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(RESEARCH ARTICLE)

Non-pharmacological interventions combined with multimodal analgesia after cesarean delivery: Effects on postoperative pain, rescue analgesic use, and maternal satisfaction

Hery Henintsoa RANDRIANIRINA [1,*], Tohaina Dolly VELONJARA [2], Nivoarimelina Zoly RAKOTOMALALA [3], Théophile MAGNI FOGUIENG [1], Naharisoa Giannie RASAMIMANANA [4] and Pierana Gabriel RANDAOHARISON [3]

[1] *Surgical intensive care unit, University Hospital Center PZaGa, Faculty of medicine, university of Mahajanga, Madagascar.*
[2] *Emergency and triage department, University Hospital Center Mahavoky Atsimo, Faculty of medicine, university of Mahajanga, Madagascar.*
[3] *Department of obstetrics and gynecology, University Hospital Center PZaGa, Faculty of medicine, university of Mahajanga, Madagascar.*
[4] *Emergency and intensive care unit, University Hospital Center PZaGa, Faculty of medicine, university of Mahajanga, Madagascar.*

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Abstract

Introduction: Post-cesarean pain management remains a major challenge, as it directly influences postpartum recovery, maternal–infant bonding, and the overall childbirth experience. This study aimed to evaluate the effectiveness of combining non-pharmacological interventions with pharmacological analgesia on postoperative pain following cesarean delivery.

Methods: A prospective cohort study (1 exposed:2 non-exposed) was conducted between May and October 2025 and included 96 women undergoing cesarean delivery. The exposed group (n = 32) received standard pharmacological analgesia combined with a standardized non-pharmacological intervention protocol, whereas the non-exposed group (n = 64) received pharmacological analgesia alone. The primary outcome was postoperative pain intensity assessed at 1 hour (H1) and 2 hours (H2) after admission to the post-anesthesia care unit. Secondary outcomes included the need for rescue analgesia and maternal satisfaction assessed using a five-point Likert scale.

Results: Ninety-six women were included, including 32 in the exposed group and 64 in the non-exposed group. Baseline characteristics were generally comparable between groups, except for a slightly higher body mass index in the exposed group. Women receiving non-pharmacological interventions had a significantly lower prevalence of moderate-to-severe postoperative pain at H1 (18.8% vs. 73.4%; RR = 0.26, 95% CI: 0.12–0.53; $p < 0.001$) and H2 (12.5% vs. 81.3%; RR = 0.15, 95% CI: 0.06–0.39; $p < 0.001$). They also required rescue analgesia less frequently (12.5% vs. 43.8%; RR = 0.29, 95% CI: 0.11–0.75; $p = 0.002$) and reported a higher level of satisfaction with postoperative care (84.4% vs. 50.0%; RR = 1.69, 95% CI: 1.27–2.25; $p = 0.001$).

Conclusion: Integrating non-pharmacological interventions into a multimodal analgesic strategy significantly improves postoperative pain control and maternal satisfaction after cesarean delivery. These findings support the incorporation of non-pharmacological interventions into multimodal postoperative pain management protocols, particularly in resource-limited settings

* Corresponding author: Henintsoa RANDRIANIRINA

Keywords: Analgesia; Cesarean Delivery; Acute Postoperative Pain; Non-Pharmacological Interventions

1. Introduction

Cesarean delivery is one of the most commonly performed surgical procedures worldwide. Despite advances in anesthesia and analgesia, acute postoperative pain remains common. When inadequately controlled, it may delay functional recovery, hinder early mobilization, impair maternal–infant bonding and breastfeeding, and increase the risk of developing chronic pain (1). Current international guidelines recommend a multimodal analgesic approach combining several pharmacological strategies to optimize pain control and reduce opioid consumption. However, despite their proven efficacy, pharmacological treatments alone do not address all dimensions of postoperative pain and may be limited by adverse effects (2). Non-pharmacological interventions, including psychological support, relaxation techniques, controlled breathing exercises, massage, and music therapy, represent valuable complementary approaches that may reduce pain intensity, anxiety, and analgesic requirements while improving maternal satisfaction (3). Nevertheless, their integration into post-cesarean pain management protocols remains limited, particularly in resource-limited settings. The present study aimed to evaluate the effectiveness of combining non-pharmacological interventions with pharmacological analgesia on postoperative pain, rescue analgesic requirements, and maternal satisfaction following cesarean delivery at the Professor Zafisaona Gabriel University Hospital Center (HUPZaGa), Mahajanga, Madagascar.

2. Materials and methods

2.1. Study design and setting

This prospective comparative cohort study was conducted in the postoperative care unit of the Professor Zafisaona Gabriel University Hospital Center (CHUPZaGa) Androva, Mahajanga, Madagascar, between May 8 and October 10, 2025.

2.2. Study population

Eligible participants were women aged 18 years or older who underwent cesarean delivery under spinal anesthesia and were admitted to the post-anesthesia care unit (PACU) during the study period. Women with a documented allergy to any medication included in the analgesic protocol, those who underwent a surgical procedure differing from the department's standard protocol, or those who declined to participate were not included. Secondary exclusions comprised patients who developed postoperative complications, those without a caregiver, or those who did not receive the complete non-pharmacological intervention protocol.

2.3. Sample size and group allocation

The minimum sample size was calculated using OpenEpi software based on the Schlesselman formula, assuming a two-sided α risk of 5%, a statistical power of 80%, an exposed-to-non-exposed ratio of 1:2, an expected outcome proportion of 30% in the non-exposed group, and a relative risk of 3.0 to be detected. The calculated minimum sample size was 96 participants. To account for potential exclusions, 100 women were initially enrolled.

Eligible participants were consecutively included until the required sample size was reached while maintaining a 1:2 ratio between the exposed and non-exposed groups. Participants were allocated according to whether they received the standardized non-pharmacological intervention protocol in addition to conventional pharmacological analgesia. The exposed group received standard pharmacological analgesia combined with non-pharmacological interventions, whereas the non-exposed group received conventional pharmacological analgesia alone.

2.4. Intervention

All participants received the department's standard postoperative analgesic regimen consisting of intravenous paracetamol (1 g) and nefopam (20 mg), administered within 30 minutes after admission to the PACU. Standard postoperative monitoring included hemodynamic parameters, regression of spinal anesthesia, uterine tone, and postoperative blood loss.

In the exposed group, pharmacological analgesia was supplemented with a standardized non-pharmacological intervention protocol. This protocol included education regarding postoperative pain and pain assessment, psychological support provided by a caregiver, continuous therapeutic touch on non-painful body areas, superficial massage for 5–10 minutes repeated every 30–45 minutes, deep breathing exercises for approximately 10 minutes every 30 minutes, and relaxation techniques tailored to the patient's preferences.

2.5. Study variables

Data were collected using a standardized case report form. Baseline variables included age, body mass index (BMI), medical, surgical, and obstetric history, and whether the cesarean delivery was elective or performed as an emergency procedure.

The primary outcome was postoperative pain intensity assessed at 1 hour (H1) and 2 hours (H2) after admission to the PACU using the Simple Verbal Scale (SVS), scored from 0 to 4 (0 = no pain, 1 = mild pain, 2 = moderate pain, 3 = severe pain, and 4 = very severe pain).

Secondary outcomes included the need for rescue analgesia (non-steroidal anti-inflammatory drugs or opioids) in patients with an SVS score >2 and maternal satisfaction, assessed using a five-point Likert scale ranging from 1 (very dissatisfied) to 5 (very satisfied). Postoperative care was considered satisfactory when the Likert score was ≥4 (satisfied or very satisfied). All participants received standardized instructions on the use of the assessment scales before data collection.

2.6. Statistical analysis

Data were entered and analyzed using SPSS® version 27.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages, whereas continuous variables were presented as means ± standard deviations or medians, depending on their distribution.

Associations between exposure to non-pharmacological interventions and study outcomes were assessed by calculating relative risks (RRs) with their corresponding 95% confidence intervals (95% CIs). Between-group comparisons were performed using Pearson's chi-square test or Fisher's exact test for categorical variables and the independent-samples Student's *t*-test or the Mann–Whitney *U* test for continuous variables, as appropriate. A two-sided p value <0.05 was considered statistically significant.

2.7. Ethical considerations

All participants received detailed information regarding the objectives of the study and provided written informed consent before enrollment. Participant anonymity and data confidentiality were maintained throughout the study.

3. Results

During the study period, 296 women underwent cesarean delivery. Following sample size calculation, 100 women were enrolled. Four participants were subsequently excluded according to the predefined exclusion criteria, resulting in a final study population of 96 women, including 32 in the exposed group and 64 in the non-exposed group. Baseline characteristics of the study population are presented in Table 1. The overall mean age was 28.30 ± 6.47 years, and the mean body mass index (BMI) was 26.50 ± 4.03 kg/m^2. The two groups were generally comparable with respect to demographic, obstetric, and clinical characteristics, except for BMI, which was slightly higher in the exposed group than in the non-exposed group (27.76 ± 4.01 vs. 25.87 ± 3.91 kg/m^2; $p = 0.030$).

Study outcomes are summarized in Table 2. Women who received non-pharmacological interventions had significantly lower postoperative pain scores at H1 (0.78 ± 0.83 vs. 1.88 ± 0.79; $p < 0.001$) and H2 (0.94 ± 0.95 vs. 2.11 ± 0.78; $p < 0.001$). The prevalence of moderate-to-severe postoperative pain was also significantly lower in the exposed group at both H1 (18.75% vs. 73.44%; RR = 0.26, 95% CI: 0.12–0.53; $p < 0.001$) and H2 (12.50% vs. 81.25%; RR = 0.15, 95% CI: 0.06–0.39; $p < 0.001$).

The use of rescue analgesia was significantly less frequent among women in the exposed group than among those in the non-exposed group (12.5% vs. 43.75%; RR = 0.29, 95% CI: 0.11–0.75; $p = 0.002$). Likewise, satisfactory postoperative care was reported more frequently by women who received non-pharmacological interventions (84.37% vs. 50.0%; RR = 1.69, 95% CI: 1.27–2.25; $p = 0.001$).

Table 1 Baseline characteristics of the study population according to study group

	Exposed (n = 32)	**Non-exposed (n = 64)**	***p* value**
Sociodemographic characteristics, mean ± SD			
Age (years)	27.66 ± 5.49	28.63 ± 6.92	0.492*
Body mass index (kg/m^2)	27.76 ± 4.01	25.87 ± 3.91	0.030*
Obstetric history, mean ± SD			
Gravidity	2.13 ± 1.26	2.63 ± 1.86	0.175*
Parity	1.84 ± 1.22	2.27 ± 1.84	0.245*
Medical and surgical history, n (%)			
Previous cesarean delivery	8 (25.0)	22 (34.4)	0.350**
Previous non-obstetric surgery	0 (0.0)	5 (7.8)	0.099**
Hypertension	2 (6.3)	3 (4.7)	0.745**
Preeclampsia	2 (6.3)	3 (4.7)	0.745**
Sickle cell disease	1 (3.1)	1 (1.6)	0.613**
Chronic pain	0 (0.0)	2 (3.1)	0.312**
Chronic paracetamol use	0 (0.0)	2 (3.1)	0.312**
Surgical characteristics, n (%)			
Emergency cesarean delivery	22 (68.8)	48 (75.0)	0.516**
Quiet recovery room at admission	25 (78.1)	42 (65.6)	0.209**

*Student's independent-samples t-test. **Pearson's chi-square test.

Table 2 Study outcomes according to study group

	Exposed n (%)	**Non-exposed n (%)**	**RR**	**95% CI**	***p* value**
Moderate-to-severe postoperative pain at H1					
Absent	26 (81.3)	17 (26.6)			
Present	6 (18.8)	47 (73.4)	0.26	0.12–0.53	<0.001**
Moderate-to-severe postoperative pain at H2					
Absent	28 (87.5)	12 (18.8)			
Present	4 (12.5)	52 (81.3)	0.15	0.06–0.39	<0.001**
Rescue analgesia (NSAID or opioid)					
No	28 (87.5)	36 (56.3)			
Yes	4 (12.5)	28 (43.8)	0.29	0.11–0.75	0.002**
Satisfactory postoperative care (Likert score ≥4)					
No	5 (15.6)	32 (50.0)			
Yes	27 (84.4)	32 (50.0)	1.69	1.27–2.25	0.001*

*Student's independent-samples t-test. **Pearson's chi-square test.

4. Discussion

4.1. Population characteristics

In the present study, women who received non-pharmacological interventions and those who received pharmacological analgesia alone exhibited generally similar baseline characteristics with respect to age, obstetric history, comorbidities, emergency cesarean delivery, and the recovery room environment. This baseline comparability strengthens the internal validity of our study and suggests that the differences observed in the study outcomes were primarily attributable to exposure to non-pharmacological interventions rather than to major baseline differences between the two groups.

The mean age of the study population was 28.3 ± 6.5 years, which is consistent with the demographic profile commonly reported among women undergoing cesarean delivery in low- and middle-income countries. This finding is comparable to those reported in several clinical trials evaluating non-pharmacological interventions after cesarean delivery, in which the mean age of participants generally ranged from 26 to 32 years [4,5]. These similarities suggest that our study population is representative of women typically undergoing this type of postoperative pain management.

Obstetric characteristics, including gravidity, parity, and previous cesarean delivery, were comparable between the two groups. These variables may influence the pain experience because of previous exposure to surgery and differing expectations regarding postoperative pain. Their balanced distribution therefore reduces the risk of confounding and supports a more reliable assessment of the effects of non-pharmacological interventions. Likewise, the prevalence of major comorbidities potentially affecting pain perception or postoperative recovery, including hypertension, preeclampsia, sickle cell disease, and previous surgical history, did not differ significantly between groups. This homogeneity is important, as several studies have shown that individual characteristics, preoperative psychological status, and certain comorbidities may influence the intensity of acute post-cesarean pain and postoperative analgesic requirements [6,7].

In contrast, body mass index (BMI) was significantly higher in the exposed group. Although this difference was modest, it should be considered when interpreting the findings. Higher BMI is generally associated with greater technical difficulty during surgery, longer operative duration, and an increased risk of postoperative pain [6]. Despite this baseline imbalance, women who received non-pharmacological interventions experienced substantially lower pain levels than those in the non-exposed group. This observation suggests that the beneficial effect of non-pharmacological interventions is unlikely to be explained by baseline differences in patient severity and may even have been underestimated.

Furthermore, the proportion of emergency cesarean deliveries was comparable between the two groups. This finding is particularly relevant because emergency procedures are frequently associated with higher levels of anxiety, limited psychological preparation, and more severe postoperative pain than elective cesarean deliveries [8].

Finally, the proportion of women admitted to a quiet recovery room environment was similar in both groups. Although this variable has rarely been investigated, recent recommendations emphasize that environmental factors, including noise, stress, and emotional support, contribute to the postoperative pain experience by modulating neuroendocrine responses and anxiety [9].

Overall, our study population closely resembles those described in contemporary studies investigating multimodal pain management following cesarean delivery [7,10]. The similarity of baseline characteristics between groups reinforces the credibility of our findings and suggests that the observed differences in postoperative pain intensity, rescue analgesic use, and maternal satisfaction were primarily attributable to the addition of non-pharmacological interventions to conventional analgesic therapy.

4.2. Effects of non-pharmacological interventions on postoperative pain

Our study demonstrated a significant reduction in postoperative pain intensity among women who received non-pharmacological interventions in addition to conventional analgesia. This effect was evident as early as the first hour after admission to the post-anesthesia care unit (PACU) and persisted throughout the second postoperative hour. Women in the exposed group not only had significantly lower mean pain scores at both H1 and H2 but also exhibited a marked reduction in the prevalence of moderate-to-severe postoperative pain, corresponding to a 74% relative risk reduction at H1 (RR = 0.26) and an 85% reduction at H2 (RR = 0.15). These findings suggest that the early implementation of non-pharmacological interventions contributes substantially to pain control during the immediate postoperative period.

These findings are consistent with current international recommendations advocating a multimodal approach to post-cesarean pain management. The PROSPECT guidelines recognize non-pharmacological interventions as valuable adjuncts to pharmacological analgesia when implemented early in the perioperative care pathway to reduce pain intensity, minimize opioid requirements, and promote functional recovery [11]. They are also in line with the principles of Enhanced Recovery After Surgery (ERAS) programs for obstetric surgery, which advocate a comprehensive perioperative care strategy to optimize clinical outcomes [12].

Our findings are consistent with those of several randomized controlled trials evaluating non-pharmacological interventions after cesarean delivery. Therapeutic massage, deep breathing exercises, relaxation techniques, and psychological support have all been shown to significantly reduce postoperative pain scores during the early postoperative period, although the magnitude of the effect varies across intervention protocols [13–15]. Unlike most previous studies, which evaluated a single intervention, our protocol combined several complementary techniques delivered in a standardized manner. This multimodal approach may explain the particularly pronounced analgesic effect observed in our study. A recent systematic review further confirmed that non-pharmacological interventions significantly reduce postoperative pain after cesarean delivery, with greater benefits observed when multiple techniques are combined rather than used individually [16]. In particular, the combination of massage therapy, relaxation techniques, patient education, and emotional support was associated with the most consistent improvements in pain scores and postoperative recovery.

Several physiological mechanisms may account for these findings. Superficial massage and prolonged therapeutic touch are thought to preferentially stimulate large-diameter myelinated afferent fibers, thereby activating the segmental inhibitory mechanisms described by the Melzack and Wall gate control theory and reducing nociceptive transmission to higher central nervous system structures [17]. In addition, deep breathing exercises and relaxation techniques are believed to attenuate sympathetic nervous system activity, decrease cortisol and catecholamine secretion, and enhance parasympathetic tone. This autonomic modulation may simultaneously reduce postoperative pain, stress, and anxiety [16].

Patient education provided before each intervention session, together with psychological support from a caregiver, may also have contributed to the observed analgesic benefit. Postoperative pain is now recognized as a multidimensional experience influenced not only by nociceptive mechanisms but also by emotional, cognitive, and environmental factors. Improved understanding of postoperative care, combined with enhanced feelings of safety and emotional support, may strengthen patients' coping abilities and consequently reduce pain perception [17].

Several limitations should be considered when interpreting these findings. First, this was an observational, non-randomized study and is therefore subject to potential selection bias despite the good baseline comparability between groups. Second, body mass index was significantly higher in the exposed group. Because obesity is generally associated with greater postoperative pain and delayed recovery, the finding that women in the exposed group experienced significantly lower pain despite this potentially unfavorable characteristic further supports a genuine beneficial effect of non-pharmacological interventions. Nevertheless, multicenter randomized controlled trials are needed to confirm these findings and to better quantify the magnitude of their effect.

Overall, our results demonstrate that the early addition of non-pharmacological interventions to conventional pharmacological analgesia significantly improves postoperative pain control following cesarean delivery. Given their simplicity, low cost, and ease of implementation, these interventions could be more widely incorporated into postoperative care protocols, particularly in resource-limited settings where optimizing multimodal analgesic strategies represents an important public health priority.

4.3. Rescue analgesic use and maternal satisfaction

Beyond reducing postoperative pain intensity, our study demonstrated that combining non-pharmacological interventions with conventional analgesic therapy was associated with a significant reduction in the need for rescue analgesia. Only 12.5% of women in the exposed group required additional analgesic medication compared with 43.8% in the non-exposed group, corresponding to a 71% relative risk reduction. This finding is of considerable clinical importance, as it reflects improved pain control while reducing exposure to medications that may cause adverse effects.

This observation is consistent with current international recommendations promoting multimodal analgesic strategies to minimize opioid requirements following cesarean delivery [18]. Bollag et al. and Roofthooft et al. reported that reduced opioid consumption is associated with lower rates of postoperative nausea and vomiting, less sedation, earlier mobilization, and fewer breastfeeding difficulties, thereby facilitating enhanced postoperative recovery [12,18].

The observed benefit is likely explained by the synergistic interaction between the various components of the non-pharmacological protocol and pharmacological analgesia. By reducing pain intensity early in the postoperative period, these interventions may limit central sensitization and delay the development of pain severe enough to require escalation of analgesic therapy. This hypothesis is supported by several recent meta-analyses demonstrating that non-pharmacological interventions not only reduce postoperative pain scores but also decrease cumulative analgesic consumption during the first 24 postoperative hours [16,19].

Our study also demonstrated significantly higher maternal satisfaction among women who received non-pharmacological interventions. More than four out of five women in the exposed group reported being satisfied or very satisfied with their postoperative care, compared with only one out of two women in the non-exposed group. Maternal satisfaction is now recognized as a key indicator of healthcare quality in both anesthesiology and obstetric practice. It depends not only on effective pain relief but also on the quality of information provided, emotional support, the patient–provider relationship, respect for patients' expectations, and their involvement in therapeutic decision-making [20].

The intervention protocol used in our study incorporated several of these dimensions. Pre-intervention education regarding pain assessment, psychological support provided by a caregiver, relaxation techniques, and continuous therapeutic touch likely enhanced patients' sense of security and their perception of individualized care. Several studies evaluating Enhanced Recovery After Surgery (ERAS) programs following cesarean delivery have reported similar findings, showing that patient-centered interventions improve maternal satisfaction, the overall childbirth experience, and the quality of perioperative care [12,20,21].

4.4. Strengths, limitations, and clinical implications

This study has several strengths. To our knowledge, it is one of the first prospective studies conducted in Madagascar to evaluate the effectiveness of a standardized protocol of non-pharmacological interventions following cesarean delivery. The prospective design, the use of a standardized intervention protocol for all women in the exposed group, and the comparison with a control group receiving conventional postoperative care strengthen the methodological quality of the study. Furthermore, the two groups were generally comparable with regard to baseline clinical characteristics that could influence postoperative pain, thereby minimizing the risk of confounding.

Nevertheless, several limitations should be acknowledged. First, the non-randomized design introduces an inherent risk of selection bias. Second, the relatively small sample size and the single-center setting may limit the generalizability of the findings. Finally, pain assessment was restricted to the first two postoperative hours. Future studies should extend follow-up to the first 24–48 postoperative hours to determine whether the analgesic benefits of non-pharmacological interventions are sustained over time.

Despite these limitations, our findings have important clinical implications. The non-pharmacological interventions evaluated in this study are simple, inexpensive, non-invasive, and easily reproducible. Their implementation mainly requires staff education and the active involvement of a caregiver, without the need for specialized equipment. In resource-limited settings, where access to certain analgesic medications may be restricted, these interventions represent a particularly relevant complementary strategy for improving postoperative pain management. Their incorporation into institutional Enhanced Recovery After Surgery (ERAS) protocols for cesarean delivery could contribute to better pain control, reduced analgesic consumption, and improved maternal experience while optimizing the use of available healthcare resources [18].

5. Conclusion

This study demonstrated that combining non-pharmacological interventions with conventional pharmacological analgesia significantly improves postoperative pain management following cesarean delivery. Women who received this multimodal approach experienced lower pain intensity during the first two postoperative hours, required rescue analgesia less frequently, and reported higher levels of satisfaction than those who received pharmacological treatment alone.

These findings support the value of a multimodal pain management strategy incorporating simple, low-cost, and easily reproducible interventions, including patient education, psychological support, massage, breathing exercises, and relaxation techniques. In resource-limited settings, such interventions represent a practical and effective adjunct to conventional analgesic therapy, improving postoperative pain control while reducing reliance on additional analgesic medications.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

Statement of informed consent

The study was conducted in accordance with informed consent obtained from patients or their legal representatives.

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