The Role of Physical Exercise in the Prevention of Musculoskeletal Disorders in Manual Workers: A Systematic Review and Meta-Analysis

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SUPPLEMENTARY MATERIAL A

Pubmed Search Strategy

1. "Exercise"[Mesh]

2. "Exercise"

3. "Physical Activity"

4. "Training Routine"

5. OR/1-4

6. "Musculoskeletal Diseases"[Mesh]

7. "Musculoskeletal Diseases"

8. "Work-related Musculoskeletal Disorders"

9. Job-Related

10. Injury

11. Illness

12. Pain

13. OR/10-12

14. 9 AND 13

15. Work-Related

16. Injury

17. Illness

18. Pain

19. OR/16-18

20. 15 AND 19

21. Pain

22. Neck

23. Hand

24. Wrist

25. Back

26. Musculoskeletal

27. "Upper Limb"

28. Intensity

29. Shoulder

30. MSK

31. OR/22-30

32. 21 AND 31

33. "Perceived"

34. "Exertion"

35. "Work"

36. AND/33-35

37. "Visual Analogue Scale"

38. VAS

39. OR/6-8,14,20,32,36-39

40. "Return to Work"[Mesh]

41. "Workplace"[Mesh]

42. "Workplace"

43. "Return to Work"

44. "Manual Labor"

45. "Blue Collar"

46. "Manual Handling of Loads"

47. Ergonom*

48. "Work Ability"

49. "Work Performance"

50. "Sick Leave"

51. "physically demanding work"

52. "Sickness Presenteeism"

53. "Sickness Absence"

54. "Assembly Work"

55. "Handwork"

56. OR/40-55

57. 5 AND 39 AND 56

EMBASE Search Strategy

1 exp exercise/

2 ("exercise" or "physical activity" or "training routine").mp. [mp=ti, ab, tx, ct, kw, ot, sh, hw, bo, bt, tn, dm, mf, dv, kf, fx, dq]

3 1 or 2

4 exp Musculoskeletal Diseases/

5 ("Musculoskeletal Diseases" or "work-related musculoskeletal disorders" or (job-related adj3 (injury or illness or pain)) or (work-related adj3 (injury or illness or pain)) or (pain adj3 (neck or hand or wrist or back or musculoskeletal or "upper limb" or intensity or shoulder or msk)) or ("perceived" adj3 "exertion" adj3 "work") or "visual analogue scale" or vas).mp. [mp=ti, ab, tx, ct, kw, ot, sh, hw, bo, bt, tn, dm, mf, dv, kf, fx, dq]

6 4 or 5

7 ("workplace" or "Return to Work" or "manual labor" or "blue collar" or "manual handling of loads" or ergonom* or "work ability" or "work performance" or "sick leave" or "physically demanding work" or "sickness presenteeism" or "sickness absence" or "assembly work" or "handwork").mp. [mp=ti, ab, tx, ct, kw, ot, sh, hw, bo, bt, tn, dm, mf, dv, kf, fx, dq]

8 exp return to work/

9 exp workplace/

10 7 or 8 or 9

11 3 and 6 and 10

CINAHL Search Strategy

S1 (MH "Exercise+")

S2 (MH "Musculoskeletal Diseases+")

S3 (MH "Work Environment+") OR (MH "Occupational-Related Injuries") OR (MH "Job Re-Entry")

S4 (MH "Exercise+") OR "exercise" OR "physical activity" OR "training routine"

S5 (MH "Musculoskeletal Diseases+") OR "Musculoskeletal Diseases" OR "work-related musculoskeletal disorders" OR (job-related AND (injury OR illness OR pain)) OR (work-related AND (injury OR illness OR pain)) OR (pain AND (neck OR hand OR wrist OR back OR musculoskeletal OR "upper limb" OR intensity OR shoulder OR MSK)) OR ("perceived" AND "exertion" AND "work") OR "visual analogue scale" OR VAS

S6 (MH "Work Environment+") OR (MH "Occupational-Related Injuries") OR (MH "Job Re-Entry") OR "workplace" OR "Return to Work" OR "manual labor" OR "blue collar" OR "manual handling of loads" OR ergonom* OR "work ability" OR "work performance" OR "sick leave" OR "physically demanding work" OR "sickness presenteeism" OR "sickness absence" OR "assembly work" OR "handwork"

S7 S4 AND S5 AND S6

Scopus Search Strategy

TITLE-ABS-KEY (("exercise" OR "physical activity" OR "training routine") AND ("Musculoskeletal Diseases" OR "work-related musculoskeletal (job- related W/3 (injury OR illness OR pain)) OR (work-related W/3 (injury OR illness OR pain)) OR (pain AND (neck OR hand OR wrist OR back OR musculoskeletal OR "upper disorders" OR limb" OR intensity OR shoulder OR msk)) OR ("perceived" W/3 "exertion" W/3 "work") OR "visual analogue scale" OR vas) AND ("workplace" OR "Return to Work" OR "manual labor" OR "blue collar" OR "manual handling of loads" OR ergonom* OR "work ability" OR "work performance" OR "sick leave" OR "physically demanding work" OR "sickness presenteeism" OR "sickness absence" OR "assembly work" OR "handwork")) AND NOT INDEX (medline)

Web of Science Search Strategy

TS=(("exercise" OR "physical activity" OR "training routine") AND ("Musculoskeletal Diseases" OR "work-related musculoskeletal disorders" OR (job-related NEAR/3 (injury OR illness OR pain)) OR (work-related NEAR/3 (injury OR illness OR pain)) OR (pain NEAR/3 (neck OR hand OR wrist OR back OR muscoloskeletal OR "upper limb" OR intensity OR shoulder OR msk)) OR ("perceived" NEAR/3 "exertion" NEAR/3 "work") OR "visual analogue scale" OR vas) AND ("workplace" OR "Return to Work" OR "manual labor" OR "blue collar" OR "manual handling of loads" OR ergonom* OR "work ability" OR "work performance" OR "sick leave" OR "physically demanding work" OR "sickness presenteeism" OR "sickness absence" OR "assembly work" OR "handwork"))

SUPPLEMENTARY MATERIAL B

Table B1: Studies quality summary.

Citation	Randomization procedure	Similarity of study groups	Inclusion or exclusion criteria	Dropouts	Blinding	Compliance	Intention-to-treat analysis	Timing of outcomes assessment	Follow-up	Results
AUTHOR	+/-									0/9
Weyh 2020	-	+	+	+	-	+	+	+	-	6/9
Moreira-Silva 2014	+	+	-	+	-	-	-	+	-	4/9
Sundstrup 2014, disability	+	+	+	+	-	+	+	+	+	8/9
Krüger 2015	-	+	+	-	-	-	-	+	-	3/9
Cimarras-Otal 2020	+	+	+	+	+	+	-	+	+	8/9
Ludewig	-	-	+	-	+	+	+	+	+	6/9

Study										Score
2002										
Rasotto 2014	+	+	+	+	+	+	-	+	-	7/9
Zebis 2011	+	-	+	+	-	+	+	+	+	7/9
Pedersen 2013	+	-	+	+	+	+	+	+	+	8/9
Rasotto 2015	+	+	+	+	-	+	+	+	-	7/9
Muñoz-Poblete 2019	+	+	+	+	+	+	-	+	+	8/9
Kang 2018, lowback	+	+	+	-	-	-	+	+	-	5/9
Camargo 2009	-	+	+	+	-	-	-	+	-	4/9
Gram 2012	+	-	+	+	-	-	+	+	-	5/9
Bertozzi 2014	-	+	+	-	-	+	+	+	-	5/9
Nurminen	+	+	+	+	-	+	+	+	+	8/9

2002									
Sundstrup 2014, upperlimb	+	+	+	+	+	+	+	+	+	9/9
Gobbo 2021	-	-	+	+	-	+	-	+	-	4/9
Kang 2018, finger	+	+	+	+	+	+	-	+	-	8/9
Cheng 2007	+	+	+	-	-	-	-	+	-	4/9
Malarvizhi 2017	-	-	+	-	-	-	-	+	-	2/9
Lowe 2017	+	+	-	+	-	+	+	+	+	7/9
Mesquita 2012	+	+	+	+	-	+	+	+	+	8/9

Table B3: studies descriptions.

Study	Subjects and grouping, age	Training modality, program and intensity	Duration and frequency
Gobbo et al (2021)	22 (M) Age: 49.11 ± 7.58	1st-3rd wk: 10 min warm-up; resistance exercises for major muscular groups with elastic bands or free weights: squat, lunges, glute bridge, standing calf, floor press, upright row, lateral raise (5 sec reps), face pull (5 sec reps), external/internal rotation (5 sec reps), bicep curl, push down, crunches/plank; 10 min cool-down of stretching exercises. 4th-12th wk: 10 min warm-up; workout adapt for each participant with resistance and stretching specific exercises for neck, wrist, forearm, shoulders, and pelvic/hamstrings muscles: isometric neck flexion/extension (5 sec reps), lateral bending, wrist flexion/extension, forearm supination /pronation, shoulder mobility exercises in all directions, pelvic tilt/ hamstrings flexibility exercise; 10 min cool-down of stretching exercises.	12 weeks Hour: 5:00 p.m.
Cimarras-Otal et al (2020)	18 IG – intervention group: 10 (8 M, 2 F) CG – control group: 8 (4 M, 4 F) Age IG: 42.25 ± 7.28 Age CG: 42.20 ± 5.59	Compensatory exercises (displacement of workplace, cervical, spinal movement, handle loads, shoulder movement, use of tools). Three exercise levels of difficulty: starting level (1st-3rd wk), average level (4th-5th wk) and advanced level (7th-8th wk).	8 weeks
Weyh et al (2020)	77 ETG – endurance training group : 27 (M), 1 (F) STG – strength training group: 28 (M) CG – control group: 21 (M) Age ETG: 39 ± 10 Age STG: 42 ± 8	STG: 1st-12th wk: 3 sets of 20-25 reps at 55-60% 1RM 13th-24th wk: 3 sets of 10-15 reps at 70-75% 1RM 10 min of global warming before each session 60-sec break between each set. Chest or bench press, shoulder raises, seated row, dumbbell neck lift, fore-arm dumbbell curls, cable internal/external rotation, back extension, abdominal crunch/common crunches, leg press. ETG: 1st-12th wk: moderate intensity (65-75% HRmax), 30 min each 4 wk by 5 min up to 40 min, vigorous (75-85% HRmax) intensity stayed consequently at 20 min.	24 weeks STG: 2-3 d/w ETG: 3 d/w

	Age CG: 39 ± 11	13th-24th wk: moderate intensity (65-75% HRmax) once and vigorous intensity twice (75-85% HR max). Duration of vigorous intensity increased from 30 min each 4 wk by 5 min up to 40 min, moderate intensity keeps at 40 min. Cycling, jogging, (nordic-) walking. 24 hours rest, training volume increased every 4 wk by 10%.	
Muñoz-Poblete et al (2019)	105 IG – intervention group: 52 (M: 83.2%; F: 16.98%) CG – control group: 53 (M: 78.6%; F: 21.4%) Age IG: 29.03 ± 5.38 Age CG: 28.36 ± 5.42	Progressive resistance; training was bilateral, focusing on three areas of the body: scapular waist zone, shoulder zone, forearm-hand zone-started with a pre-tensioned rubber band, concentric contraction, isometric contraction (6 sec), eccentric contraction. Pause between each cycle (10 sec). Phase 1 (48 sessions): shoulder stabilizing muscles with three progressive levels of resistance using the Theraband of 4.6 kg, 6.3 kg and 8.5 kg for 16 sessions each. Phase 2 (36 sessions): three progressive levels of resistance, Theraband of 4.6 kg, 6.3 kg and 8.5 kg for 12 sessions each. Phase 3 (24 sessions): three progressive levels of resistance, Theraband of 4.6 kg, 6.3 kg and 8.5 kg for 8 sessions each. Women carried out the same protocol as men, but with a lower resistance, Theraband of 3.2 kg, 4.6 kg and 6.3 kg. The control group maintained a daily routine established by both companies consisting of stretching exercises. These exercises consisted of limb movements to stretch musculoskeletal tissues.	16 weeks 3 d/w 15 min
Kang et al (2018, finger)	29 (M) IG – intervention group: 15 CG – control group: 14 Age IG: 46.7 ± 4.6 Age CG: 47.9 ± 4.0	Paraffin bath therapy: temperature 50 °C, subjects dipped the affected hand into the paraffin, removed the hand, and waited for the layer of paraffin to harden and become opaque. Then they redipped the affected hand. These procedures were repeated 10 times. Later the affected hand was covered with a towel for 20 min. Finger exercise program: four exercises [finger stretch (1), roll into a first (2), make an "O-sign" (3), thumb abduction/extension (4)]. After the paraffin bath, exercise 2-6 for 15 reps, Intensity was determined through 10 RM. 1st-2nd wk: 10 reps 3rd-8th wk: 15 reps	8 weeks 5 d/w 30 min/d

Kang et al (2018, lowback)	24 SSG – stable surface group: 12 USG – unstable surface group: 12 Age SSG: 43.41 ± 5.96 Age USG: 42.83 ± 6.99	10-min hot pack treatment at 80 °C, 15-min interferential current therapy (2000–2500 Hz), and 5-minute ultrasonic treatment (0.8–1 MHz). Later, familiarization period (30 sec) of lumbar stabilization exercises. 5 min warm-up and stretching protocol, 20 min main (elbow-toe, back bridge, side bridge, curl up, 10-20 rep/set and 30 sec rest), 5 min cool down and stretching protocol. 1st-2nd wk: 3 sets, 10 reps 3rd-4th wk: 3 sets, 15 reps 5th-6th wk: 3 sets, 20 reps	6 weeks 5 d/w 30 min/d
Lowe et al (2017)	66 IG – intervention group: 37 CG – control group: 29 Age IG: 33.3 ± 8.61 Age CG: 37.4 ± 10.26	Resistance band (Therabands, The Hygenic Corporation, Akron, Ohio) strengthening movements and stretching/lengthening of the pectoralis and trapezius muscles. Stretches to be less than 30-sec.	12 months As many sessions per week as possible 15 min/d
Malarvizhi et al (2017)	30 (M) IG – intervention group: 15 CG – control group: 15	1st-2nd wk: free exercises, Codman's pendular exercises, wall climbing, sideways, circling and strengthening exercises for all the shoulder muscles with dumbbells (max 10 reps). 3rd-4th wk: strengthening exercises, external/internal rotators. 5th-6th wk: stretches, stretch for pectoralis minor, anterior/posterior shoulder, minimize awkward postures, handling tools (power tools create less torque than air tools, reducing forces).	6 weeks
Krüger et al (2015)	14 (M) IG – intervention group: 7 CG - control group: 7 Age IG: 26.4 ± .2 Age CG: 28.1 ± .5	Subjects were tested for their strength (1RM). Strength training for trapezius (shoulder press machine in a standing position), forearm extensor and flexor m, infraspinatus m, deltoid m., erector spinae m., biceps and triceps and abdominis m. 3 sets, 12-15 reps, 90" rest between exercises; 3' rest between sessions. Subjects exercised at an intensity of 70–75% of 1RM. Intensity was measured using RPE.	12 weeks 2 d/w, at the same time each day 60 min/d
Rasotto et al (2015)	60 (F) IG – intervention group: 30 CG - control group: 30 Age IG: 38.05 ± 6.07	1 month: first part (~8 minutes) included warm-up exercises at very low intensities; mobilization exercises of shoulder and upper limbs. 3 sets for each exercise Second part: strength training, 15 minutes, intensity was targeted between 5 to 7 on a perceived exertion scale of 0 to 10.	6 months 2 d/w 30 minutes

	Age CG: 40.32 ± 6.32	At the end of each training session, approximately 8 minutes were dedicated to the cool down, using six additional stretching positions maintained from 60 to 90 seconds. The CG received no intervention.	
Bertozzi et al (2014)	40 (70% F) IG - intervention group: 20 CG - control group: 20 Age IG: 42.7 ± 8.7 Age CG: 47.5 ± 7.5	The 20 participants allocated to the EG were further divided into four subgroups. They received the same intervention in 10 treatment sessions. The worker could choose when to perform them. The same group also performed a home exercise protocol. Simple postural exercises, relaxation, stretching and extension aimed at the lumbar spine and lower limbs. Same sequence of exercise to be able to perform the exercise also at home. The 20 participants allocated to the comparative group study performed the exercise protocol only at home. Pain intensity was measured with a 10-cm VAS.	5 weeks 2 d/w 1 hour
Moreira-Silva et al (2014)	70 (M, F) IG (TOI) - intervention group: 39 CG (TOR): reference group 31 Age IG: 38.8 ± 8.6 Age CG: 38.0 ± 6.9	The training sessions were given during work time. Stretching exercises: hands, wrists, elbows, shoulders, neck, and dorsal and lumbar regions. Strengths were included: lower extremities. Intimate to do some aerobic training at home.	6 months 3 d/w 10-15 min
Rasotto et al (2014)	68 (M) IG - intervention group: 34 CG - control group: 34 DROP OUT IG: 17 Age IG: 41.65 ± 8.26 Age CG: 40.88 ± 7.55	1st month: general exercise familiarization. Three parts in each training sessions: Warm up: 8', at very low intensity, mobilization of lumbar-, dorsal- and cervical-spine, shoulder and upper-limb. 3 sets x 5 reps, 30" rest between exercise. Strength exercises: 15', were performed with low weight dumbbells and elastic bands and were upper-limb abductions/adductions on transverse plane, shoulder flexions/ex- tensions, shoulder abductions/adductions, pushes forward, and lateral pushes. Intensity was set from 5 to 7 on a scale 0 to 10. Cool Down: 7 / 8', stretching positions maintained from 60 to 90 s. Stretching intensity was maintained at moderate intensity. Participants allocated in the CG were invited to continue in performing their normal daily activities.	9 months 2 d/w 30 min for session

Sundstrup et al (2014, disability)	66 (M, F) STG - strength training group: 33 (25M, 8F) ETG - ergonomic training group: 33 (26M, 7F) Age STG: 48 ± 9 Age ETG: 43 ± 9	STG performed supervised high-intensity strength training for the shoulder, arm, and hand muscles during 3 sessions of 10 minutes. Training intensity (loads) was progressively increased from 20 repetition maximum to 8 RM during the later phase. EG received ergonomic training addressing job-specific training where participants received appropriate guidance and training in how to correctly handle the individual work task stations.	10 weeks 3 d/w 10 min per session
Sundstrup et al (2014, upperlimb)	66 (M, F) RTG - resistance training group: 33 (25M, 8F) ETG- ergonomic training group:: 33 (26M, 7F) Age RTG: 48 ± 9 Age ETG: 43 ± 9	STG performed supervised high-intensity strength training specifically for the shoulder, arm, and hand muscles during 3 sessions of 10 minutes. The training program consisted of 8 exercises: 1 - 2: shoulder rotation in 2 planes with elastic tubing, 3 - 4: ulnar and radial deviation of the wrist using sledgehammers, 5: eccentric training of the wrist extensors using a FlexBar, 6: wrist flexion and extension by the use of a wrist roller, 7: flexion of the hand using a hand gripper, 8: extension of the hand and fingers using expand-your-hand bands. Training intensity (loads) was progressively increased from 20 RM to 8 RM during the later phase. EG received ergonomic training addressing job-specific training where participants received appropriate guidance and training in how to correctly handle the individual work task stations.	10 weeks 3 d/w 10 min per session
Pedersen et al (2013)	537 TG1 - training group 1: 282 (80% F) TG2 - training group 2: 255 (89% F) Age TG1: 42 ± 10 Age TG2: 42 ± 11	TG1 performed strength training for the shoulder, neck and arm with dumbbells (wrist extension, shoulder lateral raise, shoulder front raise, shoulder shrugs, reverse flies) 20 min, 3 times per week, for 20 weeks. Training loads were progressively increased from moderate loadings of 15-20 RM during the initial weeks to relatively heavier loadings of 8-12 RM during the final weeks. Adherence was quantified from questionnaire replies on training frequency at follow-up. After 20 weeks TG2 was offered the same training as TG1 did the first 20 weeks for half a year until January 2010. Participants in TG1 were allowed to continue training until 2010 but without supervision or any form of guidance. TG1 was not allowed to train, when TG2 had supervised training. However, they were allowed to train during working hours as previously and the management was positive to this continued training.	20 weeks - 1 year TG1: strength training 20' x 3d/w from 15-20 RM to 8-12 RM TG2: same as TG1 after 20 weeks

Gram et al (2012)	67 (M)	All training sessions included 10-minute dynamic exercises for warm-up and aerobic capacity (increasing from ~50% to 70% estimated maximal workload) followed by 10 minutes with the individually tailored exercises. The intensity of the muscle strength training was approximately 60% 1RM, and the intensity of the aerobic capacity training was at least 70% of Vo2max.	12 weeks
	EG - exercise group: 35		1 hour a week
	CG - control group: 32		3 x 20 minutes
	Age EG: 44 ± 11.1	The intensify was measured and adjusted if needed 2 times during the 12-week training period. The control group was not offered exercise training, but was given a 1-hour lecture on general health promotion.	
	Age CG: 43 ± 10.0	Pain Intensity from 0 to 10 (BORG)	
Mesquita et al (2012)	98 (M)	An isometric electronic dynamometer was used to measure the resistance (in seconds) and maximal isometric strength (in Kgf) of trunk flexors and extensors.	11 months
	IG – intervention group: 57	This program included 9 easily-executed exercises to promote stretching and strengthening of soft tissues responsible for spinal stability, especially lumbar stability. This program was being executed daily for 8' ca, at the beginning of the working time, at the company facilities.	8 min daily on working days
	CG – control group: 41		
	Age IG: 33.50 ± 8.17	To motivate the workers to adhere to the program and follow it, there were several training sessions and posters illustrating the exercise program to execute were distributed at the company facilities.	
	Age CG: 27.40 ± 6.25	The program efficacy was evaluated twice – at baseline and 11 months later. A physiotherapists visited the warehouse facilities every 15 days, to correct the exercises executions and to evaluate the programme efficacy. All evaluations were preceded by a 5 minute warming up, which involved some calisthenic exercises.	
Zebis et al (2011)	537	The intervention took place over a 20-week period with questionnaires sent out in January 2009 and June 2009.	20 weeks
			3 d/w
	TG - training group: 282 (80% F)	Training group used 1H/week during work hours for the specific training program. Experienced instructors introduced the program in small groups and then the subjects were allowed to train on individual basis or in self organized groups.	> 20 min
	CG – control group: 255 (89% F)	TG performed high-intensity specific strength training locally for the neck and shoulder muscles with 4 different dumbbell exercises and 1 exercise for the wrist extensor muscles.	
	Age TG: 42 ± 11	The training regime consisted of three sessions per week, each lasting 20 minutes.	
	Age CG: 42 ± 10	After two introductory training sessions relative loadings were progressively increased	
		- from 15 RM ~70% of maximal intensity at the beginning of the training period (week 1-12)	
		- to 8-12 RM ~75-85% of maximal intensity during the later phase (week 13-20).	
		Slow to moderate lifting velocity in EC and CC.	

		Participants in the control group received advice to stay physically active and were consulted once a week by a supervisor during the 20-week period. After the 20 weeks intervention period, the control group was offered an equivalent 20 weeks training period - i.e. 1 hour a week during work hours.	
Camargo et al (2009)	14 (M) Age: 31.93 ± 5.86	A standardized intervention consisting of cryotherapy, stretching, and strengthening exercises: trapezius, pectoralis minor and posterior shoulder stretching, lateral rotation, scapular retraction, serratus anterior, shoulder abduction strengthening exercises with bands. The intervention was performed for eight consecutive weeks, twice a week, on alternate days. All sessions were supervised by the same physiotherapist and completed during working hours in the physiotherapy room at the industry site. Stretch: 3 reps of 30'', rest 30" strength: 3 sets of 10 reps, rest 30" 20' of cryotherapy Progression of intervention program: Weeks 1-2; yellow band Weeks 3-4; red band Weeks 5-6; green band DASH and McGill Pain Questionnaire.	8 weeks 2 d/week, on alternate days
Cheng et al (2007)	94 CWH - Clinic-based work hardening training: 48 (35 M, 13 F) WWH - Workplace-based work hardening training: 46 (37 M, 9 F) Age CHW: 32.1 ± 10.33 Age WWH: 32.6 ± 10.13	Three sessions a week in both CWH and WWH group. The training content in the CWH group was comprised of mobilization activities for upper limb extremities, strength and endurance training as well as work simulation. In addition, it was also ensured that CWH group workers did not receive any workplace-based intervention such as on-site job analysis, job placement or liaison with the superior or employer. The Training for WWH was Static stretching methods for posterior, anterior and inferior shoulder structure are performed slowly. Shoulder stretch. Stretching exercises for the shoulder were used as warm up exercises to decrease the resistance of soft tissues. Static stretching methods for posterior, anterior and inferior shoulder structure are performed slowly and held for at least 15 s each time, one set of 10 stretches for each one.	4 weeks 3d/week

		Scapular control exercises (3 sets x 10 each) are closed chain exercises in which the hand of the injured shoulder is placed against the wal: Scapular elevation, depression, protraction and retraction, wall push-ups and knee push-ups. Strengthening isometric exercises (3 sets x 10 each) for shoulder (shoulder abduction, shoulder adduction, shoulder flexion, shoulder extension, shoulder external rotation and shoulder internal rotation) and specifically for rotator cuff muscle were started immediately after the scapular control exercises, and also progressive resistive dynamic exercises (holding a bottle of distilled water for 15 min) The training program was based on Phase 2 (the recovery phase) & Phase 3 (the functional phase)	
Ludewig et al (2002)	92 (M) IG – intervention group: 34 SCG - symtomatic control group: 33 ACG - asymptomatic control group: 25 Age IG: 48 ± 1.8 Age SCG: 49.2 ± 1.8 Age ACG: 49.4 ± 2.5	Subjects in the control groups received no intervention. Subjects returned after 8-12 weeks for follow up testing. Stretching: 2x30s each repetition and five repetitions each day. One for the pectoralis minor and one for the posterior shoulder. A muscle relaxation exercise for the upper trapezius was performed five times daily by having the subjects raise the arm overhead in the scapular plane without shrugging the shoulder. Relaxation was enhanced through visual input by performing the exercise in front of a mirror, or by proprioceptive input by placing the uninvolved hand on the active upper trapezius. Progressive RT: three days per week for two muscle groups. For the serratus anterior muscle, strengthening was performed supine by protracting the scapula and raising a handheld weight superiorly. Humeral external rotation was resisted with Thera-Band while subjects were in a standing position. Subjects were instructed to progress from an initial position of the arm close to their side, to a position of abduction of the arm. Week 1: 3x10 Week 2: 3x15 Week 3: 3x20 After achieving 3x20 repetitions for three consecutive sessions, subjects were to further progress their program by increasing weight resistance or Thera-Band tension (by shortening the band), and repeating the repetition sequence as described. Subjects were instructed that exercises may induce muscle fatigue but should not cause increased shoulder pain.	8 weeks daily for flexibility and stretching exercise 3 d/w for both strengthening exercises 3x10 week 1 3x15 week 2 3x20 week 3 (3 sessions) then increasing weight resistance or Thera-Band tension
Nurminen et al (2002)	260 (F)	The sessions lasted 60 minutes once a week during workhours and totaled 26 sessions over an 8-month period. The adherence to the intervention and the mode of exercise were rated on a participation form	8 months 1 d/w x 26 times 1h

| | IG – intervention group: 133

CG – control group: 127

Age IG: 40.7

Age CG: 39.1 | that the physiotherapist filled out after each session. Two additional 60-minute reinforcement sessions were arranged for the intervention group in the autumn of 1997 to promote physical activity.

The group sessions consisted of moderate worksite exercise based on a guidebook published by the Finnish Institute of Occupational Health for promoting work ability and physical activity through group exercise. The program involved muscle strengthening, cardiovascular exercise, and stretching. The exercise intensity increased progressively, the mean of the perceived exertion rating being 7.8 (SD 4.7) in the spring at the third exercise session and 8.6 (SD 4.4) at tenth session, on a scale of 0–10. | Two additional 60' reinforcement sessions at 14 months |

d/w: day/week;

Table B3: Studies outcomes.

Author (year)	Group	Pain and disabilities	Health-related physical fitness	Cardiological parameters
Gobbo et al (2021)	RT	L-VAS, 4.08 ± 3.08 to 4.22 ± 3.46 DASH, *p < .03* * 20.69 ± 16.20 to 16.04 ± 12.95	2-minutes step test, *p < .01* ** 76.29 ± 22.81 to 91.00 ± 22.50 Chair sit and reach R (cm), *p <.03* * - 9.54 ± 11.31 to - 5.22 ± 10.64 Chair sit and reach L (cm), *p < .04* * - 7.71 ± 11.58 to - 3.65 ± 10.02 Back scratch R (cm), - 0.86 ± 7.16 to 0.25 ± 7.67 Back scratch L (cm), - 4.90 ± 8.75 to - 3.55 ± 7.98 Handgrip test R (kg), *p < .01* ** 42.81 ± 8.76 to 46.58 ± 7.87 Handgrip test L (kg), *p < .02* * 40.63 ± 7.42 to 42.84 ± 5.89	
Cimarras-Otal et al (2020)	IG	ODI 17 ± 16.42 to 18.6 ± 14.67 BPI short form Pain intensity in last 24 hours (total) 3.9 ± 2.05 to 2.85 ± 2.3 Maximum pain 5.2 ± 2.74 to 4 ± 2.91 Minimum pain 2.3 ± 1.89 to 1.8 ± 1.99 Average pain 4.2 ± 2.3 to 3.3 ± 2.67 Pain at time of completion 3.9 ± 2.18 to 2.3 ± 2.36	General activities 4.9 ± 3.18 to 2.9 ± 2.85 Mood 3.4 ± 3.06 to 1.8 ± 2.44, *p <.05* * Walking 1.1 ± 1.91 to 0.6 ± 1.07 Usual work 4.2 ± 3.26 to 3.1 ± 3.14 Relations with others 2 ± 2.67 to 1 ± 1.94 Sleep 3.6 ± 3.75 to 2.9 ± 3.21	

		Pain interference (total) 3.23 ± 2.48 to 2.03 ± 2.11, $p < .01$ **	Enjoyment 3.4 ± 3.13 t 1.9 ± 2.47 F/R test Flexion angle (°) 68.38 ± 9.47 to 75.94 ± 8.34, $p < .05$ * Flexion speed (°/sg) 31.33 ± 8.47 to 31.33 ± 9.25 FER spinalis (uV) 1.10 ± 0.97 to $0.90 +. 0.60$	
	CG	ODI[a] 16.75 ± 13.09 to 12.25 ± 12.98 BPI short form Pain intensity in last 24 hours (total) 4.75 ± 1.16 to 3.44 ± 1.19, $p < .05$ * Maximum pain 7.63 ± 2 to 5.5 ± 2.33 Minimum pain 3.13 ± 2.03 to 2 ± 1.77 Average pain 5 ± 1.41 to 3.63 ± 1.51 Pain at time of completion 3.25 ± 1.67 to 2.63 ± 1.77 Pain interference (total) 3.91 ± 3.21 to 2.82 ± 2.04	General activities 4.38 ± 3.2 to 2.75 ± 2.66 Mood 4.88 ± 4.29 to 3.38 ± 3.54 Walking 3.5 ± 3.85 to 1.38 ± 2.5 Usual work 3.88 ± 2.95 t 3.13 ± 1.64 Relations with others 3.38 ± 3.85 to 1.75 ± 2.76 Sleep 3.5 ± 2.83 to 3.88 ± 3.36 Enjoyment 3.88 ± 3.91 to 3.5 ± 3.63 F/R test[c] Flexion angle (°) 74.32 ± 13.89 to 72.86 ± 12.56 Flexion speed (°/sg) 33.69 ± 10.47 to 22.56 ± 6.63 FER[e] spinalis (uV) 0.95 ± 0.33 to 1.07 ± 0.32	
Weyh et al (2020)	ETG	RPEmax (Borg) StOP: 16 ± 2 to 15 ± 2, $p \leq .05$* SiBP: 15 ± 1 to 13 ± 2, $p \leq .05$*	Erector spinae m. StOP: 6.1 ± 4.4 to 5.6 ± 2.9 SiBP: 7.9 ± 5.6 to 6.4 ± 3.9, $p \leq .05$*	SBPmax (mm Hg) StOP: 154 ± 16 to 158 ± 18 SiBP: 151 ± 19 to 143 ± 13

Weight (kg) 92.0 ± 20.7 to 90.8 ± 20.0	VASmax (mm) StOP: 48 ± 23 to 40 ± 25 SiBP: 37 ± 21 to 26 ± 17	Infraspinatus m. StOP: 12.4 ± 4.9 to 11.7 ± 5.7, $p \leq .05*$ SiBP: 11.7 ± 4.7 to 9.3 ± 4.3	DBPmax (mm Hg) StOP: 109 ± 13 to 105 ± 10 SiBP: 103 ± 11 to 97 ± 10
BMI (kg/m^2) 29.3 ± 6.5 to 28.6 ± 6.2	PCS (SF-36-score) 52.7 ± 4.8 to 52.4 ± 4.4	Deltoideus m. StOP: 17.5 ± 7.8 to 17.2 ± 7.2 SiBP: 8.3 ± 5.1 to 6.5 ± 3.9	HRmax (beats/min) StOP: 98 ± 16 to 91 ± 11; $p \leq .05*$ SiBP: 87 ± 16 to 80 ± 15; $p \leq .05*$
Fat mass (%) 25 ± 7 to 23 ± 6, $p \leq .05*$	MCS (SF-36-score) 52.3 ± 4.0 to 53.2 ± 5.5	Pectoralis major m. StOP: 11.4 ± 6.8 to 11.9 ± 7.9 SiBP: 2.5 ± 3.5 to 3.1 ± 5.8	EWT-duration (s) StOP: 439 ± 62 to 468 ± 31; $p \leq .05*$ SiBP: 464 ± 50 to 476 ± 20
Muscle mass (%) 54 ± 5 to 55 ± 5, $p \leq .05*$		Extensor dig. long m. StOP: 14.3 ± 4.5 to 16.7 ± 6.6 SiBP: 6.8 ± 7.1 to 8.6 ± 5.4, $p \leq .05*$	Maximum bicycle performance (W) 206 ± 34 to 226 ± 37; $p \leq .05*$
		Biceps b. m. StOP: 2.6 ± 1.4 to 3.2 ± 2.3 SiBP: 5.3 ± 5.0 to 4.2 ± 2.9	Relative bicycle performance (WAg/BW) 2.3 ± 0.6 to 2.5 ± 0.6; $p \leq .05*$
		Triceps b. m. StOP: 2.7 ± 1.6 to 3.1 ± 3.7 SiBP: 3.8 ± 3.8 to 3.5 ± 4.3	
		Arm flexion (Nm) 132.9 ± 34.0 to 138.1 ± 33.3	
		Arm extension (Nm) 70.5 ± 17.5 to 74.7 ± 21.6	
		Knee flexion (Nm) 201.4 ± 63.1 to 216.5 ± 71.3	
		Knee extension (Nm) 371.1 ± 111.6 to 399.5 ± 108.2	
		Trunk flexion (Nm) 151.8 ± 50.6 to 167.1 ± 57.9	
		Back extension (Nm) 259.2 ± 109.4 to 287.1 ± 91.8; $p \leq .05*$	

STG	RPEmax (Borg)	Erector spinae m.	SBPmax (mm Hg)
	StOP: 16 ± 2 to 15 ± 2; $p \le .05*$	StOP: 5.7 ± 4.2 to 4.9 ± 2.5	StOP: 152 ± 24 to 150 ± 17
Weight (kg)	SiBP: 15 ± 2 to 14 ± 2	SiBP: 6.9 ± 4.7 to 5.9 ± 3.9; $p \le .05*$	SiBP: 150 ± 23 to 150 ± 23
87.7 ± 12.0 to 88.2 ± 11.7			
	VASmax (mm)	Infraspinatus m.	DBPmax (mm Hg)
	StOP: 50 ± 29 to 34 ± 27; $p \le .05*$	StOP: 11.3 ± 7.3 to 8.4 ± 5.2; $p \le .05*$	StOP: 103 ± 12 to 103 ± 10
BMI (kg/m^2)	SiBP: 41 ± 24 to 30 ± 25	SiBP: 9.7 ± 5.4 to 9.4 ± 7.0	SiBP: 100 ± 12 to 102 ± 18
27.9 ± 3.5 to 28.0 ± 3.5			
	PCS (SF-36-score)		HRmax (beats/min)
	45.7 ± 7.8 to 52.0 ± 4.8	Deltoideus m.	StOP: 100 ± 16 to 95 ± 14
Fat mass (%)		StOP: 14.5 ± 4.6 to 12.0 ± 6.2	SiBP: 89 ± 15 to 84 ± 12
23 ± 6 to 21 ± 5; $p \le .05*$	MCS (SF-36-score)	SiBP: 7.6 ± 6.4 to 6.2 ± 4.0	
	50.6 ± 8.6 to 53.2 ± 5.2		EWT-duration (s)
		Pectoralis major m.	StOP: 424 ± 67 to 458 ± 45; $p \le .05*$
Muscle mass (%)		StOP: 9.9 ± 5.2 to 12.0 ± 7.1	
54 ± 4 to 57 ± 4; $p \le .05*$		SiBP:.5 ± 2.4 to 6.1 ± 6.1; $p \le .05*$	SiBP: 471 ± 33 to 478 ± 11
		Extensor dig. long m.	Relative bicycle performance (WAg/BW)
		StOP: 14.5 ± 6.2 to 14.7 ± 5.5	
		SiBP: 9.8 ± 5.2 to 9.6 ± 6.0	2.5 ± 0.7 to 2.7 ± 0.6
		Biceps b. m.	
		StOP: 4.7 ± 3.8 to 2.9 ± 2.5	
		SiBP: 6.0 ± 4.9 to 4.2 ± 3.2	
		Triceps b. m.	
		StOP: 5.7 ± 3.9 to 4.4 ± 4.7	
		SiBP: 7.6 ± 4.3 to 6.5 ± 5.9	
		Arm flexion (Nm)	
		131.1 ± 24.9 to 135.9 ± 28.5	
		Arm extension (Nm)	
		75.1 ± 20.9 to 77.3 ± 19.1	
		Knee flexion (Nm)	
		188.4 ± 49.8 to 202.3 ± 53.7	
		Knee extension (Nm)	
		390.1 ± 92.8 to 416.2 ± 120.7	
		Trunk flexion (Nm)	
		143.1 ± 44.8 to 169.1 ± 60.5	
		Back extension (Nm)	

			299.7 ± 93.0 to 373.2 ± 111.9; $p \leq .05*$	
CG	RPEmax (Borg) StOP: 16 ± 3 to 16 ± 3 SiBP: 14 ± 4 to 15 ± 3	Erector spinae m. StOP: 6.7 ± 5.2 to 6.7 ± 4.1 SiBP: 4.6 ± 3.0 to 6.8 ± 4.9; $p \leq .05*$	SBPmax (mm Hg) StOP: 156 ± 27 to 157 ± 24 SiBP: 155 ± 24 to 152 ± 23	
Weight (kg) 87.8 ± 17.1 to 88.2 ± 18.8	VASmax (mm) StOP: 48 ± 30 to 52 ± 28 SiBP: 39 ± 29 to 47 ± 26	Infraspinatus m. StOP: 12.0 ± 9.7 to 10.6 ± 6.1; $p \leq .05*$ SiBP: 9.8 ± 6.2 to 10.5 ± 5.9	DBPmax (mm Hg) StOP: 107 ± 13 to 105 ± 10 SiBP: 107 ± 14 to 103 ± 12	
BMI (kg/m²) 28.2 ± 4.5 to 28.2 ± 4.5	PCS (SF-36-score) 50.8 ± 6.0 to 49.7 ± 7.3	Deltoideus m. StOP: 16.5 ± 6.2 to 17.2 ± 7.2 SiBP: 9.5 ± 6.2 to 8.9 ± 4.0	HRmax (beats/min) StOP: 99 ± 14 to 95 ± 15 SiBP: 87 ± 11 to 84 ± 10	
Fat mass (%) 23 ± 6 to 24 ± 6	MCS (SF-36-score) 51.4 ± 7.4 to 50.1 ± 9.2	Pectoralis major m. StOP: 12.0 ± 6.4 to 11.8 ± 6.4 SiBP: 2.7 ± 2.2 to 2.2 ± 1.9; $p \leq .05*$	EWT-duration (s) StOP: 428 ± 77 to 428 ± 79 SiBP: 463 ± 47 to 463 ± 47	
Muscle mass (%) 54.6 ± 47 to 199 ± 43		Extensor dig. long m. StOP: 16.2 ± 8.0 to 14.6 ± 6.8	Maximum bicycle performance (W) 202 ± 47 to 199 ± 43	

			SiBP: 8.9 ± 4.8 to 10.0 ± 7.2	Relative bicycle performance (WAg/BW)
			Biceps b. m.	2.4 ± 0.5 to 2.4 ± 0.5
			StOP: 3.3 ± 2.9 to 4.1 ± 3.3	
			SiBP: 3.7 ± 2.5 to 4.2 ± 3.4	
			Triceps b. m.	
			StOP: 4.2 ± 3.1 to 8.0 ± 9.2	
			SiBP: 4.9 ± 3.5 to 8.9 ± 8.6	
			Arm flexion (Nm)	
			129.1 ± 23.4 to 131.5 ± 18.1	
			Arm extension (Nm)	
			71.0 ± 23.4 to 67.8 ± 19.6	
			Knee flexion (Nm)	
			206.5 ± 59.8 to 208.1 ± 45.9	
			Knee extension (Nm)	
			409.6 ± 120.8 to 394.4 ± 122.6	
			Trunk flexion (Nm)	
			181.1 ± 70.9 to 162.3 ± 56.0	
			Back extension (Nm)	
			337.0 ± 126.9 to 303.0 ± 132.6	
Muñoz-Poblete et al (2019)	IG	Pain intensity VAS 0–100 mm Upper limb 8.0 ± 7.1 to 5.4 ± 8.8; $p <.007$ ** Neck 5.8 ±15.1 to 1.1 ± 5.4; * Right shoulder 10.9 ±21.1 to 8.5 ±20.3; Left shoulder 8.8 ± 21.2 to 6.5 ±15.9 Right elbow-forearm 6.7 ±12.9 to 4.3 ±14.2; $p <.016$ * Left elbow-forearm	Everyday functional difficulties in the last week (%), $p < .112$ to $p <.018$ * None: 54.7 to 86.54 Few: 17.1 to 11.54 Moderate: 28.2 to 1.92 Substantial: - A lot: - Everyday working difficulties in the last week (%) None: 34.7 to 71.15 Few: 25.2 to 17.31 Moderate: 23.1 to 9.62 Substantial: 17.0 to 1.92 A lot: - Difficulty in performing work (%), $p < .303$ to $p <.041$*	

		4.8 ±13.2 to 5.3 ±16.4 Right wrist-hand 10.6 ±19.7 to 4.5 ±16.4; *p <.034 ** Left wrist-hand 6.2 ±16.4 to 1.1 ±5.4; *p <.013 ** Functionality initial DASH: 0–105 points 27.2 ±8.9 to 25.8 ±8.7; *p <.037 **	None: 49.1 to 78.85 Little difficulty: 14.2 to 3.85 Moderate difficulty: 9.8 to 3.85 Great difficulty: 26.9 to 9.62 Incapable: - to 3.85 Difficulty in performing work as well as you would wish (%) *p <.282 to p<.021** None: 31.5 to 71.15 Little difficulty: 19.2 to 13.46 Moderate difficulty: 21.2 to 5.77 Great difficulty: 28.1 to 9.62 Incapable: -	
	CG	Pain intensity VAS 0–100 mm Upper limb 9.7 ± 10.4 to 10.4 ± 11.3; *p <.007 ** Neck 9.9 ± 18.9 to 6.6 ± 17.6; *p <.045 ** Right shoulder 12.4 ± 23.9 to 11.1 ± 21.9 Left shoulder 7.4 ± 16.7 to 6.6 ± 17.6 Right elbow-forearm 10.4 ± 19.9 to 12.8 ± 24.6; *p <.016 ** Left elbow-forearm 5.6 ±16.7 to 8.7 ±21.5 Right wrist-hand 13.9 ±26.0 to 12.2 ±25.5; *p <.034 ** Left wrist-hand 8.7 ±21.8 to, 10.9 ±20.8, p<.013 * Functionality initial DASH: 0–105 points 27.2 ±8.9 to 28.7 ±9.1; *p <.037 **	Everyday functional difficulties in the last week (%), *p < .112 to p <.018** None: 56.4 to 71.7 Few: 21.3 to 9.43 Moderate: 22.3 to 18.87 Substantial: - A lot: - Everyday working difficulties in the last week (%), None: 32.3 to 43.40 Few: 28.1 to 32.0 Moderate: 19.4 to 16.98 Substantial: 20.2 to 5.66 A lot: - to 1.89 Difficulty in performing work (%), *p < .303 to p <.041** None: 48.3 to 64.15 Little difficulty: 12.2 to 1.89 Moderate difficulty: 11.5 to 13.21 Great difficulty: 28.1 to 18.87 Incapable: - to 1.89 Difficulty in performing work as well as you would wish (%) *p <.282 to p <.021** None: 33.6 to 45.28 Little difficulty: 17.8 to 26.42 Moderate difficulty: 22.4 to 20.75	

			Great difficulty: 26.2 to 7.55 Incapable: -	
Kang et al (2018, finger)	IG	Pain 63.67 ± 9.42, to 42.07 ± 5.26, $p < .001**$ Difference (pain, AUSCAN index) 21.6 ± 8.3	Hand grip strength 15.62 ± 2.96, p < .88 to 19.14 ± 3.88, $p < .001**$ Stiffness: 56.33 ± 8.9, p < .64 to 42.47 ± 7.20, $p < .001**$ Physical function 67.73 ± 9.42, p < .91 to 50.93 ± 7.01 6.37, $p < .001**$	
	CG	Pain 64.36 ± 9.36 to 56.50 ± 6.19 Difference (pain, AUSCAN index) 7.9 ± 5.5	Hand grip strength 15.46 ± 2.31, p < .88 to 16.04 ± 2.29, $p < .05*$ Stiffness 57.93 ± 9.34, p < .64 to 50.50 ± 9.20, $p < .001**$ Physical function 68.07 ± 6.72, p < .91 to 56.64 ± 5.26, $p < .001**$	
Kang et al (2018, lowback)	IG	VAS: 5.1 ± 0.5 to 3.0 ± 1.0 p<0.05 pre-post and vs CG Owestry Disability Index: 36.8 ± 1.3 to 32.5 ± 1.5 p<0.05 pre-post and vs CG	Back muscle strength: 32.9 ± 2.7 to 34.6 ± 1.6 p<0.05 pre-post and vs CG Stork balance stand test: 13.1 ± 3.5 to 25.1 ± 6.1 p<0.05 pre-post and vs CG	
	CG	VAS: 5.0 ± 0.3 to 1.6 ± 0.3 p<0.05 pre-post Owestry Disability Index: 37.5 ± 2.0 to 24.4 ± 1.3 p<0.05 pre-post	Back muscle strength: 33.8 ± 1.3 to 40.4 ± 1.6 Stork balance stand test: 13.1 ± 1.4 to 33.1 ± 8.0 p<0.05 pre-post	

Lowe et al (2017)	IG	SRQ 83.8 ± 12.1 to 87.5 ± 12.3 DASH 12.1 ± 13.2 to 21.2 ± 11.8 Nordic questionnaire (% last 12 months) 64.5 to 54.9 Nordic questionnaire (% last 12 months) 22.3 to 25.7 Nordic questionnaire (% 7 days) 38 to 21.4		
	CG	SRQ 81.1 ± 12.3 to 74.0 ± 20.8 DASH 16.0 ± 12.0 to 21.2 ± 18.2 Nordic questionnaire (% last 12 months) 89.6 to 92.1 Nordic questionnaire (% last 12 months) 26.1 to 41.6 Nordic questionnaire (% last 7 days) 52.5 to 44.4		
Malarvizhi et al (2017)	IG (A)	VAS 5.87 ± .352 to 1.60 ± .507, *p < .000**** SPADI 47.2893 ± 3.95766 to 10.5073 ± 2.90073, *p < .001*** EG (A) vs CG (B) VAS A: 1.60; B: 2.80; 2.20 ± .761, *p < .000**** SPADI A: 10.507; B: 16.868; 13.688 ± 4.1919, *p < .001***		

	CG (B)	VAS 5.80 ± .414 to 2.80 ± .414, $p < .000$*** SPADI 43.1240 ± 7.59179 to 16.8681 ± 2.51144, $p < .001$**		
Krüger et al (2015)	IG	<u>Sitting position:</u> Rating of Perceived Exertion during welding 14.50 ± .2 to 12.57 ± .20, $p < .05$ * <u>Standing position:</u> Rating of Perceived Exertion during welding 18.71 ± .57 to 16.44 ± .44, $p <.05$ *		<u>Sitting position:</u> Heart Rate (bpm) 74.57 ± 3.41 to 73.00 ± 4.34 Systolic Blood Pressure (mmHg) 134.43 ± 5.12 to 123.71 ± 4.56 Diastolic Blood Pressure (mmHg) 88.86 ± 5.51 to 84.86 ± 1.44 Lactate (mmol/L) .97 ± .14 to 1.16 ± .22 <u>Standing position:</u> Heart Rate (bpm) 84.29 ± 9.40 to 79.29 ± 4.87 Systolic Blood Pressure (mmHg) 143.86± 7.42 to 139.86 ± 4.79 Diastolic Blood Pressure (mmHg) 84.00 ± 9.05 to 92.71 ± 3.01 Lactate (mmol/L) 1.26 ± .13 to 1.36 ± .24

	CG	Sitting position:		Sitting position:
				Heart Rate (bpm)
				74.86 ± 1.26 to 74.00 ± 1.91
		Rating of Perceived Exertion during welding		
				Systolic Blood Pressure (mmHg)
		13.71 ± .68 to 14.00 ± .31		130.71 ± 7.43 to 129.71 ± 3.64
		Standing position:		Diastolic Blood Pressure (mmHg)
				82.71 ± 3.73 to 89.00 ± 3.04
		Rating of Perceived Exertion during welding		
				Lactate (mmol/L)
		18.86 ± .34 to 18.57 ± .43		.83 ± .06 to .86 ± .07
				Standing position:
				Heart Rate (bpm)
				85.43 ± 3.24 to 75.14 ± 2.41
				Systolic Blood Pressure (mmHg)
				136.14 ± 5.86 to 139.00 ± 4.55
				Diastolic Blood Pressure (mmHg)
				89.71 ± 3.61 to 95.43 ± 2.46
				Lactate (mmol/L)
				1.66 ± .29 to 1.42 ± .27
Rasotto et al (2015)	IG	VAS neck (cm) 4.09 ± 2.88 to 3.73 ± 2.65	SH el 164.91 ± 7.25 to 170.12 ± 7.67, *p < .05**	
		VAS shoulder (cm) 2.39 ± 2.58 to 1.76 ± 2.56, *p < .05**	SH ab 162.99 ± 13.42 to 170.05 ± 10.12, *p < .05**	
		VAS elbow (cm) 1.07 ± 1.93 to 0.65 ± 1.19	FL head 44.75 ± 10.11 to 45.38 ± 7.48	
		VAS wrist (cm) 3.25 ± 2.51 to 1.70 ± 1.85	EX head 54.73 ± 11.66 to 56.03 ± 11.99	

			LI head 35.80 ± 3.86 to 39.56 ± 3.66, $p < .05*$ RO head 69.93 ± 11.48 to 74.02 ± 7.62, $p < .05*$	
	CG	VAS neck (cm) 4.81 ± 2.79 to 4.38 ± 3.00 VAS shoulder (cm) 2.03 ± 2.20 to 2.85 ± 2.41 VAS elbow (cm) 0.86 ± 1.51 to 0.51 ± 1.01 VAS wrist (cm) 4.36 ± 2.94 to 3.50 ± 2.55	SH el 167.60 ± 11.48 to 167.05 ± 16.48 SH ab 161.46 ± 16.83 to 160.20 ± 26.15 FL head 42.40 ± 12.50 to 42.59 ± 8.67 EX head 51.56 ± 11.41 to 48.68 ± 7.46 LI head 36.48 ± 5.05 to 37.87 ± 5.55 RO head 73.82 ± 8.39 to 67.60 ± 12.34	
Bertozzi et al (2014)	IG	Cervical VAS 3.9 ± 4.2 to 3.2 ± 3.7 Lumbar VAS 7.3 ± 2.3 to 7.3 ± 2.3 RMDQ 12.8 ± 4.7 to 7.3 ± 4.3 ODI 33.0 ± 17.8 to 20.6 ± 11.8 Difference within groups Cervical VAS -0.7 ± 0.8		

		Lumbar VAS -1.9 ± 0.3, *p < .05** RMDQ -5.5 ± 1.0, *p < .05** ODI -12.4 ± 3.6, *p < .05**		
	CG	Cervical VAS 3.4 ± 3.7 to 3.1 ± 3.6 Lumbar VAS 7.3 ± 2.6 to 6.1 ± 2.4 RMDQ 13.2 ± 5.3 to 10.0 ± 5.2 ODI 39.3 ± 18.7 to 25.5 ± 18.9 Difference within groups; Cervical VAS -0.3 ± 0.8 Lumbar VAS -1.2 ± 0.4, *p < .05** RMDQ -3.2 ± 1.1, *p < .05** ODI -13.8 ± 3.7. *p < .05**		
Moreira-Silva et al (2014)	Reference (TOR) Weight (kg) 68.7 ± 17.6 to 70.5 ± 20.4 BMI (kg/m2) 26.4 ± 3.5 to 27.0 ± 3.8 Weight status (%)	Neck 12 m (% yes) 19 ± 61.3 to 20 ± 64.5 Limit (% yes) 7 ± 22.6 to 6 ± 19.4 7 days (% yes) 9 ± 29.0 to 9 ± 29.0 Pain intensity 2 ± 5 to 3 ± 5 Shoulders		Blood pressure (mmHg) systolic 123.7 ± 14.3 to 127.0 ± 17.1 diastolic 75.5 ± 8.8 to 75.9 ± 10.7 MPVA (min/week) 180 ± 390 to 90 ± 135

non-overweight 25.8 to 19.4	12 m (% yes) 18 ± 58.1 to 18 ± 58., Limit (% yes)		
overweight 54.8 to 54.8	6 ± 19.4 to 5 ± 16.1 7 days (% yes) 9 ± 29.0 to 12 ± 38.7		
obese 19.4 to 25.8	Pain intensity 3 ± 6 to 3 ± 6		
Body fat (%) ; 30.17 ± 9.61 to 29.3 ± 9.8	Elbows 12 m (% yes) 9 ± 29.0 to 10 ± 32.3 Limit (% yes)		
Waist circumfer-ence (cm) 91.1 ± 11.8 to 92.7 ± 11.3	5 ±16.1 to 4 ± 12.9 7 days (% yes) 6 ± 19.4 to 5 ± 16.1 Pain intensity 0 ± 5 to 0 ± 3		
	Wrists/hands 12 m (% yes) 21 ± 67.1 to 24 ± 77.4 Limit (% yes) 7 ± 22.6 to 8 ± 25.8 7 days (% yes) 11 ± 35.5 to 10 ± 32.3 Pain intensity 3 ± 5 to 4 ± 6		
	Dorsal region 12 m (% yes) 6 ± 19.4 to 4 ± 12.9 Limit (% yes) 2 ± 6.5 to 2 ± 6.5 7 days (% yes) 2 ±6.5 to 1 ± 3.2 Pain intensity 0 ± 0 to 0 ± 0,		
	Lumbar region 12 m (% yes) 22 ± 71.0 to 23 ± 74.2 Limit (% yes) 9 ± 29.0 to 5 ± 16.1 7 days (% yes)		

	8 ± 25.8 to 8 ± 25.8		
	Pain intensity		
	3 ± 5 to 4 ± 4		
	Hips/thighs		
	12 m (% yes)		
	6 ± 19.4 to 9 ± 29.0		
	Limit (% yes)		
	3 ± 9.7 to 4 ± 12.9		
	7 days (% yes)		
	3 ± 9.7 5 ± 16.1		
	Pain intensity		
	0 ± 0 to 0 ± 4		
	Knees		
	12 m (% yes)		
	9 ± 29.0 to 11 ± 35.5		
	Limit (% yes)		
	6 ± 19.4 to 2 ± 6,5		
	7 days (% yes)		
	4 ± 12.9 to 4 ± 12.9		
	Pain intensity		
	0 ± 3 to 0 ± 3		
	Ankles/feet		
	12 m (% yes)		
	14 ± 45.2 to 16 ± 51.6		
	Limit (% yes)		
	4 ± 12.9 to 3 ± 9.7		
	7 days (% yes)		
	5 ± 16.1 to 10 ± 32.3		
	Pain intensity		
	0 ± 3 to 3 ± 7		
Intervention (TOI)	Neck		Blood pressure (mmHg)
	12 m (% yes)		systolic;
Weight (kg)	33 ± 56.4 to 20 ± 51.3		124.1 ± 12.5 to 122.7 ± 17.7
57.2 ± 15.2 to 67.3	Limit (% yes)		p<.477
± 18.4	11 ± 28.2 to 2 ± 5.1, *p<.004**￼*		
p<.194	7 days (% yes)		diastolic
	11 ± 28.2 to 9 ± 23.1		75.2 ± 10.3 to 74.7 ± 11.7
BMI (kg/m2)	Pain intensity		
26.0 ± 6.8 to 25.0	3 ± 6 to ± 5		MPVA (min/week)
± 7.4			180 ± 390 to 150 ± 345
p<.194	Shoulders		
	12 m (% yes)		

Weight status (%)	26 ± 66.7 to 28 ± 71.8		
p<.739	Limit (% yes)		
non overweight	7 ± 17.9 to 8 ± 20.5		
46.2 to 51.3	7 days (% yes)		
	11 ± 28.2 to 12 ± 30.8		
overweight	Pain intensity		
25.6 to 17.9	4 ± 7 to 4 ± 5		
obese	Elbows		
28.2 to 30.8	12 m (% yes)		
	10 ± 25.6 to 4 ± 10.3		
Body fat (%)	Limit (% yes)		
28.24 ± 10.97 to	3 0 ± 7.7 to 3 ± 7.7		
27.5 ± 11.5	7 days (% yes)		
p<.514	5 ± 12.8 to 1 ± 2.6		
	Pain intensity		
Waist	0 ± 1 to 0 ± 0, *p<.003****		
circumference			
(cm)	Wrists/hands		
90.3 ± 13.7 to 89.5	12 m (% yes)		
± 12.3	26 ± 66.7 to 24 ± 64.1		
p<.512	Limit (% yes)		
	15 ± 38.5 to 9 ± 23.1		
	7 days (% yes)		
	12 ± 30.8 to 10 ± 25.5		
	Pain intensity		
	4 ± 7 to 3 ± 6		
	Dorsal region		
	12 m (% yes)		
	8 ± 20.5 to 4 ± 10.3		
	Limit (% yes)		
	3 ± 7.7 to 1 ± 2.6		
	7 days (% yes)		
	2 ± 5.1 to 3 ± 7.7		
	Pain intensity		
	0 ± 2 to 0 ± 0, *p<.015****		
	Lumbar region		
	12 m (% yes)		
	24 ± 52.2 to 23 ± 59.0		
	Limit (% yes)		
	11 ± 28.2 to 0 ± 23.7		
	7 days (% yes)		
	12 ± 30.8 to 13 ± 33.3		

		Pain intensity 6 ± 7 to 4 ± 6 Hips/thighs 12 m (% yes) 7 ±17.9 to 8 ± 20.5 Limit (% yes) 3 ± 7.7 to 1 ± 2.6 7 days (% yes) 1 ± 2.6 to 1 ± 2.6 Pain intensity 0 ± 1 to 0 ± 0 Knees 12 m (% yes) 11 ± 28.2 to 17 ± 43.6 Limit (% yes) 3 ± 7.7 to 2 ± 5.1 7 days (% yes) 6 ± 15.4 to 8 ± 20.5 Pain intensity 0 ± 3 to 0 ± 3 Ankles/feet 12 m (% yes) 18 ± 46.2 to 16 ± 41.0 Limit (% yes) 5 ± 12.8 to 4 ± 10.3 7 days (% yes) 6 ± 15.4 to 10 ± 25.6 Pain intensity 1 ± 5 to 0 ± 6		
Rasotto et al (2014)	IG	VAS neck (cm) 3.08 ± 2.80 to 0.76 ± 1.31* to 1.54 ±1.91* VAS shoulder (cm) 1.12 ± 1.42 to 0.69 ± 1.07* to 0.20 ± 0.45* VAS elbow (cm); 0.44 ± 0.99 to 0.34 ± 1.08* to 0.00 ± 0.00* VAS wrist (cm)	SH el (degrees) 165.46 ± 8.92 to 171.38* ± 5.22 to 172.02 ± 6.45* SH ab (degrees) 158.69 ± 19.06 to 175.25* ± 6.60 ± 175.69 ± 5.92* EX head (degrees) 58.41 ± 14.84 to 58.41 ± 6.61* to 62.16 ± 6.68* FL head (degrees)	

		1.69 ± 2.33 to 0.63 ± 0.97* to 0.32 ± 1.12*	47.51 ± 13.42 to 54.45 ± 9.66* to 55.75 ± 5.02* LI head (degrees) 37.43 ± 6.35 to 39.70 ± 3.14 to 42.93 ± 1.86 RO head (degrees) 76.27 ± 5.78 to 78.77 ± 1.67* to 79.49 ± 2.75*	
	CG	VAS neck (cm) 1.96 ± 2.62 to 1.47 ± 1.99 to;2.38 ± 2.57 VAS shoulder (cm) 0.92 ± 1.66 to ;0.98 ± 1.62 to 1.12 ± 1.68 VAS elbow (cm) 0.24 ± 1.20 to 0.53 ± 1.74 to 0.08 ± 0.35 VAS wrist (cm) 1.06 ± 1.81 to 1.13 ± 1.57 to 0.69 ± 1.25	SHel (degrees) 169.21 ± 9.60 to 167.48 ± 9.06 to 167.96 ± 7.33 SHab (degrees) 164.67 ± 16.77 to 170.43 ± 11.22 to 167.72 ± 12.84 FLhead (degrees) 48.54 ± 9.12 to 45.23 ± 13.28 to 48.82 to 10.34 EXhead (degrees) 55.13 ± 10.91 to 54.52 ± 10.11 to 54.41 ± 9.26 LIhead (degrees) 40.72 ± 5.28 to 35.68 to 5.28 to 37.29 ± 5.22 ROhead (degrees) 73.64 ± 9.62 to 72.70 ± 9.48 to 72.75 ± 9.01	
	Average differences between groups	<u>T5 – T0</u> VAS neck (cm) IG - 2.32 ± 2.15 CG -0.49 ± 2.42* VAS shoulder (cm) IG -0.43 ± 1.26 CG 0.05 ± 1.70 VAS elbow (cm)	<u>T5 – T0</u> SH el (degree) IG 5.92 ± 5.59 CG -1.73 ±4.59* SH ab (degree) IG 16.56 ± 17.25 CG 5.75 ± 18.78* FL head (degree)	

		IG -0.09 ± 1.57 CG 0.29 ±1.8 VAS wrist (cm) IG - 1.05 ± 2.25 CG 0.06 ± 1.48* T10 – T0 VAS neck (cm) IG – 1.29 ± 2.72 CG -0.39 ± 2.51* VAS shoulder (cm) IG -0.94 ± 1.09* CG 0.17 ± 2.02 VAS elbow (cm) IG -0.43 ± 0.98 CG 0.16 ±1.12 VAS wrist (cm) IG - 1.40 ± 1.87 CG 0.39 ± 0.93*	IG 2.27 ± 4.67 CG -5.03 ± 5.19* EX head (degree) IG 0.00 ± 12.27 CG -0.61 ± 10.01 LI head (degree) IG 2.26 ± 4.66 CG -5.04 ± 5.19* RO head (degree) IG 2.51 ± 5.22 CG -0.93 ± 10.27* T10 – T0 SH el (degree) IG 7.03 ± 8.39 CG -0.99 ± 5.66* SH ab (degree) IG 15.07 ± 13.58 CG -1.73 ± 4.59* FL head (degree) IG 4.83 ± 4.38 CG -3.32 ± 4.93* EX head (degree) IG 1.89 ± 8.17 CG -0.36 ± 10.47 LI head (degree) IG 4.83 ± 4.39 CG -3.34 ± 4.93* RO head (degree) IG 3.25 ± 3.80 CG -0.73 ± 6.89*	
Sundstrup et al (2014, disability)	RT	WAI score: 0.3 (-1.1–1.7) Item 1: (0–10) 0.0 (-0.5–0.5) Item 2: (2–10) 0.4 (0.0–0.8) Item 3: (1–7) -0.2 (-0.6–0.3)	Baseline characteristics of the two intervention groups. (the same as Sundstrup et al, 2014, upperlimb)	

		Item 4: (1–6) 0.1 (-0.1–0.3) Item 5: (1–5) -0.2 (-0.6–0.0) Item 6: (1–7) 0.2 (-0.5–0.8) Item 7: (1–4) 0.1 (-0.1–0.4) Changes in work ability index (WAI) and single-item scores from baseline to 10-week follow-up (between group difference) Mean (95% CI), p-value WAI score: 2.3 (0.9–3.7), 0.012* Item 1: 0.5 (0.0–1.0) 0.18 Item 2: 0.7 (0.3–1.2) 0.003* Item 3: 0.1 (-0.3–0.6) 1.00 Item 4: 0.0 (-0.2–0.2) 1.00 Item 5: 0.2 (-0.1–0.5) 0.47 Item 6: 0.3 (-0.4–1.0) 1.00 Item 7: 0.3 (0.1–0.6) 0.021*	Work ability index (7–49): 39.2 ± 3 Item 1: Current work ability compared with the lifetime best (0–10): 7.3 ± 1.0 Item 2: Work ability in relation to the demands of the job (2–10): 7.5 ± 0.9 Item 3: Number of current diseases diagnosed by a physician (1–7): 5.6 ± 0.1 Item 4: Estimated work impairment due to diseases (1–6): 5.7 ± 0.4 Item 5: Sick leave during the past year (1–5): 4.7 ± 0.6 Item 6: Own prognosis of work ability two years from now (1–7): 5.5 ± 0.4 Item 7: Mental resources (1–4): 3.0 ± 0.5 Shoulder, elbow and hand pain intensity previous week (scale 0–10) 4.5 ± 1.2 Work disability (DASH work module; scale 0–100) 28.3 ± 13.8 WAI (7–49) 39.± 4 3 Item 1: 7.2 ± 1.0 Item 2: 7.5 ± 0.9 Item 3: 5.6 ± 0.9 Item 4: 5.7 ± 0.4 Item 5: 4.6 ± 0.6 Item 6: 5.7 ± 0.4 Item 7: 3.0 ± 0.5 Shoulder, elbow and hand pain intensity previous week (scale 0–10) 4.5 ± 1.2 Work disability (DASH work module; scale 0–100): 27.8 ± 13.8	
	ET	WAI score: -2.2 (-3.5– -0.8) Item 1: -0.5 (-0.9–0.0) Item 2: -0.3 (-0.8–0.1) Item 3: -0.3 (-0.7–0.1)		

		Item 4: 0.0 -(0.2–0.2) Item 5: -0.5 (-0.8– -0.2) Item 6: -0.3 (-0.9–0.3) Item 7: -0.3 (-0.5–0.0)		
Sundstrup et al (2014, upperlimb)	RT	Pre post difference (C.I.) Modified VAS (0–10) - Pain intensity: -1.8 (-2.3 to -1.2) DASH-W score (0–100) -6.5 (-13.2 to 0.1)	Shoulder rotation strength (N) 28 (19 to 36) Wrist extensor strength (N) 30 (18 to 42)	
	ET	Pre post difference (C.I.) Average pain intensity (0–10) -0.3 (-0.8 to 0.3) DASH-W score (0–100) 2.8 (-3.7 to 9.4)	Shoulder rotation strength (N) -10 (-18 to -2) Wrist extensor strength (N) -11 (-23 to 2)	
	Between group difference	Average pain intensity (0–10): -1.5 (-2.0 to -0.9) (< 0.0001)* DASH-W score (0–100) -8.8 (-15.6 to -2.0) (< 0.05)*	Shoulder rotation strength (N) 37 (28 to 45) (< 0.0001)* Wrist extensor strength (N) 42 (29 to 54) (< 0.0001)*	
Pedersen et al (2013)	TG1 DASH: 18,4 ± 21,5	Changes of pain within groups (Intention-to-treat) the last 7 days: Neck T2-1 (Diff. of least squares means): 0.31±0.12 *p<.008**,* T3-1: 0.70±0.13, *p<.001*** T3-2: 0.38±0.13, *p<.004** R-shoulder T2-1: 0.49±0.12, *p<.001*** T3-1: 0.92±0.13, *p<.001*** T3-2: 0.43±0.14, *p<.002** R-hand		

		T2-1: 0.18±0.10, T3-1: 0.36±0.11, *p<.002**,* T3-2: 0.18±0.12; lower back T2-1: -0.04±0.12, , T3-1: 0.42±0.14, *p<.002**,* T3-2: 0.46±0.14, *p<.001***;* DASH at T2-1: 5.19±0.95, *p<.001***,* T3-1: 7.70±1.06, *p<.001***,* T3-2: 2.51±1.08, *p<.021** Changes within groups (cases only) of pain in the last 7 days: Neck T2-1 (Diff. of least squares means): 1.70±0.24, *p<.001**,* T3-1: 2.57±0.27, *p<.001***,* T3-2: 0.87±0.27, *p<.002**,* R-shoulder T2-1: 2.13±0.29, *p<.001*** T3-1: 3.38±0.32, *p<.001*** T3-2: 1.25±0.32, *p<.001*** Upper back T2-1: 1.62±0.30, *p<.001***,* T3-1: 2.44±0.35, *p<.001***,* T3-2: 0.82±0.35, *p <.020*** lower back T2-1: 0.78±0.27, *p<.005**,* T3-1: 2.21±0.30, *p<.001***,* T3-2: 1.43±0.30, *p<.001****		
	TG2 DASH: 15,1 ± 21	Changes of pain within groups (Intention-to-treat) the last 7 days: Neck T2-1 (Diff. of least squares means): 0.92±0.12, *p<.001*** T3-1: 0.85±0.13, *p<.001***,* T3-2: -0.06±0.14,		

		R-shoulder T2-1: 0.90±0.12, *p<.001****, T3-1: 0.79±0.13, *p<.001****, T3-2: -0.11±0.14, p<.441*; R-hand T2-1: 0.53±0.10, *p<.001****, T3-1: 0.62±0.11, *p<.001****, T3-2: 0.08±0.12, p<.480*; lower back T2-1: 0.38±0.12, *p<.002***, T3-1: 0.48±0.13, *p<.001****, T3-2: 0.11±0.14, *p<.452*;* DASH T2-1: 9.96±0.97, *p<.001**, T3-1: 9.70±1.03, *p<.001**, T3-2: -0.26±1.10 Changes within groups (cases only) of pain in the last 7 days: Neck T2-1 (Diff. of least squares means): 2.76±0.24, *p<.001****, T3-1: 2.50±0.25, *p<.001****, T3-2: -0.26±0.27 R-shoulder T2-1: 3.23±0.30, *p<.001****, T3-1: 2.38±0.32, *p<.001****, T3-2: -0.84±0.34, *p <.014**;* Upper back T2-1: 2.91±0.30, *p<.001****, T3-1: 2.69±0.30, *p<.001****, T3-2: -0.22±0.33 Lower back T2-1: 2.52±0.30, *p<.001****, T3-1: 3.22±0.32, *p<.001****, T3-2: 0.70±0.35, *p<.048*;*		

Gram et al (2012)	EG (n = 35)	Perceived exertion at work (scale, 6–20) 13.4 ± 2.9		
		Self-rated productivity (scale, 0–10): 8.2 ± 1.5 (n = 35)		
		Sick leave (d) last 3 months: 0.8 ± 1.4 (35)		
		Pain intensity last 7 days (scale, 0–10): Neck: 1.3 ± 2.1 R Shoulder: 1.4 ± 2.3 L Shoulder: 1.0 ± 2.3 Shoulder dominant: 1.7 ± 2.7 Upper back: 1.3 ± 1.9 Low back: 2.7 ± 2.9 Hip: 1.0 ± 2.4 Knee: 1.9 ± 2.7		
		T0 (week 1-2) and T1 (week 11-12) measures, Based on Text Messages and Questionnaire for Each Study Group, Based on Intention-to-Treat Text Messages Neck–shoulder T0: 2.5 ± 2.4, difference T0−T1: −0.2 ± 1.9		
		Low back 2.4 ± 2.7 difference T0−T1: −0.5 ± 1.7		
		Hip–knee 2.3 ± 2.5 difference T0−T1: −0.1 ± 1.9		
		Work ability T0: 7.8 ± 2.4, difference T0-T1: 0.1 ± 3.1,		
		Questionnaire (pooled data): Neck–shoulder 2.1 ± 2.8 difference T0−T1: −0.3 ± 1.9		
		Low back		

		2.7 ± 2.9 difference T0−T1: −0.2 ± 2.2 Hip–knee 2.1 ± 3.0 difference T0−T1: −0.1 ± 2.7 Work ability 7.8 ± 2.0 difference T0-T1: 0.4 ± 1.6 Work ability (scale, 0–10) 0.4 ± 1.6 Perceived exertion at work (scale, 6–20) 0.1 ± 2.2 Self-rated productivity (scale, 1–10) (total n = 64): −0.3 ± 2.1 (n = 34) Sick leave (d) last 3 months (total n = 64): 0.7 ± 2.2 (n = 35) Pain intensity last 7 days (scale, 0–10): Neck: −0.2 ± 1.5 Shoulder right: 0.0 ± 1.7 Shoulder left: −0.3 ± 2.4 Shoulder dominant: −0.3 ± 2.3 Upper back: −0.2 ± 1.6 Low back: −0.2 ± 2.2 Hip: −0.1 ± 3.0 Knee: −0.2 ± 2.7		
	CG (n = 32)	Work ability (scale, 0–10) 8.1 ± 1.9 Perceived exertion at work (scale, 6–20) 14.0 ± 2.4 Self-rated productivity (scale, 0–10) 8.8 ± 1.3 (n = 29)		

		Sick leave (d) last 3 months		
		2.0 ± 3.9 (n = 29)		
		Pain intensity last 7 days (scale, 0–10)		
		Neck: 1.4 ± 1.7		
		R Shoulder: 1.1 ± 1.7		
		L Shoulder: 0.8 ± 1.5		
		Shoulder dominant: 1.1 ± 1.7		
		Upper back: 1.2 ± 2.1		
		Low back: 2.6 ± 2.6		
		Hip: 0.8 ± 2.0		
		Knee: 1.6 ± 2.4		
		Text Messages		
		Neck–shoulder		
		1.9 ± 1.8		
		difference T0-T1: 0.2 ± 1.0		
		Low back		
		2.5 ± 2.7		
		difference T0−T1: -0.5 ± 1.7		
		Hip–knee		
		2.0 ± 2.5		
		difference T0−T1: -0.1 ± 2.2		
		Work ability		
		8.4 ± 2.2		
		difference T0−T1: -0.7 ± 1.7		
		Questionnaire (pooled data):		
		Neck–shoulder		
		2.1 ± 1.9		
		difference T0−T1: -0.2 ± 1.6		
		Low back		
		2.6 ± 2.6		
		difference T0-T1: 0.0 ± 2.3		
		Hip–knee		
		1.9 ± 2.5		
		difference T0−T1: -0.0 ± 2.1		
		Work ability		
		8.0 ± 1.9		

		difference T0−T1: −0.1 ± 1.3		
		Work ability (scale, 0–10) −0.1 ± 1.3		
		Perceived exertion at work (scale, 6–20) −0.3 ± 1.6		
		Self-rated productivity (scale, 1–10) (total n = 64) −0.1 ± 1.1 (n = 29)		
		Sick leave (d) last 3 months (total n = 64) 0.1 ± 4.6 (n = 29)		
		Pain intensity last 7 days (scale, 0–10): Neck: −0.2 ± 1.3 Shoulder right: −0.4 ± 1.0 Shoulder left: 0.1 ± 1.4 Shoulder dominant: −0.4 ± 1.0 Upper back: −0.2 ± 1.9 Low back: 0.0 ± 2.3 Hip: 0.2 ± 1.9 Knee: −0.3 ± 1.8		
	TOTAL (n = 67)	Work ability (scale, 0–10): 7.9 ± 2.0 Still able to perform the job in 2 years' time ("inconceivable," "not sure," "surely"), %: 3/12/85		
		Perceived exertion at work (scale, 6–20) 13.7 ± 2.7		
		Self-rated productivity (scale, 0–10) 8.5 ± 1.5		
		Sick leave (d) last 3 months 1.4 ± 2.9		
		Pain intensity last 7 days (scale, 0–10): Neck: 1.3 ± 1.9 R Shoulder: 1.3 ± 2.0 L Shoulder: 0.9 ± 2.0 Shoulder dominant: 1.4 ± 2.3		

		Upper back: 1.2 ± 2.0 Low back: 2.6 ± 2.7 Hip: 0.9 ± 2.2 Knee: 1.8 ± 2.6		
Mesquita et al (2012)	IG		SFle (Kgf) 72.07 ± 14.33 to 73.39 ± 14.42 RFle (Sec) 42.43 ± 15.58 to 44.31 ± 15.89 SExt (Kgf) 79.48 ± 15.94 to 83.29 ± 13.73, *p< .014*** RExt (Sec) 51.57 ± 17.60 to 58.69 ± 15.38, *p< .006*** Ratio 1.10 ± 0.25 to 1.16 ± 0.21; *p< .037**	
	CG		SFle (Kgf) 63.49 ± 20.94 to 58.81 ± 18.40, *p< .002*** RFle (Sec) 42.71 ± 19.45 to 45.17 ± 17.06 SExt (Kgf) 65.74 ± 18.42 to 61.90 ± 20.10, RExt (Sec) 62.41 ± 18.46 to 61.79 ± 18.97 Ratio 1.12 ± 0.30 to 1.08 ± 0.27	
Zebis et al (2011)	CG	Pain intensity in the neck and shoulder at baseline and follow-up for cases and non-cases, separately. Cases Neck: 4.6 ± 1.8 to 2.9 ± 2.3; n = 77 R shoulder: 4.7 ± 1.8 to 2.5 ± 2.6; n = 69	>30 days with Neck pain previous year (% of participants): 31% / >30 days with Right shoulder pain previous year (% of participants): 20% >30 days with Left shoulder pain previous year (% of participants): 13%	

		L shoulder: 5.0 ± 1.8 to 22 ± 2.6; n = 43 Non-cases Neck: 0.5 ± 0.7 to 0.8 ± 1.5; n= 175 R shoulder: 0.4 ± 0.7 to 0.5 ± 1.2; n = 183 L shoulder: 0.4 ± 0.7 to 0.5 ± 1.1; n = 209	Neck Pain intensity of 3 or more during previous week (% of participants): 31% Right shoulder Pain intensity of 3 or more during previous week (% of participants): 27% Left shoulder Pain intensity of 3 or more during previous week (% of participants): 17% Percentage of participants spending more than half of total work time: Sitting: 87% Standing: 37% Bend forward without arm- or hand-support: 9% Twisting or bending the back: 23% Hand at shoulder height or higher: 1% Performing physical strenous work: 10% Bent neck: 24% Hand twisted or flexed: 28% The same finger movements several times a minute: 57% The same arm movements several times a minute: 34% Static work posture: 48% Kneeling: 2% Other work-related characteristics: Weekly working hours: 35± 8 Years working in the same type of job: 15±11	
	TG	Pain intensity in the neck and shoulder at baseline and follow-up for cases and non-cases, separately. Cases Neck: 4.7 ± 1.6 to 1.8 ± 1.9; n = 95 R shoulder: 4.8 ± 1.7 to 1.4 ± 1.7; n = 76 L shoulder: 4.5 ± 1.5 to 0.9 ± 1.3; n = 46 Non-cases Neck: 0.6±0.8 to 0.5±1.3; n = 182 R shoulder: 0.6±0.8 to 0.5±1.2; n = 200	>30 days with Neck pain previous year (% of participants): 34% >30 days with Right shoulder pain previous year (% of participants): 27% >30 days with Left shoulder pain previous year (% of participants): 17% Neck Pain intensity of 3 or more during previous week (% of participants): 34%	

| | | L shoulder: 0.4±0.7 to 0.4±1.0; n = 231 | Right shoulder Pain intensity of 3 or more during previous week (% of participants): 28%
Left shoulder Pain intensity of 3 or more during previous week (% of participants): 17%

Percentage of participants spending more than half of total work time:
Sitting: 83%
Standing: 41%
Bend forward without arm- or hand-support: 11%
Twisting or bending the back: 32%
Hand at shoulder height or higher: 0%
Performing physical strenous work: 14%
Bent neck: 29%
Hand twisted or flexed: 33%
The same finger movements several times a minute: 65%
The same arm movements several times a minute: 38%
Static work posture: 51%
Kneeling:0%

Other work-related characteristics:
Weekly working hours: 35±8
Years working in the same type of job: 16±12 | |
| | DECLINERS | | >30 days with Neck pain previous year (% of participants): 17%
>30 days with Right shoulder pain previous year (% of participants): 6%
>30 days with Left shoulder pain previous year (% of participants): 11%

Neck Pain intensity of 3 or more during previous week (% of participants): 20%
Right shoulder Pain intensity of 3 or more during previous week (% of participants): 8% | |

			Left shoulder Pain intensity of 3 or more during previous week (% of participants): 14%	
			Percentage of participants spending more than half of total work time: Sitting: 92% Standing: 42% Bend forward without arm- or hand-support: 14% Twisting or bending the back: 21% Hand at shoulder height or higher: 3% Performing physical strenuous work: 10% Bent neck: 19% Hand twisted or flexed: 30% The same finger movements several times a minute: 62% The same arm movements several times a minute: 33% Static work posture: 58% Kneeling: 3% Other work-related characteristics: Weekly working hours: 35±9 Years working in the same type of job: 12±12	
Camargo et al (2009)	IG 14 male workers	DASH score and DASH work score in 14 workers with SIS at pre- and post-intervention DASH score: Pre-intervention: 22.32 ± 16.80 Post Intervention: 9.64 ± 8.38 * Pre-Post Difference: 12.67 ±17.55 DASH work score Pre-intervention: 23.21 ± 18.90 Post Intervention;10.27 ± 11.91 * Pre-Post Difference: 12.94 ± 18.90 PRI category (max score) Sensory (34) Pre-intervention: 14.36 ±- 3.88 Post-Intervention: 8.50 ± 8.23 *		

		Affective (17) Pre-intervention: 5.00 ± 2.18 Post-Intervention: 1.71 ± 1.49 * Evaluative (5) Pre-intervention: 2.21 ± 1.25 Post-Intervention: 1.29 ± 1.14 Miscellaneous (12) Pre-intervention: 3.29 ± 1.64 Post-Intervention: 1.00 ± 1.24 * Total (68) Pre-intervention: 24.86 ± 6.72 Post-Intervention: 12.50 ± 11.55 *		
Cheng et al (2007)	CHW	SPADI 54.25 ± 12.07 to 40.50 ± 16.30, p*	Shoulder flexion (degree) 163.38 ± 10.98 Shoulder extension (degree) 38.85 ± 8.14 Shoulder abduction (degree) 163.23 ± 11.69 Shoulder external Rotation (degree) 56.56 ± 6.03 Shoulder internal rotation (degree) 66.77 ± 11.83 Leg lift (lbs) 43.66 ± 15.89 Arm lift (lbs) 34.16 ± 13.35 High near lift (lbs) 23.56 ± 9.35 Bilateral pushing (lbs) 21.18 ± 10.22	

| | | | Bilateral pulling (lbs)
19.96 ± 9.03

Bilateral carrying (lbs)
14.06 ± 4.69

Unilateral lifting (affected hand) (lbs)
13.88 ± 5.32

Overhead tolerance (IS%)
54.04 ± 17.40

Pre–post differences in functional outcome

Shoulder flexion (degree)
163.38 ± 10.98 to 169.79 ± 9.34, p* (between groups)

Shoulder extension (degree)
38.85 ± 8.14 to 43.65 ± 7.84

Shoulder abduction (degree)
163.23 ± 11.69 to 166.72 ± 23.91

Shoulder external rotation (degree)
56.56 ± 6.03 to 59.58 ± 6.51

Shoulder internal rotation (degree)
66.77 ± 11.83 to 70.52 ± 11.82

Leg lift (lbs)
43.66 ± 15.89 to 51.60 ± 19.62

Arm lift (lbs)
34.16 ± 13.35 to 38.52 ± 14.47, p* (between groups)

High near lift (lbs)
23.56 ± 9.35 to 28.62 ± 10.54, p** (between groups)

Bilateral pushing (lbs)
21.18 ± 10.22 to 24.41 ± 10.92 | |

| | | | Bilateral pulling (lbs)
19.96 ± 9.03 to 23.73 ± 9.73

Bilateral carrying (lbs)
14.06 ± 4.69 to 26.46 ± 8.69, p*
(between groups)

Unilateral lifting (affected hand) (lbs)
13.88 ± 5.32 to 17.86 ± 6.55

Overhead tolerancea (IS%)
54.04 ± 17.40 to 76.61 ± 23.12, p*
(between groups) | |
| | WWH | Pre–post-differences in SPADI
52.09 ± 10.89 to 31.54 ± 13.37 | Shoulder flexion (degree)
166.63 ± 8.30, p* (between groups)

Shoulder extension (degree)
40.98 ± 6.47

Shoulder abduction (degree)
165.65 ± 9.92

Shoulder external Rotation (degree)
57.93 ± 6.02

Shoulder internal rotation (degree)
66.41 ± 10.98

Leg lift (lbs)
44.58 ± 12.50

Arm lift (lbs)
37.35 ± 12.47, p* (between groups)

High near lift (lbs)
25.09 ± 8.14, p** (between groups)

Bilateral pushing (lbs)
22.92 ± 10.11

Bilateral pulling (lbs)
22.29 ± 9.95 | |

| | | | Bilateral carrying (lbs)
15.65 ± 4.90, p* (between groups)

Unilateral lifting (affected hand) (lbs)
14.17 ± 5.06

Overhead tolerance (IS%)
59.66 ± 14.83, p* (between groups)

Pre–post differences in functional outcome;

Shoulder flexion (degree)
166.63 ± 8.30 to 175.11 ± 5.92

Shoulder extension (degree) 40.98 ± 6.47 to 45.76 ± 5.67

Shoulder abduction (degree) 165.65 ± 9.92 to 173.48 ± 7.29

Shoulder external rotation (degree)
57.93 ± 6.02 to 61.09 ± 6.23

Shoulder internal rotation (degree)
66.41 ± 10.98 to 72.93 ± 9.16

Leg lift (lbs)
44.58 ± 12.50 to 56.66 ± 14.40

Arm lift (lbs)
37.35 ± 12.47 to 46.27 ± 14.09

High near lift (lbs)
25.09 ± 8.14 to 39.33 ± 12.63

Bilateral pushing (lbs)
22.92 ± 10.11 to 27.50 ± 10.58

Bilateral pulling (lbs)
22.29 ± 9.95 to 26.92 ± 10.09

Bilateral carrying (lbs)
15.65 ± 4.90 to 31.85 ± 10.35 | |

			Unilateral lifting (affected hand) (lbs) 14.17 ± 5.06 to 19.77 ± 6.63 Overhead tolerance (IS%) 59.66 ± 14.83 to 23.80	
Ludewig et al (2002)	IG	SRQ score 65.9 ± 1.96 to 78.0±2.31 ** Satisfaction score 4.5±0.31 to 6.2 ± 0.35 * Work related pain 4.8 ± 0.28 2.8 ± 0.29 * Work related disability 4.1 ± 0.30 to 2.5 ± 0.29 * Change (pretest to post-test) scores and percent change scores in function and pain measures by group SRQ Difference score mean (17-100) 11.17 ± 2.83 ** SRQ % change (1-10) 19.23 ± 4.75 Satisfaction score (dsm) (1-10) 1.50 ± 0.33 Satisfaction score % change 43.61 ± 10.22 Work related pain questions (dsm) (1-10) -1.95 ± 0.28 Work related pain questions % change -29.99 ± 8.22 Work related disability questions (dsm) (1-10): -1.52 ± 0.35		

		Work related disability questions % change: -39.6 ± 5.06		
	SCG	SRQ score: 72.5 ± 1.99 to 71.1 ± 2.24 Satisfaction score: 5.0 ± 0.31 to 5.0 ± 0.34 Work related pain: 4.6 ± 0.28 to 4.1 ± 0.29 Work related disability: 3.8 ± 0.30 to 3.7 ± 0.29 Change (pretest to post-test) scores and percent change scores in function and pain measures by group SRQ Difference score mean (17-100): -1.56 ± 2.5 SRQ % change (1-10): -0.27 ± 3.72 Satisfaction score (dsm) (1-10): -0.09 ± 0.38 Satisfaction score % change: 12.45 ± 11.94 Work related pain questions (dsm) (1-10): -0.48 ± 0.34 Work related pain questions % change: 8.43 ± 8.69 Work related disability questions (dsm) (1-10): -0.09 ± 0.31 Work related disability questions % change: -3.43 ± 7.90		

	ACG	Means (standard error of mean) of outcome variables by group		
		SRQ score: 93.8 ± 2.28 to 94.0 ± 2.64 *		
		Satisfaction score: 9.1 ± 0.37 to 8.8 ± 0.40 *		
		Work related pain: 1.3 ± 0.32 to 1.4 ± 0.34 *		
		Work related disability: 1.3 ± 0.35 to 1.3 ± 0.34 *		
		Change (pretest to post-test) scores and percent change scores in function and pain measures by group		
		SRQ Difference score mean (17-100): 0.04 ± 1.45		
		SRQ % change (1-10): 0.36 ± 1.65		
		Satisfaction score (dsm): -0.36 ± 0.28		
		Satisfaction score % change: -3.03 ± 3.42		
		Work related pain questions (dsm): 0.08 ± 0.13		
		Work related pain questions % change: 2.34 ± 4.13		
		Work related disability questions (dsm): 0.03 ± 0.08		
		Work related disability questions % change: 12.8 ± 8.55		
	ACG			

Nurminen et al (2002)	IG	Perceived work ability WAI (mean): 7–49 points/7 items: 40.0 Work ability (%): good (37–43 points) or excellent (44–49 points) 73.7 Work ability compared with lifetime best: scale 0–10 (mean): 8.5 Work ability in relation to physical demands of the work (%): very good or rather good 76.7 Work ability in relation to mental demands of the work (%): very good or rather good: 82.7	Health-related factors Health status compared with that of persons of the same age (%): very good or rather good: 69.0 Prognosis of work ability with respect to health after 2 years (%): fairly sure able to do current job: 81.2 Prognosis of work ability during next 5 years with respect to musculoskeletal symptoms (%): no difficulties: 59.1 Mental resources (mean): 3 items: 9.5 Perceived well-being Stress (%): very much or rather much: 8.3 Job satisfaction (%): very good or rather good: 75.6 Life satisfaction (%): very good or rather good: 87.9	
	CG	Perceived work ability WAI (mean): 7–49 points/7 items: 39.8 Work ability (%): 75.7 Work ability compared with lifetime best: scale 0–10 (mean): 8.4 Work ability in relation to physical demands of the work (%): 77.4 Work ability in relation to mental demands of the work (%): 78.2	Health-related factors Health status compared with that of persons of the same age (%): 64.0 Prognosis of work ability with respect to health after 2 years (%): 82.9 Prognosis of work ability during next 5 years with respect to musculoskeletal symptoms (%): 60.3 Mental resources (mean): 3 items: 9.3 Perceived well-being Stress (%): 8.1 Job satisfaction (%): 71.8 Life satisfaction (%): 85.5	

Results are shown as mean ± standard deviation, or median (interquartile range), or change Δ

Abbreviations: $p < 0.05$ * within group comparison, ** between groups comparison

*Gobbo et al (2021): **RT**: resistance training, **L-VAS**: Low back Visual Analog Scale, **DASH**: Disabilities of Arm, Shoulder and Hand Score*

Cimarras-Otal et al (2020): IG: intervention group, CG: control group, ODI: Oswestry Disability Index, BPI: Brief Pain Inventory, F/R test: Flexion-Relaxation test, FER: Flexion-Extension Ratio

Weyh et al (2020): ETG: endurance training group, STG: strength training group, CG: control group, SiBP: sitting bended position, StOP: standing overhead position, BMI: Body Mass Index, BW: body weight, MCS: mental component summary, Nm: newton meter, PCS: physical component summary, DBPmax: maximum diastolic blood pressure, EWT: experimental welding task, HRmax: maximum heart rate, RPEmax: maximum rating of perceived exertion, SBPmax: maximum systolic blood pressure, VASmax: maximum visual analogue scale

Muñoz-Poblete et al (2019): IG: intervention group, CG: control group, VAS: visual analogue scale, DASH: Disabilities of Arm, Shoulder and Hand Score

Kang et al (2018, finger): IG: intervention group, CG: control group, BMI: body mass index, AUSCAN index: Australian/Canadian osteoarthritis hand index

Kang et al (2018, lowback): IG: intervention group, CG: control group, AUSCAN index: Australian/Canadian osteoarthritis,

Lowe et al (2017): IG: intervention group, CG: control group, SRQ: Shoulder Rating Questionnaire, DASH: Disabilities of Arm, Shoulder and Hand Score.

Malarvizhi et al (2017): IG: intervention group, CG: control group, VAS: visual analogue scale, SPADI: shoulder pain and disability index.

Krüger et al (2015): IG: intervention group, CG: control group.

Rasotto et al (2015): IG: intervention group, CG: control group, VAS: visual analogue scale, EL: elevation, AB: abduction, FL: flexion, EX: extension, LI: lateral inclination, RO: rotation

Bertozzi et al (2014): IG: intervention group, CG: control group, VAS: visual analog scale, RMDQ: Roland Morris Disability Questionnaire, ODI: Oswestry Disability Index

Moreira-Silva et al (2014): TOI: intervention group, TOR: reference group, BMI: body mass index, MVPA: moderate and vigorous physical activity

Rasotto et al (2014): IG: intervention group, CG: control group, VAS: visual analogue scale, EL: elevation, AB: abducion, FL: flexion, EX: extension, LI: lateral inclination, RO: rotation.

Sundstrup et al (2014, disability): RT: resistance training, ET: endurance training, WAI: work ability index, DASH: Disability of Arm, Shoulder and Hand Score.

Sundstrup et al (2014, upperlimb): RT: resistance training, ET: ergonomic training, DASH: Disabilities of Arm, Shoulder and Hand Score, VAS: visual analogue scale

Pedersen et al (2013): TG1: training group 1, TG2: training group 2, DASH: Disabilities of Arm, Shoulder and Hand Score.

Gram et al (2012): EG: Exercise group, CG: control group.

Mesquita et al (2012): SFle: Trunk flexors strength; RFle: Trunk flexors resistance; SExt: Trunk extensors strength; RExt: Trunk extensors resistance. Ratio between trunk extensors/flexors strength.

Zebis et al (2011): TG: training group; CG: control group.

Camargo et al (2009): DASH: Disabilities of Arm, Shoulder and Hand Score; PRI: Pain rating index in the four different categories assessed using the Brazilian version of the McGill Pain Questionnaire.

Cheng et al (2007): CWH: Clinic-based work hardening training; Workplace-based work hardening training; SPADI: Shoulder Pain and Disability Index; Percent of Industrial Standard (%IS) is the evaluee's demonstrated ability as a percent of the Industrial Standard, where 100% and up indicates performance at or above the IS, while below 100% indicates performance below the IS.

Ludewig et al (2002): IG: intervention group; SCG: symtomatic control group; ACG: asymptomatic control group; SRQ: Shoulder Rating Questionnaire.

Nurminen et al (2002): IG: intervention group, CG: control group; WAI: work ability index

Table B4: List of papers with more than one intervention group, and relative interventions.

Paper ID	Intervention 1	Intervention 2
Cheng_2007	Clinical based work hardening training	Workplace based work hardening training
Sundstrup_2014_disability	Resistance training	Ergonomic training
Sundstrup_2014_upperlimb	Resistance training	Ergonomic training
Kang_2018_finger	Finger exercises	Paraffin bath
Kang_2018_lowback	Heat, current and ultrasonic treatments + unstable surface training	Heat, current and ultrasonic treatments + stable surface training
Weyh_2020	Resistance training	Endurance training
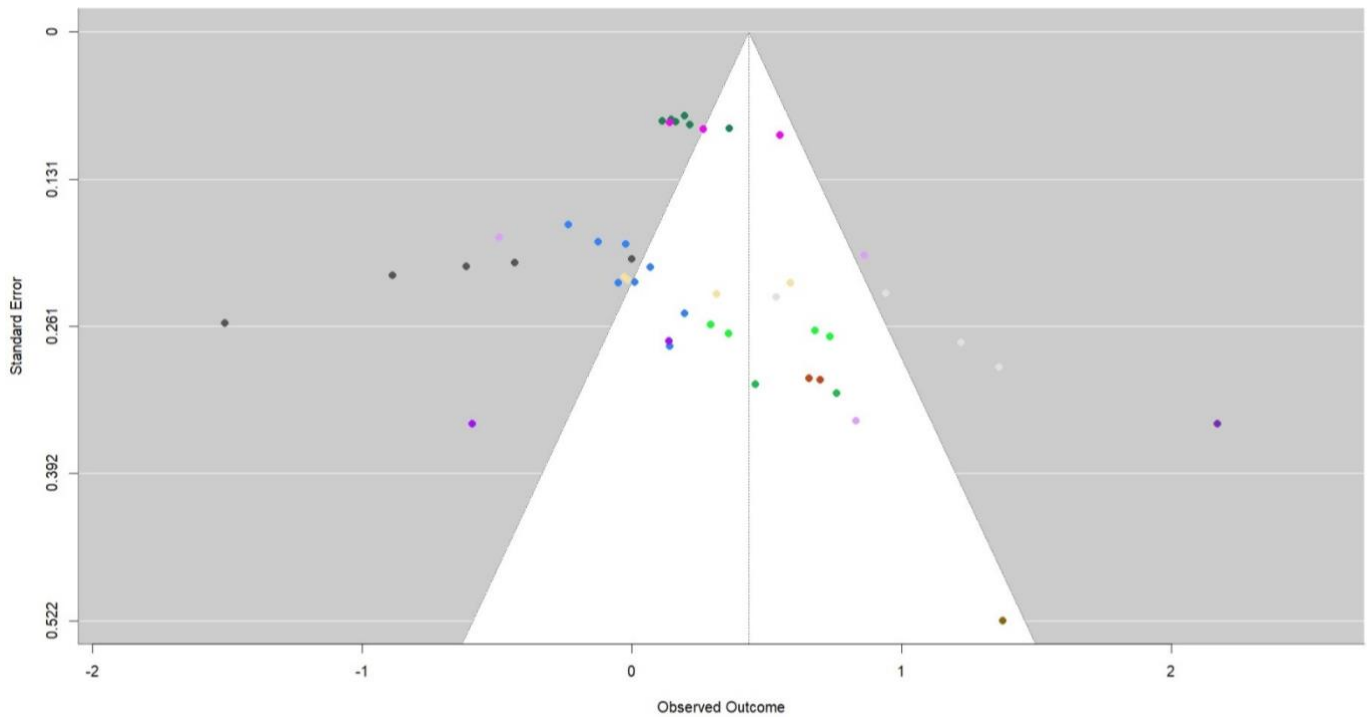
Figure B1.   Funnel plot for pain outcomes, showing asymmetry towards the null. Different colors denote different studies.
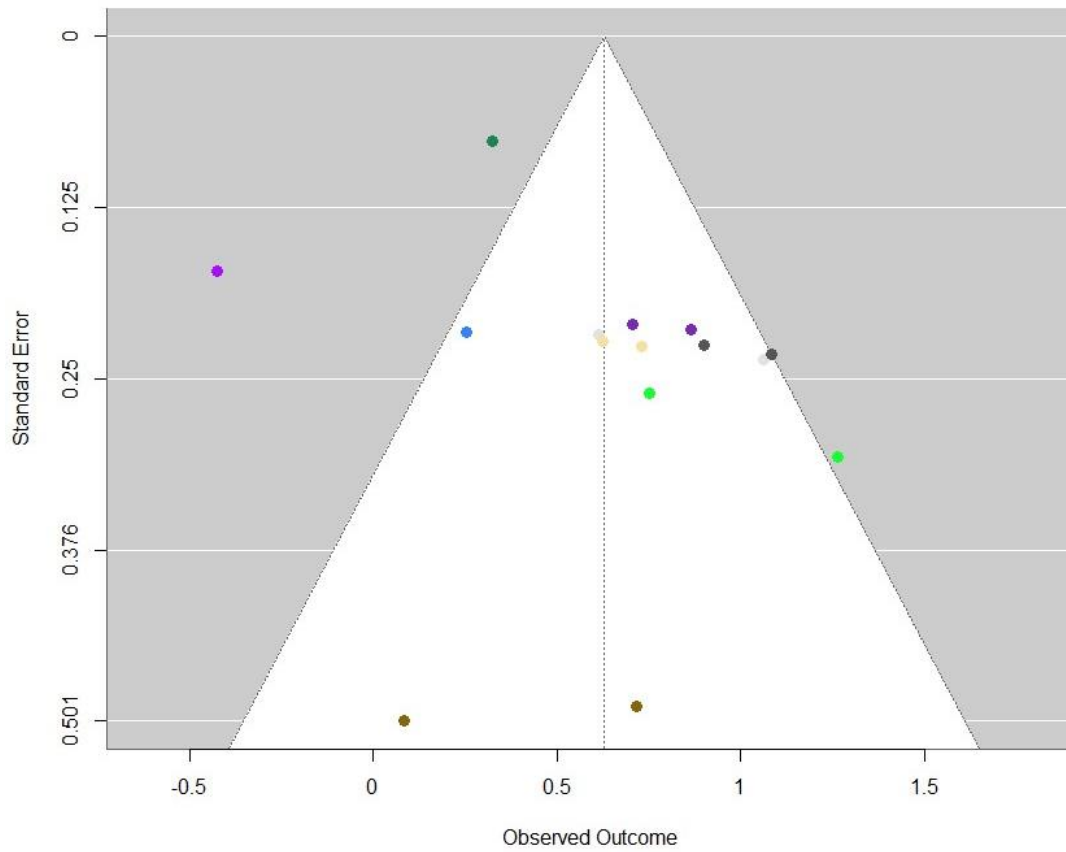
Figure B2. Funnel plot for disability outcomes, showing asymmetry towards positive effects. Different colors denote different studies.
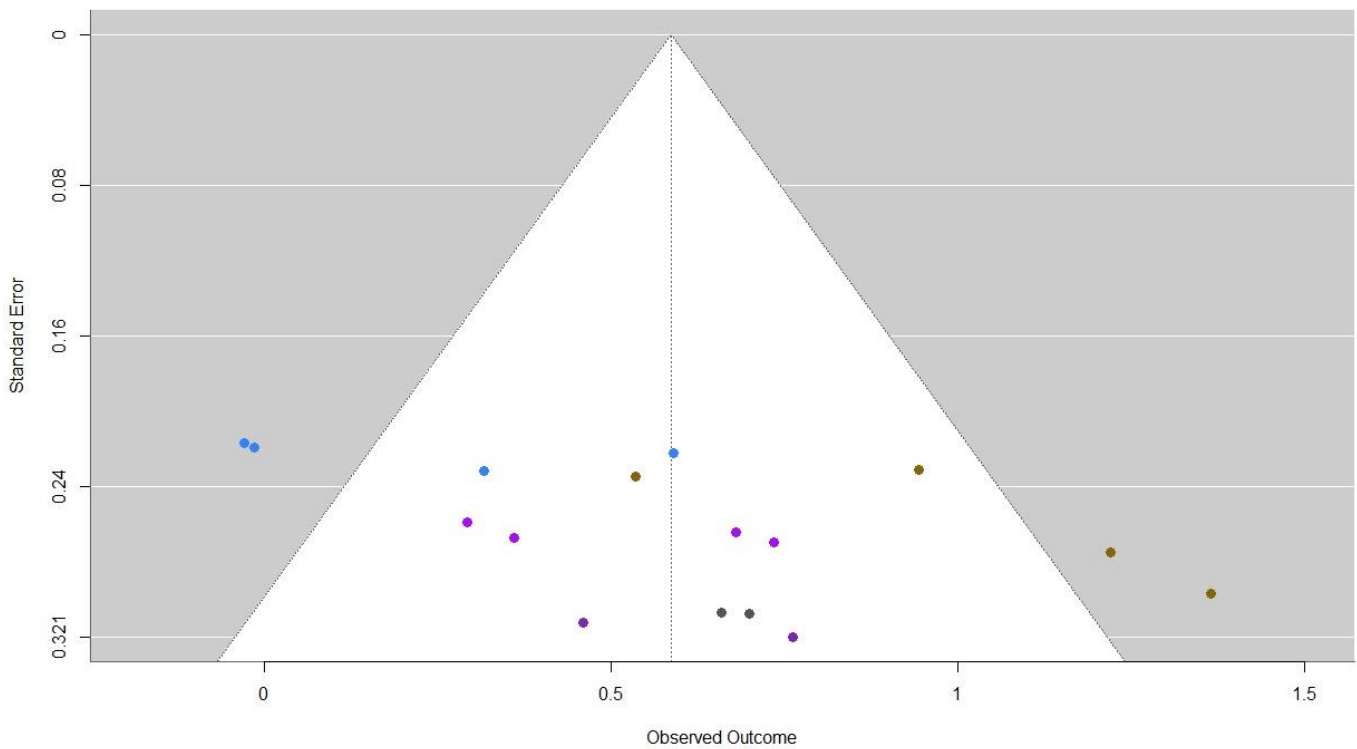
Figure B3. Forest plot for VAS outcomes, showing good symmetry. Different colors denote different studies.