challenges in comparing cost-effectiveness across contexts. A narrative approach was used to manage this heterogeneity, but underlying inconsistencies in analytic methods, perspectives, and outcome valuation may still affect comparability.

Fourth, although the methodological quality of studies was generally acceptable based on the CHEC-Extended checklist and ECOBIAS appraisal, many evaluations lacked key components such as long-term follow-up, broad costing perspectives, or detailed sensitivity analyses. A few studies relied on intermediate outcomes like increased ANC visits rather than final health outcomes such as maternal mortality or DALYs, which weakens confidence in the strength of economic conclusions.

Finally, no weighting was applied to study quality during synthesis. While studies with high risk of bias were noted, all findings were discussed equally, potentially introducing variation in evidence strength across intervention categories.

This review identified key gaps in the economic evidence for maternal health interventions targeting Indigenous and rural populations.

First, while many evaluations focused on antenatal care and delivery, few examined the postpartum period. This evidence gap should prompt research funders and program designers to prioritise evaluation of mental health, breastfeeding, or long-term maternal wellbeing.

Second, most studies adopted narrow perspectives, typically those of the provider or health system, with limited attention to broader societal costs or benefits. For health economists and policymakers, expanding to societal perspectives, including indirect costs such as transportation, productivity loss, and informal caregiving, would more accurately capture the true value of maternal programs.

Third, studies often used short time frames and lacked robust uncertainty analysis. Researchers and academic collaborators should therefore design future economic evaluations with longer follow-up and thorough sensitivity testing to assess sustainability.

Finally, there is a need for high-quality economic evaluations in high-income countries with Indigenous populations where persistent disparities demand context-specific, culturally appropriate solutions, an agenda relevant to national health research councils, Indigenous-led organisations, and international funding agencies.

Conclusion

This systematic review aimed to evaluate the economic effectiveness of maternal healthcare interventions targeting Indigenous and rural populations. In doing so, it addressed a critical gap in understanding how health resources can be allocated efficiently in settings marked by structural and access-related barriers.

The review found that community-based, culturally adapted, and integrated service models were most consistently associated with favourable cost-effectiveness outcomes. Interventions that aligned with local needs and delivery systems tended to achieve better health outcomes at lower or comparable costs, particularly in resource-limited settings. However, the evidence base remains uneven, with limited evaluations from high-income Indigenous contexts and underrepresentation of interventions beyond antenatal and delivery care.

These findings offer a useful evidence base for policymakers seeking to improve maternal health outcomes in underserved populations while ensuring efficient use of limited resources. Integrating economic evaluations into maternal health program planning, especially for culturally adapted and community-delivered models, can support more informed, equitable health investment decisions.

Further research that addresses current gaps, adopts broader perspectives, and reflects local implementation realities will be essential to advancing economic evidence for maternal health interventions in diverse global settings.

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Conflicts of interest

The authors declare no conflicts of interest.

AI disclosure statement

The authors used ChatGPT (OpenAI, GPT-4o version) in editing the manuscript. The authors verified accuracy of all AI-generated changes and take full responsibility for the final published work.

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Appendix I: Search strategy

PubMed:

("maternal health services"[MeSH Terms] OR "maternal healthcare"[Title/Abstract] OR "maternal health"[Title/Abstract] OR "pregnancy care"[Title/Abstract] OR "antenatal care"[Title/Abstract] OR "postnatal care"[Title/Abstract] OR "childbirth"[Title/Abstract] OR "delivery care"[Title/Abstract])

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International Health Technology Assessment Database:

(maternal OR pregnancy OR antenatal OR childbirth OR postnatal OR delivery)

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AND (economic OR "economic evaluation" OR "cost-benefit" OR "cost-effectiveness" OR "cost-utility" OR "cost analysis")

Appendix II: Summary of included economic evaluations†

First author and year of publication (country)	Sample/setting	Study/intervention	Intervention focus areas (WHO social determinants of health framework)	Outcomes in economic evaluation	Economic evaluation type and perspective	Key study findings and methodological insights
Alfonso 2015 (Uganda)[24]	Women of reproductive age in two rural Ugandan districts; quasi-experimental design comparing treatment and control subdistricts (22 facilities each)	Voucher scheme for maternal delivery services and transportation, combined with obstetrical quality improvements (health system strengthening)	Access to healthcare, healthcare quality, transportation, financial barriers	20 maternal deaths averted; 1356 DALYs averted. ICER per DALY averted of US$302 and per death averted of US$20,475	CEA and CUA; societal and healthcare provider perspectives	Voucher program increased institutional deliveries by 52.3 percentage points (9.4% new users); ICER of US$302 per DALY averted; highly cost-effective; conservative estimates used; quasi-experimental design with difference-in-differences analysis; facility-based data; robust sensitivity analysis
Gomez 2015[25](Nigeria)	Pregnant women in rural Kwara State, Nigeria; decision-analytic model simulating a cohort of 10,000 women	Kwara State Health Insurance program offering subsidised maternal healthcare through upgraded facilities and quality assurance	Healthcare access, service quality, financial protection, public–private partnership	47 maternal deaths averted; ICER: US$46.40 per DALY averted	CUA; healthcare provider perspective	Kwara State Health Insurance program very cost-effective (ICER < Nigeria GDP/capita); improved ANC and essential obstetric care use reduced mortality; robust across sensitivity and scenario analyses; program feasibility dependent on increased state health budget
Jo 2019 (Bangladesh)[26]	Pregnant women in rural Gaibandha district, Bangladesh; quasi-experimental study with 610 women (330 intervention, 280 control)	Comprehensive mCARE package using test message and home visit reminders for maternal and newborn health; compared to basic mobile surveillance only	Access to health care, digital technology, community health workforce, service utilisation	354 newborn deaths averted; 10,443 DALYs averted. ICER of US$901 per death averted and US$31 per DALY averted	CEA and CUA; provider perspective	Cost per DALY averted: US$31; cost per newborn death averted: US$901; 88% probability of being highly cost-effective; Test messages and home visits were low-cost but impactful; outcomes conservatively estimated; robust sensitivity analysis
Prinja 2018 (India)[27]	Pregnant women in rural Kaushambi district, Uttar Pradesh, India; quasi-experimental design using two intervention and two matched control blocks	ReMiND program – mobile health intervention through accredited social health activists using mobile job aid for maternal and newborn health counselling and follow-up	Access to health care, digital health technology, community health workforce, quality of care, health information	312 maternal deaths and 149,468 neonatal deaths averted; 4,127,529 DALYs averted. ICER of US$90 per DALY averted and US$2569 per death averted	CEA and CUA; health system and societal perspectives	Cost per DALY averted: US$205 (health system); ReMiND was cost-saving from societal perspective; robust model-based evaluation over 10 years; used decision-tree with sensitivity analyses; driven by improved uptake of preventive care and care-seeking behaviour; high transferability and policy relevance
Willcox 2019 (Ghana)[28]	Women of reproductive age in semi-rural Gomoa West district, Ghana; modelled scale-up to 170 districts using data from community-based health planning and services facilities, health centers, and one district hospital	MOTECH program – Mobile Midwife (voice messages to pregnant/postpartum women) and client data application (digital health records and reminders for frontline workers)	Access to health care, digital health tools, health information systems, community health workforce	11,938 lives saved; 1,550,028 DALYs averted. ICER of US$20.92 per DALY averted and US$586.72 per death averted	CEA and CUA; program perspective	Cost per DALY averted: US$20.94; cost per death averted: US$586.72; highly cost-effective over 10 years; results sensitive to health effects and personnel costs; first study to assess both demand- and supply-side mobile health impact at scale
Jan 2004 (Australia)[29]	Aboriginal women in urban Western Sydney; observational study using clinic and hospital records, plus qualitative interviews and focus groups	Daruk Aboriginal Medical Service's community-controlled midwifery program providing culturally appropriate antenatal, intrapartum, and postnatal care	Indigenous health, culturally appropriate care, healthcare access, social support, trust in health services	Lower gestational age at first visit, more antenatal visits, higher test uptake; similar birthweight and perinatal survival; cost: A$1200 per client	Holistic economic evaluation (cost analysis and qualitative); health sector perspective	Quantitative differences in antenatal engagement; strong qualitative benefits (trust, empowerment, access); modest net health sector costs; downstream savings; holistic approach valued broader impacts beyond clinical outcomes

Barger 2017 (Bolivia)[30]	Indigenous women in rural and peri-urban municipalities (Corque and Caracollo), Oruro Department, Bolivian highlands; program evaluation with costing analysis	Community-based maternal and newborn care package using volunteer CHWs delivering home visits for antenatal and postnatal care	Indigenous health, access to health care, geographic barriers, culturally appropriate care, health workforce	Cost per mother–child pair: US$296; cost per home visit: US$43; scale-up scenario: US$35 per mother, US$9 per visit	Cost analysis; provider (Ministry of Health) perspective	Low coverage (18%) despite high per-mother contact; high management costs (56% of total); efficiency gains possible with higher CHW activity; fixed costs 97% of total; highlighted challenges of volunteer-based models in remote, low-density settings
Gao 2014 (Australia)[31]	Aboriginal women from seven remote communities in the Top End of the Northern Territory, Australia; retrospective and prospective cohort study at a regional hospital	Midwifery group practice model providing continuity of care for remote-dwelling Aboriginal women transferred to Darwin for birth	Indigenous health, rural healthcare access, culturally safe care, continuity of care, maternal support	Non-significant cost saving (A$703 per episode); reduced special care nursery stay length, increased antenatal/postnatal care, no change in major birth outcomes	Cost–consequences analysis; Department of Health (provider) perspective	Midwifery group practice reduced catastrophic vaginal births and special care nursery stay; more antenatal/postnatal care in town; no difference in birth weight or preterm rate; conservative assumptions used; missing data handled via expert-informed cost models
Gao 2023 (Australia)[32]	First Nations women in urban South-East Queensland; prospective non-randomised trial at Mater Mothers Public Hospital, Brisbane	Birthing in Our Community model – community-led, culturally safe, midwifery group practice integrated with First Nations workforce and wraparound support	Indigenous health, culturally appropriate care, health system redesign, continuity of care, social support	5.34% absolute reduction in preterm birth; cost saving of A$4810 per mother–baby pair. 95%CI ICER from –A$210,108 to –A$44,822 per 1% preterm birth rate reduction. The point estimate and the majority of the replicated ICERs are indicating that the Birthing in Our Community model dominates standard care	CEA; health system and societal perspectives	The Birthing in Our Community model significantly reduced preterm birth and neonatal admissions; dominated standard care (less costly, better outcomes); robust IPTW-adjusted analysis; societal perspective included productivity loss and out-of-pocket costs; strong policy relevance for national scale-up
Accorsi 2017 (Ethiopia)[33]	Pregnant women in four rural districts of Oromiya Region, Ethiopia; prospective observational study on 111 ambulance referrals to a zonal hospital	Ambulance-based referral system for emergency obstetric and neonatal care, integrated within district health services	Rural access to health care, transportation, emergency obstetric care, health system infrastructure	336 life years saved; cost per year saved: US$24.70	CEA; district health provider perspective	Highly cost-effective (below WHO 'very attractive' threshold of US$30/year saved); conservative assumptions; robust sensitivity analysis; effectiveness based on expert judgement; did not include disability or broader household impacts
Ahmed 2023 (Uganda)[34]	Mother–child dyads in rural Kabale and Kisoro districts, South-Western Uganda; cluster-randomised controlled trial (*n*=511)	Maternal education intervention on nutrition, hygiene, and child stimulation; delivered as group sessions with practical demonstrations	Rural access, maternal nutrition, early childhood development, health education, cognitive stimulation	Cognitive composite score gain: 16.11 points; cost per score gained: US$16.50; average cost per child: US$265.79	CEA intermediate outcome; healthcare provider perspective	Significant improvement in cognitive development; robust ICER with sensitivity analyses (range: US$10.14–$22.68); highly cost-effective under local and global thresholds; personnel costs were key driver; findings support potential for scalable, community-based cognitive development strategies in low- to middle-income countries
Baek 2023 (Vietnam)[35]	Pregnant women in rural Ha Nam province, Vietnam; cluster-randomised controlled trial (*n*=1008) across 84 communes	'Learning Clubs' – multicomponent early childhood development program combining group sessions and home visits, addressing maternal nutrition, mental health, parenting, infant health, and gender norms	Rural health equity, maternal wellbeing, early childhood development, health education, community engagement	Higher cognitive scores across all subgroups; cost per cognitive point gained ranged from cost-saving to US$16 depending on wealth and maternal education; more cost-effective among poorest and least educated groups	CEA intermediate outcome; service provider and household perspectives with equity analysis	Equity-informed CEA showed greater benefit and cost-effectiveness among disadvantaged subgroups; robust bootstrapped ICERs; universal program with 'proportionate universalism' implications; cautious interpretation due to limited study power for subgroup effects

Baek 2023 (Vietnam)[36]	1245 pregnant women and mothers in 84 rural communes, HaNam province, Viet Nam	Cluster-randomised controlled trial of 'Learning Clubs' – a multicomponent intervention delivered as group sessions and home visit from mid-pregnancy to 12 months postpartum	Health, education, parenting support, gender norms, early childhood development	Child cognitive, language, motor, and social-emotional development (Bayley scales); maternal and child out-of-pocket healthcare costs	Cost-effectiveness analysis; provider and household perspectives	The intervention was cost-effective (eg US$14 per cognitive score gain, ~0.5% of GDP per capita); improved cognitive, language, and motor development; no increase in health costs; rigorous methods including bootstrapping and discounting applied; supports scaling in similar settings
Blandford 2007 (South Africa)[37]	Pregnant women attending antenatal clinics in rural Eastern Cape Province; decision-analytic modelling based on field implementation data	On-site antenatal syphilis screening and same-day treatment using rapid tests (ICS and RPR); compared to standard offsite RPR/TPHA	Rural healthcare access, infectious disease screening, maternal health services, health system responsiveness	ICS: 27 congenital syphilis cases averted per 1000 pregnancies; ICER: US$104 per case averted	CEA; provincial health authority perspective	On-site ICS most effective (82% congenital syphilis cases averted); offsite RPR/TPHA less effective but slightly cheaper (US$82 per case); onsite RPR dominated; ICS favoured where high syphilis prevalence exists; robust sensitivity analyses confirmed cost-effectiveness
Borghi 2005 (Nepal)[38]	Women in rural Makwanpur district, Nepal; cluster-randomised controlled trial with 86,704 population across 12 intervention clusters	Participatory women's group meetings facilitated by trained local women to improve maternal and newborn health practices	Community participation, health education, rural access, maternal and neonatal care, social empowerment	30.9 neonatal deaths averted; 852 discounted YLS; cost per YLS: US$211	CEA; provider perspective	29% neonatal mortality reduction; cost per YLS decreased to US$138 in scale-up scenario; robust sensitivity analyses; conservative assumptions; excluded maternal deaths and future reproductive impact in base case
Buser 2019 (Liberia)[39]	Women in rural Bong County, Liberia; quasi-experimental cohort study across 10 rural clinics (5 with maternity waiting homes, 5 without)	Maternity waiting homes near rural primary healthcare facilities to reduce barriers to facility-based delivery	Geographic access, maternal health services, health infrastructure, community engagement	6.25 maternal lives saved (population-adjusted) over 3 years; discounted cost per YLS: US$574	CEA; health system/provider perspective	Highly cost-effective over 10 years (US$309 per life year); significant reduction in maternal deaths (p=0.047); includes infant survival impact in extended analysis; community-driven model; findings support maternity waiting home scale-up in low-resource settings
Chinkhumba 2020 (Malawi)[40]	Pregnant women in four rural districts (Balaka, Dedza, Mchinji, Ntcheu), Malawi; decision-analytic model based on data for results-based financing for maternal and neonatal health	Results-based financing program combining performance-based financing for facilities/providers and conditional cash transfers for women, supported by infrastructure upgrades	Rural healthcare access, financial incentives, quality of care, health system performance, service utilisation	1 DALY averted at US$1122; 1 death averted at US$26,220; 1 life year gained at US$987	CEA and CUA; societal perspective	Cost-effective at higher willingness-to-pay thresholds (77% probability at US$1485/DALY); major health gains from improved quality, not increased service use; results sensitive to quality of non-results-based financing facilities and maternal life expectancy; robust model, first full CEA of results-based financing for maternal and neonatal health in Sub-Saharan Africa
Colbourn 2015 (Malawi)[41]	Women and newborns in rural Lilongwe, Kasungu, and Salima districts, Malawi; cluster-randomised controlled trial using 2×2 factorial design	Community mobilisation through participatory women's groups, health facility quality improvement, and their combination	Community engagement, quality of care, rural healthcare access, health system strengthening, maternal and neonatal health education	Community mobilisation: 67,361 DALYs averted (ICER: INT$79/DALY¶); facility quality improvement: 19,901 DALYs (ICER: INT$281/DALY); combination: 75,180 DALYs (ICER: INT$146/DALY)	CUA; provider perspective	Community mobilisation dominated facility quality improvement (more effective, less costly); combination most cost-effective at higher willingness-to-pay thresholds; 98% probability of cost-effectiveness for community mobilisation at INT$780/DALY¶; scale-up cost of combination was 13.8% of maternal and neonatal health budget; robust Bayesian modelling with probabilistic sensitivity and affordability analysis

Curry 2013 (Ethiopia)[42]	Population in rural catchments of 30 primary healthcare units across four regions in Ethiopia; systems-based intervention evaluated over 18 months, with modelled follow-up for 5 years	Ethiopian Millennium Rural Initiative – health system strengthening of primary healthcare units including infrastructure, human resources, service delivery, and referral systems	Rural healthcare access, health system infrastructure, community health workforce, maternal and child health services, service quality	134 child lives saved during 18 months; 852 additional lives saved during 5-year follow-up. Ethiopian Millennium Rural Initiative cost US$5758 per life saved, very cost effective	CEA; provider perspective	Cost per life saved: US$37,313 (18 months); US$5071 (with 5-year sustained performance); cost-effective only if impact sustained; improvements in water, electricity, staffing, and service coverage; robust modeling via LiST and Spectrum tools; conservative estimates likely understate benefits
Fotso 2020 (Sierra Leone)[43]	Women in rural Bo District, Sierra Leone; three-arm quasi-experimental study across 18 health facility catchments (population ˜105,000)	'Rebranding' TBAs as maternal and newborn health promoters; health promotion alone versus health promotion plus social enterprise	Indigenous and rural health, healthcare access, community health workforce, economic empowerment	Life years saved: 141 (health promotion only), 468 (health promotion plus social enterprise); ICER: US$4130 (health promotion only), US$1539 (health promotion plus social enterprise)	CEA; health sector (provider) perspective	Health promotion plus social enterprise significantly improved ANC visits and facility deliveries; only health promotion plus social enterprise met WHO threshold for cost-effectiveness; higher returns from social enterprise integration; conservative model, robust design with baseline/endline surveys and LiST modelling
Goldie 2010 (India)[44]	Women in rural and urban India; decision-analytic model simulating natural history of pregnancy and complications, stratified by state and healthcare access	Integrated strategies including family planning, safe abortion, and stepwise scale-up of skilled attendance, transport, referral, and emergency obstetric care	Reproductive health access, rural health equity, emergency care systems, fertility control, health system infrastructure	150,000 maternal deaths and US$1.5 billion in costs averted over 5 years; 75% maternal mortality reduction achievable with full integrated strategy	CEA; societal perspective	Family planning and safe abortion are cost-saving; full strategy ICERs: US$150–300/YLS (rural); stepwise upgrades essential for Millennium Development Goal 5; validated models across Indian states; strong policy relevance and cost-effectiveness even compared to major global health priorities
Haghparast-Bidgoli 2023 (India)[45]	Jharkhand, India, covering 20 districts (˜40 million, predominantly rural)	Participatory women's groups (FLAG) facilitated by accredited social health activists under the National Health Mission; evaluated through a cluster non-randomised controlled trial (six districts) and extrapolated to 20 districts over 42 months	Community empowerment, maternal and newborn health, education/literacy through group learning, and social cohesion	Neonatal deaths averted, YLS (discounted), and cost–benefit ratio using VSL and VSLY	ICER per neonatal death averted and life year saved) and cost–benefit analysis from a provider perspective	Highly cost-effective (ICER INT$1272¶ per death averted, INT$41 per life year saved), benefit–cost ratio 71–218, robust sensitivity analysis, low unit cost (INT$9.40 per live birth), potential for scalability, but limitations include provider-only perspective and underestimation of long-term benefits
Hutchinson 2006 (Bangladesh)[46]	Women of reproductive age and their children in rural Bangladesh; national and local evaluation of Smiling Sun health communication campaign (2001–2003)	Smiling Sun – multichannel mass media and local promotion campaign encouraging use of non-government organisation health services, including ANC and immunisation	Rural access to care, health promotion, maternal and child health services, media-based health education	Cost per new user (national campaign): US$0.05 (ANC), US$0.30 (measles), US$0.36 (DTP3); local promotion: US$8 (ANC), US$37 (DTP3), US$32 (measles)	Cost analysis; provider perspective	Mass media was highly cost-effective, especially compared to local promotion; stronger associations in bivariate probit models (eg 18–21% increase in uptake); addressed non-random exposure with advanced econometric methods; large sample and robust statistical controls enhance validity
Lewycka 2013 (Malawi)[47]	Women and children in rural Mchinji District, Malawi; cluster-randomised controlled trial (2×2 factorial design) across 48 clusters, covering ˜186,000 population	Community mobilisation through women's groups and volunteer peer counselling (home-based visits for breastfeeding and infant care education)	Rural access to health care, community engagement, maternal health education, infant feeding, Indigenous health workers	Women's groups: 74% maternal mortality rate and 41% neonatal mortality rate reduction (years 2–3); peer counselling: 36% infant mortality rates reduction; cost per YLL averted: US$114 (women's groups), US$33 (peer counselling)	CEA; provider perspective	Strong effects when interventions applied alone; no added benefit from combined delivery; robust surveillance, conservative assumptions; cluster-randomised with stratified and adjusted analyses; cost per YLL below GDP per capita – highly cost-effective

Manzi 2019 (Rwanda)[48]	Pregnant women attending antenatal care in rural health centres of Kirehe and Rwinkwavu districts, Rwanda; pre–post evaluation with modelled costing	Mentorship and Enhanced Supervision for Healthcare and Quality Improvement to improve quality of ANC through clinical mentorship and data-driven quality improvement	Rural health access, quality of care, health workforce development, system supervision	ICER per additional complete assessment: US$0.92 (danger signs), US$1.40 (vital signs)	CEA intermediate outcome; provider perspective	Significant improvements in quality of care at modest incremental cost; cost-effectiveness improved with increased service volume; ICER sensitive to ANC visit frequency; effectiveness measured by adherence to national ANC guidelines; potential for integration into national systems to lower costs
McPake 2015 (Ethiopia, Indonesia, Kenya)[49]	Populations in rural and peri-urban districts (Shebedino – Ethiopia, Sumba and Takala – Indonesia, Kasarani – Kenya); cost-effectiveness model using national program data and district-level effectiveness estimates	Community-based practitioner programs deploying health extension workers, village midwives, or CHWs to improve maternal and child health services	Rural access to health care, health workforce, maternal and child health, community engagement, health system integration	Life years gained: 471 (Ethiopia), 475 (Sumba), 1894 (Takala), 36 (Kenya); ICER: INT$999¶ (Ethiopia), INT$3396 (Sumba), INT$2470 (Takala), INT$82 (Kenya)	CEA; government (provider) perspective	All programs were cost-effective (less than GDP per-capita thresholds); Kenyan model most efficient due to volunteer-based structure; estimates sensitive to YLS assumptions; used LiST tool for modelling lives saved; highlighted trade-offs between cost, design, and coverage; underscored need for integration into broader health system for sustainability
Modi 2020 (India)[50]	Predominantly tribal and rural communities in Gujarat, India; cluster randomised controlled trial across 22 primary health centres (561 accredited social health activists; population ˜477,000)	ImTeCHO – mobile health platform supporting accredited social health activists with task reminders, multimedia health promotion, decision support, and supervisory tools	Tribal health, rural healthcare access, digital health, community health workforce, maternal and child health	11 infant deaths averted per 1000 live births; 735 YLS	CEA; program (provider) perspective	Cost per YLS: US$74; cost per infant death averted: US$5057; highly cost-effective (less than GDP per capita); robust per-protocol and intention-to-treat analyses; sustained cost-effectiveness under district scale-up and sensitivity scenarios; designed for public system integration
Newlands 2008 (Burkina Faso)[51]	Women in remote, rural Ouargaye and Diapaga districts; quasi-experimental design assessing Skilled Care Initiative	Skilled Care Initiative combining health system upgrades, community mobilisation, and behavioural communication for increased skilled birth attendance	Rural healthcare access, health system infrastructure, community mobilisation, skilled birth attendance	Incremental cost per additional delivery: INT$164¶ (narrow), INT$1306 (broad); average cost per delivery: INT$214	CEA intermediate outcome; provider perspective	Skilled Care Initiative linked to sharp increase in institutional deliveries (2004–2005); community mobilisation was key driver; narrow estimate highly cost-effective; findings sensitive to assumptions about additionality; standardised health system allowed comparative analysis; supported scale-up potential of demand-side strategies
Ogbuoji 2024 (Mali)[52]	Pregnant women in rural Bankass health district, central Mali; cluster-randomised controlled trial (137 village clusters; ˜100,000 population)	Proactive Community Case Management – CHWs conducted home visits for pregnancy detection and ANC support; compared to site-based CHW care	Rural health access, community health workforce, maternal care utilisation, proactive outreach, health system strengthening	Cost-saving across all ANC outcomes, eg ICER per additional ANC contact: –US$21.39 (CHW perspective), –US$1.70 (full ANC perspective)	CEA intermediate outcome; CHW program and full ANC program perspectives	Proactive home visits dominated site-based care (lower cost, better outcomes); 100% cost-effective at willingness-to-pay thresholds of US$0–$50; high generalisability for low- to middle-income countries; robust bootstrap sensitivity analyses; no differences in mortality but significant ANC uptake gains
Palmer 2022 (Kenya)[53]	Pregnant women in rural Siaya County, Kenya; cluster-randomised controlled trial across 48 public health facilities (*n*=5488)	Afya trial – conditional cash transfers (KSh450 per visit) via mobile money for ANC, delivery, postnatal care, and child immunisation attendance	Rural access to care, financial incentives, digital payment systems, maternal and child health service utilisation	ICER: INT$1035¶ per additional eligible ANC visit; total program cost per mother: INT$313; cost transfer ratio: 2.39	CEA intermediate outcome; provider perspective	Modest gains in ANC and immunisation attendance; no impact on delivery or mortality; high implementation cost; payment delays undermined acceptability; equity-neutral across Multi-Dimensional Poverty Index quintiles; not cost-effective under current county health budget constraints

Perry 2023 (Guatemala)[54]	Indigenous Maya women and children in remote, mountainous areas of rural Huehuetenango Department, Guatemala; CBIO+ program implemented across three municipalities (~98,000 population)	CBIO+ approach – integration of Census-Based, Impact-Oriented (CBIO), care group, and community birthing centre strategies	Indigenous health, rural access, community engagement, culturally safe care, women's empowerment	2146 DALYs averted per year; cost per DALY averted: US$265; cost per life saved: US$17,224	CUA; provider perspective	Highly cost-effective (7% of Guatemala's gross national income per capita); CBIO+ improved maternal child health coverage, reduced stunting and maternal mortality, empowered women; robust mixed-methods evaluation over 4 years; limitations include incomplete baseline mortality data and partial implementation timeframe in Area B
Sabin 2012 (Zambia)[55]	Rural Lufwanyama district, Zambia; cluster-randomised trial with 120 TBAs serving a remote population with limited healthcare access	Lufwanyama Neonatal Survival Project – training TBAs in neonatal resuscitation and sepsis management; provision of clean delivery kits and follow-up refresher trainings	Rural access to care, community health workforce, essential newborn care, Indigenous maternal health services	DALYs averted (10-year forecast): 3451; Cost per DALY averted: US$74 (base), US$24 (optimistic), US$120 (conservative)	CUA; societal and program perspectives	45% neonatal mortality reduction; cost per death avoided: US$1866 (base); highly cost-effective across all forecast scenarios; fixed costs (training/supervision) dominated; results sensitive to TBA productivity and intervention effect size; robust Monte Carlo and sensitivity analyses
Saronga 2017 (Tanzania)[56]	Women receiving ANC and childbirth care in rural Lindi District, Tanzania; pre-post intervention study in six health centres	Electronic Clinical Decision Support System for antenatal and childbirth care, implemented through QUALMAT project	Rural healthcare access, digital health, health system strengthening, quality of maternal care, clinical decision support	4.5% ANC and 23% childbirth quality improvement; ICERs: US$2469 (ANC), US$338 (childbirth) per 1% quality increase	CEA intermediate outcome; provider perspective	Marginal quality improvements, not statistically significant; ANC gains in history taking and continuity of care; childbirth gains in monitoring and interpersonal care; highly fixed cost system; effectiveness limited by system adoption barriers and short duration of implementation
Schackman 2007 (Haiti)[57]	Pregnant women in rural and urban Haiti; decision-analytic model comparing syndromic surveillance, RPR with follow-up, and rapid syphilis testing integrated into prenatal HIV programs	Rapid syphilis testing with immediate results and treatment during first antenatal visit; integrated with national prenatal HIV screening	Rural and urban access to care, infectious disease screening, maternal health, integrated service delivery	1125 congenital syphilis cases and 1223 stillbirths/neonatal deaths averted annually; DALY cost: US$6.83 (rural), US$9.95 (urban)	CUA; societal and payer perspectives	Rapid test dominated other strategies (more effective, lower ICER); cost-effective even at low prevalence and sensitivity; national scale-up cost: US$525,000/year; robust one- and two-way sensitivity analyses; findings support integrated STI/HIV screening models in resource-limited settings
Sinha 2017 (India)[58]	Women of reproductive age in rural tribal districts of Jharkhand and Odisha, India; cluster-randomised controlled trial (30 clusters; ~156,500 population)	Participatory learning and action with women's groups facilitated by accredited social health activists to improve maternal and newborn health	Indigenous and rural health, community mobilisation, women's empowerment, health education, maternal and newborn care	50 neonatal deaths averted; 1541 DALYs averted	CEA and CUA; provider perspective	Cost per DALY averted: US$83 (US$99 including Village Health Sanitation and Nutrition Committees support); cost per newborn death averted: US$2545 (US$3046 including Village Health Sanitation and Nutrition Committees); highly cost-effective by WHO threshold; strong impact in most marginalised groups (tribal, low asset, low literacy); robust sensitivity analyses; scalable via accredited social health activist supervisor model
Somigliana 2011 (Uganda)[59]	Women referred for obstetric emergencies in rural Oyam District, Uganda; 3-month prospective evaluation of a hospital-based ambulance service	Ambulance referrals as part of a comprehensive reproductive health program in remote settings; evaluated effectiveness and cost-efficiency of emergency transport	Rural access to emergency obstetric care, health infrastructure, referral systems, maternal health equity	611.7 YLS (undoubtedly effective cases); cost per year saved: US$15.82	CEA; district health provider perspective	Intervention classified as 'very attractive' (below US$30/YLS); robust across multiple sensitivity analyses; even with 10x higher costs or 10x fewer effective cases, remained cost-effective; underestimates likely due to conservative assumptions; exclusion of non-obstetric cases and quality-of-life impacts

Sutherland 2009 (India)[60]	Home births in rural India; decision-analytic simulation model of 10,000 deliveries without access to skilled care	Use of 600 µg misoprostol in third stage of labour to prevent postpartum haemorrhage; comparison with prenatal iron supplementation and no intervention	Rural health access, maternal haemorrhage prevention, community-based delivery, essential medicines	Maternal deaths averted: 7.5 (misoprostol), 1.1 (iron); ICER: US$1401 (misoprostol), US$2241 (iron) per life saved	CEA; societal perspective	Misoprostol substantially more cost-effective than iron supplementation; misoprostol use reduced maternal deaths by 38%; simulation modelled haemoglobin and blood loss distributions; conservative assumptions; iron had weaker, uncertain mortality impact but remains important for maternal health
Sutherland 2010 (India)[61]	Women delivering at home in rural India; Monte Carlo simulation model of 10,000 births based on national data and empirical inputs	Community-based distribution of misoprostol for prevention (600 µg orally) or treatment (800 µg sublingually) of postpartum haemorrhage	Rural healthcare access, maternal haemorrhage management, community-based delivery, essential medicines	DALYs averted: 216 (treatment), 250 (prevention); ICER: US$6 (treatment), US$170 (prevention) per DALY	CUA; health system/provider perspective	Treatment strategy highly cost-effective and cost-saving versus standard care; prevention averts more DALYs but at higher cost; both reduce maternal deaths and anaemia; robust sensitivity analysis; scalable to high regions; decision-tree modelling with real-world constraints (eg training, transport)
Svefors 2018 (Bangladesh)[62]	Pregnant women in rural Matlab, Bangladesh; factorial randomised controlled trial (MINIMat trial) assessing food and micronutrient supplementation (*n*=4436)	EMMS (early prenatal food supplementation (starting ~9 weeks) with multiple micronutrients); compared to routine iron–folate and usual timing of food (UFe60)	Rural nutrition, maternal supplementation, child survival, early-life growth, health equity	Under-five mortality reduction; stunting increase with MMS alone; EMMS: lowest DALYs lost; ICER: US$24 per DALY averted (lifetime perspective)	CUA; healthcare provider perspective	Despite increased stunting risk with MMS, EMMS remained highly cost-effective; included both mortality and disability (stunting) in DALY estimates; robust modelling with empirical and lifetime projections; cost-effective even under highest-cost scenario
Vlassoff 2016 (Senegal)[63]	Women delivering in rural maternity huts in three Senegalese districts; cluster-randomised trial (1445 deliveries) with modelled extrapolation to 150,000 deliveries/year	Community-based prophylactic administration of misoprostol v oxytocin (Uniject) for postpartum haemorrhage prevention	Rural access, maternal haemorrhage prevention, community-based delivery, essential medicines, task-shifting	Postpartum haemorrhage referrals averted: 4666 (misoprostol), 4250 (oxytocin); ICER: US$38.96 (misoprostol), US$119.15 (oxytocin) per postpartum haemorrhage referral averted	CEA; health system (provider) perspective	Misoprostol intervention dominated oxytocin in base and best-case scenarios; remained cost-effective under all sensitivity scenarios; lower drug, training, and logistics costs drove cost-effectiveness; national scale-up could prevent ~192 maternal deaths/year; strong policy case for misoprostol in low-resource, home-delivery settings
Wang 2016 (Zambia)[64]	Pregnant women in rural Chadiza and Serenje districts, Zambia; cluster-randomised controlled trial across 30 rural health facilities	'Mama' kits – small non-monetary incentive packages (cloth, diaper, blanket) provided to women who delivered in health facilities	Rural access to skilled delivery, non-monetary incentives, maternal health service utilisation	9.9 percentage point increase in facility deliveries; cost per death averted: US$5183	CEA; government/provider perspective	Statistically significant increase in facility delivery (odds ratio: 1.63); conservative modelling showed cost-effectiveness; quality of care and transport barriers remain; mama kits effective but should be integrated with broader maternal health strategies
Zeng 2018 (Zambia)[65]	Women and children in 30 rural districts across Zambia; cluster-randomised trial covering 1.33 million people in results-based financing arm	Results-based financing – increased funding to health facilities tied to performance on maternal and child health indicators; compared with input-based financing and standard care	Rural health access, maternal and child health, quality improvement, performance-based financing, service utilisation	641 lives saved versus control; 12,291 QALYs gained; ICER: US$999/QALY (unadjusted), US$809/QALY (quality-adjusted)	CUA; health system (provider) perspective	Significant improvements in institutional delivery (+12.8%), postnatal care (+8.2%), and family planning (+19.5%); quality-adjusted results doubled QALYs gained; results-based financing dominated control and remained cost-effective versus input-based model; comprehensive modelling using LiST, Delphi panel for quality weighting, robust sensitivity analyses

† 1 USD = 1.45 AUD.

¶ International dollars (INT$) are a hypothetical currency unit used to enable cross-country cost comparisons. One international dollar is equivalent in purchasing power to one US dollar in the US. Costs expressed in international dollars are adjusted using purchasing power parity (PPP) conversion factors to account for differences in price levels between countries, and therefore differ from direct market exchange rate conversions.

ANC, antenatal care. CEA, cost-effectiveness analysis. CI, confidence interval. CUA, cost–utility analysis. DALY, disability-adjusted life year. DTP, diptheria–tetanus–pertussis. EMMS, early invitation to food and micronutrient supplementation. ICER, incremental cost-effectiveness ratio. ICS, immunochromatographic strip. IPTW, inverse probability of treatment weighting. MMS, multiple micronutrients. QALY, quality-adjusted life year. RPR, rapid plasma reagin. TBA, traditional birth attendant. TPHA, Treponema pallidum hemagglutination. VSL, value of a statistical life. VSLY, value of a statistical life year. YLL, years of life lost. YLS, years of life saved.

Appendix III: Risk of bias summary using the ECOBIAS checklist for each included study

First author, year (country)	Part A: Overall checklist for bias in economic evaluation											Part B: Model-specific aspects of bias in economic evaluation										
												I†			II¶							III§
	Narrow perspective bias	Inefficient comparator bias	Cost measurement omission bias	Intermittent data collection bias	Invalid valuation bias	Ordinal ICER bias	Double-counting bias	Inappropriate discounting bias	Limited sensitivity analysis bias	Sponsor bias	Reporting and dissemination bias	Structural assumptions bias	No treatment comparator bias	Wrong model bias	Limited time-horizon bias	Bias related to data identification	Bias related to baseline data	Bias related to treatment effects	Bias related to quality-of-life weights (utilities)	Non-transparent data incorporation bias	Limited scope bias	Bias related to internal consistency
Jan 2004 (Australia)[29]	Y	N	P	Y	Y	NA	P	Y	Y	Y	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Willcox 2019 (Ghana)[28]	P	N	N	N	N	Y	N	N	N	N	P	N	N	P	N	N	P	NA	N	N	N	N
Alfonso 2015 (Uganda)[24]	N	N	N	N	N	N	N	N	N	N	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gomez 2015 (Nigeria)[25]	P	N	N	N	N	N	N	N	N	N	N	P	N	N	N	N	N	N	NA	N	N	N
Jo 2019 (Bangladesh)[26]	P	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Prinja 2018 (India)[27]	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Barger 2017 (Bolivia)[30]	Y	Y	N	N	N	NA	N	N	NA	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gao 2014 (Australia)[31]	Y	U	Y	Y	N	N	U	N	Y	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gao 2023 (Australia)[32]	Y	N	N	N	N	N	N	N	U	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Accorsi 2017 (Ethiopia)[33]	P	Y	P	N	P	Y	N	N	P	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ahmed 2023 (Uganda)[34]	P	N	P	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Baek 2023 (Vietnam)[35]	N	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Baek 2023 (Vietnam)[36]	N	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Blandford 2007 (South Africa)[37]	N	N	N	N	N	N	N	NA	N	N	N	N	N	N	N	N	N	N	NA	N	N	N
Borghi 2005 (Nepal)[38]	P	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Buser 2019 (Liberia)[39]	Y	N	Y	Y	P	N	N	N	Y	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chinkhumba 2020 (Malawi)[40]	N	N	N	P	N	N	N	N	N	N	N	N	N	N	N	N	N	N	NA	N	N	N
Colbourn 2015 (Malawi)[41]	Y	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Curry 2013 (Ethiopia)[42]	Y	N	NA	P	N	N	N	N	Y	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fotso 2020 (Sierra Leone)[43]	Y	N	N	N	N	N	N	N	Y	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Goldie 2010 (India)[44]	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Haghparast-Bidgoli 2023 (India)[45]	Y	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hutchinson 2006 (Bangladesh)[46]	Y	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lewycka 2013 (Malawi)[47]	Y	N	N	Y	N	N	N	N	Y	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manzi 2019 (Rwanda)[48]	Y	N	N	N	N	N	N	Y	Y	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
McPake 2015 (Ethiopia, Indonesia, Kenya)[49]	Y	N	Y	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Modi 2020 (India)[50]	Y	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Newlands 2008 (Burkina Faso)[51]	Y	N	N	N	N	N	N	N	P	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ogbuoji 2024 (Mali)[52]	Y	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Palmer 2022 (Kenya)[53]	Y	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Perry 2023 (Guatemala)[54]	Y	N	U	U	U	N	U	U	Y	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sabin 2012 (Zambia)[55]	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Saronga 2017 (Tanzania)[56]	Y	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Schackman 2007 (Haiti)[57]	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N	N	N	N	P	N
Sinha 2017 (India)[58]	Y	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Somigliana 2011 (Uganda)[59]	Y	N	N	N	N	N	N	N	N	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sutherland 2009 (India)[60]	Y	N	Y	N	N	N	N	Y	N	N	N	N	N	P	Y	N	N	N	N	N	P	N
Sutherland 2010 (India)[61]	Y	N	N	NA	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	P	N
Svefors 2018 (Bangladesh)[62]	Y	N	N	N	N	N	N	N	P	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vlassoff 2016 (Senegal)[63]	Y	N	N	NA	N	N	N	NA	N	N	N	N	N	P	N	N	N	P	NA	N	N	N
Wang 2016 (Zambia)[64]	Y	N	N	N	N	N	N	NA	P	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zeng 2018 (Zambia)[65]	Y	N	N	N	N	N	N	N	Y	N	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

† Bias related to structure.
¶ Bias related to data.
§ Bias related to consistency.
ECOBIAS, Bias in Economic Evaluation. ICER, incremental cost-effectiveness ratio. N, no – high risk of bias. N/A, not applicable. NA, not available. NR, not related. P, part bias. Y, yes – low risk of bias.

Appendix IV: Quality assessment of included studies using CHEC-Extended checklist

First author, year (country)	CHEC-Extended list item, score and grade[†]																				
	Patient population	Competing alternatives	Research question	Economic study design	Model description	Time horizon	Study perspective	Costs identification	Costs measurement	Costs valuation	Outcomes identification	Outcomes measured	Outcomes valuation	Incremental CEA	Discounting	Uncertainty analysis	Conclusions	Generalisability	Conflict of interest	Ethical issues	Total score	Grade
Jan 2004 (Australia)[29]	1	1	1	0.5	N/A	0	1	1	1	1	1	1	1	0	0	0	0.5	0.5	1	0	65.79	Moderate
Willcox 2019 (Ghana)[28]	1	1	1	0.5	0.5	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	90.00	Good
Alfonso 2015 (Uganda)[24]	1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	0.5	1	0.5	92.50	Good
Gomez 2015 (Nigeria)[25]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.5	1	0.5	95.00	Good
Jo 2019 (Bangladesh)[26]	1	1	1	1	0.5	1	1	1	1	1	1	1	0.5	1	1	1	1	0.5	1	0.5	90.00	Good
Prinja 2018 (India)[27]	1	1	1	0.5	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	95.00	Good
Barger 2017 (Bolivia)[30]	1	0	1	0.5	N/A	N/A	1	1	1	1	N/A	N/A	N/A	N/A	1	N/A	1	0	1	1	80.77	Good
Gao 2014 (Australia)[31]	1	1	1	0.5	1	1	1	1	1	1	N/A	N/A	N/A	N/A	1	N/A	1	0.5	1	1	93.33	Good
Gao 2023 (Australia)[32]	1	1	1	1	N/A	1	1	1	1	1	0.5	1	1	1	N/A	1	1	1	1	1	97.22	Excellent
Accorsi 2017 (Ethiopia)[33]	1	1	1	1	N/A	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	97.37	Excellent
Ahmed 2023 (Uganda)[34]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Baek 2023 (Vietnam)[35]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Baek 2023 (Vietnam)[36]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Blandford 2007 (South Africa)[37]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.5	1	1	1	1	1	97.50	Excellent
Borghi 2005 (Nepal)[38]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Buser 2019 (Liberia)[39]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Chinkhumba 2020 (Malawi)[40]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Colbourn 2015 (Malawi)[41]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Curry 2013 (Ethiopia)[42]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Fotso 2020 (Sierra Leone)[43]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	94.74	Good
Goldie 2010 (India)[44]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Haghparast-Bidgoli 2023 (India)[45]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Hutchinson 2006 (Bangladesh)[46]	1	1	1	1	N/A	1	0.5	0.5	1	0.5	1	1	1	1	0.5	1	1	1	0	0.5	81.58	Good
Lewycka 2013 (Malawi)[47]	1	1	1	1	N/A	1	1	1	1	0.5	1	1	1	1	0.5	0	1	1	1	1	89.47	Good
Manzi 2019 (Rwanda)[48]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
McPake 2015 (Ethiopia, Indonesia, Kenya)[49]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Modi 2020 (India)[50]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Newlands 2008 (Burkina Faso)[51]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Ogbuoji 2024 (Mali)[52]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Palmer 2022 (Kenya)[53]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Perry 2023 (Guatemala)[54]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	89.47	Good
Sabin 2012 (Zambia)[55]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Saronga 2017 (Tanzania)[56]	1	1	1	1	N/A	0.5	1	1	1	1	0.5	1	1	1	1	1	1	0.5	1	1	92.11	Good
Schackman 2007 (Haiti)[57]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Sinha 2017 (India)[58]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100.00	Excellent
Somigliana 2011 (Uganda)[59]	1	0	1	1	N/A	0.5	1	1	1	1	0.5	0.5	1	0.5	1	1	1	1	1	1	84.21	Good
Sutherland 2009 (India)[60]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N/A	1	1	1	1	1	100.00	Excellent
Sutherland 2010 (India)[61]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	95.00	Good
Svefors 2018 (Bangladesh)[62]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	94.74	Good
Vlassoff 2016 (Senegal)[63]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	N/A	1	1	1	1	0	94.44	Good
Wang 2016 (Zambia)[64]	1	1	1	1	N/A	1	1	1	1	1	1	1	1	1	N/A	1	1	1	1	1	100.00	Excellent
Zeng 2018 (Zambia)[65]	1	1	1	1	N/A	1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	97.37	Excellent

[†] Each item scored as 1 for a positive response and 0 for a negative one. Total scores are sums of individual item scores, expressed as a percentage.
CEA, cost-effectiveness analysis. CHEC, Consensus Health Economic Criteria. N/A, not applicable.