Application-Based Digital Support for Labor Pain Across Cervical Dilatation: A Rapid Scoping Review and Evidence-Informed Design Framework

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Abstract. Application-based non-pharmacological support is increasingly used during childbirth, yet its effects on labor pain are frequently conflated with effects on cervical progress. This rapid scoping review mapped patient-facing digital applications for labor-pain support, examined how intervention delivery related to cervical dilatation, and derived requirements for an intrapartum mobile-health application. PubMed/MEDLINE, Europe PMC, and OpenAlex were searched for empirical reports published from January 2015 to 26 July 2026. Eligibility followed a Population-Concept-Context framework, and reporting was guided by JBI methodology, PRISMA-ScR, and PRISMA-S. Thirty-three reports representing 31 unique studies or development programs were included. Immersive virtual reality dominated the evidence and generally reduced pain during or immediately after exposure; anxiety, fear, comfort, and satisfaction also commonly improved. Cervical dilatation was primarily used to determine eligibility, time intervention sessions, or standardize pain measurement. No study validated an increase in cervical dilatation rate, and findings for labor duration were inconsistent. An evidence-informed application should therefore make pain coping its primary claim, use clinically confirmed stage information, offer calming audio, affirmation, paced breathing, and mindfulness, support offline one-tap use and partner-midwife integration, and remain separate from clinical labor-progress monitoring.

Keywords: labor pain; cervical dilatation; mobile health; virtual reality; scoping review

INTRODUCTION

Labor pain is a multidimensional experience arising from uterine contractions, cervical change, pelvic-floor distension, and tissue pressure, while fear, uncertainty, perceived control, and the care environment shape its interpretation (Lowe, 2002). The World Health Organization recommends woman-centered intrapartum care that respects preferences and provides effective pain-relief options without imposing one model of a normal birth experience (Jones et al., 2012; World Health Organization, 2018). Digital interventions may extend these options through repeatable education, distraction, relaxation, breathing guidance, and communication support within a broader digital-health strategy (World Health Organization, 2021).

Cervical dilatation is central to clinical labor assessment, but it should not be reduced to a rigid expectation of 1 cm per hour. Contemporary WHO guidance recognizes substantial physiological variation and cautions that labor may not accelerate until approximately 5 cm (World Health Organization, 2020, 2025). This distinction is important for digital-health research: delivering an application at 4-5 cm, comparing pain scores at 4 and 9 cm, and estimating a dilatation rate are methodologically different uses of cervical data.

Systematic reviews indicate that virtual reality can reduce labor pain and anxiety, but pooled effects are heterogeneous and the underlying evidence is dominated by small, single-center trials (Baradwan et al., 2022; Özer & Çetinkaya Şen, 2024; Xu et al., 2022). Previous reviews have not sufficiently separated cervical-dilatation timing from cervical-progress outcomes or translated the evidence into requirements for a broader mobile application. This review therefore aimed to map application types and therapeutic components, identify when applications were delivered in relation to cervical dilatation, summarize maternal and labor outcomes, and develop an evidence-informed architecture for future intrapartum applications.

METHODS

Design and eligibility

A rapid scoping-review design was selected because the field contains heterogeneous interventions, developmental studies, randomized and nonrandomized trials, and qualitative evidence. The review followed updated JBI guidance and was reported using PRISMA-ScR; search reporting was informed by PRISMA-S (Peters et al., 2020; Rethlefsen et al., 2021; Tricco et al., 2018). Eligible populations were pregnant or laboring women preparing for vaginal birth. The concept comprised patient-facing smartphone, tablet, web, audiovisual, animation, or virtual-reality applications delivering education, distraction, music, affirmation, breathing, mindfulness, relaxation, or communication. Antenatal preparation, early labor, and intrapartum care were eligible contexts.

Outcomes included pain or coping, pharmacological analgesia, anxiety or fear, comfort, satisfaction, childbirth experience, labor duration or progress, cervical-dilatation timing or rate, safety, acceptability, and design requirements. Provider-only partograph tools, fetal-monitoring algorithms without patient support, student simulation, non-labor procedures, reviews, protocols, and reports without empirical data were excluded.

Information sources, selection, and charting

PubMed/MEDLINE, Europe PMC, and OpenAlex were searched from 1 January 2015 to 26 July 2026. Search concepts combined childbirth or labor pain with mobile application, mHealth, digital intervention, audiovisual application, and virtual reality. Reference lists and cited-by records were examined for included studies and recent reviews. Records were normalized by DOI and title, de-duplicated, and screened against the eligibility criteria. A single reviewer performed screening and repeated uncertain decisions after the first pass. A piloted form captured design, sample, platform, intervention content, comparator, timing by labor phase or cervical dilatation, pain measures, psychological and experiential outcomes, analgesia, labor progress, safety, and implementation features. Formal risk-of-bias appraisal and meta-analysis were not undertaken because the purpose was evidence mapping rather than effect estimation.

RESULTS AND DISCUSSION

Search results and evidence characteristics

The searches identified 1,384 records: 153 from PubMed/MEDLINE, 1,134 from Europe PMC, and 97 from OpenAlex. After removal of 84 duplicates, 1,300 records were screened. Seventy-eight full-text reports were assessed and 33 reports representing 31 unique studies or development programs were included. The main exclusions were an irrelevant population or outcome, training or non-labor procedures, duplicate or secondary reports, and insufficient empirical data.

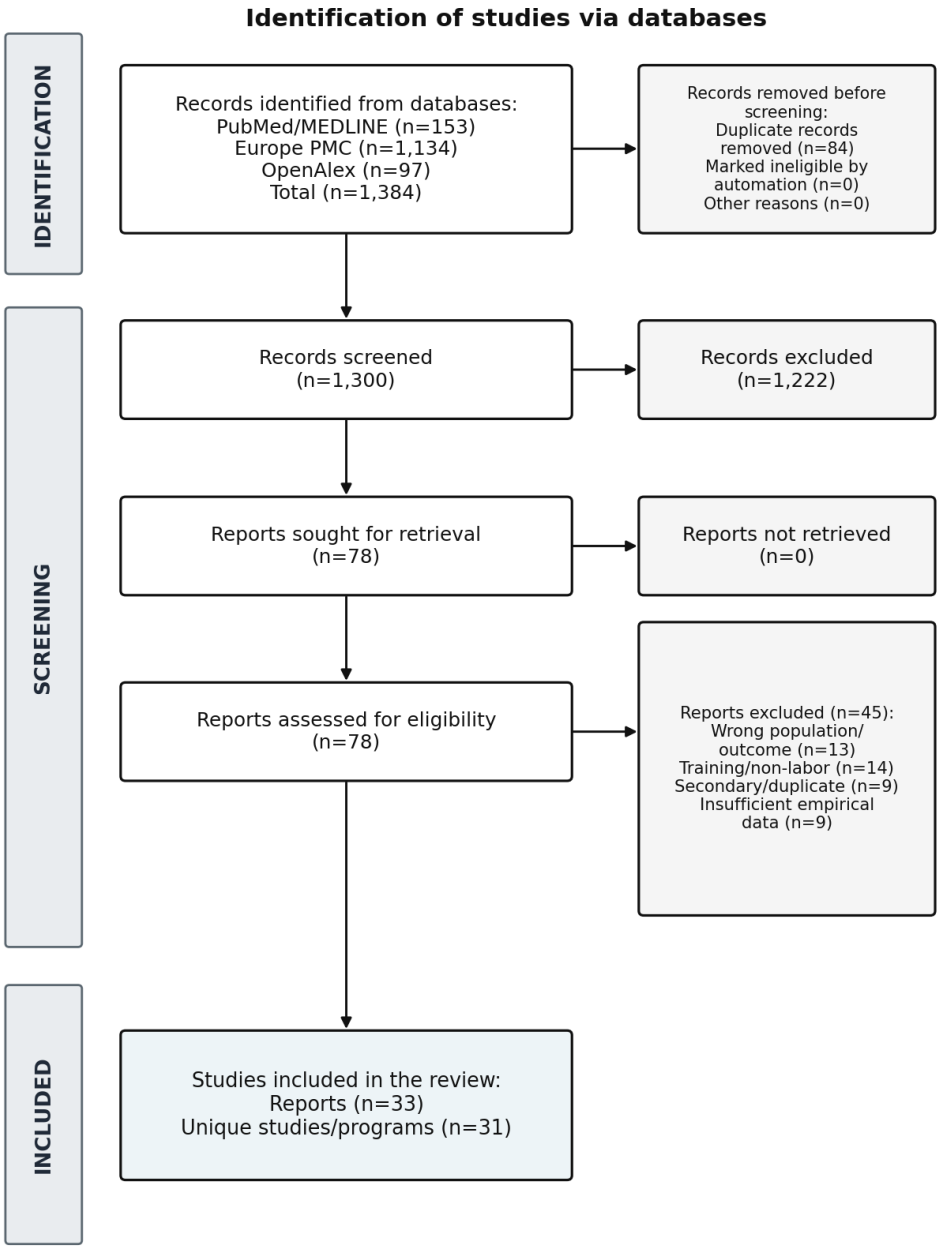
The literature expanded rapidly after 2020 and included research from Asia, Europe, the Middle East, North America, and Oceania. Immersive or headset-based virtual reality accounted for most outcome studies and was usually delivered during active first-stage labor. Conventional mHealth applications were concentrated in antenatal preparation and early labor, while qualitative and co-design studies emphasized implementation, choice, communication, and comfort.

Table 1. Evidence map of application pathways and principal outcomes.

Pathway	Typical content	Timing/stage	Direction of evidence
Immersive distraction	Nature scenes, beaches, fetal images, games, or guided virtual environments	Usually active first stage; sessions commonly aligned to 4-5, 6-7, 7-8, or 8-9 cm	Pain and anxiety generally decreased during exposure; comfort or satisfaction often improved

Pathway	Typical content	Timing/stage	Direction of evidence
Calming/cognitive content	Music, newborn imagery, mindfulness, hypnosis, pain education, or positive suggestion	Antenatal preparation, early labor, and active first stage	Improved coping, preparedness, fear, self-efficacy, or immediate pain attention
Skill coaching	Paced breathing, relaxation, animation, contraction-synchronized cues	Training during pregnancy; use between or during contractions	Promising pain and anxiety effects; intervention dose and adherence inconsistently reported
Relational/blended applications	Education, partner exercises, reminders, midwife contact, and early-labor support	Antenatal period and self-management of early labor	Feasible and acceptable; clinical outcomes mixed and often observational
Qualitative/design evidence	Co-design, focus groups, and interviews about virtual reality or early-labor applications	Antenatal familiarization and intrapartum use	User choice, simple control, physical comfort, offline access, and partner-midwife connection were central

Figure 1. PRISMA-ScR flow of evidence selection.



Labor pain, analgesia, and psychological outcomes

The direction of evidence favored short-term pain relief. Early and contemporary studies reported lower pain during or immediately after virtual-reality or audiovisual exposure (Akin et al., 2021; Ballıkaya & Bilgin, 2026; Ebrahimian et al., 2022; El Sharkawy et al., 2022; Carus et al., 2022; El-Sayed Hussein et al., 2022; Frey et al., 2019; Gür & Apay, 2020; Mahalan & Smitha, 2023; Massov et al., 2023; Mohammadi et al., 2023; Momenyan et al., 2021; Pratiwi et al., 2017; Sunay & Uçar, 2025; Wong et al., 2021; Yu et al., 2026). The most defensible interpretation is an on-demand coping effect: Correia et al. (2026) found a significant benefit during use, but the difference was no longer significant 30 minutes after exposure.

Evidence for reduced pharmacological analgesia was limited. A pilot comparison with nitrous oxide showed feasibility but was not powered to demonstrate clinical equivalence (Yun et al., 2025), while a matched study found favorable analgesia use and labor-duration findings but retained substantial selection uncertainty (Van Leugenhaege et al., 2025). Anxiety and fear generally improved alongside pain. Comfort and satisfaction also tended to improve, although conventional applications produced more variable clinical findings. The ELSA Birth App did not significantly alter early-labor distress, pain relief, or childbirth experience, despite improvement in fear of a future birth (Ängeby et al., 2025). Other mobile applications primarily improved knowledge, preparedness, self-efficacy, or early-labor support (Fritzson et al., 2023; Hock et al., 2026; Iwaya et al., 2023; Khademioore et al., 2023).

Cervical dilatation and labor progress

Cervical dilatation served three main roles: an eligibility threshold, a trigger for repeated sessions, and a standardized point for pain measurement. Several trials assessed participants at 4-5 cm and again at 7-9 cm, which improves comparison across changing labor intensity but does not establish that the application caused the cervix to dilate faster. No included study specified cervical dilatation rate in cm/hour as a validated primary endpoint or used repeated time-stamped examinations to estimate a robust dilatation slope.

Some studies reported shorter active-stage or total labor duration, whereas others found no difference in total labor, second-stage duration, or neonatal outcomes (Ebrahimian & Rahmani Bilandi, 2021; Oruç & Kabukcuoglu, 2026). Shorter-stage findings were more common in nonrandomized or methodologically weaker studies. Labor duration is influenced by parity, fetal position, induction or augmentation, neuraxial analgesia, mobility, hydration, support, and clinical decision thresholds. Therefore, claiming that an application 'accelerates cervical dilatation' is not currently evidence supported.

Table 2. Interpretation of cervical-dilatation variables in application research.

Use of dilatation	Operational meaning	Valid interpretation
Eligibility	Minimum cervical opening used to enroll participants	Defines the labor context; not an outcome
Intervention timing	Sessions delivered at prespecified bands such as 4-5, 6-7, or 8-9 cm	Standardizes exposure across labor intensity
Pain assessment	Pain measured at the same dilatation point in intervention and control groups	Improves comparability but does not measure dilatation speed
Labor progress	Stage duration or time between clinical examinations	Mixed findings; vulnerable to confounding and inconsistent definitions
Dilatation rate	Repeated time-stamped examinations analyzed as cm/hour or trajectory	Not established as a validated primary endpoint in the included evidence

Safety, acceptability, and implications for application development

Most studies reported no clinically important maternal or fetal adverse effects, but adverse-event ascertainment was inconsistent. Headset weight, heat, nausea, dizziness, visual discomfort, reduced situational awareness, hygiene, and interruption of communication were not systematically measured in many trials. Qualitative studies emphasized antenatal familiarization, varied content, simple controls, freedom to stop, physical comfort, partner involvement, and continued connection with the midwife (Massov et al., 2024; Musters et al., 2023; Van Leugenhaege et al., 2024).

The evidence supports a CALM intervention engine comprising Calming audio, Affirmation, Lamaze-type paced breathing, and Mindfulness or relaxation. These components should be delivered through a stage-and-safety gate rather than as an undifferentiated media library. A user could select a brief audio-only mode during intense contractions, a visual breathing coach between contractions, or immersive content when appropriate. Contraction-synchronized cues are promising (Melillo et al., 2024), but automated clinical recommendations require validation. The application should supplement shared decision-making and never substitute for requested pharmacological analgesia or skilled clinical monitoring.

Figure 2. Evidence-informed architecture for an intrapartum application.

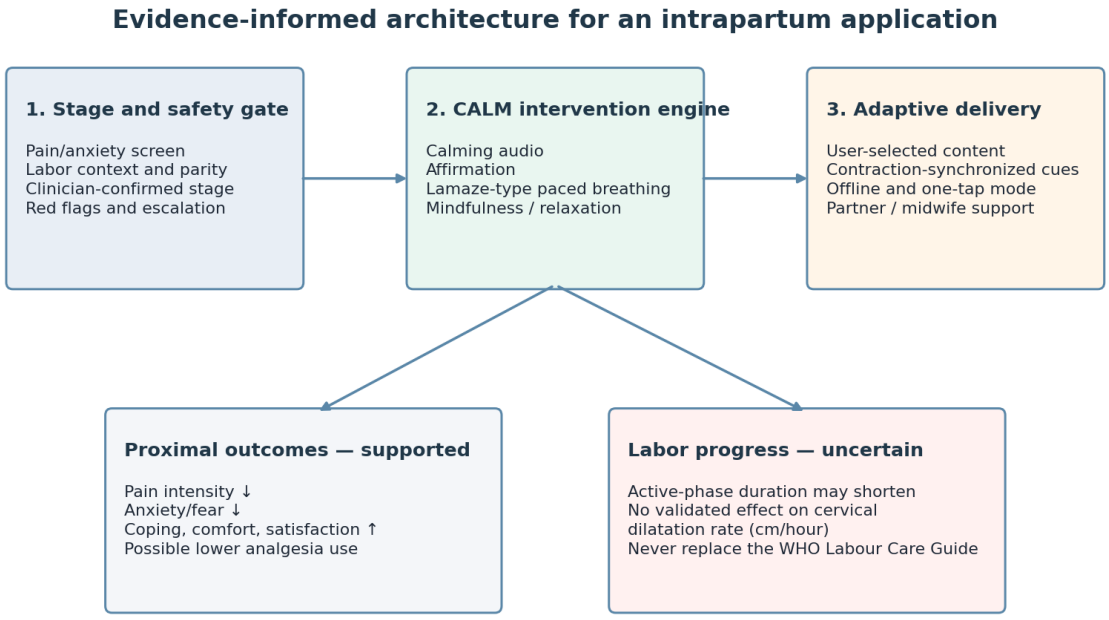


Table 3. Evidence-informed application requirements.

Requirement	Operational feature
Stage-aware onboarding	Teach and test the application antenatally; offer early- and active-labor modes
CALM content library	Calming audio, affirmation, paced breathing, mindfulness/relaxation, and audio-only alternatives
User choice	One-tap start, pause, change, and stop functions with minimal navigation
Adaptive delivery	Optional contraction timing and brief content sized to contraction cycles
Partner-midwife integration	Partner prompts, supportive-language scripts, and a clear escalation route
Offline operation	Downloadable audio and visual assets without mandatory continuous connectivity
Safety boundary	Red-flag information, stop criteria, adverse-effect prompts, and no self-estimation of cervical dilatation
Privacy and governance	Minimal data collection, consent, encryption, role-based access, and incident management

Requirement	Operational feature
Research logging	Pain, coping, use time, content, interruptions, analgesia, and clinician-entered stage

Strengths and limitations

This review used a broad application definition, explicitly separated dilatation as a timing variable from dilatation as an outcome, included quantitative and qualitative evidence, and translated findings into design and evaluation requirements. However, the search did not directly include subscription databases such as Embase, CINAHL, or Scopus; OpenAlex and Europe PMC were used to broaden coverage beyond PubMed. Screening and charting were completed by one reviewer using a rapid method, and no formal critical appraisal was performed. Interventions, comparators, parity, dilatation thresholds, and pain measures were heterogeneous. Accordingly, the synthesis maps evidence and gaps but does not provide a pooled estimate or certainty rating.

CONCLUSION

Application-based digital support is a promising adjunct for reducing labor pain and anxiety and improving coping, comfort, or satisfaction, particularly while the application is actively used. Cervical dilatation may be used to tailor and standardize supportive content only when the stage has been clinically assessed. Current evidence does not show that an application directly increases cervical dilatation rate or safely prevents labor dystocia. A clinically responsible development program should therefore make pain coping the primary claim, treat labor duration and dilatation trajectory as secondary or exploratory outcomes, provide user-controlled offline content, integrate partner and midwife support, and embed the application within woman-centered clinical monitoring.

ACKNOWLEDGEMENT

The author acknowledges the researchers and women whose studies informed this evidence map. No specific funding was received for this rapid scoping review. The author is developing an application-informed educational model for childbirth support; no commercial product was evaluated in this review.

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