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Effects of Integrated Referral Information Systems on Maternal Survival-Related Outcomes and Referral Performance: A Focused Systematic Review of SISRUTE-Like Maternal Referral Interventions

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Abstract

Timely referral is central to maternal survival, yet evidence on whether integrated or mobile referral information systems improve clinically meaningful maternal outcomes remains fragmented. To synthesize evidence on whether SISRUTE-like maternal referral interventions improve maternal survival-related outcomes and referral effectiveness. A focused systematic review following PRISMA 2020 logic searched Scopus and PubMed for English-language records published between 2000 and 2025. The review intentionally restricted the main synthesis to mature digital, mobile, or information-based maternal referral interventions rather than all maternal referral studies. After deduplication and screening, six full-text studies met the criteria for the main synthesis. Included studies were conducted in Liberia (n=3), Ghana (n=1), Uganda (n=1), and Iraq (n=1). Interventions comprised prereferral phone communication, a WhatsApp-based referral platform, and the Mobile Obstetric Referral Emergency System (MORES), sometimes combined with midwife-led triage. Evidence consistently favored process improvements. In Uganda, prereferral phone calls were associated with lower adverse maternal-fetal outcomes (adjusted odds ratio [aOR] 0.22, 95% CI 0.09-0.44). In Ghana, the median response time on the WhatsApp platform was 17 minutes, and a receiving hospital was identified in 82.7% of posted cases. In Liberia, MORES plus midwife-led triage reduced the median decision-to-incision interval by 117.5 minutes and increased the odds of cesarean delivery within 75 minutes (aOR 11.75, 95% CI 1.32-104.54). Direct evidence for maternal mortality reduction was insufficient. SISRUTE-like maternal referral interventions appear most effective for strengthening communication, triage, preparedness, and emergency timeliness rather than for demonstrating direct mortality reduction. Their contribution to maternal survival is most plausibly indirect and depends on transport, receiving-facility readiness, and implementation support

Keyword: maternal referral, digital health, e-referral, obstetric emergency, mHealth, triage, maternal survival.

INTRODUCTION

Maternal mortality remains a persistent marker of health-system inequity, especially where women with obstetric complications depend on rapid access to comprehensive emergency obstetric care. According to the World Health Organization, maternal mortality remains unacceptably high worldwide, and most deaths are still concentrated in low- and lower-middle-income countries (World Health Organization, 2025). In these settings, referral pathway is not a peripheral administrative issue. It is often the practical bridge between first contact care and definitive, life-saving intervention.

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Long-standing maternal referral research has shown that breakdowns in communication, documentation, transport coordination, and receiving-facility preparedness can worsen outcomes even when women do reach formal care (Daniels & Abuosi, 2020; Ofosu et al., 2021; Avoka et al., 2022; Ameyaw et al., 2022; Mengist et al., 2024; Harahap et al., 2021). Qualitative and process-mapping studies in Ghana and Ethiopia, for example, describe referral systems that are slowed by incomplete information, weak feedback loops, poor coordination between referring and receiving facilities, and uncertainty about service readiness (Daniels & Abuosi, 2020; Ofosu et al., 2021; Mengist et al., 2024). A systematic review focused on sub-Saharan Africa similarly concluded that referral decision-making, communication, and feedback interventions may improve emergency obstetric referral functioning, although the evidence base remains methodologically uneven (Avoka et al., 2022).

Digital health has increasingly been proposed as one way to reduce these coordination failures. The WHO classification of digital interventions emphasizes that digital tools can support provider-to-provider communication, care coordination, data visibility, and health-system management rather than merely replacing paper forms (World Health Organization, 2023). Broader maternal digital-health reviews suggest that mobile and electronic interventions can improve service use, antenatal attendance, follow-up, and selected maternal-newborn indicators, but these reviews also show that evidence is heterogeneous and often centered on general mHealth or antenatal care rather than emergency referral pathways (Ameyaw et al., 2024; Knop et al., 2024; Kachimanga et al., 2024; Kirwa et al., 2025; Mohamed et al., 2025; Shartyanie et al., 2025; Ngwenya et al., 2025).

This distinction matters for SISROUTE-like systems. In practical terms, these interventions include structured prereferral phone alerts, messaging-based referral platforms, mobile obstetric emergency systems, and linked triage tools that make referral pathways more visible, more responsive, and more accountable. Yet the current literature often mixes three different evidence streams: non-digital studies describing referral barriers, developmental studies describing prototype apps, and mature intervention studies reporting measurable changes in referral effectiveness. Without separating these streams, the effect of digital maternal referral systems on survival-related outcomes remains difficult to judge.

This review therefore focuses deliberately on mature digital, mobile, or information-based maternal referral interventions analogous to SISROUTE-like systems. The review asks whether these interventions improve maternal survival-related outcomes and referral effectiveness, and which contextual factors appear to shape their success or failure.

METHODS

2.1 Review design and reporting framework

This study was designed as a focused systematic review and is reported using PRISMA 2020 logic (Page et al., 2021). Narrative synthesis was specified as the main analytic approach because the final evidence base was heterogeneous in intervention architecture, study design, outcome definitions, and implementation maturity (Paré & Kitsiou, 2017). A formal protocol was not prospectively registered, which is acknowledged as a limitation of the present review.

2.2 Eligibility criteria

Studies were eligible if they involved pregnant, intrapartum, or postpartum women; obstetric emergency referrals; or health workers managing maternal referrals, and if they evaluated a digital, mobile, or information-based referral intervention. Eligible interventions included structured prereferral phone communication, WhatsApp-based referral systems, digital referral platforms, and mobile obstetric emergency systems. Outcomes of interest were maternal survival-related outcomes, maternal-fetal adverse outcomes, referral timeliness, communication, coordination, treatment preparedness, or implementation feasibility directly linked to referral effectiveness. Studies focused only on non-digital referral barriers, prototype development without meaningful implementation evidence, or non-maternal referral populations were excluded from the main synthesis.

2.3 Information sources and search strategy

Searches were completed in Scopus and PubMed for English-language records published between 1 January 2000 and 31 December 2025. The search strategy combined four concept blocks: maternal or obstetric population; referral or transfer processes; digital or mobile referral interventions; and survival-related or referral-effectiveness outcomes. Scopus records were refined to article and review records and PubMed results were filtered to English-language publications within the defined period. The completed search rounds yielded 37 Scopus records and 19 PubMed records for final export and screening.

2.4 Selection process, data extraction, and quality appraisal

After deduplication, records were screened by title and abstract against predefined criteria. Full texts of potentially relevant records were then reviewed against the stricter digital-systems scope used for the main synthesis. Data extraction captured country, design, setting, sample, intervention features, comparator framework, outcomes, key findings, implementation insights, and major limitations. Design-appropriate critical appraisal was conducted using JBI

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qualitative and quasi-experimental logic, supplemented by a structured appraisal of feasibility and observational process studies.

2.5 Synthesis approach

The main synthesis was restricted to mature digital or mobile maternal referral interventions that provided empirical evidence on referral effectiveness or closely related maternal outcomes. One Indonesian maternal referral app paper and one Malawian radio-network communication study were retained as contextual studies for Discussion only. They informed interpretation of digital maturity and transport bottlenecks, but were not counted as effectiveness studies in the main synthesis.

RESULTS

3.1 Study selection

The database searches yielded 56 records (37 from Scopus and 19 from PubMed). After the removal of 14 duplicates, 42 unique records underwent title and abstract screening. Thirty records were excluded as clearly outside the strict review scope. Twelve full texts were reviewed in detail. Six studies met the criteria for the primary synthesis. Six additional full texts were excluded from the primary synthesis because they represented broader non-digital communication interventions, development-focused application studies without evaluative effectiveness data, or contextual/background papers without eligible intervention-effect estimates. Two of these excluded studies were retained for narrative contextual discussion only and were not counted as included studies in the primary synthesis.

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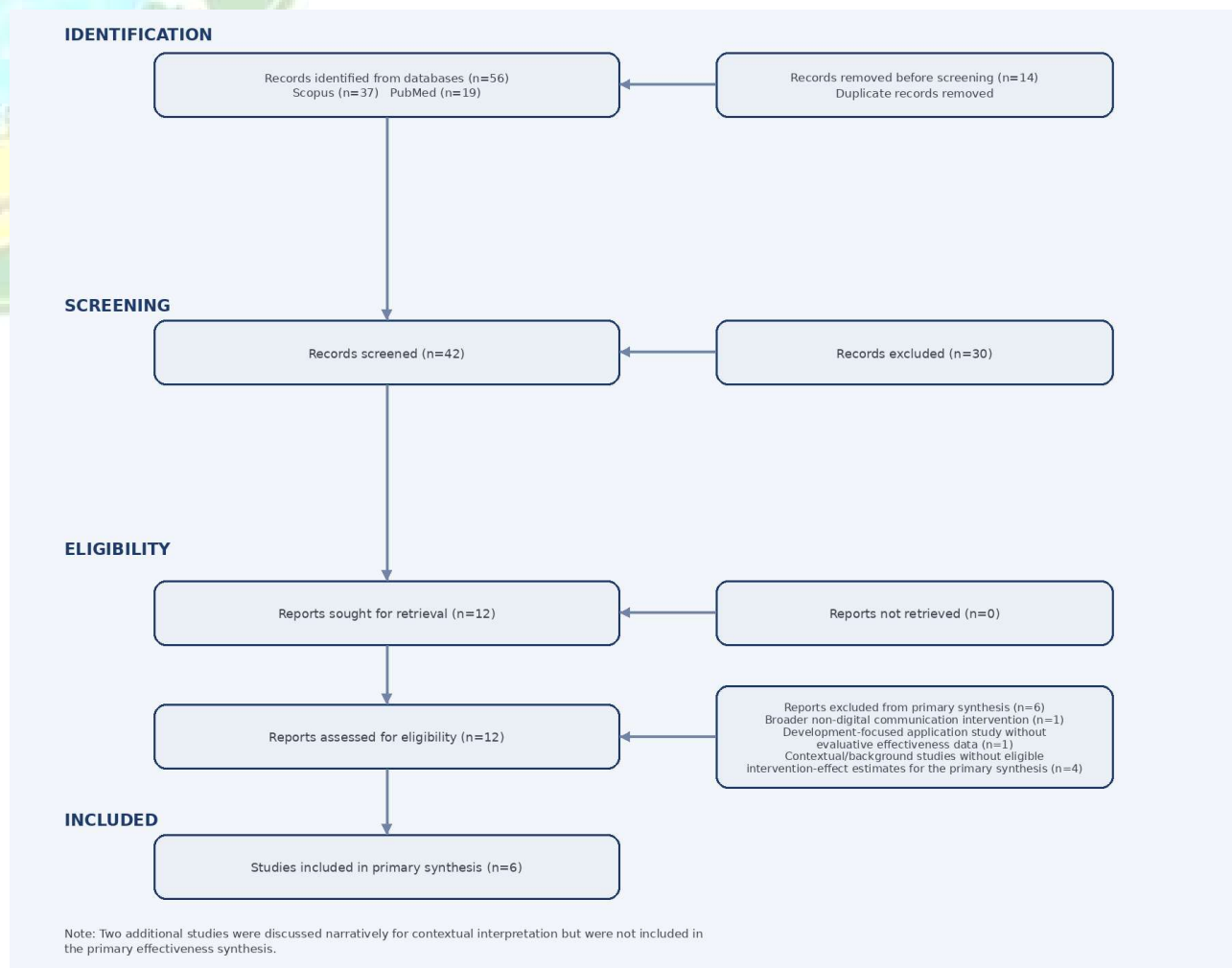


Figure 1. PRISMA 2020 flow diagram for identification, screening, eligibility assessment, and inclusion of studies in the primary synthesis.

3.2 Characteristics of included studies

The six main-synthesis studies were conducted in Liberia (n=3), Ghana (n=1), Uganda (n=1), and Iraq (n=1). Four studies used quantitative designs, including quasi-experimental, pre-post, and feasibility analyses, while two used qualitative implementation-oriented designs. The dominant intervention models were prereferral phone communication, WhatsApp-based referral coordination, and the Mobile Obstetric Referral Emergency System (MORES), with one Liberian study combining MORES with a midwife-led triage package (Kanyesigye et al., 2022; Owen et al., 2022; Lee et al., 2024; Reynolds et al., 2024; Lee et al., 2025; Relyea et al., 2021).

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Table 1. Main-synthesis studies included in the review.

Study	Country	Design	Intervention	Main outcomes
(Kanyesigye et al., 2022)	Uganda	Quasi-experimental	Prereferral phone call communication	Adverse maternal-fetal outcomes; admission delay
(Owen et al., 2022)	Ghana	Feasibility study	WhatsApp referral communication platform	Response time; receiving hospital identification; prereferral treatment; referral-to-arrival time
(Lee et al., 2024)	Liberia	Pre-post study	MORES across rural health facilities and referral hospitals	Transfer time, cesarean delivery; newborn vigor
(Reynolds et al., 2024)	Liberia	Qualitative implementation study	MORES implementation assessment	Usability; coordination; accountability; transfer process perceptions
(Lee et al., 2025)	Liberia	Quasi-experimental	MORES plus midwife-led triage	Decision-to-incision interval; timely emergency cesarean delivery
(Relyea et al., 2021)	Iraq	Qualitative feasibility study	Prospective mHealth referral concept	Feasibility; acceptability; implementation barriers and facilitators

3.3 Effects on maternal survival-related outcomes

Direct evidence that digital maternal referral systems reduce maternal mortality was insufficient. None of the six main studies provided a robust mortality effect estimate, and one of the strongest quantitative studies reported no maternal deaths during the observation period, which made direct mortality evaluation impossible (Lee et al., 2025). The main evidence therefore concerns survival-related proxy outcomes and adverse maternal-fetal outcomes rather than mortality itself.

Even so, the quantitative studies provided several clinically meaningful signals. In Uganda, prereferral phone communication was associated with fewer adverse maternal-fetal outcomes and remained protective in adjusted analysis (aOR 0.22, 95% CI 0.09-0.44) (Kanyesigye et al., 2022). In Liberia, the network-wide MORES pre-post study suggested higher odds of cesarean delivery and better newborn vigor at endline, although transfer time

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itself did not improve significantly (Lee et al., 2024). The MORES plus midwife-led triage study showed the clearest emergency timeliness effect, reducing the median decision-to-incision interval by 117.5 minutes and increasing the odds of cesarean delivery within 75 minutes (aOR 11.75, 95% CI 1.32-104.54) (Lee et al., 2025).

3.4 Effects on referral effectiveness and implementation

The strongest and most consistent evidence was observed for process outcomes. In Ghana, the WhatsApp referral platform recorded a median response time of 17 minutes, identified a receiving hospital in 82.7% of posted cases, and facilitated prereferral treatment in more than half of referrals (Owen et al., 2022). Ambulance use and midwife accompaniment were associated with shorter referral-to-arrival intervals (Owen et al., 2022). In Uganda, the phone-call intervention reduced delay at the admission bench and improved the receiving team's readiness for referral arrivals (Kanyesigye et al., 2022). In Liberia, MORES was described by providers as improving attentiveness, feedback, accountability, and the visibility of delays across the referral chain (Reynolds et al., 2024). The Iraq feasibility study reinforced the importance of implementation context, as participants considered the mHealth concept useful but highlighted barriers related to connectivity, digital literacy, ambulance reliability, security, and cultural acceptability (Relyea et al., 2021).

3.5 Methodological appraisal

Methodological quality was moderate overall. The evidence base was dominated by quasi-experimental, pre-post, feasibility, and qualitative studies, with no randomized trials. The most common threats to validity were non-random allocation, modest sample sizes, incomplete matched records, and bundled interventions that made attribution difficult. Nevertheless, outcome measurement was generally objective for the main process outcomes, especially admission delay, platform response time, transfer coordination, and decision-to-incision interval.

Table 2. Summary of methodological appraisal for main-synthesis studies.

Study	Appraisal focus	Overall judgement	Main concerns
(Kanyesigye et al., 2022)	Quasi-experimental	Moderate	Non-random allocation; single-hospital setting
(Owen et al., 2022)	Feasibility/process study	Moderate	No concurrent control for process outcomes; process metrics dominate

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(Lee et al., 2024)	Pre-post study	Moderate	Before-and-after design; limited attribution; incomplete matched records
(Reynolds et al., 2024)	Qualitative appraisal	Moderate to high	Transferability limited; perception-based outcomes
(Lee et al., 2025)	Quasi-experimental	Moderate	Bundled intervention; modest sample; no mortality events
(Relyea et al., 2021)	Qualitative feasibility	Moderate	Feasibility-focused; no direct effectiveness estimate

DISCUSSION

This focused review shows that SISROUTE-like maternal referral interventions have their clearest evidence in process outcomes rather than in direct maternal mortality reduction. Across Uganda, Ghana, and Liberia, digital or phone-based referral systems improved communication, strengthened preparedness, and, in the strongest Liberian study, shortened the interval between decision and emergency cesarean section (Kanyesigye et al., 2022; Owen et al., 2022; Lee et al., 2024; Reynolds et al., 2024; Lee et al., 2025). The evidence therefore supports a mechanistic interpretation: digital maternal referral systems appear to improve how emergency obstetric care is organized and activated, even when they do not yet provide direct proof of mortality reduction.

This interpretation is consistent with the broader maternal digital-health literature. Reviews of mHealth and digital maternal care have reported encouraging effects on service use, continuity, and care processes, but they also emphasize heterogeneous intervention designs, context dependency, and limited direct evidence for severe maternal outcomes (Ameyaw et al., 2024; Knop et al., 2024; Kachimanga et al., 2024; Kirwa et al., 2025; Mohamed et al., 2025; Shartyanie et al., 2025; Ngwenya et al., 2025). The present review sharpens that broader literature by focusing specifically on referral-pathway interventions. Once the scope is tightened in this way, the evidence base becomes smaller but conceptually more coherent.

The contrast between communication gains and travel-time constraints is one of the most important findings. The Ghana WhatsApp platform and the Ugandan prereferral phone intervention both improved the information environment of referral care, yet they did not eliminate structural bottlenecks related to transport and receiving-facility capacity (Kanyesigye et al., 2022; Owen et al., 2022). Likewise, the broader Liberian MORES pre-post study improved some maternal-newborn indicators without demonstrating a significant reduction in interfacility transfer time (Lee et al., 2024). These findings suggest that digital referral systems

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can improve readiness and internal clinical timeliness, but cannot by themselves overcome weak ambulance systems, poor roads, fuel shortages, or capacity limitations.

The Liberian evidence is particularly informative because it spans implementation, process, and downstream clinical proxies. The MORES implementation study explains why the quantitative findings are plausible: providers described better prehospital transfer, attentiveness, feedback, and accountability after one year of use (Reynolds et al., 2024). The quasi-experimental decision-to-incision study then shows what that mechanism may mean in practice when combined with midwife-led triage: women reached emergency cesarean section more quickly (Lee et al., 2025). This layered pattern strengthens confidence that the observed benefits are not merely technical artifacts, even though the studies remain observational.

Two contextual studies sharpen this interpretation further. The Indonesian maternal referral application paper demonstrates that a SISRUTE-like digital referral application can be developed in principle, but it did not provide mature effectiveness evidence and still relied on parallel offline communication (Indriani et al., 2020). The Malawian radio-network study, although outside the strict digital-platform scope, showed that improved communication alone does not guarantee rapid referral when ambulance logistics remain weak (Lungu & Ratsma, 2007). Together, these contextual studies support the broader argument that communication technologies are necessary but not sufficient. The surrounding referral system still determines how much clinical benefit can be realized.

For policy and practice, the review suggests that the most promising maternal referral technologies are those that remain simple, fit existing workflows, and are tightly linked to triage and escalation decisions. Messaging-based or phone-based systems may be particularly attractive in low-resource settings because they build on infrastructure already familiar to staff. However, implementation support matters: training, network reliability, escalation protocols, receiving-hospital accountability, and transport arrangements remain central to effectiveness. From a systems perspective, the digital platform is best seen as one enabling layer within a broader emergency obstetric pathway rather than as a stand-alone solution.

The review also clarifies priorities for future research. More rigorous quasi-experimental work is needed, preferably with longer time horizons, standardized definitions for referral delay and treatment timeliness, and outcome sets that combine proximate process* measures with severe maternal and newborn endpoints. Direct maternal mortality will remain difficult to study because event rates are low and system effects are diffuse. Future evaluations

should therefore combine realistic process indicators, such as response time or decision-to-incision interval, with survival-related outcomes that are sensitive to referral-system change.

CONCLUSIONS

The available full-text evidence indicates that integrated, digital, or mobile maternal referral interventions analogous to SISROUTE-like systems are most effective at improving communication, preparedness, and emergency treatment timeliness. Their strongest documented benefits lie in process outcomes such as reduced admission delays, faster referral response, improved coordination, and shorter decision-to-incision intervals.

At present, direct evidence that these systems reduce maternal mortality remains insufficient. The most credible interpretation is therefore that digital maternal referral systems contribute to maternal survival indirectly, by helping women move through emergency pathways more safely and more efficiently when transport, triage, and receiving-facility readiness are also functioning.

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