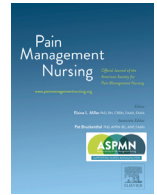




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Review Article

Healthcare Providers' Utilization of Nonpharmacological Methods in Managing Labor Pain: An Integrative Review



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ABSTRACT

Background: The management of labor pain is a critical aspect of maternal care, with implications for the well-being of both the mother and the newborn. Nonpharmacological pain management (NPPM) offers a safe and more accessible option to labor pain management in African healthcare settings.

Objective: This review aims to determine the facilitators of and barriers to using NPPM during labor among healthcare professionals (HCPs) in Africa.

Methods: This integrative review was done using articles that focused on NPPM and published between 2013 and 2023. Databases searched include PubMed, CINAHL, SCOPUS, and EMBASE. Content analysis was done independently by two reviewers using inductive coding to generate categories.

Findings: Three main themes emerged: Perceived barriers to the utilization of NPPM among HCPs, categories that emerged under this theme include lack of training, resource limitation, lack of priority, cultural norms and beliefs, and lack of awareness. The second theme is potential facilitators to the utilization of NPPM among HCP, the categories generated include healthcare provider' knowledge, positive attitude of healthcare providers, family support, infrastructure/working environment, experiences of HCPs, and client preferences. The third theme that emerged is the most utilized methods of NPPM among HCPs, with back massage and psychological support being the most used, whereas music and exercise were the least NPPM methods used by HCPs.

Recommendations and implications for care: The findings from this study show that the attitudes and knowledge of HCPs about NPPM can either be a facilitator or a barrier in its utilization. In the clinical setting, HCPs need to be sensitized on the benefits of using these methods of pain management during labor to encourage use. Interventions designed based on the findings from this study can promote a more holistic approach to labor pain management in African healthcare settings.

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Background

Labor, while a transformative experience, can be accompanied by intense pain, impacting women's physical and emotional well-being. The management of labor pain is a critical aspect of maternal care, with implications for the well-being of both the mother and the newborn (Barut et al., 2024). Effective pain management during labor results in a more satisfactory birthing experience and a healthy reproductive outcome for mother and child

(Jones et al., 2012). Labor pain can be managed pharmacologically, using opioids and neuraxial methods, and nonpharmacologically using techniques like breathing and back massages that have shown evidence of reducing pain and improving relaxation and mental health of women during active labor (Jones et al., 2012). Large disparities exist between the use of these methods and the rationale behind them (Mousa et al., 2018; Osório et al., 2014). While medications undeniably hold a place in labor analgesia, concerns regarding potential overprescribing, side effects like a prolonged second stage, increased rate of cesarean or assisted vaginal delivery (Jones et al., 2012; Smith et al., 2021), and limited access in certain regions necessitate exploring alternative approaches.

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Table 1
Eligibility Criteria.

PICo Format	Inclusion Criteria	Exclusion Criteria
Population	Healthcare providers	Nonmedical personnel such as mothers, doulas, and any other family or community members
The phenomenon of interest (I)	The utilization of nonpharmacological techniques for labor pain management	The utilization of pharmacological techniques for labor pain management, the utilization of nonpharmacological techniques for other pain management
Context (Co)	Any hospital or clinical setting in African countries	Home, other than African countries
Publication date	All articles published between 2013 and 2023	Articles before 2013
Language	English	Non-English articles

PICo, phenomenon of interest, and context.

Studies report high rates of uncontrolled labor pain in Africa (McCauley et al., 2017; Wakgari et al., 2020) with only about 13.8% of healthcare professionals (HCP) who participated in a study routinely practicing labor pain management. Contributing to the poor labor management practices include cultural beliefs that pain is a normal aspect of labor and therefore does not require pharmacological intervention, growing awareness of the negative effects of overusing pharmacological interventions for mother and baby, lack of resources and knowledge and training gaps in hospitals, and women's desire for more natural birthing experiences (Smith et al., 2021).

Nonpharmacological pain management (NPPM) methods for controlling labor pain refer to a variety of techniques and approaches that aim to reduce or manage the discomfort associated with childbirth without the use of drugs or medical interventions (Barut et al., 2024). NPPM methods in Africa are deeply rooted in cultural practices that have been prevalent across the continent for centuries (Cheyney & Davis-Floyd, 2021). Rhythmic breathing, communal support systems, traditional massage techniques, and the use of specific birthing positions are some of the various approaches used by various communities to manage a woman's pain during labor (Cheyney & Davis-Floyd, 2021; Mwakawanga et al., 2022). These practices, passed down generations, not only help to alleviate pain but hold cultural significance and build a sense of community and shared experiences. Exploring the effectiveness of a more holistic NPPM approach, Osório et al. (2014) found that in addition to reducing pain perception, NPPM lowers anxiety and stress levels and does not interfere with the kind and duration of labor, making it safe in clinical practice.

Given the challenges in utilizing pharmacological methods of pain control and the benefits and cultural significance of NPPM, one wonders why HCPs in Africa hesitate to employ NPPM more frequently. Understanding the unique challenges and opportunities within the African healthcare system and incorporating culturally relevant practices is vital for successful NPPM implementation (Morris & Roques, 2018). The purpose of this review is to synthesize the current evidence of the facilitators for and the barriers to using NPPM among HCPs in Africa. In addition, this review also examined often-used NPPM among HCPs in Africa. The following research questions guide this review. First, what are the facilitators for the utilization of NPPM among HCPs in Africa? Second, what are the barriers to the utilization of NPPM among HCPs in Africa? And lastly, what are the commonly used methods among HCPs in Africa?

Materials and Methods

Design

This integrative review adhered to the methodology outlined by Whittemore and Knafl (2005), which offers a systematic and flexible approach for integrative reviews, accommodating diverse

study designs and ensuring methodological rigor. Whittemore and Knafl proposed a five-step process to increase the methodological rigor in nursing research. Their integrative review approach involves identifying the research problem, conducting a thorough literature search, assessing the data quality, analyzing the data, and presenting the findings (Whittemore & Knafl, 2005).

Eligibility Criteria

This was based on the Population, Intervention/phenomenon of interest, and context (PICo) framework. The focus population comprises healthcare providers, with the intervention utilizing non-pharmacological techniques for labor pain management. The context includes studies conducted in clinical settings in Africa (see Table 1).

Types of Sources

In this review, we exclusively selected studies written in English language, broadly including quantitative, qualitative, and mixed-methods research designs. This also included both experimental and nonexperimental designs. The scope of our review was limited to studies published between 2013 and 2023.

Search Strategy

Our search strategy was aligned with the PICo question format to identify articles pertinent to the review questions. In October 2023, we searched PubMed, CINAHL, Embase, and Scopus. Our keyword search across PubMed and additional databases focused on terms such as “non-pharmacological,” “NPPM,” “pain,” “labor pain,” “healthcare providers,” “health personnel,” “Healthcare professionals,” “clinicians,” “nurses,” “doctors,” “midwives,” “pain management,” “Facilitators,” “enablers,” “promoting factors,” “challenges,” “obstacles,” “non-drug pain management,” “common methods,” “preferred methods,” “utilization,” “practices,” and “Africa.”

Study Selection

A total of 327 (44, 129, 100, 54) articles were retrieved from all databases, which we initially screened based on their titles and abstracts. The chosen articles were imported into the Rayyan article management software designed to help researchers efficiently manage and review vast amounts of scientific literature. The articles were then independently assessed for eligibility based on pre-defined inclusion and exclusion criteria by all reviewers (LA, TH, HD, and PS). Twenty-two duplicates were removed, and 283 articles were initially excluded by title and abstract. Twenty-six articles were reviewed in full text. After a thorough evaluation, we narrowed down the selection to 15 relevant articles that aligned with our research questions. Most of the excluded articles focused

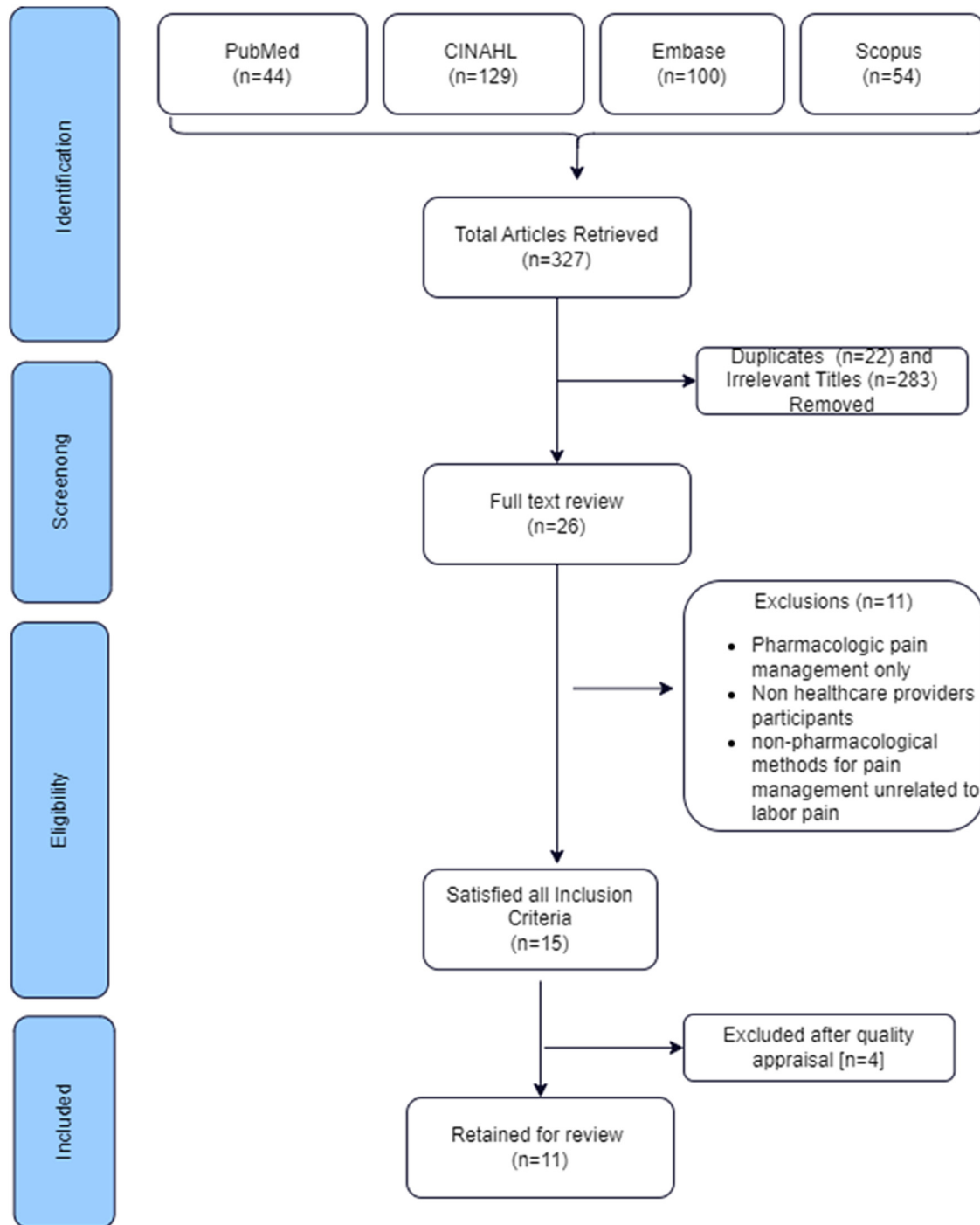


Figure 1. PRISMA flow diagram.

on pharmacological approaches to labor pain management, strategies employed by mothers for managing labor pain, and the application of nonpharmacological methods for pain management unrelated to labor pain. Four articles were subsequently removed after quality appraisal. A total of 11 articles were retained for the final review (Fig. 1).

A pilot screening of 3 articles was conducted to identify and resolve any challenges in the screening process. Following this, a comprehensive screening was initiated without delay. Any disagreements encountered during this phase were resolved through discussion until a consensus was reached.

Data Extraction and Synthesis

We created a Microsoft Excel spreadsheet to facilitate data extraction from the selected articles. The tool was periodically adjusted to align with the evolving study questions. Data extraction was carried out by two reviewers (PS and TH), after which the remaining reviewers (HD and LA) reviewed the extracted data for completeness. To fully comprehend the facilitators and barriers to utilizing NPPM methods, information regarding author/year, study aims, study characteristics, research methods, and other key features were meticulously

extracted (see data matrix of included studies in Supplemental File 1).

Quality Appraisal

The appraisal tool used in this review to assess the quality of the evidence of the studies was adapted from the Johns Hopkins Nursing Evidence-Based Practice (JNEBP) Research Appraisal Tool (Ryan et al., 2017). The JNEBP-Research Evidence Appraisal Tool has 13 criteria for assessing and evaluating the quality of the evidence. The quality rating for the studies is composed of “A” for High-quality studies, “B” for Good-quality studies, and “C” for Low-quality studies with major flaws. For this review and easy understanding, we categorized the studies as follows: A—studies were those with a score of 11–13, hence a high-quality study; B—studies were with a score of between 7 and 10 entails good quality studies; and C—studies were with a score of 6 or less/poor quality studies. Only articles with A and B quality were included in this review. All 11 articles that met the criteria went through the quality of evidence assessment process. The initial quality appraisal of studies was conducted by two authors (LA and TH) and checked for accuracy and completeness by the other two authors (PS and HD).

Data Analysis and Presentation

Data about study characteristics were processed using descriptive statistical techniques. For qualitative data, such as the barriers and facilitators of utilizing NPPM, a narrative synthesis was conducted through descriptive qualitative content analysis (Vaismoradi et al., 2013). This method entailed systematically organizing and interpreting data content, employing coding and categorization strategies to analyze the information thoroughly. In order to make sense of our data, analysis began by identifying meaning units and then condensed units. Following this step, condensed units were developed into codes and categories. Finally, categories were merged with major themes. The review adopted an inductive approach for data synthesis and categorization, beginning with specific observations and progressing toward a broader theoretical framework (Younas et al., 2022). The findings were presented through tables, figures, and narrative summaries to effectively convey the reviewed data.

Results

Study Characteristics

A total of 11 articles were included in this review; 7 were quantitative studies (Bishaw et al., 2020; Eyeberu et al., 2022; Getu et al., 2020; McCauley et al., 2017; Ohaeri et al., 2019; Shiferaw et al., 2022; Wassihun et al., 2022), and 4 were qualitative studies (Aziato et al., 2017; Boateng et al., 2019; McCauley et al., 2018; Mwakawanga et al., 2022). The studies were published between 2013 and 2023 and conducted in Africa. Six studies were from Ethiopia (Bishaw et al., 2020; Eyeberu et al., 2022; Getu et al., 2020; McCauley et al., 2017; Shiferaw et al., 2022; Wassihun et al., 2022), two from Tanzania (McCauley et al., 2018; Mwakawanga et al., 2022), two from Ghana (Aziato et al., 2017; Boateng et al., 2019), and one from Nigeria (Ohaeri et al., 2019). Most studies examined the factors influencing the utilization of NPPM methods among healthcare providers. About nine studies mentioned the often-utilized NPPM methods in healthcare facilities. Most of the studies included Skilled Birth Attendants (mid-

wives, nurses, and doctors), and two included nurses and anesthetists.

Data collection was mainly through structured questionnaires and semi-structured interview guides. All quantitative studies used primary data sources (Bishaw et al., 2020; Eyeberu et al., 2022; Getu et al., 2020; McCauley et al., 2017; Ohaeri et al., 2019; Shiferaw et al., 2022; Wassihun et al., 2022); three conducted In-depth Interviews (Aziato et al., 2017; Boateng et al., 2019; Mwakawanga et al., 2022), and one used Focused Group Discussion and in-depth interviews (McCauley et al., 2018). Most studies took place in hospitals, followed by health centers.

All studies reported the factors for the utilization of NPPM methods among healthcare providers. Factors that facilitated the utilization of NPPM methods were HCPs' knowledge, healthcare providers' positive attitude, good infrastructure and working environment, family support, healthcare providers' experiences, and healthcare providers' and clients' preferences. Factors that hindered the utilization of the NPPM method included lack of training, resource limitation, lack of priority, cultural norms, and beliefs. After thorough data synthesis, three themes emerged. These are Theme 1: Potential facilitators to the utilization of NPPM among healthcare providers; Theme 2: Perceived barriers to the utilization of NPPM among healthcare providers; and Theme 3: Often utilized methods of NPPM among healthcare providers.

Theme 1: Potential facilitators to the utilization of NPPM among healthcare providers

Seven studies reported the facilitators to the utilization of NPPM among healthcare providers (Bishaw et al., 2020; Eyeberu et al., 2022; Getu et al., 2020; McCauley et al., 2018; Mwakawanga et al., 2022; Shiferaw et al., 2022; Wassihun et al., 2022). Categories derived from the synthesis were: (A) health provider's knowledge, (B) healthcare providers' positive attitude, (C) good infrastructure and working environment, (D) family support, (E) healthcare providers' experiences, and (F) healthcare providers' and clients' preferences (see Table 2 for the details of codes and categories). Six authors highlighted that adequate knowledge of the use and the benefits of NPPM facilitated the utilization of NPPM methods among healthcare providers (Bishaw et al., 2020; Eyeberu et al., 2022; Getu et al., 2020; McCauley et al., 2017; Shiferaw et al., 2022; Wassihun et al., 2022). Five authors reported healthcare providers' positive attitudes about using NPPM within hospitals. Authors noted positive attitudes among healthcare providers based on reasons such as the advantages of NPPM in terms of lacking side effects and comfort measures that naturally relieve labor pain (Bishaw et al., 2020; Eyeberu et al., 2022; Getu et al., 2020; McCauley et al., 2018; Wassihun et al., 2022). A favorable working environment, including having labor rooms that ensure women's privacy, facilitates NPPM utilization (Wassihun et al., 2022).

Furthermore, the authors mentioned that healthcare providers' clinical experience was an enabler of the utilization of NPPM. Wassihun et al. (2022) and Bishaw et al. (2020) stated that the likelihood of utilizing NPPM methods increases as the years of experience increase (Bishaw et al., 2020; Wassihun et al., 2022). Family support and companionship were also noted as facilitators for utilizing NPPM methods. Having the husband/partner or a close family member around during labor was beneficial for the psychological support of laboring women (Shiferaw et al., 2022). It was also observed that healthcare providers' and clients' inclination to NPPM over pharmacological pain management methods facilitated the utilization of NPPM (Eyeberu et al., 2022; Mwakawanga et al., 2022).

Table 2
Potential Facilitators and Barriers to the Utilization of NPPM Methods Among Healthcare Providers.

Themes	Categories	Codes
Potential facilitators to the utilization of NPPM among healthcare providers	Healthcare providers knowledge	<ul style="list-style-type: none"> • Adequate knowledge • Good knowledge
	Healthcare providers' positive attitude	<ul style="list-style-type: none"> • Positive attitude • Being a midwife
	Good infrastructure and working environment	<ul style="list-style-type: none"> • Availability of resources • Availability of infrastructure • Availability of protocols
	Family support	<ul style="list-style-type: none"> • Companion availability
	Healthcare providers experiences Healthcare providers and clients' preferences	<ul style="list-style-type: none"> • Experience • Preference
Perceived barriers to the utilization of NPPM among healthcare providers	Lack of training	<ul style="list-style-type: none"> • Incompetence • Uncertainty of what to do
	Resources Limitation	<ul style="list-style-type: none"> • Staff shortage • Lack of resources • Time constraints • Privacy
	Lack of priority	<ul style="list-style-type: none"> • Not important • Client preference
	Cultural norms and beliefs	<ul style="list-style-type: none"> • Cultural norms and beliefs

NPPM, nonpharmacological pain management.

Theme 2: Perceived barriers to the utilization of NPPM among healthcare providers

Seven articles reported the barriers to the utilization of NPPM among healthcare providers. These were described as potential hindrances to the utilization of NPPM methods and were grouped into five categories: (A) lack of training, (B) resource limitation, (C) lack of priority, and (D) cultural norms and beliefs (see Table 2).

Unskillfulness resulting from a lack of training in utilizing NPPM methods among healthcare providers was reported by Bishaw et al., (2020), Getu et al. (2020), and McCauley et al., (2018). Resources limitations include time constraints, understaffing/staff shortage, high patient flow, limited protocols, limited space, and heavy workload distribution among healthcare providers, which hinder the utilization of the NPPM method during laboring (Bishaw et al., 2020; Boateng et al., 2019; Getu et al., 2020; McCauley et al., 2018). McCauley et al. (2018) pointed out that the way labor rooms are constructed hinders the provision of individualized care during delivery, as the following quotation affirms:

We need to keep privacy, and if you have a lot of relatives around and only a small curtain, there is no privacy to patients, no secrets for them... We need more space (McCauley et al., 2018 p. 5).

Some authors pointed out that healthcare providers lack priority in utilizing NPPM because they think pain relief is not a priority during labor (Getu et al., 2020; McCauley et al., 2018). The cultural norms, beliefs, and misconceptions within society and how labor pain is perceived make it difficult for healthcare providers to utilize NPPM within healthcare facilities (McCauley et al., 2017; Mwakawanga et al., 2022).

Theme 3: Often utilized methods of NPPM among healthcare providers

The most frequently cited NPPM method was back massage, which was mentioned nine times (Aziato et al., 2017; Bishaw et al., 2020; Eyeberu et al., 2022; McCauley et al., 2017, 2018; Mwakawanga et al., 2022; Ohaeri et al., 2019; Shiferaw et al., 2022; Wassihun et al., 2022). Psychotherapy and breathing control/relaxation were mentioned eight and seven times. Other methods included showing women how to bear down, allowing a com-

panion of her choice, position change, allowing the mother to ambulate, hot compression, warm birth, talking distraction, and music. The least used NPPM methods were exercise, subcutaneous water injection, and Transcutaneous Electrical Nerve Stimulation (see Fig. 2).

Discussion

The primary objective of this integrative review was to synthesize the barriers and facilitators for utilizing nonpharmacological labor pain management among healthcare providers in Africa and then highlight the often-utilized methods of NPPM among healthcare providers. The key findings of narrative data from the articles were presented into three main Theme 1; Potential facilitators to the utilization of NPPM among healthcare providers which included healthcare providers' knowledge, healthcare providers' positive attitude, good infrastructure and working environment, family support, healthcare providers' experiences, and healthcare providers' and clients' preferences; Theme 2; Perceived barriers to the utilization of NPPM among healthcare providers which composed of lack of training, resource limitation, lack of priority, and cultural norms and beliefs, and Theme 3; Often utilized methods of NPPM among healthcare providers. As far as we know, this research is the first integrative review to investigate the factors that facilitate and hinder the use of NPPM in Africa.

The review identifies key facilitators that can enhance the adoption and effectiveness of NPPM in Africa, including healthcare providers' knowledge, healthcare providers' positive attitudes toward NPPM, family support, and healthcare providers' experiences with NPPM, and alignment with healthcare providers and clients' preferences. Conversely, the results show that lack of training, resource limitations, lack of priority, and cultural norms and beliefs are the major barriers to utilizing nonpharmacological labor pain management among healthcare providers in Africa. The lack of training highlights a gap in the current healthcare education and professional development programs, which may not adequately cover NPPM strategies. This is further exacerbated by the limited resources available in healthcare settings, affecting the ability to implement NPPM even when knowledge exists (Eyeberu et al., 2022). The findings regarding cultural norms and beliefs point to the deep-rooted societal perspectives that may hinder the

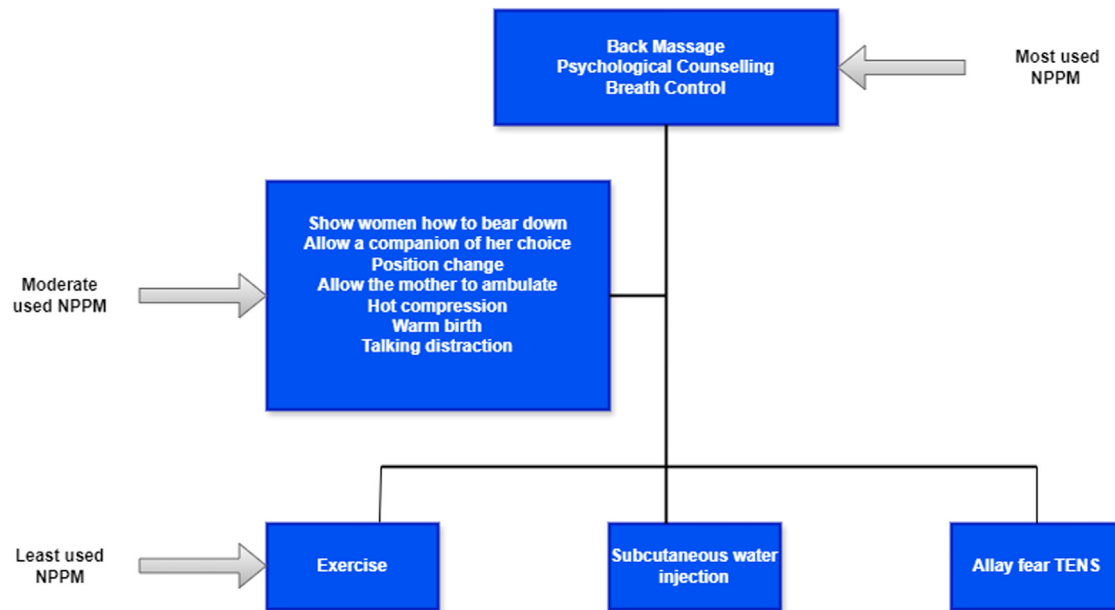


Figure 2. Often-used NPPM methods among healthcare providers.

acceptance and utilization of NPPM, suggesting that any interventions must be culturally sensitive and appropriate (Cheyney & Davis-Floyd, 2021). Lastly, the lack of priority given to NPPM over pharmacological interventions could reflect a broader issue within the healthcare system's approach to pain management, possibly influenced by pharmaceutical availability, ease of use, and prevailing medical practices (Barut et al., 2024).

Healthcare providers' knowledge emerges as both a barrier and a facilitator, underscoring the importance of comprehensive education and skill development in NPPM techniques for healthcare providers. The positive attitudes of healthcare providers toward NPPM, combined with supportive family involvement and conducive working environments, can significantly influence the successful implementation of NPPM strategies (Tsegaye et al., 2023). These facilitators highlight the potential for creating a supportive ecosystem for NPPM, leveraging the experiences and preferences of healthcare providers and clients to tailor interventions effectively. The study conducted by Ibrahim et al. (2024) also supported the finding that adequate knowledge and positive attitudes of healthcare providers toward NPPM can facilitate its use in managing labor pain.

Concerning often utilized methods of NPPM among healthcare providers in Africa, the findings highlight a diverse range of techniques, including back massage, breathing control, and psychological support, as the most used methods in Africa. These findings underscore the multifaceted approach to pain management that transcends pharmacological interventions, emphasizing the importance of holistic and patient-centered care practices. The diversity of NPPM methods identified in this review reflects the adaptability of healthcare providers in Africa to utilize available resources creatively to enhance patient comfort and pain management. Techniques such as back massage and psychological support indicate a personalized approach to care, recognizing the importance of physical and emotional support during labor. The allowance of a companion and the encouragement of position changes and ambulation align with the World Health Organization's recommendations for promoting a positive childbirth experience, highlighting the shift toward more woman-centered care practices (Oladapo et al., 2018). However, the emphasis on methods that do not require extensive resources, such as psychological support, may reflect the resource

constraints typical in many African healthcare settings. This contrasts with more resource-intensive methods like water birth, more commonly reported in high-resource settings, indicating a pragmatic adaptation to the local context (Burns et al., 2022).

Strengths and Limitations

This integrative review has several strengths. First, the approach allows for a broad examination of existing literature, combining data from various studies to comprehensively understand the topic across different settings and disciplines within Africa. Second, by focusing on Africa, the review addresses unique cultural, infrastructural, and economic contexts, offering insights that are directly applicable to improving healthcare practices within the continent. Thirdly, the review systematically identified barriers and facilitators, offering a balanced view that can effectively inform targeted interventions to promote NPPM during labor. Lastly, involving a range of HCP in the studies reviewed (e.g., obstetricians, anesthetists, nurses, and midwives) enriches the findings with diverse professional insights, enhancing the applicability of the recommendations.

However, several limitations to this study should be acknowledged. The review included studies with varying methodologies, sample sizes, and quality levels, potentially affecting the consistency and reliability of the findings. Africa's vast cultural and geographical diversity means that findings may not be universally applicable across all regions or settings, requiring localized adaptations of recommendations.

Implications to Practice, Policy, and Future Research

The study underscores the urgent need for comprehensive NPPM training among healthcare providers and the integration of such training into continuous professional development programs. This approach ensures providers are well-equipped with diverse pain management skills, emphasizing the adoption of patient-centered care that respects individual preferences and cultural nuances in labor. It further advocates for open patient-provider dialogues about NPPM options, tailoring care to each patient's needs.

Policymakers are encouraged to recognize NPPM's role in enhancing maternal health and satisfaction, urging the incorporation of NPPM into national maternal care protocols and the provision of resources for its implementation. This includes training materials, necessary equipment, and environments supportive of NPPM alongside policies promoting cultural sensitivity in pain management.

Additionally, given some healthcare providers' skepticism about NPPM's effectiveness, there's a call for rigorous research comparing NPPM's outcomes with pharmacological methods and exploring its impact on labor, satisfaction, and neonatal outcomes. Future studies should also address NPPM implementation barriers and facilitators in varied African contexts and how cultural beliefs affect NPPM acceptance, guiding the development of culturally competent strategies that resonate with patients and their families.

Conclusions

This integrative review aimed to explore the facilitators and barriers to utilizing NPPM techniques among healthcare providers in Africa and identify the NPPM methods most frequently employed. Key barriers identified include a lack of training, resource limitations, cultural norms and beliefs that may not align with NPPM practices, and a general lack of prioritization of nonpharmacological methods within healthcare settings. Conversely, the facilitators promoting the use of NPPM encompass HCPs' knowledge, positive attitudes and experiences among healthcare providers, and the inclusion of family support. The review also highlighted a variety of NPPM methods utilized by healthcare providers in Africa, including back massage, breathing techniques, and psychological support, allowing the presence of a companion of choice, the use of hot compression, and engaging in talking distractions.

This study underscores the critical need for comprehensive strategies to overcome the identified barriers and enhance the facilitators to NPPM use in Africa. It calls for targeted educational programs to increase awareness and skill among healthcare providers, policy reforms to support NPPM practices, and research to further explore the efficacy and implementation of these methods. By addressing these areas, there is a significant opportunity to improve maternal healthcare outcomes through the increased adoption and effective utilization of NPPM in labor and delivery across Africa.

Declaration of competing interest

The authors have no conflicts to disclose.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.pmn.2024.06.010](https://doi.org/10.1016/j.pmn.2024.06.010).

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