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The 72-Hour Effects of Heat, Cold, and Sham Packs in Acute and Subacute Nonspecific Neck Pain: A Three-Arm Randomized Controlled Trial

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Abstract

Background and Objectives: Evidence on the short-term effects associated with superficial heat and cold in neck pain remains limited. This study compared hot, cold, and room-temperature sham packs, combined with active range-of-motion exercises, in acute and subacute nonspecific neck pain. *Materials and Methods*: In this three-arm, sham-controlled randomized trial (NCT06507761), 60 participants were randomized and 56 completed the 72 h assessment. Packs were applied for 15 min daily for three days. Pain, Global Rating of Change, Neck Disability Index (NDI), and pressure pain threshold (PPT) were assessed at baseline and 72 h and analyzed using baseline-adjusted ANCOVA. *Results*: Compared with sham, resting pain was lower after hot packs (mean difference, 0.92; 95% CI, 0.31–1.53; $p = 0.002$) and cold packs (1.11; 0.49–1.74; $p < 0.001$). Movement pain was lower after cold packs than after sham in the primary analysis (1.73; 0.70–2.75; $p < 0.001$), but this finding was less robust in sensitivity analysis. Neither active pack showed a consistent advantage over a sham for the Global Rating of Change. In the primary analysis, NDI was lower after hot packs than sham ($p = 0.038$) and cold packs ($p = 0.001$), while trapezius PPT was higher after cold packs than sham ($p = 0.034$) and hot packs ($p = 0.003$); these secondary findings were less consistent in the missing-data sensitivity analyses. *Conclusions*: Hot and cold packs were associated with modest short-term reductions in resting pain when added to active exercise, but benefits were not consistent across other outcomes. They may be considered optional adjuncts rather than essential components of active management.

Keywords: neck pain; superficial heat; cryotherapy; hot pack; cold pack; sham-controlled trial; randomized controlled trial; physical therapy

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1. Introduction

Neck pain is a major musculoskeletal health problem associated with substantial pain, disability, and socioeconomic burden worldwide [1]. According to the Global Burden of Disease Study 2021, approximately 203 million people were affected by neck pain globally in 2020, and the number of cases is projected to increase to 269 million by 2050 [1]. Most cases lack an identifiable structural or pathological cause requiring specific treatment and

are therefore classified as nonspecific neck pain [2]. Based on symptom duration, neck pain is commonly categorized as acute (0–3 weeks), subacute (4–12 weeks), or chronic (>12 weeks) [2]. In acute and subacute neck pain, most of the improvement in pain and disability occurs within the first few weeks after symptom onset [3,4]. However, complete recovery is not always achieved, and symptoms may persist beyond this period [3], particularly in individuals with higher baseline pain intensity and disability among the factors associated with poorer prognosis [5]. The first 12 weeks, which encompass the acute and subacute phases, are also the period in which conservative treatments are commonly initiated.

Current management of nonspecific neck pain emphasizes patient education, reassurance, maintenance of activity, self-management, and exercise-based approaches, with manual therapy considered where appropriate [2,6,7]. Despite this emphasis on active care, superficial heat and cold continue to be used as adjunctive modalities in musculoskeletal rehabilitation and self-management, and heat in particular is frequently recommended by health professionals for neck pain [8]. Their use is supported by distinct physiological mechanisms. Superficial heat increases tissue temperature, local blood flow, and tissue metabolism, enhances connective-tissue extensibility, and may reduce pain and muscle spasm [9]. In contrast, local cooling decreases tissue temperature and nerve conduction velocity and, under experimental conditions, has been shown to increase pressure pain threshold and pain tolerance, providing a plausible peripheral mechanism for its analgesic effects [9,10]. These contrasting physiological responses suggest that heat and cold may influence pain, mechanical sensitivity, and mobility through different pathways. However, whether these temperature-dependent physiological effects translate into clinically meaningful differences in individuals with nonspecific neck pain remains uncertain.

Despite their widespread use, the clinical evidence supporting superficial heat and cold for nonspecific neck pain remains limited, and recommendations differ across clinical guidelines. The key unresolved clinical question is not whether thermal modalities can produce short-term symptom relief, but whether adding heat or cold to active management provides an effect beyond natural recovery, exercise, and the nonspecific effects of treatment procedures. An update of the Bone and Joint Decade Task Force by the OPTIMa Collaboration concluded that several passive physical modalities, including heat and cold, were not effective and should not be used to manage neck pain, although no new trials of heat therapy were identified [11]. The corresponding clinical practice guideline accordingly advised against clinic-based heat for recent-onset (≤3 months) grade I–II neck pain [12]. In contrast, the more recent German S3 guideline recommends self-applied heat for nonspecific neck pain, while cold may be used when perceived by the patient as comfortable or pain relieving; however, the latter recommendation is based solely on expert consensus [2]. Thus, current clinical recommendations remain inconsistent despite the continued widespread use of these modalities. This uncertainty is reflected in the current evidence base. A 2026 systematic review identified only two eligible randomized controlled trials of heat therapy in nonspecific neck pain, comprising 67 participants in total, and concluded that the available evidence was too limited to support a clear recommendation for or against heat therapy [13]. Evidence directly comparing heat and cold is similarly sparse. In a randomized trial of patients with acute neck or back strain, heat and cold produced modest and comparable short-term reductions in pain; however, all participants received 400 mg of ibuprofen, neck and back conditions were analyzed together, no sham condition was included, and the authors noted that the observed pain relief may have been attributable mainly to ibuprofen [14]. Moreover, although a Cochrane review protocol addressing cryotherapy for acute nonspecific neck pain was published in 2013, to our knowledge, no completed review has subsequently been published [15]. Accordingly, the available literature does not provide a clear estimate of the added short-term effect of either heat or cold in nonspecific neck

pain, nor does it establish whether one thermal modality offers an advantage over the other when both are delivered under comparable conditions.

The choice of comparator is also important when evaluating the specific effects of thermal interventions. Pain during the early weeks after onset may improve as part of the natural course of nonspecific neck pain [4], and contextual components of physiotherapy, such as therapeutic contact, positioning, treatment rituals, and therapist–patient interaction, may influence pain outcomes independently of the specific treatment component [16]. In a sham-controlled trial of local heat, for example, pain intensity also decreased significantly in the sham group, although the reduction was greater with active heat [17]. A control intervention that reproduces the key procedural features of the active treatments while omitting therapeutic heating or cooling may therefore help to distinguish effects associated with pack temperature from natural recovery and nonspecific treatment effects [18]. In the present study, a room-temperature pack applied with the same procedure, duration, and positioning was used for this purpose, although we acknowledge that such a comparator may not be completely thermally neutral. To our knowledge, no previous randomized trial has directly compared hot, cold, and room-temperature sham packs, applied using an identical protocol and combined with the same active exercise program, in individuals with acute and subacute nonspecific neck pain. This design was intended to address three specific gaps in the existing literature: the absence of a direct hot-versus-cold comparison under standardized conditions, the lack of a sham comparator capable of accounting for procedural and contextual effects, and the limited evidence regarding the added value of thermal modalities when used alongside active management. Therefore, this three-arm randomized controlled trial aimed to compare the 72 h effects of hot, cold, and room-temperature sham packs, each combined with active range-of-motion exercises, in individuals with acute and subacute nonspecific neck pain. The prespecified primary outcomes were pain intensity, cervical range of motion and patient-perceived global change, and the secondary outcomes were neck-related disability and pressure pain threshold. We hypothesized that hot and cold packs would each produce greater improvements in the study outcomes than the sham pack over the 72 h follow-up period. The comparison between hot and cold packs was exploratory and was tested without a directional hypothesis.

2. Materials and Methods

2.1. Study Design and Setting

This prospective, three-arm, parallel-group, sham-controlled randomized clinical trial was conducted between July 2024 and July 2025 at the Physical Therapy and Rehabilitation Clinic of a private hospital in Istanbul, Turkey. Participants were recruited from patients with acute or subacute nonspecific neck pain who were waiting to begin their routine physiotherapy program, and were randomly allocated in a 1:1:1 ratio to a hot-pack group, a cold-pack group, or a room-temperature sham-pack group. Following completion of the 72 h study protocol, all participants proceeded to their routinely scheduled physiotherapy program.

The study protocol was approved by the Acıbadem University and Acıbadem Healthcare Institutions Medical Research Ethics Committee (ATADEK; approval no. 2024/9/340; date: 30 May 2024). The study was conducted in accordance with the Declaration of Helsinki, and all participants provided written informed consent after receiving verbal and written information about the study. The trial was prospectively registered at ClinicalTrials.gov (NCT06507761) on 12 July 2024. After completion of data collection, several descriptive elements of the ClinicalTrials.gov record were corrected for accuracy, including the masking classification and descriptions of some outcome-assessment procedures. The original registry entry had classified the study as double-blind because participants were not informed of the study hypotheses, their group labels, or which intervention was considered active

or sham; however, given the perceptible temperature differences between interventions, participant blinding to treatment temperature could not be ensured. The registry was therefore subsequently updated to more accurately reflect the actual masking procedures. These corrections did not alter the study design, intervention groups, prespecified outcome domains, or conduct of the trial.

This trial is reported in accordance with the Consolidated Standards of Reporting Trials (CONSORT) 2025 statement [19] (Checklist S1). The interventions are described according to the Template for Intervention Description and Replication (TIDieR) checklist [20] (Checklist S2), and the control intervention is reported in line with the recommendations of the CoPPS statement [18] (Checklist S3).

2.2. Participants and Eligibility Criteria

Participants were recruited from patients referred to the physical therapy and rehabilitation clinic with neck pain. Eligibility was assessed by a physiatrist with 10 years of clinical experience (M.Y.).

Inclusion criteria were as follows:

- Age 18–65 years;
- Diagnosis of nonspecific neck pain;
- Symptom duration of less than 12 weeks;
- Grade I or II neck pain according to the classification of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders [21];
- Negative results on the Spurling, cervical distraction, Lhermitte, and Adson tests.

Exclusion criteria were as follows:

- History of neck or shoulder surgery;
- Concomitant shoulder pain of any origin;
- Serious underlying pathology, such as infection, tumor, fracture, or inflammatory disease;
- Clinical signs of cervical stenosis or discogenic pathology;
- Neurological signs, including motor deficits, reflex changes, or sensory abnormalities indicating nerve root compression or peripheral nerve entrapment in the upper extremity;
- Any other neurological disorder;
- Systemic rheumatological or metabolic disease, or cancer;
- Severe psychiatric disorder;
- Contraindications to superficial heat or cold application, including impaired skin sensation, open wounds or skin lesions in the treatment area, cold urticaria or cold hypersensitivity, Raynaud's phenomenon, peripheral vascular disease, and heat intolerance.

Participants were instructed not to use analgesic, anti-inflammatory, or muscle-relaxant medications during the 72 h study period.

2.3. Sample Size

The sample size was calculated a priori using G*Power software (version 3.1.7) [22]. The calculation was based on a repeated-measures analysis of variance (within–between interaction) with three groups and two measurements (baseline and 72 h), assuming a medium effect size ($f = 0.25$) [23], a two-sided α level of 0.05, a statistical power of 80%, and a correlation of 0.4 between repeated measures. This analysis indicated that a minimum of 51 participants (17 per group) was required. To account for an anticipated dropout rate of approximately 15%, the target sample size was set at 60 participants (20 per group). The sample size calculation was performed at the design stage using a repeated-measures ANOVA framework. The final between-group analyses were performed using baseline-adjusted ANCOVA because baseline imbalances were observed for some outcomes;

therefore, the original sample size calculation was not specific to the final analytical model or to a predefined clinically important difference for any individual outcome. Accordingly, the nominal 80% power from the original calculation should not be interpreted as 80% power for each individual outcome or for the final ANCOVA-based pairwise comparisons, particularly given the presence of multiple prespecified primary outcomes. The findings should therefore be interpreted cautiously, with emphasis on effect estimates and confidence intervals rather than statistical significance alone.

2.4. Randomization and Allocation Concealment

Participants were randomly allocated to the three groups in a 1:1:1 ratio. A set of 60 group assignments, with 20 assignments for each group, was generated by an independent unit secretary using Research Randomizer (www.randomizer.org). The unit secretary, who was not involved in participant assessment or treatment, placed each assignment in an identical, opaque, sealed, and sequentially numbered envelope. The envelopes were thoroughly mixed before recruitment and kept by the unit secretary. After eligibility had been confirmed, written informed consent had been obtained, and baseline assessments had been completed, each participant selected one sealed envelope. The envelope was opened by the unit secretary, who communicated the allocation only to the physiotherapist responsible for delivering the intervention. The envelope number and corresponding group allocation were recorded in the study documentation at the time of randomization. The outcome assessor remained unaware of group allocation.

2.5. Blinding

Blinding of the physiotherapist delivering the interventions (D.K.) was not feasible because of the perceptible temperature differences between the treatments. Participants were not informed of the study hypotheses, the group labels, or which intervention was considered active or sham; however, because the thermal sensations of the interventions were perceptible, participant blinding to treatment temperature could not be ensured. Outcome assessments were performed by an independent physiotherapist (A.G.) who was blinded to group allocation. The outcome assessor was not formally asked to guess treatment allocation; therefore, the success of assessor blinding was not formally evaluated. The researcher responsible for the statistical analyses (N.A.) was also blinded to group identity during the analyses. To minimize communication between participants and the possibility of comparing treatment experiences, participants were treated individually, and no two study participants were present in the treatment unit at the same time. Participants were also instructed not to disclose details of their treatment to the outcome assessor. Treatment expectations and treatment credibility were not formally assessed.

2.6. Interventions

All interventions were administered by the same physiotherapist (D.K.), who had 5 years of clinical experience, once daily for three consecutive days (three sessions in total). In each session, a treatment pack wrapped in two layers of towel was applied to the posterior cervical and upper thoracic region for 15 min while the participant lay in the prone position. A 15 min application duration was selected as a clinically practical exposure for superficial thermal application and was used consistently across all groups to standardize treatment exposure [24,25]. The same duration was used across all groups to standardize treatment exposure. Applications were repeated once daily for three consecutive days to evaluate the short-term cumulative response to repeated thermal exposure over the predefined 72 h study period. Towel wrapping, application duration, body position, treatment region, and general application procedure were standardized across the three groups, with the thermal

condition constituting the intended treatment difference. During the 72 h study period, no additional physiotherapy modalities were administered, and participants were instructed not to use analgesic, anti-inflammatory, or muscle-relaxant medication.

2.6.1. Hot-Pack Group

Participants received a superficial moist-heat application using a hot pack prepared in a Hydrocollator unit (Chattanooga Group, Hixson, TN, USA). The temperature of the hot pack was measured with a thermometer immediately before each application and maintained within the target range of 55–60 °C. The pack was wrapped in two layers of towel and applied to the posterior cervical and upper thoracic region for 15 min while the participant remained in the prone position.

2.6.2. Cold-Pack Group

Participants received a superficial cold application using a cold pack cooled in a refrigerator. The temperature of the cold pack was measured with a thermometer immediately before each application and maintained within the target range of 2–4 °C. The pack was wrapped in two layers of towel and applied to the posterior cervical and upper thoracic region for 15 min while the participant remained in the prone position. The anterior neck and carotid sinus region were avoided during application [24].

2.6.3. Room-Temperature Sham-Pack Group

Participants received a cold pack of the same type as that used in the cold-pack group, which was kept at room temperature without heating or cooling. The temperature of the sham pack was measured with a thermometer immediately before each application and maintained within the target range of 20–22 °C. The pack was wrapped in two layers of towel and applied to the same posterior cervical and upper thoracic region for 15 min while the participant remained in the prone position. Apart from the absence of therapeutic heating or cooling, the application duration, towel wrapping, treatment region, and participant positioning were identical to those used in the active treatment groups.

2.6.4. Exercise Program

Following the pack application, all participants performed active cervical range-of-motion exercises consisting of flexion, extension, bilateral lateral flexion, and bilateral rotation within the pain-limited active range. Exercises were performed twice daily, with each session consisting of 10 repetitions of each movement. One session was performed under supervision immediately after the pack application, and the second session was performed independently at home.

2.6.5. Monitoring of Discomfort and Adverse Events

During each application, participants were actively monitored by the treating physiotherapist for excessive heat or cold sensation, discomfort, skin irritation, or any other adverse reaction. Participants were also asked to rate treatment-related discomfort on a 0–100 numerical scale, with higher scores indicating greater discomfort. If clinically relevant discomfort or a skin reaction occurred, the application was to be stopped immediately and the participant reassessed. Any adverse events or treatment-related reactions were recorded throughout the 72 h intervention period.

2.7. Outcome Measures

Baseline demographic and clinical characteristics, including age, sex, body mass index, symptom duration, education level, and medical history, were recorded before randomiza-

tion. All clinical outcomes were assessed by the same assessor (A.G.), who was blinded to group allocation, at baseline and at 72 h (after the final intervention session). The Global Rating of Change (GRC) was assessed only at 72 h. The prespecified primary outcomes were pain intensity, active cervical range of motion, and patient-perceived global change. However, during post hoc verification of the study data, the reliability and consistency of the cervical range-of-motion measurements could not be confirmed with sufficient confidence. Therefore, cervical range-of-motion data were excluded from inferential analysis and interpretation in the revised manuscript. Neck-related disability and pressure pain threshold were prespecified secondary outcomes.

2.7.1. Primary Outcomes

Pain Intensity

Neck pain intensity at rest and during movement was assessed using the 11-point Numeric Pain Rating Scale (NPRS), ranging from 0 ("no pain") to 10 ("worst imaginable pain"). Participants selected the integer that best represented their pain intensity, with higher scores indicating greater pain. For pain during movement, the active cervical movement that provoked the greatest pain was identified at baseline, and the same movement was reassessed at the 72 h follow-up. The NPRS has demonstrated acceptable test–retest reliability and adequate responsiveness in individuals with mechanical neck pain [26].

Global Rating of Change

At 72 h, participants rated the overall change in their neck condition relative to baseline using a five-point Global Rating of Change (GRC) scale ranging from −2 ("much worse") to +2 ("much better"), with 0 indicating "no change". Higher scores indicate greater perceived improvement [27].

2.7.2. Secondary Outcomes

Neck-Related Disability

Neck-related disability was assessed using the validated Turkish version of the Neck Disability Index (NDI) [28,29]. The NDI consists of 10 items assessing pain intensity, personal care, lifting, reading, headache, concentration, work, driving, sleep, and recreation. Each item is scored from 0 (no disability) to 5 (maximum disability), yielding a maximum total score of 50, with higher scores indicating greater disability. The total score (0–50) was used in the analyses.

Pressure Pain Threshold

Pressure pain threshold (PPT) was assessed using a handheld digital pressure algometer (JTECH Medical, Midvale, UT, USA) according to standardized procedures [30,31] and based on the anatomical assessment approach previously described by Yıldırım et al. [32]. Twelve standardized anatomical sites were assessed bilaterally (six on each side). On each side, three sites were located over the upper trapezius region (medial to the acromion, over the muscle belly, and at the C7 level), and three sites were located over the cervical paravertebral region between the C3–C4 and C7 levels.

The algometer was applied perpendicular to the skin, with pressure increased at a rate of approximately 0.5 $kg/cm^2/s$ until the participant first reported that the sensation had changed from pressure to pain [31]. The pressure at that point was recorded as the PPT (kg/cm^2). Three measurements were obtained at each site, with a brief rest interval between successive measurements, resulting in 18 measurements for the upper trapezius region and 18 measurements for the cervical paravertebral region. The mean of the bilateral upper trapezius measurements was defined as the global trapezius local sensitivity (GTLS)

score, whereas the mean of the bilateral cervical paravertebral measurements was defined as the global cervical local sensitivity (GCLS) score [32]. Higher PPT values indicated lower mechanical pain sensitivity.

2.8. Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics, version 21.0 (IBM Corp., Armonk, NY, USA). Analyses included participants who completed the 72 h assessment (complete-case analysis). Continuous variables are presented as mean ± standard deviation (SD), categorical variables as number (percentage), and ordinal variables as median (interquartile range [IQR]). The distribution of continuous variables was examined using the Shapiro–Wilk test [33] and skewness and kurtosis values. Parametric tests were used where distributional assumptions were considered acceptable [34].

Baseline continuous variables were compared among the three groups using one-way analysis of variance (ANOVA). Welch's ANOVA was used when the homogeneity of variance assumption, assessed using Levene's test, was violated. Categorical variables were compared using Pearson's chi-square test. Within-group changes from baseline to 72 h were examined using paired-samples t-tests and are reported as the mean change (72 h minus baseline) with 95% confidence intervals (CIs).

Between-group differences in pain intensity, neck disability, and pressure pain threshold at 72 h were analyzed using analysis of covariance (ANCOVA), with the 72 h value as the dependent variable, treatment group as the fixed factor, and the corresponding baseline value as the covariate [35]. Pairwise comparisons of estimated marginal means were adjusted using the Bonferroni method and are reported as baseline-adjusted mean differences with 95% CIs. Effect sizes are reported as partial eta squared (partial η^2); values of approximately 0.01, 0.06, and 0.14 were used as conventional reference points for small, medium, and large effects, respectively, while recognizing that such thresholds should be interpreted cautiously and in context [23]. The assumptions of ANCOVA were examined using Levene's test for homogeneity of error variances and the group × baseline interaction for homogeneity of regression slopes. The homogeneity-of-regression-slopes assumption was not met for resting pain, as indicated by a significant group × baseline interaction ($p = 0.048$). Therefore, Quade's rank analysis of covariance was performed as a sensitivity analysis for the pain outcomes [36]. In addition, a conservative missing-data sensitivity analysis was performed for pain intensity, neck disability, and pressure pain threshold. For the four participants who did not complete the 72 h assessment, baseline values were carried forward to the 72 h time point under a no-improvement assumption, while the complete-case ANCOVA remained the primary analysis.

Global Rating of Change (GRC) scores were compared among groups using the Kruskal–Wallis test. Mean treatment-related discomfort across the three treatment sessions was compared among groups using one-way ANOVA. Bonferroni adjustment was applied to pairwise comparisons within individual outcomes; no adjustment for multiplicity was applied across outcomes. All statistical tests were two-sided; and $p < 0.05$ was considered statistically significant.

3. Results

3.1. Participant Flow

Between July 2024 and July 2025, 78 individuals were assessed for eligibility. Of these, 18 were excluded: 9 did not meet the eligibility criteria, and 9 declined to participate. The remaining 60 participants were randomized equally to the hot-pack, cold-pack, or sham-pack group (n = 20 per group), and all received the allocated intervention.

During follow-up, one participant in each group declined further participation and did not complete the 72 h assessment. In addition, one participant in the cold-pack group was withdrawn because of analgesic use on two days of the study period, contrary to the study protocol. No participant was classified as lost to follow-up. Consequently, 56 participants were included in the primary complete-case analysis: 19 in the hot-pack group, 18 in the cold-pack group, and 19 in the sham-pack group (Figure 1). No adverse events were reported in any group.

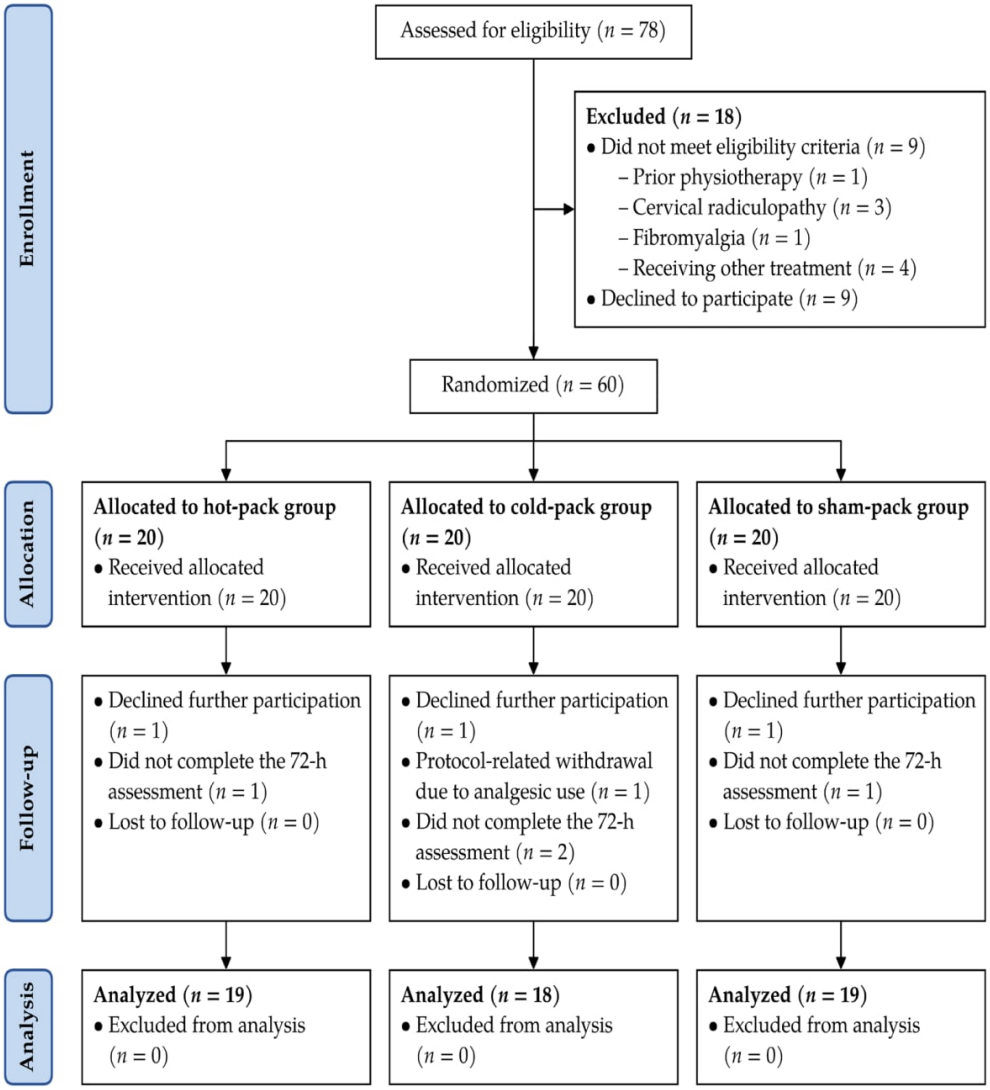

Figure 1. CONSORT flow diagram of participant enrollment, allocation, follow-up, and analysis.

CONSORT, Consolidated Standards of Reporting Trials. "Receiving other treatment" refers to participants who were receiving another treatment for neck pain at the time of screening.

3.2. Participant Characteristics and Baseline Values

Baseline demographic characteristics, pain intensity, and neck-related disability did not differ significantly among groups ($p > 0.05$). Significant baseline differences were observed in cervical pressure pain threshold measures ($p < 0.05$; Table 1). These baseline differences were accounted for in the subsequent adjusted analyses.

Table 1. Baseline demographic and clinical characteristics of the study groups.

Variable	Sham Pack Group (n = 19)	Hot Pack Group (n = 19)	Cold Pack Group (n = 18)	*p*-Value
	Mean ± Standard Deviation or n (%)			
Age, years	32.05 ± 8.42	38.47 ± 10.10	35.06 ± 12.66	0.178 [a]
Sex, n (%)				0.889 [b]
Male	6 (31.6)	5 (26.3)	6 (33.3)	
Female	13 (68.4)	14 (73.7)	12 (66.7)	
Body Mass Index, kg/m²	20.58 ± 5.01	22.58 ± 4.35	22.17 ± 5.15	0.413 [a]
Education, years	13.68 ± 3.00	13.42 ± 2.89	12.89 ± 3.07	0.714 [a]
Symptom duration, weeks	6.74 ± 2.33	6.05 ± 2.37	6.83 ± 2.55	0.562 [a]
Pain intensity				
NPRS at rest, 0–10	5.26 ± 1.52	4.84 ± 1.26	4.67 ± 0.77	0.332 [c]
NPRS during movement, 0–10	6.16 ± 1.17	6.05 ± 1.39	5.50 ± 1.29	0.261 [a]
Disability score				
Neck Disability Index, 0–50	17.68 ± 2.87	18.26 ± 5.88	15.39 ± 3.81	0.095 [c]
Pressure pain threshold (PPT)				
Cervical PPT (GCLS), kg/cm²	4.83 ± 1.40	5.69 ± 1.06	4.63 ± 0.98	**0.010** [c]
Trapezius PPT (GTLS), kg/cm²	5.73 ± 0.85	5.70 ± 1.06	5.57 ± 0.94	0.866 [a]

[a] One-way analysis of variance (ANOVA); [b] Pearson's chi-square test; [c] Welch's ANOVA was used when the homogeneity of variance assumption was violated; NPRS: Numeric Pain Rating Scale; GCLS: global cervical local sensitivity; GTLS: global trapezius local sensitivity. Bold values indicate $p < 0.05$.

3.3. Pain Intensity

Pain intensity decreased from baseline to 72 h in all groups, both at rest and during movement (all $p < 0.001$; Table 2). After adjustment for baseline, pain at rest differed between groups ($F(2, 52) = 11.19$, $p < 0.001$, partial $\eta^2 = 0.30$). Adjusted pain was lower in the hot-pack group (mean difference, 0.92; 95% CI, 0.31 to 1.53; $p = 0.002$) and in the cold-pack group (1.11; 95% CI, 0.49 to 1.74; $p < 0.001$) than in the sham-pack group, with no difference between the hot-pack and cold-pack groups (0.20; 95% CI, −0.42 to 0.81; $p = 1.000$). Because the group × baseline interaction was significant for this outcome ($p = 0.048$), the result was examined with Quade's rank analysis of covariance, which yielded the same conclusions ($F(2, 53) = 12.47$, $p < 0.001$).

Pain during movement also differed between groups ($F(2, 52) = 8.95$, $p < 0.001$, partial $\eta^2 = 0.26$). Adjusted pain was lower in the cold-pack group than in the sham-pack group (1.73; 95% CI, 0.70 to 2.75; $p < 0.001$). The difference between the hot-pack and sham-pack groups was smaller (1.05; 95% CI, 0.06 to 2.04; $p = 0.034$) and was not confirmed in the sensitivity analysis ($p = 0.140$). The hot-pack and cold-pack groups did not differ (0.68; 95% CI, −0.34 to 1.69; $p = 0.316$).

Table 2. Outcomes at baseline and 72 h, within-group changes, and between-group comparisons adjusted for baseline.

Outcome	Group	Baseline, Mean ± SD	72 h, Mean ± SD	Mean Change (95% CI)	Within-Group p [a]	Adjusted F	Partial η^2	Adjusted Between-Group p [b]	Sham vs. Hot Pack p [c]	Sham vs. Cold Pack p [c]	Hot Pack vs. Cold Pack p [c]
Pain intensity											
NPRS at rest †	Sham Pack	5.26 ± 1.52	3.47 ± 0.77	−1.79 (−2.23 to −1.35)	**<0.001**	11.186	0.301	**<0.001**	**0.002**	**<0.001**	1.000
	Hot Pack	4.84 ± 1.26	2.42 ± 1.02	−2.42 (−3.03 to −1.81)	**<0.001**						
	Cold Pack	4.67 ± 0.77	2.17 ± 0.71	−2.50 (−3.07 to −1.93)	**<0.001**						
NPRS during movement	Sham Pack	6.16 ± 1.17	2.58 ± 1.92	−3.58 (−4.52 to −2.64)	**<0.001**	8.948	0.256	**<0.001**	**0.034**	**<0.001**	0.316
	Hot Pack	6.05 ± 1.39	1.47 ± 1.22	−4.58 (−5.04 to −4.12)	**<0.001**						
	Cold Pack	5.50 ± 1.29	0.50 ± 0.79	−5.00 (−5.42 to −4.58)	**<0.001**						
Disability											
NDI (0–50)	Sham Pack	17.68 ± 2.87	8.68 ± 4.77	−9.00 (−11.17 to −6.83)	**<0.001**	7.744	0.229	**0.001**	**0.038**	0.494	**0.001**
	Hot Pack	18.26 ± 5.88	5.42 ± 3.42	−12.84 (−15.36 to −10.32)	**<0.001**						
	Cold Pack	15.39 ± 3.81	9.56 ± 5.72	−5.83 (−8.03 to −3.64)	**<0.001**						
Pressure pain threshold											
Cervical PPT (GCLS), kg/cm²	Sham Pack	4.83 ± 1.40	6.30 ± 0.92	1.47 (1.04 to 1.90)	**<0.001**	2.456	0.086	0.096	1.000	0.172	0.189
	Hot Pack	5.69 ± 1.06	6.79 ± 0.87	1.10 (0.73 to 1.47)	**<0.001**						
	Cold Pack	4.63 ± 0.98	5.77 ± 0.94	1.13 (0.71 to 1.56)	**<0.001**						
Trapezius PPT (GTLS), kg/cm²	Sham Pack	5.73 ± 0.85	6.06 ± 0.76	0.33 (0.22 to 0.44)	**<0.001**	6.412	0.198	**0.003**	1.000	**0.034**	**0.003**
	Hot Pack	5.70 ± 1.06	5.96 ± 1.04	0.26 (0.16 to 0.36)	**<0.001**						
	Cold Pack	5.57 ± 0.94	6.12 ± 1.16	0.55 (0.39 to 0.71)	**<0.001**						

Data are presented as mean ± standard deviation (SD). Mean change was calculated as the 72 h value minus the baseline value; therefore, negative values indicate reductions in NPRS and NDI scores, whereas positive values indicate increases in pressure pain threshold. [a] Within-group comparisons were performed using paired-samples *t*-tests. [b] Between-group differences at 72 h were evaluated using analysis of covariance (ANCOVA), with the corresponding baseline value entered as a covariate. [c] Pairwise comparisons were based on estimated marginal means with Bonferroni adjustment for multiple comparisons. † A significant group × baseline interaction was identified in the preliminary assessment of the homogeneity of regression slopes. Bold values indicate $p < 0.05$. NPRS, Numeric Pain Rating Scale; NDI, Neck Disability Index; PPT, pressure pain threshold; GCLS: global cervical local sensitivity; GTLS: global trapezius local sensitivity; CI, confidence interval; SD, standard deviation.

In an additional conservative sensitivity analysis addressing the four participants with missing 72 h data, baseline pain scores were carried forward under a no-improvement assumption. For resting pain, the overall between-group effect remained significant ($F = 5.394$, $p = 0.007$, partial $\eta^2 = 0.162$), and the sham-versus-hot ($p = 0.014$) and sham-versus-cold ($p = 0.022$) comparisons remained significant, whereas the hot-versus-cold comparison remained non-significant ($p = 1.000$). For movement pain, the overall group effect was attenuated but remained statistically significant ($F = 3.221$, $p = 0.047$, partial $\eta^2 = 0.103$); however, none of the Bonferroni-adjusted pairwise comparisons remained statistically significant (sham vs. hot, $p = 0.195$; sham vs. cold, $p = 0.057$; hot vs. cold, $p = 1.000$). These findings indicate that the resting-pain results were relatively robust to conservative assumptions regarding missing follow-up data, whereas the movement-pain findings were more sensitive. Overall, the sensitivity analysis supported the main conclusion for resting pain, whereas the findings for movement pain were less robust.

3.4. Neck Disability

NDI scores decreased in all groups (all $p < 0.001$). The adjusted between-group effect was significant ($F(2, 52) = 7.74$, $p = 0.001$, partial $\eta^2 = 0.23$). Adjusted NDI scores were lower in the hot-pack group than in the sham-pack group (mean difference, 3.55 points; 95% CI, 0.15 to 6.95; $p = 0.038$) and the cold-pack group (5.56 points; 95% CI, 1.99 to 9.12; $p = 0.001$). The cold-pack and sham-pack groups did not differ (2.01 points; 95% CI, −1.52 to 5.53; $p = 0.494$).

In the conservative missing-data sensitivity analysis, the overall between-group effect for NDI remained significant ($F (2, 56) = 6.89$, $p = 0.002$, partial $\eta^2 = 0.20$). The difference between the hot- and cold-pack groups remained significant after Bonferroni adjustment ($p = 0.002$), whereas the sham-versus-hot ($p = 0.093$) and sham-versus-cold ($p = 0.371$) comparisons were not significant.

3.5. Pressure Pain Threshold

PPT increased at both the cervical and trapezius sites in all groups (all $p < 0.001$). No between-group effect was found for cervical PPT ($F (2, 52) = 2.46$, $p = 0.096$, partial $\eta^2 = 0.09$). For trapezius PPT, the between-group effect was significant ($F(2, 52) = 6.41$, $p = 0.003$, partial $\eta^2 = 0.20$); adjusted values were higher in the cold-pack group than in the sham-pack group (0.22 kg/cm^2; 95% CI, 0.01 to 0.43; $p = 0.034$) and the hot-pack group (0.29 kg/cm^2; 95% CI, 0.08 to 0.50; $p = 0.003$).

In the missing-data sensitivity analysis, cervical PPT remained non-significant ($F(2, 56) = 2.06$, $p = 0.137$, partial $\eta^2 = 0.07$). The overall between-group effect for trapezius PPT remained significant ($F(2, 56) = 4.43$, $p = 0.016$, partial $\eta^2 = 0.14$). The cold-versus-hot comparison remained significant after Bonferroni adjustment ($p = 0.017$), whereas the cold-versus-sham comparison was no longer significant ($p = 0.118$).

3.6. Global Rating of Change and Treatment-Related Discomfort

At 72 h, GRC scores did not differ significantly among the three groups (Kruskal–Wallis $H (2) = 0.66$, $p = 0.720$). Most participants in each group reported being "much better" (+2): 68.4% in the sham-pack group, 78.9% in the hot-pack group, and 72.2% in the cold-pack group. Median GRC scores were 2 (IQR, 1–2) in the sham-pack group, 2 (IQR, 2–2) in the hot-pack group, and 2 (IQR, 1–2) in the cold-pack group.

Mean treatment-related discomfort across the three treatment sessions was low in all groups and did not differ significantly between groups ($p = 0.107$; Table 3).

Table 3. Global Rating of Change and Treatment-Related Discomfort.

Outcome	Sham Pack (n = 19)	Hot Pack (n = 19)	Cold Pack (n = 18)	*p*-Value
GRC score, n (%)				
0 (No change)	1 (5.3%)	0 (0.0%)	1 (5.6%)	
+1 (A little better)	5 (26.3%)	4 (21.1%)	4 (22.2%)	0.720 [a]
+2 (Much better)	13 (68.4%)	15 (78.9%)	13 (72.2%)	
Median (IQR)	2 (1–2)	2 (2–2)	2 (1–2)	
Treatment-related discomfort across the three treatment sessions, 0–100				
Mean ± SD	6.32 ± 6.63	9.21 ± 8.21	11.72 ± 7.95	0.107 [b]
Range	0–20	0–25	0–30	

Data are presented as n (%), median (IQR), or mean ± SD, as appropriate. [a] Between-group differences in GRC scores were evaluated using the Kruskal–Wallis test. [b] Between-group differences in mean treatment-related discomfort across the three treatment sessions were evaluated using one-way ANOVA. GRC, Global Rating of Change; IQR, interquartile range; SD, standard deviation.

4. Discussion

This three-arm, sham-controlled trial examined whether the temperature of a superficial pack contributes to short-term outcomes in acute and subacute nonspecific neck pain. All participants also performed active range-of-motion exercises, and all three groups improved over 72 h. Compared with the room-temperature sham pack, both the hot and the cold pack were associated with lower pain at rest, and these findings remained robust in the conservative missing-data sensitivity analysis. In the primary analysis, the cold pack was also associated with lower pain during movement; however, movement-pain findings were less robust, and the pairwise differences were not retained in the missing-data sensitivity analysis. Pain did not differ between the hot and cold packs. Neither active pack was superior to the sham pack for patient-perceived global change. Neck disability was lower after the hot pack than after the cold and sham packs in the primary analysis; however, in the missing-data sensitivity analysis, only the hot-versus-cold difference remained significant. Pressure pain threshold at the trapezius sites was slightly higher after the cold pack than after both the sham and hot packs in the primary analysis, whereas only the cold-versus-hot difference remained significant in the missing-data sensitivity analysis. Overall, the findings provide the most consistent evidence for a short-term effect on resting pain, whereas the findings for movement pain, neck disability, and trapezius pressure pain threshold were less robust across sensitivity analyses. The hypothesis that hot and cold packs would be superior to sham was therefore only partially supported and was not supported for patient-perceived global change.

The most consistent between-group differences in this trial were observed for pain intensity. Both the hot and the cold pack were associated with greater reductions in pain at rest than the room-temperature sham pack. For pain during movement, the difference was most evident for the cold pack; the hot pack also differed from the sham pack in the primary analysis, but this was not confirmed in the sensitivity analysis. Although the three interventions were standardized in procedure, duration, and positioning [18], the perceptible differences in pack temperature and the inability to ensure participant blinding mean that contextual and expectation-related effects cannot be excluded [16]. The observed differences may therefore reflect a combination of temperature-associated analgesic effects and nonspecific treatment effects. Such an effect would be compatible with the reported physiological actions of the two agents, including increased tissue temperature and blood flow with heat [9] and reduced nerve conduction velocity and raised pain threshold with

cold [10], although these mechanisms were not assessed in the present study. Pain did not differ between the hot-pack and cold-pack groups, and the present data do not indicate that one thermal modality is superior to the other. The magnitude of the within-group reduction in movement pain, particularly in the cold-pack group, should also be interpreted cautiously. Pain decreased considerably in the sham-pack group, suggesting that the large short-term changes cannot be attributed solely to pack temperature. Given the acute and subacute nature of the condition and the short 72 h follow-up period, the favorable natural course of neck pain [3,4], regression to the mean, the active exercises performed by all participants [6,7], and contextual effects [16] may all have contributed to the observed improvement. Moreover, the movement-pain findings were less robust in the conservative missing-data sensitivity analysis, in which the pairwise between-group differences were no longer statistically significant. Therefore, the large within-group reduction in movement pain, particularly in the cold-pack group, should not be interpreted as evidence of a large temperature-associated treatment effect.

These findings are broadly consistent with the randomized trial by Garra et al., in which a single 30 min application of heat or cold produced similarly mild reductions in pain in patients with acute neck or back strain [14]. In that trial, however, all participants also received 400 mg of ibuprofen, no sham comparator was included, and only the immediate response to a single application was evaluated, which limited the ability to isolate the contribution of temperature. Importantly, statistical significance should not be interpreted as equivalent to clinical importance. The magnitude of the between-group differences in the present trial was generally modest. The magnitude of the between-group differences in the present trial was generally modest. For comparison, a within-person minimal clinically important difference of approximately 1.5 points has been reported for the NPRS in patients with mechanical neck pain [37], with comparable estimates reported in nonspecific neck pain populations [38]. However, the interpretation of between-group differences is distinct from that of change in individual patients and should take into account the characteristics of the intervention and its risk–benefit ratio [39]. Thus, the adjusted between-group differences in resting pain (0.92–1.11 points) were below these commonly cited within-person MCID estimates. The 1.73-point difference in movement pain between the cold and sham groups reached this range in the primary analysis, but this comparison was not retained in the conservative missing-data sensitivity analysis. The clinical importance of the observed differences therefore cannot be determined with certainty, particularly as the confidence intervals were wide. Accordingly, the pain findings are more appropriately interpreted as small-to-modest short-term effects rather than evidence of a substantial clinically important benefit. The evidence base for superficial thermal agents in nonspecific neck pain remains limited: a recent systematic review of heat therapy identified only two randomized trials with 67 participants in total and concluded that the evidence was insufficient to support a recommendation for or against its use [13]. Within these limits, the present findings provide preliminary sham-controlled evidence that pack temperature may be associated with short-term pain relief when added to active range-of-motion exercises. Given the 72 h follow-up period, these modest between-group differences should be interpreted as short-term effects, and their durability and longer-term clinical relevance remain uncertain. This association was most robust for resting pain and requires confirmation in larger trials.

Neck disability findings were less consistent than those for pain. NDI scores improved in all groups, and adjusted scores at 72 h were lower in the hot-pack group than in the sham-pack and cold-pack groups, by 3.6 and 5.6 points, respectively. Both between-group differences were below the 7-point threshold used in a Cochrane review of neck pain to represent a clinically important difference in NDI [40], and the lower confidence limit for the comparison with the sham pack was close to zero. Moreover, in the conservative

missing-data sensitivity analysis, the hot-versus-sham comparison was no longer statistically significant, whereas the hot-versus-cold difference was retained. Together with the fact that the NDI was developed for a broader recall period than the present 72 h follow-up, these findings further limit interpretation of the observed disability differences as clinically meaningful. Direct evidence on the isolated effect of superficial heat on disability in nonspecific neck pain is limited, as heat has mostly been applied together with other treatments. In a randomized trial in chronic nonspecific neck pain, Karaarslan et al. [41] reported improvements in pain and disability after a program that combined hot packs with transcutaneous electrical nerve stimulation and home exercises; in the absence of a sham condition, however, these changes cannot be attributed to heat alone. Given the short assessment period, the secondary-outcome status of NDI, and the reduced robustness of the hot-versus-sham comparison in the missing-data sensitivity analysis, the disability findings should therefore be interpreted cautiously.

Changes in pressure pain threshold were modest and site-specific. PPT increased in all groups at both measurement sites, with no between-group difference at the cervical sites, whereas trapezius PPT was slightly higher after the cold pack than after the sham and hot packs. This pattern is compatible with a hypoalgesic effect of cold. Algafly and George showed that local cooling reduced nerve conduction velocity and increased pressure pain threshold and pain tolerance, suggesting that reduced peripheral nerve conduction may contribute to cold-induced analgesia [10]. However, that study was conducted at the ankle in healthy participants, and its findings should be extrapolated to individuals with neck pain with caution. In the present trial, the between-group differences were small (0.22 and 0.29 kg/cm^2, approximately 4–5% of baseline values) and were not observed at the cervical sites, suggesting that any temperature-associated effect on PPT was neither large nor uniform across measurement sites. Furthermore, in the missing-data sensitivity analysis, the cold-versus-sham comparison was no longer statistically significant, whereas the cold-versus-hot comparison remained significant. This further supports a cautious interpretation of the PPT findings as small and exploratory rather than clinically established effects. Consistent with this finding, a randomized trial in patients with mechanical neck pain of less than three months' duration found that adding ice massage to a manual technique did not provide additional improvement in pressure pain threshold [42]. Although cold application may provide short-term analgesic effects, its use in the cervical region warrants particular caution because of the anatomical complexity of the neck and the proximity of important neurovascular structures. In the present study, the cold pack was applied only to the posterior cervical and upper thoracic region, with the anterior neck and carotid sinus region avoided, and no adverse events were observed. These findings therefore apply to a carefully controlled, short-duration, supervised application and should not be generalized to prolonged, unsupervised, or anatomically inappropriate use of cold in the cervical region.

Despite the between-group differences observed in pain, disability, and trapezius pressure pain threshold, global perceived improvement was similar across groups, and most participants reported being "much better" at 72 h. This may partly reflect the nature of global change ratings, which are influenced by the patient's current status and may integrate pain, function, and the overall treatment experience rather than a single clinical outcome [27]. The clustering of responses at the upper end of the scale may also have limited its ability to discriminate between groups. All groups performed active range-of-motion exercises and had repeated contact with the therapist, and some improvement may also have reflected the natural course of acute and subacute neck pain. Recovery expectations may have contributed to the improvement shared across groups, as they have been associated with outcomes of musculoskeletal physical therapy, including in patients with neck pain [43]. Expectations may also have differed between groups: although participants were not informed that

different temperature conditions were being compared, pack temperature was perceptible. Treatment credibility and expectations, which are recommended to be assessed in sham-controlled trials [18], were not measured; therefore, their contribution to the observed effects cannot be determined. Treatment-related discomfort was low and similar across groups, and no adverse events were reported, indicating that all three applications were well tolerated during the 72 h study period.

Current guidelines differ in their recommendations on superficial thermal agents for neck pain: the OPTIMa Collaboration advised against passive physical modalities [11,12], whereas the recent German guideline recommends self-applied heat for nonspecific neck pain [2]. The present findings do not resolve this disagreement, but they may help to clarify the role of these agents. When added to active range-of-motion exercises, both hot and cold packs were associated with modest additional reductions in resting pain over the first 72 h, while neither showed a consistent advantage for perceived overall improvement. Although the primary analysis suggested additional differences in movement pain, disability, and trapezius PPT, these findings were less consistent in the missing-data sensitivity analyses and were generally small in clinical magnitude. Importantly, improvement was also observed in the sham group, suggesting that active exercise, natural recovery, therapist contact, and other contextual effects may have contributed substantially to the short-term changes observed across groups. As heat and cold did not differ in pain, and the remaining differences were small and partly exploratory, this pattern should be regarded as hypothesis-generating rather than as a basis for choosing one over the other. These findings do not support hot or cold packs as primary therapeutic interventions; active management should remain the central component of care. In clinical practice, hot or cold packs may therefore be considered optional short-term adjuncts within an active management approach rather than stand-alone treatments, and the choice between them may reasonably be guided by patient preference and tolerance. Because the packs were applied under supervision in a clinical setting, these findings cannot be directly extended to self-applied heat or cold at home, and whether the short-term benefit translates into better longer-term outcomes remains to be determined.

The strengths of this trial include its three-arm, randomized, sham-controlled design, standardized application procedures, blinded outcome assessment, baseline-adjusted analyses, and complementary sensitivity analyses addressing both model assumptions and missing follow-up data. Several limitations should also be considered. The sample was relatively small and recruited from a single center. The sample size was calculated using a repeated-measures ANOVA framework rather than the baseline-adjusted ANCOVA used in the final analyses and was not based on a specific primary outcome or a predefined clinically important between-group difference; therefore, the study may have had limited power to detect clinically important effects for individual outcomes. Outcomes were assessed only at 72 h, so it cannot be determined whether the observed effects persist or influence longer-term recovery. In addition, the NDI was developed to assess neck-related disability over a broader recall period; therefore, its responsiveness to changes occurring within the short 72 h assessment interval may be limited, and the NDI findings should be interpreted accordingly. Because the temperature of the packs was readily perceptible, participant blinding could not be ensured, the treating physiotherapist was not blinded, and treatment credibility and expectations were not measured; a contribution of contextual effects to the observed differences therefore cannot be excluded. Although the outcome assessor was blinded to group allocation, the success of assessor blinding was not formally evaluated. In addition, the sham pack was kept at room temperature, which is below skin temperature, and a mild cooling effect may have reduced the observed differences. Skin temperature beneath the packs was not measured; therefore, the actual thermal dose delivered through

the two towel layers could not be quantified. An additional limitation concerns the cervical range-of-motion measurements. During the post hoc verification process, we were unable to confirm the reliability and consistency of the cervical range of motion measurements with sufficient confidence; therefore, these data were excluded from inferential analysis and interpretation in the revised manuscript. Although cervical range of motion had been prespecified as a primary outcome, we considered exclusion of these measurements to be the most transparent and methodologically appropriate approach given the unresolved concerns regarding measurement reliability and data integrity. The primary analyses were based on participants who completed the follow-up assessment; however, the robustness of the findings to missing follow-up data was additionally examined using a conservative no-improvement sensitivity analysis. No overall adjustment was made for multiplicity across outcomes, which may have increased the likelihood of chance findings, particularly for secondary outcomes such as disability and pressure pain threshold. Accordingly, statistically significant findings for these outcomes should be interpreted cautiously and considered exploratory rather than confirmatory. Adherence to the home exercise session was not monitored. Furthermore, as all participants performed active range-of-motion exercises under supervision, the findings apply to hot and cold packs used as an adjunct to exercise and cannot be extended to their use alone or to unsupervised home application. Future trials should include larger samples, longer follow-up, assessment of treatment expectations and credibility, direct measurement of skin temperature or other markers of delivered thermal dose, and direct evaluation of self-applied heat and cold at home, and should be adequately powered to test whether specific patient characteristics or treatment goals modify the response to temperature. Given the modest effect sizes, short follow-up, and limited robustness of some findings in sensitivity analyses, the present results should be regarded as preliminary and hypothesis-generating pending confirmation in larger trials.

5. Conclusions

In adults with acute and subacute nonspecific neck pain performing active range-of-motion exercises, both hot and cold packs were associated with modest short-term reductions in resting pain over 72 h compared with a room-temperature sham pack. Other between-group differences in movement pain, disability, and trapezius pressure pain threshold were small and less consistent across the primary and sensitivity analyses. Pain did not differ between heat and cold, and neither showed a clear advantage for perceived global improvement. Both applications were well tolerated. These findings do not support hot or cold packs as primary therapeutic interventions. Active management should remain the central component of care, whereas superficial heat or cold may be considered optional short-term adjuncts according to patient preference, comfort, and tolerance. The present findings should be considered preliminary and require confirmation in larger, adequately powered trials with longer follow-up to determine their durability and clinical importance.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/medicina62122338/s1, Checklist S1: CONSORT 2025 checklist; Checklist S2: TIDieR checklist; Checklist S3: TIDieR-Placebo/CoPPS reporting checklist.

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Abbreviations

The following abbreviations are used in this manuscript:

ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
ATADEK	Acıbadem University and Acıbadem Healthcare Institutions Medical Research Ethics Committee
CI	Confidence interval
CONSORT	Consolidated Standards of Reporting Trials
CoPPS	Control interventions in physical, psychological, and self-management therapies
GCLS	Global cervical local sensitivity
GRC	Global Rating of Change
GTLS	Global trapezius local sensitivity
IQR	Interquartile range
MCID	Minimal clinically important difference
NDI	Neck Disability Index
NPRS	Numeric Pain Rating Scale
OPTIMa	Ontario Protocol for Traffic Injury Management
PPT	Pressure pain threshold
SD	Standard deviation
TIDieR	Template for Intervention Description and Replication

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