The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 21(2): S.I (2), 194-204, 2026 www.thebioscan.com

Effectiveness of Cold Application on Needle Stick Pain During Intramuscular Injection Among Adult Patients

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DOI: https://doi.org/10.63001/tbs.2026.v21.i02.S.I(2).pp194-204

KEYWORDS

Cold application, Intramuscular injection, Needle-stick pain, Non-pharmacological intervention, Pain management, Nursing practice, Numerical Rating Scale.

Received on:
17-02-2026

Accepted on:
03-04-2026

Published on:
13-04-2026

Abstract

Background: Pain associated with intramuscular (IM) injections remains a significant concern in clinical practice, and cold application, a simple non-pharmacological intervention, helps reduce pain by decreasing nerve conduction velocity and inhibiting the transmission of pain impulses.

Objective: This study aimed to evaluate the effectiveness of cold application in reducing needle-stick pain among adult patients receiving IM injections**.**

Methods: A quantitative approach with a quasi-experimental post-test-only control group design was adopted, and a total of 60 participants were selected using purposive sampling and assigned to experimental (n=30) and control (n=30) groups; pain intensity was measured using the Numerical Rating Scale (NRS) following the intervention.

Results: The experimental group reported significantly lower pain levels, with 53.3% experiencing no pain and only 3.3% reporting moderate pain, whereas in the control group, 50.1% reported moderate pain and 6.6% severe pain; the mean pain score in the experimental group (0.93 ± 1.20) was markedly lower than in the control group (3.5 ± 1.97), demonstrating a statistically significant difference ($t = 6.153$, $p < 0.01$), and a significant association was also observed between educational status and pain perception in the control group.

Conclusion: Cold application is an effective, economical, and easily implementable intervention for reducing injection-related pain and can be incorporated into routine nursing practice to improve patient comfort and quality of care.

Introduction

Pain associated with intramuscular (IM) injections persists as a salient and clinically consequential issue, exerting a tangible influence on patient comfort, procedural adherence, and the overall therapeutic experience. Among the spectrum of non-pharmacological interventions, cryotherapy has emerged as a viable and efficacious modality for pain attenuation. Its analgesic effect is principally attributed to the

diminution of peripheral nerve conduction velocity, inhibition of nociceptor activation, and modulation of afferent pain transmission pathways. Owing to its operational simplicity, economic feasibility, and negligible risk profile, cold application has been widely integrated into clinical practice across both technologically advanced and resource-limited healthcare environments.

Pain, by its very nature, is a multifaceted and inherently subjective phenomenon encompassing sensory, affective, and cognitive dimensions. The International Association for the Study of Pain conceptualizes pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage," thereby underscoring its biopsychosocial underpinnings. Furthermore, the recognition of pain as the "fifth vital sign," advocated by the American Pain Society, accentuates the imperative for its systematic evaluation and judicious management within clinical settings, particularly by nursing professionals who assume a pivotal role in procedural care. Intramuscular injections represent one of the most ubiquitously performed invasive procedures worldwide, with billions administered annually for both therapeutic and prophylactic purposes. Notwithstanding their indispensable clinical utility, IM injections are frequently accompanied by procedural discomfort arising from dermal penetration, as well as the physicochemical characteristics of the injected agents. Within the Indian healthcare milieu, the pervasive use of IM injections especially for the administration of antibiotics, vitamins, and analgesics further amplifies the necessity for robust, evidence-informed strategies aimed at mitigating injection-related pain. Recurrent exposure to such nociceptive stimuli may engender heightened anxiety, diminish patient satisfaction, and adversely affect compliance with prescribed treatment regimens.

The alleviation of pain is not merely a clinical objective but a fundamental patient right and an ethical obligation intrinsic to healthcare delivery. Although pharmacological interventions remain the cornerstone of pain management, there is a discernible shift towards adjunctive non-pharmacological approaches, driven by their safety, cost-effectiveness, and ease of implementation. Techniques such as the Z-track method, cutaneous stimulation, application of pressure, and thermal modulation have been employed with varying degrees of success. However, inconsistencies in outcomes, lack of standardization in intervention protocols, and inter-individual variability in pain perception highlight important limitations within the existing body of evidence. Moreover, a substantial proportion of prior studies have predominantly focused on pediatric populations or have been conducted in non-Indian settings, thereby restricting the contextual applicability of findings to adult patients within the Indian healthcare system.

In this context, cold application has garnered considerable scholarly and clinical attention as a pragmatic intervention for procedural pain alleviation. By inducing localized vasoconstriction and attenuating peripheral nerve excitability, cold application elicits a transient yet clinically meaningful analgesic effect, thereby potentially reducing

needle-stick pain associated with IM injections. Nevertheless, there remains a paucity of rigorously designed studies examining its effectiveness among adult populations in India, along with limited comparative evidence against other non-pharmacological techniques under standardized conditions. Additionally, insufficient consideration has been given to patient-specific factors such as anxiety levels, prior experiences, and individual pain thresholds, as well as the translation of research findings into routine nursing practice.

In light of these gaps, the present investigation was undertaken to critically evaluate the effectiveness of cold application in mitigating needle-stick pain during intramuscular injections among adult patients. The anticipated findings are expected to augment the extant body of knowledge on non-pharmacological pain management and to inform evidence-based nursing practices aimed at optimizing patient comfort, enhancing procedural tolerance, and elevating the overall quality of care.

Objectives

To assess & compare the level of needle stick pain among patients undergoing intramuscular injection after cold application in the experimental group and without cold application in the control group.

To find association between the level of needle stick pain with selected demographic variables of experimental and control group.

Materials and Methods

A quantitative research paradigm was rigorously adopted, grounded in a quasi-experimental post-test-only control group design, to critically evaluate the therapeutic efficacy of pre-procedural cold application in attenuating needle-stick pain among adult patients undergoing intramuscular injections in a selected tertiary care institution in Thiruvallur district, Tamil Nadu. The selection of this design was predicated upon its methodological strength in enabling systematic comparison between intervention and non-intervention cohorts within a naturalistic clinical environment, while concurrently accommodating the ethical and logistical constraints intrinsic to applied healthcare research.

The study population comprised adult patients receiving intramuscular injection therapy within the designated clinical setting. A total of 60 participants were deliberately recruited through a non-probability purposive sampling technique, thereby ensuring the inclusion of individuals who conformed to the explicitly defined eligibility criteria. Following recruitment, participants were systematically allocated into two cohorts: an experimental group (n = 30), which received the cold application intervention, and a control group (n = 30), which was subjected to routine standard care without adjunctive measures, thereby facilitating robust intergroup comparison. Inclusion criteria encompassed individuals aged between 18 and 60 years who demonstrated willingness to participate and possessed adequate proficiency in Tamil or English to comprehend study-related instructions. Conversely, individuals presenting with chronic pain disorders,

comorbid conditions capable of altering pain perception, compromised peripheral circulation, peripheral vascular disorders, localized infection at the injection site, or absence during the data collection phase were stringently excluded to mitigate confounding influences and enhance internal validity.

The sample size of 60 participants was deemed adequate for the present quasi-experimental investigation, as it allowed for equal representation in both experimental and control groups, thereby enhancing the comparability of outcomes. The determination of sample size was guided by feasibility considerations, including the availability of eligible participants within the data collection period, as well as by reference to similar previous studies that employed comparable sample sizes to detect statistically meaningful differences in pain scores. Furthermore, this sample size was considered sufficient to achieve an acceptable level of statistical power for identifying moderate effect sizes between groups, while maintaining the practicality and manageability of the research within the clinical setting.

Within the conceptual framework of the investigation, the administration of localized cold application prior to intramuscular injection constituted the independent variable, whereas the intensity of needle-stick pain experienced by participants was delineated as the dependent variable. Pain perception was quantitatively measured using the Numerical Pain Rating Scale, a psychometrically robust and extensively validated instrument calibrated on a continuum ranging from 0 (denoting absence of pain) to 10 (indicating the worst conceivable pain). Additionally, baseline demographic and clinical characteristics were elicited using a structured questionnaire meticulously developed by the investigator in alignment with the study objectives.

Intervention and Rationale

The intervention comprised the application of localized cold therapy using an ice pack enveloped in a clean, dry cloth to prevent direct skin injury. The cold application was administered over the selected intramuscular injection site (commonly the deltoid or gluteal region) for a standardized duration of 5 minutes immediately prior to the injection procedure in the experimental group. The temperature of the cold pack was maintained within a therapeutically safe range (approximately 10-15°C) to ensure efficacy while preventing tissue damage. Following the intervention, the intramuscular injection was administered using standard aseptic technique.

The rationale for employing cold application is grounded in its well-established physiological effects, including vasoconstriction, reduction in local tissue metabolism, and decreased peripheral nerve conduction velocity. These mechanisms collectively contribute to diminished nociceptor sensitivity and attenuation of pain signal transmission, thereby reducing the perceived intensity of needle-stick pain. Furthermore, the intervention serves as a simple, cost-effective, and non-invasive nursing measure that can be readily integrated into routine clinical practice without requiring specialized equipment or extensive training, making it particularly

suitable for both resource-rich and resource-constrained healthcare settings.

The content validity of the research instruments was stringently established through critical evaluation by a panel of experts in Medical-Surgical Nursing and allied disciplines. Their recommendations were systematically incorporated to enhance the clarity, relevance, and comprehensiveness of the tools. The reliability of the NPRS was ascertained through a pilot study conducted among 20 participants, yielding a high internal consistency coefficient (r = 0.91), thereby affirming its strong reliability. Furthermore, the pilot study substantiated the feasibility, clarity, and operational practicability of the research protocol, thereby justifying its implementation in the main study.

Prior to data collection, institutional ethical clearance and formal administrative permissions were duly obtained from the concerned authorities. Eligible participants were approached individually and provided with a comprehensive explanation of the study's purpose, procedures, potential benefits, and minimal associated risks, following which written informed consent was obtained in accordance with established ethical standards. Pain intensity was assessed immediately following the administration of the injection using the NPRS, thereby ensuring temporal uniformity and minimizing measurement bias.

Throughout the research process, stringent adherence to ethical principles was meticulously maintained. Confidentiality and anonymity of participant information were rigorously safeguarded, and participation was entirely voluntary. Participants were explicitly informed of their unequivocal right to withdraw from the study at any stage without incurring any adverse consequences. Such ethically grounded practices were integral to preserving the integrity, credibility, and scientific rigor of the research endeavor.

Results

A total of 60 adult participants were included in the final analysis, with an equal distribution between the experimental group (n = 30) and the control group (n = 30), thereby ensuring structural equivalence and enhancing the internal validity of comparative inferences. Needle-stick pain intensity was assessed immediately following the administration of intramuscular injection using the Numerical Rating Scale (NRS), a standardized and psychometrically sound instrument that facilitates the quantification of subjective pain experience on a linear continuum. The immediacy of assessment was methodologically advantageous in minimizing recall bias and capturing the acute nociceptive response with greater precision.

The descriptive statistical findings demonstrated a pronounced reduction in mean pain intensity within the experimental cohort (0.933 ± 1.20) relative to the control cohort (3.5 ± 1.97), thereby indicating a substantial attenuation of pain perception attributable to the intervention. The calculated 95% confidence intervals further reinforced the reliability and precision of these estimates, with the experimental group exhibiting a narrow interval ranging from 0.49 to 1.38, while the control group

demonstrated a comparatively broader and elevated interval extending from 2.76 to 4.24. The absence of overlap between these intervals provides strong inferential support for a true difference between the groups, rather than a variation attributable to sampling error.

Inferential statistical analysis, conducted using the independent samples t-test, revealed a highly statistically significant difference between the two groups ($t = 6.153$, $p < 0.01$), thereby leading to the rejection of the null hypothesis and confirming the effectiveness of the intervention. The observed mean difference in pain scores was −2.57, with a 95% confidence interval ranging from −3.41 to −1.73, further substantiating the magnitude and consistency of the analgesic effect. These findings not only demonstrate statistical significance but also underscore clinical relevance, as the reduction in pain intensity is sufficiently large to be perceptible and meaningful from a patient-centered perspective.

To further elucidate the practical significance of the intervention, effect size estimation was performed using Cohen's d, calculated on the basis of pooled standard deviation. The resultant value of approximately 1.57 is indicative of a very large effect size according to established interpretative conventions, thereby signifying that the impact of pre-procedural cold application extends beyond statistical detectability to encompass substantial clinical efficacy.

From a theoretical standpoint, the observed reduction in pain can be cogently explained through established neurophysiological and pain modulation frameworks. Cold application exerts its analgesic effect primarily through the reduction of peripheral nerve conduction velocity, which in turn diminishes the transmission of nociceptive impulses from the site of tissue insult to the central nervous system. Additionally, cold application induces localized vasoconstriction, thereby reducing inflammatory mediator release and subsequent sensitization of nociceptors.

These mechanisms are further aligned with the principles of the Gate Control Theory of Pain, which posits that non-nociceptive stimuli, such as cold, can modulate pain perception by "closing the gate" at the spinal cord level, thereby inhibiting the transmission of pain signals to higher cortical centers. The sensory input generated by cold stimulation effectively competes with and suppresses nociceptive transmission, resulting in diminished pain perception. Moreover, the intervention may engage descending inhibitory pathways, contributing to the modulation of pain at both peripheral and central levels.

Further analysis exploring the association between post-test pain scores and selected demographic variables revealed a statistically significant relationship between educational status and pain intensity within the control group ($p < 0.05$). This finding may be theoretically interpreted through cognitive-evaluative dimensions of pain, wherein individuals with differing educational backgrounds may vary in their perception, interpretation, and reporting of pain stimuli. However, no statistically significant associations were observed with

respect to age, gender, occupational status, or prior pain experience, suggesting that the analgesic effect of cold application operates relatively independently of these variables in the immediate procedural context.

In summation, the findings of the present investigation provide compelling empirical and theoretical evidence supporting the efficacy of pre-procedural cold application as a potent non-pharmacological intervention for the mitigation of needle-stick pain. The convergence of statistically robust outcomes, precise confidence intervals, and a large effect size, when interpreted in conjunction with established neurophysiological theories of pain modulation, underscores the intervention's substantial clinical utility and reinforces its applicability within evidence-based nursing practice aimed at optimizing patient comfort and procedural tolerance.

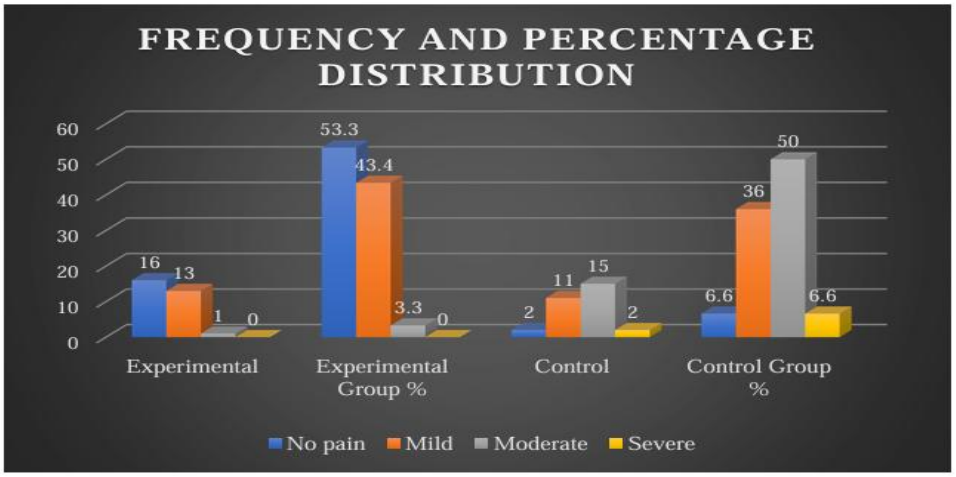

Figure 1: Frequency and percentage distribution of level of Needle stick pain score of patients in experimental group and control group receiving IM injection

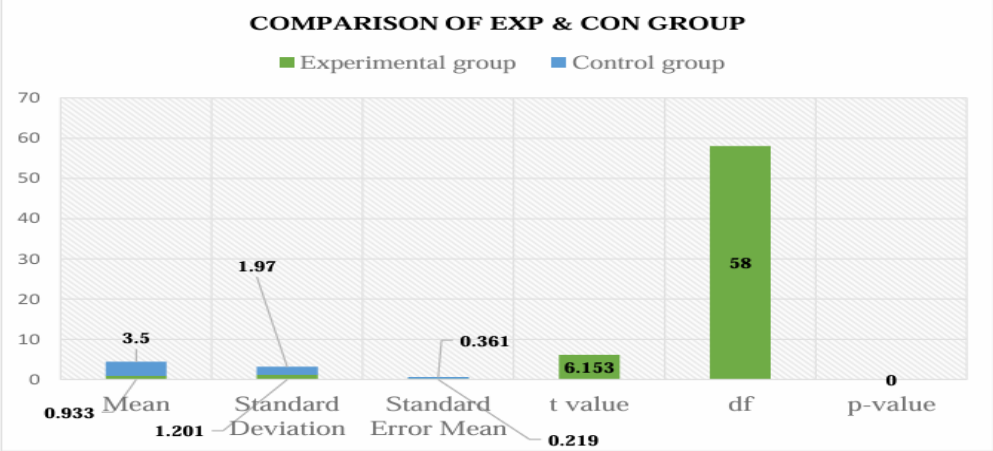

Figure 2: Frequency and percentage distribution of pre and post-test level of practice regarding cold application among adult patients

Discussion

The present study provides strong evidence that pre-procedural cold application significantly reduces needle-stick pain among adult patients receiving intramuscular injections. Participants in the experimental group reported a mean pain score of 0.933 ± 1.20, which was markedly lower than the control group's mean score of 3.5 ± 1.97, with a highly significant difference between groups ($t = 6.153$, $p < 0.01$). These findings demonstrate that cold application is an effective, non-pharmacological, and cost-efficient intervention for alleviating procedural pain. The analgesic effect observed can be explained through physiological mechanisms such as local vasoconstriction, decreased peripheral nerve conduction velocity, and modulation of nociceptive signals through the gate control theory, collectively contributing to diminished pain perception.

These results are consistent with prior research evaluating the role of cryotherapy in reducing injection-related pain. A systematic review by Durgun, Şirin, and Dalcalı (2025) concluded that cold application, whether applied as ice packs or cold sprays, significantly lowers intramuscular injection pain across adult populations, reinforcing the external validity of the present findings. Similarly, a randomized controlled trial by Gurdap and Cengiz (2022) demonstrated that cold spray applied prior to intramuscular diclofenac injection resulted in significantly lower pain scores compared to controls. Additional studies using vapocoolant sprays have reported comparable reductions in procedural pain, supporting the principle that pre-procedural cooling mitigates nociceptive input and enhances patient comfort. Despite differences in technique and clinical context, the underlying mechanism of cold-induced analgesia appears consistent across studies, highlighting the reproducibility and reliability of this intervention.

The study also examined the influence of demographic variables on pain perception. A significant association was found between educational status and pain scores in the control group, suggesting that cognitive and psychosocial factors, such as health literacy and coping strategies, may influence subjective pain experience. This finding aligns with prior research indicating that educational attainment can affect pain reporting and tolerance, while other variables such as age, gender, occupation, and prior pain experience showed no significant associations. These observations underscore the multidimensional nature of pain, in which both physiological and psychosocial determinants interact to shape individual responses.

The absence of significant associations between most demographic variables and post-intervention pain scores suggests that cold application produces a

uniform analgesic effect across diverse patient subgroups, enhancing its generalizability and clinical applicability. Incorporating cold application into routine intramuscular injection procedures may improve patient satisfaction, reduce procedural anxiety, and optimize overall care quality. This is particularly advantageous in resource-limited settings, as the intervention is safe, non-invasive, and straightforward to implement.

Nevertheless, certain limitations should be acknowledged. The quasi-experimental design and purposive sampling may restrict generalizability and introduce potential selection bias. Additionally, the relatively small sample size limits precision and warrants cautious interpretation. Future research employing randomized controlled trials with larger and more heterogeneous populations is recommended to further validate the effectiveness of cold application, explore underlying physiological and psychosocial mechanisms, and assess long-term outcomes, including patient satisfaction and adherence to treatment protocols. Overall, the present study contributes to the growing body of evidence supporting cold application as an effective, evidence-based, non-pharmacological strategy for procedural pain management in nursing practice.

Conclusion and Recommendations

The present investigation robustly demonstrates that pre-procedural application of localized cold constitutes a clinically efficacious, non-invasive, and mechanistically grounded strategy for attenuating needle-stick pain among adult patients undergoing intramuscular injections. The substantial diminution in pain intensity observed within the intervention cohort, reinforced by statistically robust outcomes, narrow confidence intervals, and a pronounced effect size, underscores the therapeutic relevance of cold application within contemporary clinical practice. Mechanistically, the analgesic effect of cold application is attributable to a constellation of physiological processes, including localized vasoconstriction, reduction in peripheral nerve conduction velocity, and modulation of nociceptive signal transmission consistent with the gate control theory, collectively contributing to a marked attenuation of pain perception. The relative uniformity of analgesic efficacy across heterogeneous demographic strata further accentuates the intervention's broad applicability and potential for standardization across diverse healthcare environments.

From a professional nursing standpoint, these findings highlight the pivotal role of nurses as both implementers and advocates of evidence-based non-pharmacological interventions. Nurses occupy a central position in procedural care delivery, encompassing the technical administration of intramuscular injections, precise application of cold application modalities, and vigilant monitoring of patient responses. Beyond technical execution, nurses are instrumental in mitigating anticipatory anxiety through effective communication, patient education, and supportive engagement, thereby enhancing procedural tolerance and patient-centered outcomes. The integration of cold application into routine nursing practice exemplifies a holistic approach that simultaneously

addresses the physiological and psychosocial dimensions of pain, thereby reinforcing the role of nurses as agents of both clinical efficacy and compassionate care.

The translational potential of this intervention is substantial. Its simplicity, cost-efficiency, minimal resource demands, and ease of integration render it particularly suitable for high-volume clinical settings and resource-limited environments. Systematic incorporation of pre-procedural cold application into institutional protocols is recommended to standardize pain mitigation practices and elevate quality of care metrics. Structured competency-based training programs for nursing personnel are essential to ensure mastery of proper application techniques, optimal duration, safety considerations, and effective patient engagement strategies. Moreover, the inclusion of non-pharmacological pain management strategies, such as cryotherapy, within pre-service and in-service nursing education curricula is imperative to cultivate a cadre of practitioners adept in evidence-informed, patient-centered care delivery.

Despite the strengths of the present study, certain methodological constraints warrant cautious interpretation. The quasi-experimental design, reliance on non-probability purposive sampling, and a relatively modest sample size may limit generalizability and introduce potential selection bias. Future research should prioritize randomized controlled trial designs with larger, more heterogeneous populations to validate and extend the current findings. Investigations that examine the long-term impact of cold application on patient satisfaction, adherence to treatment regimens, and broader quality-of-care indicators would provide valuable insights into its sustained clinical utility. Additionally, comparative studies evaluating different modalities of cryotherapy, as well as synergistic combinations with adjunctive non-pharmacological interventions, may elucidate optimal strategies for maximizing analgesic efficacy.

In summation, pre-procedural cold application emerges as a straightforward yet potent intervention capable of significantly enhancing procedural comfort, mitigating pain, and advancing the overall quality of nursing care. Nurses, through their central role in implementation, patient education, and continuous assessment, are critical in translating these evidence-based practices into routine clinical excellence. Continued empirical inquiry, coupled with systematic integration of cryotherapy into clinical protocols and nursing education, holds substantial promise for the optimization of pain management and the promotion of holistic, patient-centered care across diverse healthcare contexts.

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