Review

Conservative Interventions for Non-Specific Low Back Pain in Tactical Populations: A Systematic Review of Randomized Controlled Trials

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Abstract: Limited evidence exists about non-specific low back pain (NSLBP) interventions among tactical personnel (police officers, firefighters, or army forces). The aim was to identify and systematically review the findings of randomized control trials (RCTs) investigating conservative interventions for the treatment NSLBP in tactical personnel. A search of seven databases for randomized controlled trials RCTs were conducted. Two independent reviewers extracted data and assessed the risk of bias (PEDro scale). Five RCTs (*n* = 387 military subjects; median PEDro score = 7/10) were included. The trials were highly heterogeneous, differing in pain and disability outcome measures, duration of NSLBP symptoms (acute, nonacute, nonchronic, and chronic), types of intervention (exercise, manual therapy, and physical therapy), types of control groups, and intervention durations (4–12 weeks). Two studies reported that strengthening exercise interventions were not effective for reducing pain or disability in military personnel with chronic or nonacute NSLBP. Manual therapy treatment was more effective than usual activities in current pain and pain typical symptoms in soldiers with acute NSLBP after four weeks. A multidimensional intervention reduced disability in military personnel with non-chronic NSLBP after four weeks. Strong evidence does not exist for the efficacy of any conservative interventions in the reduction of pain and disability in tactical populations with NSLBP.

Keywords: lumbar pain; treatment; occupational; lumbago; rehabilitation

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1. Introduction

The primary job of tactical personnel (i.e., military, law enforcement, or fire and rescue/first responders') is to serve and protect their community and country. In performing their duties, these professionals are required to complete tasks that can range between those that are mostly sedentary in nature (e.g., deskwork, driving, or sitting in a vehicle) to those that require maximal to near maximal physical exertion (e.g., chasing and grappling with an offender, dragging an injured person) [1–3]. Given the nature of threat to themselves, and to the need to perform these tasks and duties effectively, tactical personnel wear and carry various items of equipment. These items can include, but are not limited to, weapons, communications equipment, body armor, self-contained breathing apparatus, food, and nutrition [1,3,4]. The weight of this equipment often equates to approximately 10 kg of load

for general duties police [4], increasing to over 40 kg if these police are specialists [5], around 20 kg for firefighters [3], and over 45 kg for military personnel [6].

This occupational load carriage has the potential to alter the carrier's body posture and may lead to greater forward trunk lean [7,8]. This postural response alters the biomechanics of the spine, with the hips adopting an increased bend, which triggers a concomitant increase in the activation of the musculature surrounding the lower back and hip extensors [9]. Increasing load also brings with it changes in spinal curvatures in both females and males, with loads as small as 8 kg [10,11]. These increases in forward lean and back muscle activation, in addition to changes in spinal curvature, can heighten the risk of developing low back pain (LBP). Not only is this form of load carriage known to cause LBP [12], but these injuries are often more severe than those at other bodily sites [13]. Given the load carriage requirements of tactical personnel, it is therefore not surprising that the lower back is a leading site of musculoskeletal injury in these populations [12,14,15]. The workforce impacts of load carriage injuries can be notable with research having identified a significantly greater proportion of absenteeism in police officers, for example, who regularly wore body armor (26%) compared to those who did not (17%) [16] and loads worn by U.S. soldiers deployed to Afghanistan predictive of the development of LBP during deployment [17].

Apart from load carriage, other factors are also associated with LBP in these populations including a lack of physical fitness, higher fat mass, and long periods of sitting [18,19]. The nature of police and firefighter work, which includes shift work, is known to have a negative impact on fitness and body composition levels within these populations. Indeed, it has been reported that police officers have lower levels of fitness and higher fat mass than recruits of the same age [20]. For military soldiers, long periods of deployment have been found to likewise lead to lower levels of fitness and higher fat mass [21]. Both of these factors (lower levels of fitness and increased fat mass) are also associated with an increased risk of LBP as are long periods of sitting [17–19]. Furthermore, sitting can be further exacerbated by load carriage requirements causing increased discomfort and impacting on the range of motion in the trunk and hip [22,23].

The impacts of injuries to the lower back comes at a significant cost to the department in which they serve. In one study of an Australian police force, LBP was the most commonly reported disorder accounting for 40% of all physiotherapy treatments within the organization [24]. These injuries were found to occur across all rank levels, regardless of experience level [24]. Furthermore, when tactical personnel are injured and cannot perform their duties or can only perform partial duties, additional work must be passed to other officers. This additional time on the job leads to a greater risk of occupational-factor injury, which increases the potential cost to the organization to pay for additional shift work [25]. In U.S. military personnel, a study of 158 soldiers with orthopedic injuries, tracked from three months before deployment to Iraq found that, despite compliance with rehabilitation, 62.7% were unable to deploy [26]. Furthermore, soldiers with spinal injuries were more likely to remain non-deployable [26]. As such, other soldiers would have needed to carry out their duties.

Noting the nature and job requirements of tactical personnel and that lower back injuries are prevalent in these occupations, means of returning injured individuals to work is of priority. In an Australian law enforcement agency, over 50% of police officers left the force due to medical retirements [27], and in a study of Swedish military soldiers, injuries to the lower back and knee were a leading cause of premature discharge [28]. Not only does this represent a loss of work force size and fiscal costs associated with personnel treatment and compensation, but there is also the cost and challenge of recruiting replacements [29]. As such, optimizing the rehabilitative and preventive treatment of LBP in tactical personnel provides benefits to both the individual and the agency in general.

Although others have reported intervention characteristics for sick leave [30] there are no systematic reviews evaluating conservative interventions for non-specific LBP (NSLBP) treatments in tactical populations. Thus, a systematic review is important to provide an evidence-based approach for LBP treatment to inform tactical personal, their organizations, and those responsible for their health care. Therefore, the aim of this study was to identify and systematically review the findings of

randomized control trials (RCTs) investigating conservative interventions compared to a control group to decrease pain and disability in tactical personnel (police officers, firefighters, and military personnel) with NSLBP at short, intermediate, and long-term follow-ups.

2. Materials and Methods

The aims and methodological approach for this systematic review were prospectively registered with the PROSPERO database (CRD42020162788), and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) of studies that evaluate health care interventions [31]. The checklist is available at Table A1 (in Appendix A). The research question was formulated through the PICOT (Population, Intervention, Comparison, Outcome, and Time) approach [32].

2.1. Eligibility Criteria

2.1.1. Study Design

Evidence from RCTs focusing on conservative interventions for NSLBP management (i.e., no known pathoanatomical cause) were included [33]. For this review, a conservative intervention was delineated as being any non-invasive, non-surgical form of treatment. Articles reporting trials with quasi-random allocation procedures, pilot studies, protocol studies, systematic review, feasibility or preliminary studies, and data on institutionalized tactical personnel were excluded. There were no publication date restrictions for included studies. Database searches were conducted in January 2020 with imposed publication languages restricted to English, Spanish, and Portuguese.

2.1.2. Population

Studies were included if they: (a) Reported on active duty police officers, firefighters, and military forces (i.e., air, army, navy, coast guard, and marine corps) with NSLBP who were aged > 18 years of age, and (b) enrolled participants with NSLBP (with or without leg pain) [34]. Studies were excluded in they (a) including other cohorts (e.g., administrative, veterans, no-tactical employees, or retirees), in which the data of the included tactical cohort could not be extracted, or (b) reported specific pathologies/conditions related to LBP (e.g., epidural abscess, compression fracture, spondyloarthropathy, cancer, cauda equine syndrome); or radicular pain, disc herniation, radiculopathy, or spinal canal stenosis [33].

2.1.3. Interventions

Any non-surgical intervention from RCTs focusing on NSLBP treatment in tactical personnel was eligible. Only studies exclusively employing surgical interventions were excluded.

2.1.4. Comparisons

Trials comparing all types of conservative interventions for NSLBP treatment in tactical personnel using placebo, another active or passive treatment technique, or group with no treatment were included.

2.1.5. Clinical Outcomes

Studies reporting at least one clinical outcome regarding pain intensity (e.g., Numerical Pain Rating Scale (NPRS), Visual Analogue Scale (VAS)), and/or functional status/disability (e.g., Roland Morris Disability Questionnaire (RMDQ), Oswestry Disability Index (ODI)) were included.

2.2. Search Strategies

The following electronic databases were searched: EMBASE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Latin American and Caribbean Health Sciences Literature (LILACS), Physiotherapy Evidence Database (PEDro), MEDLINE Epub Ahead of Print, In-Process & Other

Non-Indexed Citations and Daily (Ovid, 1946 to 24 January 2020), PubMed (using the strategy recommended by to capture studies not in MEDLINE), and Cochrane Central Register of Controlled Trials (CENTRAL). The electronic search was conducted following the strategies recommended by the Cochrane Back and Neck Review Group [35].

The reference lists from the included studies were also screened to identify any additional studies that may be relevant in this review. These studies were then subject to the same inclusion and exclusion criteria as those previously identified. A search for registered trial protocols in the World Health Organization International Clinical Trials Registry Platform (WHO ICTRP), and ClinicalTrials.gov was also performed to capture research that may not have been reported in traditional academic databases. The search strategies used in each database are described in Appendix B.

Two reviewers (EM and EC) independently screened titles, abstracts, and full text articles for potentially eligible studies. A third reviewer (CA) was consulted in case of disagreements.

2.3. Data Extraction

Two independent reviewers (EM and EC) extracted the data from included studies. In cases of disagreements, a third reviewer was consulted (CA). A standardized data extraction form was used to collect the following data items: Bibliometric data (authors, year of publication); characteristics of the studies (study design, sample size, description of the sample, duration of follow-up assessments, country); description of the interventions (both experimental and control interventions) including dose (number of sessions, duration of each session of treatment, etc.) and co-interventions; LBP classifications (according to symptom duration); outcomes assessed; and study results. When results from continuous data were not provided as a mean difference (MD) with 95% confidence intervals (CI), the size of the treatment effect (i.e., difference between intervention A and intervention B) and the 95% CI, was calculated using the mean value, standard deviation, and the number of participants in each group through a confidence interval calculator website (https://www.pedro.org.au/english/downloads/confidence-interval-calculator). Authors were contacted by email in case of insufficient data and further data were requested.

2.4. Risk of Bias Assessment

The included studies were assessed for the risk of bias using the PEDro scale [36]. This scale consists of an 11-item (higher scores = lower risk of bias) checklist, which has been validated to measure the risk of bias and statistical reporting of clinical trials [36]. These scores were extracted directly from the PEDro database (www.pedro.org.au) since all included studies were already indexed in the database, which provided a reliable rating score.

3. Results

Overall, a total of 673 records of trials were retrieved up to January 2020, of which 18 met all inclusion criteria and failed to meet any exclusion criterion. Five trials [37–41] with a pooled sample size of 387 participants (mean sample size = 77.4, SD = 46.6) ranging from 12 to 127 participants from two different countries (Netherland and USA), fulfilled the criteria for qualitative analysis. Reasons for exclusion included poor randomization technique, inclusion of non-tactical subjects in the study population, a lack of specific definition for LBP, detailed results were unavailable, and failing to measure appropriate outcome measures. In Figure 1, a flowchart the selection and inclusion process for this review is displayed. A search of the reference lists of the included studies did not result in the inclusion of other additional studies.
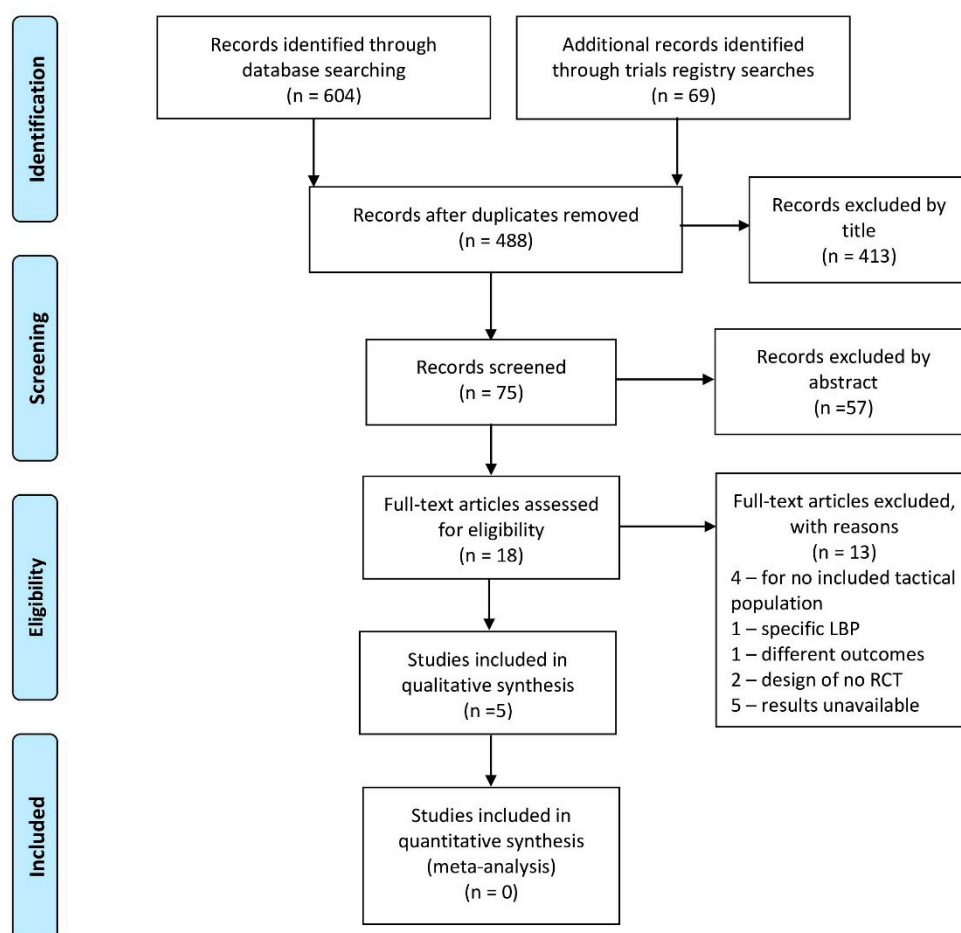
Figure 1. PRISMA study flow diagram [42]. LBP: Low Back Pain; RCT: Randomized Controlled Trials.

Participants in this review ranged in age from 26.3 to 44.0 years. All participants were military personnel with four studies representing army personnel [38–41] and one air force personnel [37]. NSLBP inclusion criteria were different among included studies. None of the trials detailed NSLBP duration of symptoms. The follow-up time ranged from four weeks to one year. A summary description of all studies included is presented in Table 1.

The type of intervention varied substantially across studies (Table 1). Exercise interventions were the most studied (3 trials, pooled n = 205 participants) [37,39,40], followed by manual therapy (1 trial, n = 63 participants) [38] and a multidimensional physical therapy (PT) treatment (n = 119 participants) [41] that included manual therapy, strengthening, or an extension-oriented treatment approach.

Table 1. Characteristics of all included studies. ↓

Study	Methods	Intervention	Comparison Group	Primary Outcomes	Results
Brandt et al. [37]	RCT; 2 groups; follow-up: 12 weeks. $n = 12$; male active duty helicopter aircrew member of U.S Air Forces; median age (yr) = 30; USA; Non-acute LBP ($\geq$ 4 week of self-reported LBP)	Exp: 5 core strengthening exercises (modified dead bug, supine curl-up, quadruped, horizontal side support and modified superman); One set of 12 repetitions; 4 times per week for 12 weeks.	Con: control condition was continuation of the subject's pre-study exercise regimen.	(1) Pain intensity (NPRS) Pain score with respect to daily activity ($NPRS_{daily}$); Pain score with respect to the flight ($NPRS_{flight}$) environment; (2) Disability (MODI).	**Within-groups:** **After 12-weeks:** <u>MODI</u>: Exp – ↓4.8 points Con–n.s. $NPRS_{daily}$: Exp–n.s. Con–n.s. $NPRS_{flight}$: Exp – ↓1.8 points Con–n.s. **Between-groups:** **After 12-weeks:** $NPRS_{daily}$: n.s. $NPRS_{flight}$: significant. <u>MODI</u>: significant.
Cruser et al. [38]	RCT; 2 groups; follow-up: 4 weeks. $n = 63$ male and female soldiers; age (yr) = exp 26.3 (SD 5.1), con 27.1 (SD 4.8); USA; Acute LBP (minimum of 30 days hiatus of pain from previous LBP episodes).	OMT: Osteopathic manipulative treatment plus usual care. Protocol included soft tissue, myofascial release, counter strain, muscle energy, sacro-iliac articulation and high-velocity, low amplitude techniques, once per week for 4 weeks, not closer than 7 or more than 10 days apart.	UC: Usual care protocol consisted of the advising to maintain as close to normal activity as is tolerable and to avoid bed rest of longer than 24 h, use of non-steroidal anti-inflammatory, prescription of muscle relaxants for up to one week or low dose opiates, and passive modalities (ice or heat).	(1) Disability (RMDQ). (2) Pain (QVAS).	**Within-groups:** **After 4-weeks:** <u>RMDQ</u>: OMT – ↓7.9 points UC – ↓5.2 points <u>Pain Now</u>: OMT – ↓3.3 points UC – ↓1.8 points Pain Typical: OMT – ↓3.6 points UC – ↓2.8 points <u>Pain at Best</u>: OMT – ↓1.1 points UC – ↓0.9 points <u>Pain at Worst</u>: OMT – ↓4.3 points UC – ↓3.2 points **Between-groups:** **After 4-weeks:** Mean difference (CI95%) RMDQ: n.s. OMT–UC = 2.9 (−0.3–6.03) points <u>Pain Now</u>: OMT–UC = −1.8 (0.74–2.8) points <u>Pain Typical</u>: OMT–UC = −1.5 (0.54–2.46) points <u>Pain at Best</u>: n.s. OMT–UC = 0.7 (−0.03–1.37) points <u>Pain at Worst</u>: n.s. OMT–UC = 1.2 (−0.14–2.52) points

Table 1. *Cont.*

Study	Methods	Intervention	Comparison Group	Primary Outcomes	Results
Harts et al. [39]	RCT; 3 groups; follow-up: 8 and 24 weeks; $n = 65$; male army personnel; age (yr) = HITG 44 (SD 10), LITG 42 (SD 10), WLCG 41 (SD 9); Netherlands; Non-specific chronic LBP (> 12 weeks).	HITG: High-intensity (50% maximal isometric lumbar extension strength on the lower back machine), 8-weeks, progressive resistance exercise program (isolated lumbar extensor muscle groups), 15 to 20 rep, two (first two weeks) and one (six weeks following) times per week. LITG: low-intensity (20% maximal isometric lumbar extension strength on the lower back machine), 8-week, nonprogressive, 1 × 15–20 repetitions.	WLCG: Participants in the control group received no intervention for the LBP during the first 8-weeks.	Disability (RMDQ).	**Within group:** **After 8-weeks:** RMDQ: HITG – ↓3.0 points LITG – ↓2.0 points WLCG – ↓1.8 points **After 24-weeks:** HITG – ↓2.5 points LITG – ↓4.5 points **Between-group:** Mean difference (95%CI) **After 8-weeks:** RMDQ: n.s. HITG–LITG = −1.7 (−4.3 to 0.9) points HITG–WLCG = −1.4 (−4.0 to 1.1) points LITG–WLCG = 0.3 (−2.3 to 2.8) points **After 24-weeks:** RMDQ: n.s. HITG–LITG = 0.9 (−0.7 to 2.4) points.
Helmhout et al. [40]	Multicenter RCT; 2 groups; follow-up: 10, and 62 weeks; $n = 127$; military employees; age (yr) = exp 37 (SD 11), con 35 (SD 11); Netherlands; Non-specific non-acute LBP (≥4 weeks of continuous or recurrent [at least 3 times a week] episodes of LBP)	ST of the isolated lumbar extensor muscle groups, 10 weeks of training, two times per week, 1 × 15–20 repetitions with load of 50% and 70% of the 1-RM, respectively, on the lower back machine.	Regular PT - Subjects allocated to the regular PT program received regular PT treatment for their lower back for 10 weeks, or less when the patient was free of complaints. Program: - passive modalities (massage and kinesiotaping) = < 1%; - exercise therapy = 65%; - aerobic activities = 25%; - instructions and advice = 10%.	Disability (RMDQ)	**Within group:** **After 10-weeks:** RMDQ: ST group – ↓3.8 points. Regular PT group – ↓3.6 points. **After 62-weeks:** ST group – ↓0.7 points. Regular PT group – ↓0.7 points. **Between-groups:** **After 10-weeks:** RMDQ: n.s. ST group–Regular PT group = −0.3 (−1.3 to 0.9) points. **After 62-weeks:** RMDQ: n.s. ST group–Regular PT group = 0 (−0.3 to 0.3) points.

Table 1. *Cont.*

Study	Methods	Intervention	Comparison Group	Primary Outcomes	Results
Rhon et al. [41]	RCT; 2 groups; follow-up: 4 weeks, 12-weeks and 1 year. *n* = 119; Active duty military service; age (yr) = exp 29.1 (SD 6.7), con 26.8 (SD 6.3); USA; Non-chronic LBP (symptoms for current episode <90 days)	PT: physical therapy treatment - manual therapy, strengthening, or an extension-oriented treatment approach, 2 per week for 4 weeks.	UC: 20-min educational session focusing on self-management strategies consistent with best evidence.	(1) Disability (ODI); (2) Pain intensity (NPRS)	**Within group:** **After 4-weeks:** <u>ODI:</u> PT group – ↓12.5 points. UC group – ↓4.7 points. <u>NPRS:</u> PT group – ↓1.7 points. UC group – ↓0.5 points. **After 12-weeks:** <u>ODI:</u> PT group – ↓12.1 points UC group – ↓8.1 points. <u>NPRS:</u> PT group – ↓1.8 points. UC group – ↓1.1 points. **After 1 year:** <u>ODI:</u> PT group – ↓10.5 points UC group – ↓7.8 points. <u>NPRS:</u> PT group – ↓1.2 points. UC group – ↓0.9 points. **Between-groups:** **After 4-weeks:** mean difference (95%CI) <u>ODI:</u> PT group–UC group = 4.4 (0.41 to 10.1) points. <u>NPRS:</u> n.s. PT group–UC group = 0.9 (0 to 1.7) points **After 12-weeks:** <u>ODI:</u> n.s. PT group–UC group = 0.6 (−5.3 to 6.4) points <u>NPRS:</u> n.s. PT group–UC group = 0.4 (−0.05 to 1.2) points. **After 1 year:** <u>ODI:</u> n.s. PT group–UC group = 0.8 (−7.2 to 5.6) points. <u>NPRS:</u> n.s. PT group–UC group = 0.06 (−0.9 to 1.0) points.

CI: Confident interval; Exp: Experimental; HITG: High-intensity training group; LBP: Low Back Pain; LITG: Low-intensity training group; MODI: Modified Oswestry Disability Index; n.s.: Non-significant; NPRS: Numerical Pain Rating Scale; ODI: Oswestry Disability Index; OMT: Osteopathic manipulative treatment; PT: Physical therapy; RCT: Randomized Controlled Trial; RM: Repetition maximal; RMDQ: Roland-Morris Disability Questionnaire; SD: Standard deviation; ST: Strength training; UC: Usual care.; yr: Years; WLCG: Waiting-list control group. ↓: Decrease.

3.1. Outcomes

Two studies assessed pain intensity using the NPRS [37,41] and one used the Quadruple Visual Analogue Scale (QVAS) [38]. Disability related to LBP was assessed by the RMDQ in three studies [38–40], and the ODI [41] and Modified Oswestry Disability Index (MODI) [37] in others.

3.2. Risk of Bias in Included Studies

Risk of bias assessment scores of included studies are shown in Table 2. Studies were considered of moderate quality, with a mean of 6.6 points (SD = 1.7) on the 10-point PEDro Scale (range 4 to 8 points). The most common methodological limitations identified across the studies included were lack of information on subjects and therapists blinding, as well as assessors blinding (three studies) [37,39,40] and intention-to-treat analysis (two studies) [37,40].

Table 2. Methodological quality of eligible studies (*n* = 5), PEDro scale.

Study Criteria	Brandt [37]	Cruser [38]	Harts [39]	Helmhout [40]	Rhon [41]
Eligibility Criteria [a]	Y	Y	Y	Y	Y
Random allocation	Y	Y	Y	Y	Y
Concealed allocation	N	Y	Y	Y	Y
Baseline comparability	Y	Y	Y	Y	Y
Blind subjects	N	N	N	N	N
Blind therapists	N	N	N	N	N
Blind assessors	N	Y	Y	N	N
Adequate follow-up	N	Y	Y	Y	Y
Intention-to-treat analysis	N	Y	Y	N	Y
Between-group comparisons	Y	Y	Y	Y	Y
Point estimates and variability	Y	Y	Y	Y	Y
PEDro score (0 to 10)	4	8	8	6	7

Y: yes; N: no. [a] Does not contribute to the total score.

3.3. Effects of Interventions

3.3.1. Manual Therapy—1 Study

Cruser et al. [38] found that active duty military personnel with acute LBP who were randomly allocated to an osteopathic manipulative treatment plus usual care group (*n* = 30) reported significantly better in two aspects of pain (Pain Now [*p* = 0.025] and Pain Typical [*p* = 0.020]) scores at four weeks when compared to a control group (*n* = 30) of usual care (advising to maintain normal activity and to avoid bed rest of longer than 24 h, use of non-steroidal anti-inflammatory, prescription of muscle relaxants or opiates, and passive modalities). However, no differences in "Pain at Best" and "Pain at Worst" (*p* = 0.065 and 0.198, respectively) and RMD scores (*p* = 0.197) were found between the groups at the four-week timepoint.

3.3.2. Exercise—3 Studies

Harts et al. [39] showed that army personnel with non-specific chronic LBP who were randomly allocated to an high-intensity progressive strength training group (*n* = 23) reported no statistically significant effect on RMDQ scores at the 8 and 24 week follow-up time points when compared to low-intensity non-progressive strength training (*n* = 21) and waiting list (*n* = 21) groups. Both exercise groups carried out interventions on a modified LB machine.

In the same context, Helmhout et al. [40] showed that male soldiers with non-acute NSLBP who were randomly allocated to an high-intensity progressive strength training of the isolated lumbar extensors group (*n* = 71) reported no statistically significant differences on RMDQ scores at the 10 week and 62 week follow-up time points when compared to a control group (*n* = 56) of regular physiotherapy program (massage and kinesiotaping, exercise therapy, aerobic activities, and instructions and advice).

Moreover, Brandt et al. [37] reported that air force helicopter aircrew with non-acute LBP who were randomly allocated to an core strengthening exercises group ($n = 5$) reported significantly better MODI and NPRS regarding to flight environment scores at 12 weeks when compared to a control group ($n = 7$) that continued a pre-study exercise regimen. Otherwise, no difference in NPRS scores, with respect to daily activity, were found between groups across 12 weeks.

3.3.3. Multidimensional PT Treatment—1 Study

Rhon et al. [41] found that military patients who were randomly allocated to an early PT intervention group ($n = 58$) reported significantly better ODI scores ($p = 0.04$) at four weeks when compared to a control group ($n = 61$) of standard treatment (20-min education session, reduced activity for up to 30 days, and optional prescription of medication for up to 10 days). There were, however, no differences at the 12-week and one-year follow-up time points ($p = 0.50$–0.65). No differences in NPRS scores ($p = 0.26$–0.60) were found between the groups across any of the timepoints. The multidimensional PT intervention commenced within 72 h of reporting to their primary health care and included manual therapy, strengthening, or extension-orientated approach delivered over up to eight treatment sessions over a four-week period.

4. Discussion

The primary aim of this systematic review was to investigate the conservative interventions for the treatment of NSLBP in tactical populations (police officers, firefighters, and military personnel). In total, five RCTs presenting different strategies for the management of NSLBP in tactical personnel were included. Also, all RCTs were conducted with military personnel, showing a lack of intervention studies with other tactical population, such as police officers and firefighters. Based on the current evidence, the included trials were very heterogeneous, presenting evidences not sufficiently robust to determine the efficacy of conservative treatments used to reduce pain and disability in tactical populations, due to lack of adequate reports in the literature and in the available databases. Reasons were mainly due to the studies being limited to a single type of duration of LBP symptoms (acute, subacute, or chronic), and findings of low clinical relevance in the investigated outcomes.

LBP has multifactorial consequences in tactical populations. Current evidence has shown the importance of assessing psychosocial and physical function outcomes in tactical personnel [18,19]. Douma et al. [18] found that police officers with chronic LBP had lower levels of quality of life in emotional and mental domains when compared to police officers without LBP. Due to the nature (stressful and dangerous) and the requirements (physical and mental) of the work of tactical personnel, LBP is highly likely to continue to be present in these professions, harming personnel, their agencies, and society in general. Despite these risks, the results of this review show that treatment for NSLBP and subsequent clinical outcomes are still under investigated in tactical populations and the evidence of effects of conservative interventions are still unknown.

Noting that, with the high prevalence of NSLBP in tactical personnel [14,18], there are no published guidelines for management of this condition in this population. As such, this review provides important findings regarding the efficacy, or lack thereof, for several types of interventions that are of use to guide current treatment and future research.

4.1. Manual Therapy

Guidelines for the management of NSLBP recommended [34,42] spinal manipulation as an effective nonpharmacologic treatment for improving pain and function in patients with acute NSLBP, however this recommendation is based in low-quality evidence. For military personnel with acute NSLBP a combination of manual handling training and usual care yielded a statistically significant reduction of two specific factors (pain now and pain typical) of LBP intensity at four weeks compared to usual care in one study with a low risk of bias [38]. However, the changes in now and typical pain intensity factors at short-term (4 weeks) did not exceed the threshold for Minimal Clinical Important

Difference (MCID) of two points for this outcome measure [43] (study findings of −1.8 and −1.5 points, respectively). In addition, it is noteworthy that patients with acute LBP had a favorable prognosis, with apparent substantial improvements already in the first month [34]. In this review, manual therapy was found to not be the best strategy for improving pain and disability outcomes in military populations with acute NSLBP. Furthermore, no evidence was found regarding manual therapy use in police officers or firefighters with acute NSLBP. Thus, it is difficult to identify best evidence-based practices for this population.

4.2. Strengthening Exercise

Strengthening exercises of the core region (i.e., the lumbo-pelvic-hip complex) is often recommended as a treatment to reduce LBP and disability in patients with subacute and chronic NSLBP [42]. Nonetheless, based on the results of this review it appears that performing strength training exercises for the lumbar extensors in isolation did not have a significant effect on subacute and chronic NSLBP symptoms in army personnel at short- and long-term follow-ups [39,40]. In contrast, Brandt et al. [37] reported significant reductions on pain and disability in member of the U.S. Air Force with non-acute NSLBP after 12 weeks of performing five different exercises aimed at strengthening key spinal stabilizers, rather than simply strengthening the lumbar extensors in isolation. However, the methodological characteristics of the study by Brandt et al. [37] presented with a high risk of bias (PEDro score = 4/10), without to report an adequate allocation concealment and was of a small sample size ($n = 12$), which may be associated with its exaggerated treatment effects [44]. These findings could be significant to those working in tactical populations, as they stress the importance of strengthening the global spinal stabilizers in a coordinated fashion, rather than in isolation, although the evidence is currently not robust enough to confirm this. For these reasons, prescribing core exercises as a modality for reducing LBP and disability in tactical populations is limited and the supposition that strengthening core exercise is effective in treating LBP in tactical populations should be considered with caution due to the lack of robust evidence.

4.3. Multidimensional PT Treatment

Even though the application of multidimensional PT interventions in patients with chronic NSLBP have been recommended previously [34], only one low risk of bias RCT could be included in this review. Rhon et al. [41] demonstrated that a multidimensional intervention, when compared to usual care, effectively reduced disability (but not pain) related to LBP in military personnel with non-chronic NSLBP in the short-term. However, the changes in disability (ODI scores) at short-term (four weeks) did not exceed the requirements for a MCID of 12 points for this outcome measure (study finding being 4.4 points) [43]. This lack of sensitivity to capture clinically significant changes in this specific military population may be due to the lack of specificity in the measure of disability, since members of the military service may perceive higher functional tasks in the ODI to be at a lower level. Therefore, the use of an instrument to measure specific disability for tactical professionals with LBP should be used. The Military Low Back Pain Questionnaire is an example [45].

4.4. Limitations

There are some potential limitations related to included studies, their outcomes, and this systematic review. Firstly, the groupings of the included studies were too heterogeneous in design and methodology impacting too on the ability to perform any meta-analysis, the types of interventions, the durations of LBP; the types of control groups, the pain and disability outcome measures used, and the time of follow-up all being widely varied between studies and limited in individual studies. Secondly, the search was limited to published studies in Portuguese, Spanish, or the English language, which may introduce a risk of publication bias.

5. Conclusions

This systematic review revealed that very few low-risk-of-bias RCTs have evaluated relevant interventions for tactical populations with NSLBP. Of most note was the complete lack of known high-quality RCTs, which verify the efficacy of interventions to treat LBP, found in police officers and firefighters. Based on this systematic review it can be concluded that there is insufficient evidence to support efficacy of any conservative intervention in treating NSLBP in tactical populations. Given the heterogeneity of the available research and lack of evidence, the review also identifies the need for more RCT studies to better inform this field of research, most notably in firefighter and police personnel.

Appendix A. Checklist of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Prisma)

Table A1. Checklist of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Prisma).

Section/Topic	#	Checklist Item	Reported on Page #
		Title	
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
		Abstract	
Structured Summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
		Introduction	
Rationale	3	Describe the rationale for the review in the context of what is already known.	2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	2–3
		Methods	
Protocol and Registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility Criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	3
Information Sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	3–4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix B
Study Selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4
Data Collection Process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data Items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4
Risk of Bias in Individual Studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	4
Summary Measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	4
Synthesis of Results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	NA
Risk of Bias Across Studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	NA

Table A1. *Cont.*

Section/Topic	#	Checklist Item	Reported on Page #
Additional Analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
		Results	
Study Selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	4–5
Study Characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	6 and Table 1
Risk of Bias Within Studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	13 and Table 2
Section/Topic	**#**	**Checklist Item**	**Reported on page #**
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	14 and Table 1
Synthesis of Results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of Bias Across Studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional Analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
		Discussion	
Summary of Evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	14–15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16
		Funding	
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	16

Appendix B. Search Strategies

Appendix B.1. Cochrane Central Register of Controlled Trials (CENTRAL) Search Strategy

Appendix B.1.1. Part A: Specific Search for Back Pain and Spinal Disorders

> #1 MeSH descriptor: [Back Pain] explode all trees
> #2 dorsalgia
> #3 backache
> #4 MeSH descriptor: [Low Back Pain] explode all trees
> #5 lumbar next pain
> #6 MeSH descriptor: [Spine] explode all trees
> #7 MeSH descriptor: [Spinal Diseases] explode all trees
> #8 lumbago
> #9 back disorder*
> #10 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9

Appendix B.1.2. Part B: Sensitive Search for Tactical Populations

> #11 MeSH descriptor: [Emergency Responders] explode all trees
> #12 MeSH descriptor: [Military Personnel] explode all trees
> #13 MeSH descriptor: [Police] explode all trees
> #14 MeSH descriptor: [Firefighters] explode all trees
> #15 navy
> #16 naval
> #17 "armed forces"
> #18 "special forces"
> #19 "sheriff"
> #20 "patrol officer"
> #21 MeSH descriptor: [Law Enforcement] explode all trees
> #22 "tactical athlete"
> #23 "police cadet"
> #24 FBI
> #25 "special operations"
> #26 #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25

Appendix B.1.3. Part C: Combined Search

> #27 #10 AND #26 in Trials

Appendix B.2. Ovid Medline(R) and Epub Ahead of Print, in-Process & Other Non-Indexed Citations and Daily (1946 to 24 January 2020) Search Strategy

Appendix B.2.1. Part A: Generic Search for Randomized Controlled Trials and Controlled Clinical Trials

> 1. randomized controlled trial.pt.
> 2. controlled clinical trial.pt.
> 3. pragmatic clinical trial.pt
> 4. comparative study.pt.
> 5. random$.ab,ti.
> 6. placebo.ab,ti.
> 7. drug therapy.fs

8. trial.ab,ti.
9. groups.ab,ti.
10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11. (animals not (humans and animals)).sh.
12. 10 not 11

Appendix B.2.2. Part B: Specific Search for Back Pain and Spinal Disorders

13. dorsalgia.ab,ti.
14. exp Back Pain/
15. (backache or back ache).ab,ti.
16. back pain.ab,ti.
17. exp Low Back Pain/
18. (lumb$ adj3 pain).ab,ti.
19 lumbago.ab,ti.
20 back disorder$.ab,ti.
21 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20

Appendix B.2.3. Part C: Sensitive Search for Tactical Populations

22. emergency responders.af
23. military personnel
24. police
25. firefighter
26. navy
27. naval
28. armed forces
29. special forces
30. sheriff
31. patrol officer
32. law enforcement
33. tactical athlete
34. police cadet
35. FBI
36. special operations
37. 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36

Appendix B.2.4. Part D: Combined Search

38. 12 AND 21 AND 37

Appendix B.3. EMBASE Search Strategy

Appendix B.3.1. Part A: Generic Search for Randomized Controlled Trials and Controlled Clinical Trials

1 "Randomized Controlled Trial"
2 "Controlled Clinical Trial"
3 "Controlled Study"
4 "Double Blind Procedure"
5 "Single Blind Procedure"
6 "crossover procedure"
7 "placebo"
8 allocat$:ab,kw,ti

9 assign$:ab,kw,ti

10 blind$:ab,kw,ti

11 (clinic$ NEXT/2 (trial OR study)):ab,kw,ti 1

12 (compare or comparing or compared or comparison or comparative).ti,ab,kw.

13 control$.ti,ab,kw.

14 (cross-over or crossover).ti,ab,kw.

15 (followup or follow-up).ti,ab,kw.

16 placebo$.ti,ab,kw.

17 prospective$.ti,ab,kw.

18 random$.ti,ab,kw.

19 ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$))

20 or/1–19

21 exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/

22 human/ or normal human/ or human cell/

23 21 and 22

24 21 not 23

25 20 not 24

Appendix B.3.2. Part B: Specific Search for Thoracic, Low Back, Sacrum and Coccyx Problems

26 dorsalgia.ti,ab,kw.

27 (back pain or backache or back ache).ti,ab,kw.

28 exp LOW BACK PAIN/

29 exp BACKACHE/

30 (lumb$ NEXT/3 pain).ti,ab,kw.

31 lumbago.ti,ab,kw.

32 back disorder$.ti,ab,kw.

33 or/26–32

Appendix B.3.3. Part C: Sensitive Search for Tactical Populations

34 'rescue personnel'/exp

35 'military personnel'/exp

36 'police':ab,kw,ti

37 'firefighter'/exp OR 'fire fighter'/exp

38 navy:ab,kw,ti

39 naval:ab,kw,ti

40 'armed forces':ab,kw,ti

41 'special forces':ab,kw,ti

42 sheriff

43 patrol officer

44 'law enforcement'/exp

45 'tactical athlete':ab,kw,ti

46 'police cadet':ab,kw,ti

47 FBI

48 'special operations':ab,kw,ti

49 or/34–48

Appendix B.3.4. Part D: Combined Search

50 25 AND 33 AND 49

Appendix B.4. CINAHL (EBSCO) Search Strategy

Appendix B.4.1. Part A: Generic Search for Randomized Controlled Trials and Controlled Clinical Trials

> S28 S26 NOT S27
> S27 (MH "Animals")
> S26 S7 OR S12 OR S19 OR S25
> S25 S20 OR S21 OR S22 OR S23 OR S24
> S24 volunteer*
> S23 prospective*
> S22 control*
> S21 followup
> S20 follow-up
> S19 S13 OR S14 OR S15 OR S16 OR S17 OR S18
> S18 (MH "Prospective Studies + ")
> S17 (MH "Evaluation Research + ")
> S16 (MH "Comparative Studies")
> S15 latin square
> S14 (MH "Study Design + ")
> S13 (MH "Random Sample")
> S12 S8 OR S9 OR S10 OR S11
> S11 random*
> S10 placebo*
> S9 (MH "Placebos")
> S8 (MH "Placebo Effect")
> S7 S1 OR S2 OR S3 OR S4 OR S5 OR S6
> S6 triple-blind
> S5 single blind
> S4 double blind
> S3 clinical W3 trial
> S2 "randomi?ed controlled trial*"
> S1 (MH "Clinical Trials + ")

Appendix B.4.2. Part B: Specific Search for Thoracic, Low Back, Sacrum and Coccyx Problems

> S36 S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35
> S35 "lumbago"
> S34 backache OR "back ache"
> S33 lumb* W3 pain
> S32 back pain
> S31 (MH "Low Back Pain")
> S30 (MH "Back Pain + ")
> S29 "dorsalgia"

Appendix B.4.3. Part C: Sensitive Search for Tactical Populations

> S52 S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51
> S51 "special operations"
> S50 FBI
> S49 "police cadet"
> S48 "tactical athlete"

S47 "law enforcement"
S46 "patrol officer"
S45 sheriff
S44 "special forces"
S43 "armed forces"
S42 naval
S41 navy
S40 "firefighter OR fire fighter"
S39 police
S38 "military personnel"
S37 "emergency responders"

Appendix B.4.4. Part D: Combined Search

S53 S28 AND S36 AND S52

Appendix B.5. PEDro

Abstract & Title:
emergency responders
military personnel
police
firefighter
navy
naval
armed forces
special forces
special operations
FBI
police cadet
tactical athete
law enforcement
patrol officer
sheriff
army

Appendix B.6. AND

Problem: Pain
Body Part: lumbar spine, sacro-iliac joint or pelvis

Appendix B.7. LILACS

Title, abstract, subject field: dor lombar AND tratamento AND (policiais OR policia OR bombeiro OR militar OR "forças armadas" OR aeronáutica OR marinha); limit to type of study: clinical trials, guideline, systematic reviews, cohort, health economic evaluation, health technology assessment, overview (all options present except case studies)

Appendix B.8. PubMed

(treatment AND (back pain OR backache Or lumbar pain OR lumbago OR dorsalgia OR sciatica) AND (emergency responders OR military personnel OR police OR firefighter OR navy OR naval OR "armed forces" OR "special forces" OR sheriff OR "patrol officer" OR "tactical athlete"OR "law

enforcement" OR "police cadet" OR FBI OR "special operations") AND (pubstatusaheadofprint OR publisher[sb] or pubmednotmedline[sb]))

Appendix B.9. Clinical Trial.gov

Advanced search, search terms field:
Condition or disease: Low Back Pain
Other terms: police officer OR firefighter OR army OR navy OR military personnel OR emergency responders OR armed forces OR tactical athlete OR law enforcement OR special forces OR special operations
Study type: Interventional Studies (Clinical Trials)
Study Results: All Studies

Appendix B.10. WHO ICTRP

Advanced search: police officer OR firefighter OR army OR navy OR military personnel OR emergency responders OR armed forces OR tactical athlete OR law enforcement OR special forces OR special operations AND back pain OR backache OR lumbago OR lumbar pain OR dorsalgia etc.

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