Appendix A – *PRISMA checklist*

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	P. 1 – line 1-3
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	P. 2 – line 4-27
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	P. 4-5 - line 78-134
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	P. 5 – line 135-210
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	P. 6 – line 222-263
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	P. 7 – line 264-306
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	'Appendix A'
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	P. 8 – line 307-318
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	P. 8 – line 320-322
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	P. 8 – line 323-329
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	P. 8 – Line 323-329
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	P. 9 – line 373-379
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	P. 9 – line 380-401
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Not reported
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	P. 10 – line 416
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	'Appendix D'
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	P. 10 – line 403- 436
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	P. 11 – line 437-467
	13f	Describe any sensitivity analyses conducted to assess robustness of the	P. 11 –

Section and Topic	Item #	Checklist item	Location where item is reported
		synthesized results.	line 437-467
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	P. 12 – line 468-473
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	P. 9 – line 373-379
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	P. 12 – line 476-487
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	P. 12 – line 480
Study characteristics	17	Cite each included study and present its characteristics.	P. 13-14 – line 542-584, 'Appendix C'
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	P. 16 – Line 620-624, 'Appendix E'
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimates and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	P. 15 – line 590-619, 'Appendix D'
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	P. 16 – Line 620-624, 'Appendix E'
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	P. 16 Line 626 - 694
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	P. 18 – line 720 - 739 'Appendix F'
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	P. 18 – line 720 - 739
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	P. 20 – line 815-819, 'Appendix G'
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	P. 17-18 – line 821-838, 'Appendix H'
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	P. 21 – line 840-991
	23b	Discuss any limitations of the evidence included in the review.	P. 24 – line 993-1048
	23c	Discuss any limitations of the review processes used.	P. 24 – line 993-1048
	23d	Discuss implications of the results for practice, policy, and future research.	P. 25 – Line 1050-1062
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	P. 6 – Line 212-221
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Not applicable

Section and Topic	Item #	Checklist item	Location where item is reported
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	P. 6 – Line 212-221
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Title Page– line 62
Competing interests	26	Declare any competing interests of review authors.	Title Page– line 61
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used	Title Page – line 64-67

Appendix B - *Search Strategies*

1) Search Strategy Researcher 1

PUBMED	
#1	(("low back pain"[MeSH Terms]) OR (“low back pain”) OR (“low back ache”) OR (“low backache”) OR (“back pain”) OR (“backache”) OR (lumbago) OR (“nonspecific low back pain”) OR (“aspecific low back pain”) OR (“acute low back pain”) OR (“sub-acute low back pain”) OR (“Chronic low back pain”) OR (“recurrent low back pain”) OR (“mechanical low back pain”) OR (“postural low back pain”))
#2	(("resistance training"[MeSH Terms]) OR ("resistance training") OR ("strength training") OR ("resistance exercise training") OR ("resistance-type exercise") OR ("resistance type training") OR ("strength-type exercise") OR ("weight training") OR ("free weight exercise") OR ("weight bearing exercise") OR ("weight lifting exercise") OR ("weight- bearing training") OR ("weightbearing exercise") OR ("weightlifting exercise") OR ("free-weight-based resistance training") OR ("free-weight-based"[All Fields]) AND ("training") OR ("water-based resistance training") OR ("progressive strength training") OR ("progressive resistance training"))
#3	((pain [MeSH Terms]) OR (pain) OR (ache) OR ("quality of life") OR ("disability"))
#4	**#1 AND #2 AND #3 AND (randomizedcontrolledtrial[Filter])**

EMBASE
('low back pain'/exp OR 'acute low back pain' OR 'back pain, low' OR 'chronic low back pain' OR 'loin pain' OR 'low back pain' OR 'low backache' OR 'low backpain' OR 'lowback pain' OR 'lower back pain' OR 'lumbago' OR 'lumbal pain' OR 'lumbal syndrome' OR 'lumbalgesia' OR 'lumbalgia' OR 'lumbar pain' OR 'lumbar spine syndrome' OR 'lumbodynia' OR 'lumbosacral pain' OR 'lumbosacral root syndrome' OR 'lumbosacroiliac strain' OR 'pain, low back' OR 'pain, lumbosacral' OR 'strain, lumbosacroiliac')
AND
('resistance training'/exp OR 'resistance exercise' OR 'resistance exercise training' OR 'resistance training' OR 'resistance-type exercise' OR 'resistance-type training' OR 'strength training' OR 'strength-type exercise' OR 'strength-type training')
AND
('pain'/exp OR 'acute pain' OR 'deep pain' OR 'lightning pain' OR 'nocturnal pain' OR 'pain' OR 'pain response' OR 'pain syndrome' OR 'treatment related pain' OR 'disability'/exp OR 'chronic disability' OR 'disability' OR 'disablement' OR 'handicap' OR 'quality of life'/exp OR 'hrql' OR 'health related quality of life' OR 'life quality' OR 'quality of life')
AND
('randomized controlled trial'/exp OR 'controlled trial, randomized' OR 'randomised controlled study' OR 'randomised controlled trial' OR 'randomized controlled study' OR 'randomized controlled trial' OR 'trial, randomized controlled')

SCOPUS
(TITLE-ABS-KEY ("low back pain") OR TITLE-ABS-KEY ("back pain") OR TITLE-ABS-KEY ("low back ache") OR TITLE-ABS-KEY ("low backache") OR TITLE-ABS-KEY ("nonspecific low back pain") OR TITLE-ABS-KEY ("aspecific low back pain") OR TITLE-ABS-KEY ("LBP") OR TITLE-ABS-KEY ("NSLBP") OR TITLE-ABS-KEY ("sub-acute low back pain") OR TITLE-ABS-KEY ("Chronic low back pain") OR TITLE-ABS-KEY ("CLBP") OR TITLE-ABS-KEY ("recurrent low back pain") OR TITLE-ABS-KEY ("mechanical low back pain"))
AND
(TITLE-ABS-KEY (“resistance exercise”) OR TITLE-ABS-KEY (“resistance exercise training”) OR TITLE-ABS-KEY (“resistance training”) OR TITLE-ABS-KEY (“resistance-type exercise”) OR TITLE-ABS-KEY (“resistance-type training”) OR TITLE-ABS-KEY (“strength training”) OR TITLE-ABS-KEY (“strength-type exercise”) OR TITLE-ABS-KEY (“strength-type training”) OR TITLE-ABS-KEY (“free weight exercise”) OR TITLE-ABS-KEY (“weight bearing exercise”) OR TITLE-ABS-KEY (“weight lifting exercise”) OR TITLE-ABS-KEY (“weight training”) OR TITLE-ABS-KEY (“weight-bearing training”) OR TITLE-ABS-KEY (“weightbearing exercise”) OR TITLE-ABS-KEY (“weightlifting exercise”))
AND
(TITLE ("randomised controlled trial") OR TITLE ("randomised controlled trial") OR TITLE ("randomised controlled study") OR TITLE ("randomised controlled study")) **AND** (LIMIT-TO (PUBSTAGE , "final")) **AND** (LIMIT-TO (DOCTYPE , "ar"))

COCHRANE CENTRAL REGISTER OF CONTROLLED TRIALS (CENTRAL)

#1	(low back pain): ti,ab,kw (Word variations have been searched)
#2	low back ache
#3	non specific low back pain
#4	lower back pain
#5	lumbalgo
#6	acute low back pain
#7	sub-acute low back pain
#8	Chronic low back pain
#9	recurrent low back pain
#10	MeSH descriptor: [low back pain] explode all trees
#11	**#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10**
#12	resistance exercise
#13	resistance exercise training
#14	resistance training
#15	resistance-type exercise
#16	resistance-type training
#17	strength training
#18	strength-type exercise
#19	strength-type training
#20	free weight exercise
#21	weight bearing exercise
#22	weightlifting exercise
#23	weight training
#24	weightlifting exercise
#25	**#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**
#26	**#11 and #25**

Filter - Trials

WEB OF SCIENCE

#1	(TI=(low back pain) OR TI=(low back ache) OR TI=(nonspecific low back pain) OR TI=(lower back pain) OR TI=(lumbago) OR TI=(acute low back pain) OR TI=(sub-acute low back pain) OR TI=(Chronic low back pain) OR TI=(CLBP) OR TI= (recurrent low back pain))
#2	(TI=(resistance exercise) OR AB=(resistance exercise) OR TI=(resistance exercise training) OR AB=(resistance exercise training) OR TI=(resistance training) OR AB=(resistance training) OR TI=(resistance-type exercise) OR AB=(resistance-type exercise) OR TI=(strength training) OR AB=(strength training) OR TI=(strength-type exercise) OR AB=(strength-type exercise) OR TI=(free weight exercise) OR AB=(free weight exercise) OR TI=(weight lifting exercise) OR AB=(weight lifting exercise) OR TI=(weight training) OR AB=(weight training) OR TI=(weightlifting exercise) OR AB=(weightlifting exercise) OR TI=(weightlifting) OR AB=(weightlifting))
#4	(TI=(randomi?ed controlled trial) OR TI=(randomi?ed controlled study)) NOT (TI=(review) OR TI=(meta-analysis) OR TI=(protocol))
#5	**#1 AND #2 AND #3**

PEDro

Title and abstract: low back pain, resistance training

Body part: lumbar spine, sacro iliac joint or pelvis

Subdiscipline: musculoskeletal

Method: Clinical trial

When searching: Match all search terms (AND)

GOOGLE SCHOLAR

allintitle: low back pain "resistance training" OR "strength training" OR "resistance exercise" OR "power training" OR "progressive resistance training" OR "progressive strength training" -review -"meta analysis"

2) Search Strategy 2

PUBMED
(("low back pain"[MeSH Terms]) OR "low back pain" OR "low back pains" OR "lumbago" OR "lower back pain" OR "lower back pains" OR "back pain" OR "lumbar pain") AND (("resistance training"[MeSH Terms]) OR "resistance training" OR ("strength training"[MeSH Terms]) OR "strength training" OR "weight training" OR "weight lifting" OR "strength exercise" OR "strength movement") AND (randomizedcontrolledtrial[Filter])
PEDro
Title and abstract: resistance training, exercise **Body part**: lumbar spine, sacro iliac joint or pelvis **Subdiscipline**: musculoskeletal **Method**: Clinical trial **When searching**: Match all search terms (AND)

3) Results

Search Strategy 1	**Search Strategy 2**
Pubmed: 88	*Pubmed: 94*
EMBASE: 193	*PEDro: 27*
CENTRAL: 929	***TOTAL: 121***
Scopus: 76	
Web of Science: 48	
PEDro: 26	
Google Scholar: 128	
TOTAL: 1488	

Total = 1609

Appendix C - Characteristics of exercise training programs

Study	G	Exercises	Resistance type	Duration, Weeks	Frequency, Days/Week	Duration, Minutes	Sets	Reps	Baseline Intensity	Max Intensity	Progressive overload variable
Aasa et al., (1)	RTG	Deadlifts	Barbell and Olympic weights	8	Weeks 1-4: 2 Weeks 5-8: 1	60		1-10		70–85% 1RM	Load (2.5 kg increase) and number of lifts
	UEG	Low-load motor control exercises individually selected and aimed to normalize the dominating movement impairment	-	8	Weeks 1-4: 2 Weeks 5-8: 1	20-30	2-3	10			Movement complexity
Cai et al., (2)	RTG (a)	Hip resistance training devices, leg press machine	Weight stack machines, Bodyweight	8	supervised: 2 home exercises: 5	45	3	10	10RM (week 0)	10RM (week 5)	Load
	RTG (b)	Leg raise in a 4-point kneel position, Prone back extension	0.5 Kg weights	8	supervised: 2 home exercises: 5	45	1	10	40% MVIC	> 65% MVIC	Intensity and Range of Motion
	UEG	low-load activation of TrA and LM, integration of this muscle activity in functional tasks	-	8	supervised: 2 home exercises: 5	45					
Calatayud et al., (3)	RTG	Squat, torso twist, deadlift, supine plank, lateral plank, front plank, modified curl up, bird-dog	TheraBands (red, blue, black, silver, and gold elastic band colors)	8	3		3	10-20	20RM	10RM	Load and Intensity
	UEG	Abdominal hollowing, knee-up, oblique crunch, supine plank, bird-dog, knees to chest, cat-camel, stretching (Back-School rehabilitation)	-	8	3		1	10			
Castro et al., (4)	RTG	Yoga with elastic resistance	Bands for pilates and minibands (Domyos, Decathlon)	8	2	50-60					Volume and intensity (Increment of elastic resistance)
	UEG	Yoga	-	8	2	50-60					Volume and intensity
Gibbs et al., (5)	RTG	Back squat, bench press, deadlift, leg press, pin-pendlay row, lat pull down	Supervised: Barbell, Cables and Olympic sized plate Home exercises: resistance bands	8	supervised: 1 home exercises: 3	45	1-3	3-10	2 RIR	1 - 2 RIR	Movement complexity, Range of Motion and Load
	UEG	Quadruped, curl up, split squat, push up, supine bridge, overhead squat, side-lying leg raise, side bridge, walking lunge, sumo squat, hip hinge	Bodyweight	8	supervised: 1 home exercises: 3	45	3	6-20			
Helmhout et al., (6)	RTG	Slow and controlled back extensions	Total Trunk Rehab (Technogym)	10	2	5-10	1	15-20	50–70% 1RM	50–70% 1RM	Load (2.5 kg increase)
	UEG	Exercises based on the physiotherapist's judgment, that do not use the lower back machine	-	10	2						
Kell et al., (7)	RTG	Leg press, leg extension, leg curl, bench press, incline bench press, lat pull-down, db shoulder press, straight bar arm curl, triceps pushdown, abdominal crunch, swiss ball crunch, prone superman	Free weights (i.e., barbell and dumbbell) and machines (Atlantis Strength Equipment products)	16	3		2-3	8-15	53% 1RM	73% 1RM	Load
	UEG	Aerobic exercise (i.e., elliptical trainer, treadmill walking or jogging) selected by patients	-	16	3	20–35			10.5 BORG	13 BORG	Intensity and Duration (min)
Mannion et al., (8)	RTG	Isoinertial loading to the lumbar spine in the sagittal, frontal, and horizontal planes following the David Back Clinic program	Weight stack machines	12	2	60					load
	UEG	low-impact aerobic exercises followed by specific exercises directed predominantly at the trunk and leg muscles	-	12	2	60					Volume and exercise complexity
Nambi et al., (9)	RTG	Lumbar extensions and flexion at 60, 90 and 120 degrees/second	Isokinetic dynamometer (Biodex Corporation, NY)	4	5		3	15			Not accounted for
	UEG (a)	Supine bridge, Sit-up, Arms-legs cross lifting, and Side bridge on the Swiss ball (Fitness world, Italy)	-	4	5		3	10			Not accounted for
	UEG (b)	Active isotonic and isometric exercise for abdominal and back muscles	-	4	5			10-15			Not accounted for
Nambi et al., (10)	RTG	Lumbar extensions and flexion at 60, 90 and 120 degrees/second	Isokinetic dynamometer (Biodex Corporation, NY)	4	5		3	15			Not accounted for
	UEG (a)	Core training sitting on the virtual reality platform (ProKin system PK 252 N Technobody, pelvic module balance trunk MF, Italy)	-	4	5	30	3	10			Difficulty of the exercises
	UEG (b)	Active isotonic and isometric exercise for abdominal and back muscles	-	4	5			10-15			Not accounted for

Santos et al., (11)	RTG (a)	Isometric supine crunch, Bodyweight Squat, Seated row, Leg extension, Bench press and Leg curl	Dumbbells; Technogym Equipment	4	3	50	3	8-15			Intensity
	RTG (b)	Isometric supine crunch, Bodyweight Squat, Seated row Leg extension, Bench press, Leg curl and core training	Dumbbells; Technogym Equipment	4	3	50	3	8-15			Intensity
	UEG	Educational lecture and core training	-	4							
Sertpoyraz et al., (12)	RTG	Maximal lumbar extensions and flexion at 60 and 90 degrees/second	Isokinetic dynamometer (Cybex Company, New York)	3	5	40	3	5	Maximal effort	Maximal effort	Not accounted for
	UEG		-	3	5	40	1-2	5-10			Not accounted for
Smith et al., (13)	RTG (a)	Sited back extensions with thigh stabilization	Lumbar Extension Machine (MedX)	12	1		1	8-15			Load (5% increase)
	RTG (b)	Sited back extensions without thigh stabilization	Lumbar Extension Machine (MedX)	12	1		1	8-15			Load (5% increase)
	UEG	Exercises based on the physiotherapist's judgment (not Lumbar Extension Machine)	-	12	1						

Data are presented as Mean ± Standard Deviation (SD), unless otherwise stated
Legend: G = group; RTG = Resistance Training Group; UEG = UEG Group;

Appendix D - Results of the included studies

Table 1 - Follow-up Short Training Program (**STP**) – **Less than 7 weeks** of training

			Resistance Training Group				Unloaded Exercise Group				
Study or Outcome	**Follow-up duration**	**Scale**	**n**	**Baseline**	**Post-Intervention**	**Within RTG change**	**n**	**Baseline**	**Post-Intervention**	**Within UEG change**	**STP post-intervention between-group difference**
Pain											
Cai et al., 2017 (a)	4 wks	NPRS (0-10)	27	3.48 ± 1	0.67 ± 0.72	**3.18 [2.36; 4.00]⁺**	14*	3.62 ± 1.13*	1.15 ± 0.97*	**2.28 [1.3; 3.26]⁺**	-0.58 [-1.23; 0.07]
Cai et al., 2017 (b)	4 wks	NPRS (0-10)	26	3.44 ± 0.87	1.36 ± 1	**2.19 [1.49; 2.88]⁺**	14*	3.62 ± 1.13*	1.15 ± 0.97*	**2.28 [1.3; 3.26]⁺**	0.21 [-0.43; 0.85]
Kell et al., 2009	6 wks	VAS (0-10)	9	5.4 ± 0.9	3.9 ± 0.8	**1.68 [0.57; 2.79]⁺**	9	5.1 ± 0.8	4.8 ± 0.7	0.38 [-0.55; 1.31]	**-1.14 [-2.10; -0.18]⁺**
Nambi et al., 2020_1 (a)	4 wks	VAS (0-10)	10*	7.2 ± 0.4*	4.6 ± 0.3*	**7.04 [4.45; 9.63]⁺**	20	7.3 ± 0.3	3.6 ± 0.3	**12.09 [9.23; 14.95]⁺**	**3.24 [2.14; 4.35]⁺**
Nambi et al., 2020_1 (b)	4 wks	VAS (0-10)	10*	7.2 ± 0.4*	4.6 ± 0.3*	**7.04 [4.45; 9.63]⁺**	20	7.4 ± 0.5	6.4 ± 0.5	**1.96 [1.19; 2.73]⁺**	**-3.93 [-5.17; -2.69]⁺**
Nambi et al., 2020_2 (a)	4 wks	VAS (0-10)	8*	7.3 ± 0.5*	4.8 ± 0.4*	**5.22 [2.92; 7.52]⁺**	15	7.1 ± 0.6	3.9 ± 0.5	**5.64 [3.95; 7.33]⁺**	**1.85 [0.86; 2.83]⁺**
Nambi et al., 2020_2 (b)	4 wks	VAS (0-10)	7*	7.3 ± 0.5*	4.8 ± 0.4*	**5.17 [2.68; 7.66]⁺**	15	7.3 ± 0.6	6.2 ± 0.4	**2.10 [1.18; 3.01]⁺**	**-3.37 [-4.68; -2.05]⁺**
Santos et al., (a) 2022	4 wks	VAS (0-10)	14	7.04 ± 1.73	3.42 ± 0.69	**2.09 [1.14; 3.04]⁺**	6*	6.53 ± 1.23*	4.89 ± 1.41*	1.14 [-0.12; 2.41]	**-1.49 [-2.51; -0.46]⁺**
Santos et al., (b) 2022	4 wks	VAS (0-10)	12	7.97 ± 1.27	3.43 ± 1.63	**3.00 [1.77; 4.23]⁺**	6*	6.53 ± 1.23*	4.89 ± 1.41*	1.14 [-0.12; 2.41]	-0.89 [-1.87; 0.09]
Sertpoyraz et al., 2009	3 wks	VAS (0-10)	20	4.85 ± 0.93	1.3 ± 1.45	**2.86 [1.95; 3.76]⁺**	20	5.4 ± 1.27	1.2 ± 1.43	**3.04 [2.11; 3.98]⁺**	0.07 [-0.54; 0.68]
Disability											
Helmhout et al., 2008	5 wks	RMDQ (0-24)	64	8.3 ± 4.8	5.8 ± 4.8	**0.52 [0.17; 0.87]⁺**	46	7.9 ± 4.4	4.2 ± 4.2	**0.85 [0.43; 1.28]⁺**	0.35 [-0.03; 0.73]
Kell et al., 2009	6 wks	ODI (0-100)	9	40.4 ± 2.4	28.2 ± 2.0	**5.26 [3.11; 7.41]⁺**	9	39.8 ± 2.3	38.1 ± 2.2	0.72 [-0.24; 1.68]	**-4.48 [-6.19; -2.78]⁺**
Santos et al., (a) 2022	4 wks	RMDQ (0-24)	14	14.79 ± 3.19	2.64 ± 2.24	**4.28 [2.86; 5.70]⁺**	6*	16.08 ± 5.65*	14.33 ± 3.5*	0.34 [-0.80; 1.49]	**-4.22 [-5.82; -2.63]⁺**
Santos et al., (b) 2022	4 wks	RMDQ (0-24)	12	16.75 ± 4.97	2.58 ± 2.94	**3.35 [2.04; 4.66]⁺**	6*	16.08 ± 5.65*	14.33 ± 3.5*	0.34 [-0.80; 1.49]	**-3.58 [-5.08; -2.08]⁺**
Sertpoyraz et al., 2009	3 wks	mODI (0-100)	20	16.6 ± 8.12	9.4 ± 6.81	**0.94 [0.28; 1.60]⁺**	20	18.8 ± 7.79	10.45 ± 5.78	**1.19 [0.51; 1.87]⁺**	-0.16 [-0.77; 0.45]
Muscle endurance											
Kell et al., 2009	6 wks	Biering-Sørensen (min)	9	1.248 ± 0.612	1.453 ± 0.632	-0.31[-1.25; 0.62]	9	1.17 ± 0.283	1.222 ± 0.258	-0.18 [-1.11; 0.74]	0.46 [-0.44; 1.35]
Santos et al., (a) 2022	4 wks	Biering-Sørensen (min)	14	0.967 ± 0.36	1.468 ± 0.236	**-1.6 [-2.47; -0.73]⁺**	6*	1.288 ± 0.541*	1.018 ± 0.367*	**0.54 [-1.7; -0.62]⁺**	**1.55 [0.51; 2.58]⁺**
Santos et al., (b) 2022	4 wks	Biering-Sørensen (min)	12	1.075 ± 0.602	1.568 ± 0.458	**-0.89 [-1.74; -0.04]⁺**	6*	1.288 ± 0.541*	1.018 ± 0.367*	**0.54 [-1.7; -0.62]⁺**	**1.21 [0.20; 2.23]⁺**
Maximal strength											
Helmhout et al., 2008	5 wks	MIBE Torque (n · m)	64	214 ± 64	244 ± 66	**-0.46 [-0.81; -0.11]⁺**	46	212 ± 65	247 ± 73	**-0.50 [-0.92; -0.09]⁺**	-0.34 [-0.72; 0.04]
Sertpoyraz et al., 2009	3 wks	PT 90°/s (n · m)	20	18.91 ± 14.32	32.47 ± 15.88	**-0.88 [-1.53; -0.23]⁺**	20	11.57 ± 13.7	22.75 ± 23.31	**-0.57 [-1.21; -0.06]⁺**	**0.48 1-0.14; 1.09]⁺**
Sertpoyraz et al., 2009	3 wks	PT 60°/s (n · m)	20	24.35±13.12	38.95 ± 13.05	**-1.09 [-1.76; -0.42]⁺**	20	18.42 ± 16.14	39.7 ± 34.1	**-0.78 [-1.43; -0.14]⁺**	-0.03 [-0.64; 0.58]

Outcomes are presented as Mean ± SD; Every outcome scale is presented with its name, range and/or unit of measure
* = Evenly divided outcomes of the shared group, to allow the inclusion in the statistical synthesis
Within and between group changes are reported as standardized mean difference (Hedges' g) and 95% Confidence Interval
+ = Significant difference; Color coding: '**red**' = Favors the Resistance Training Group; '**blue**' = Favors the Unloaded Exercise Group

Legend: ITT: Intention-to-Treat; PPT: Per-Protocol; VAS: Visual Analog Scale; NPRS: Numeric Pain Rating Scale; RMDQ: Roland and Morris Disability Questionnaire; ODI: Oswestry Disability Index; MIBE: Maximal isometric back-extension; NR: not reported

Table 2 - Follow-up Extended Training Program (**ETP**) – **At least 7 weeks** of training

			Resistance Training Group				Unloaded Exercise Group				
Study or Outcome	**Follow-up duration**	**Scale**	**n**	**Baseline**	**Post-Intervention**	**Within RTG change**	**n**	**Baseline**	**Post-Intervention**	**Within UEG change**	**ETP post-intervention between-group difference**
Pain											
Aasa et al., 2015	8 wks	VAS (0-100)	35	4.3 ± 2.4	2.2 ± 2.1	**0.92 [0.43; 1.42]**$^{+}$	35	4.7 ± 2.8	3.0 ± 2.6	**0.62 [0.14; 1.10]**$^{+}$	-0.33 [-0.80; 0.13]
Cai et al., 2017 (a)	8 wks	NPRS (0-10)	26	3.48 ± 1	0.32 ± 0.48	**3.97 [3.01; 4.93]**$^{+}$	13*	3.62 ± 1.13*	0.65 ± 0.56*	**3.23 [2.00; 4.45]**$^{+}$	**-0.62 [-1.17; -0.07]**$^{+}$
Cai et al., 2017 (b)	8 wks	NPRS (0-10)	24	3.44 ± 0.87	0.76 ± 0.78	**3.19 [2.32; 4.06]**$^{+}$	12*	3.62 ± 1.13*	0.65 ± 0.56*	**3.22 [1.94; 4.49]**$^{+}$	0.16 [-0.40; 0.72]
Calatayud et al., 2020	8 wks	NPRS (0-10)	42	6.2 ± 2	4.3 ± 2	**0.94 [0.49; 1.39]**$^{+}$	43	6.3 ± 2	5.1 ± 3	**0.47 [0.04; 0.90]**$^{+}$	-0.31 [-0.74; 0.12]
Castro et al., 2022	8 wks	VAS (0-10)	12	6.75 ± NR	3.68 ± NR	-	13	7.12 ± NR	3.48 ± NR	-	-
Gibbs et al., 2022	8 wks	VAS (0-10)	32	5.6 ± 2.1	4 ± 2.8	**0.64 [0.14; 1.14]**$^{+}$	32	5.8 ± 2.2	3.5 ± 2.3	**1.01 [0.49; 1.53]**$^{+}$	0.19 [-0.29; 0.68]
Kell et al., 2009	16 wks	VAS (0-10)	9	5.4 ± 0.9	3.3 ± 0.5	**2.75 [1.37; 4.12]**$^{+}$	9	5.1 ± 0.8	4.8 ± 0.8	0.36 [-0.58; 1.29]	**-2.14 [-3.27; -1.02]**$^{+}$
Mannion et al., 1999	12 wks	VAS (0-10)	44	4.2 ± 1.8	3.1 ± 2.1	**0.56 [0.13; 0.98]**$^{+}$	47	4.1 ± 1.8	3.6 ± 2.5	0.23 [-0.18; 0.63]	-0.21 [-0.62; 0.19]
Smith et al., (a) 2011	12 wks	VAS (0-100)	16	3.01 ± 1.72	1.34 ± 1.08	**1.13 [0.38; 1.86]**$^{+}$	6*	26.8 ± 9*	26.5 ± 10.2*	0.03 [-1.01; 1.16]	**-1.18 [-2.15; -0.22]**$^{+}$
Smith et al., (b) 2011	12 wks	VAS (0-100)	17	2.87 ± 1.739	2.807 ± 2.182	0.03 [-0.64; 0.70]	7*	26.8 ± 9*	26.5 ± 10.2*	0.03 [-1.01; 1.16]	0.08 [-0.77; 0.93]
Disability											
Aasa et al., 2015	8 wks	RMDQ (0-24)	35	7.2 ± 4.3	3.8 ± 4.0	**0.81 [0.32; 1.30]**$^{+}$	35	7.1 ± 3.9	3.6 ± 4.2	**0.85 [0.36; 1.34]**$^{+}$	**-0.92 [-1.41; -0.44]**$^{+}$
Calatayud et al., 2020	8 wks	RMDQ (0-24)	42	7.75 ± 5.08	4.97 ± 4.2	**0.59 [0.15; 1.03]**$^{+}$	43	10.2 ± 5.52	7.9 ± 5.35	0.42 [-0.01; 0.85]	**-1.90 [-2.41; -1.39]**$^{+}$
Castro et al., 2022	8 wks	RMDQ (0-24)	12	13.82 ± NR	8.55 ± NR	-	13	13.18 ± NR	6,55 ± NR	-	-
Gibbs et al., 2022	8 wks	ODI (0-100)	32	18.8 ± 7.8	11.8 ± 9.6	**0.79 [0.28; 1.30]**$^{+}$	32	15.4 ± 8.7	10.2 ± 9.8	**0.55 [0.05; 1.05]**$^{+}$	**-1.34 [-1.88; -0.80]**$^{+}$
Helmhout et al., 2008	10 wks	RMDQ (0-24)	59	8.3 ± 4.8	3.4 ± 4.6	**1.04 [0.65; 1.42]**$^{+}$	47	7.9 ± 4.4	3.5 ± 4.2	**1.01 [0.58; 1.45]**$^{+}$	**-0.87 [-1.27; -0.48]**$^{+}$
Kell et al., 2009	16 wks	ODI (0-100)	9	40.4 ± 2.4	24.2 ± 2.0	**6.98 [4.24; 9.73]**$^{+}$	9	39.8 ± 2.3	35.9 ± 2.5	**1.55 [0.46; 2.63]**$^{+}$	**-4.92 [-6.75; -3.09]**$^{+}$
Mannion et al., 1999	12 wks	RMDQ (0-24)	44	8.0 ± 5.1	6.7 ± 5.0	0.26 [-0.16; 0.67]	47	7.7 ± 4.7	6.3 ± 5.1	0.28 [-1.30; 0.97]	0.08 [-0.33; 0.49]
Smith et al., (a) 2011	12 wks	ODI (0-100)	16	39.20 ± 14.7	27.3 ± 11.6	**0.88 [0.17; 1.59]**$^{+}$	6*	32.70 ± 5.9*	33.8 ± 6.3*	-0.17 [-1.30; 0.97]	-0.59 [-1.51; 0.33]
Smith et al., (b) 2011	12 wks	ODI (0-100)	17	35.70 ± 12.6	34 ± 12.6	0.13 [-0.53; 0.79]	7*	32.70 ± 5.9*	33.8 ± 6.3*	-0.17 [-1.22; 0.88]	0.02 [-0.83; 0.87]
Muscle endurance											
Aasa et al., 2015	8 wks	Biering-Sørensen (min)	35	1.45 ± 0.73	1.683 ± 0.867	-0.29 [-0.76; 0.18]	35	1.25 ± 0.583	1.45 ± 0.6	-0.33 [-0.81; 0.14]	0.31 [-0.16; 0.78]
Calatayud et al., 2020	8 wks	Biering-Sørensen (min)	42	0.577 ± 0.477	1.317 ± 0.97	**-0.96 [-1.41; -0.51]**$^{+}$	43	0.433 ± 0.498	0.495 ± 0.468	-0.13 [-0.55; 0.3]	**1.07 [0.62; 1.52]**$^{+}$
Kell et al., 2009	16 wks	Biering-Sørensen (min)	9	1.248 ± 0.612	1.583 ± 0.642	-0.51 [-1.45; 0.43]	9	1.17 ± 0.283	1.262 ± 0.247	-0.33 [-1.2; 0.60]	0.63 [-0.27; 1.53]
Maximal strength											
Aasa et al., 2015	8 wks	Lift Strength (n)	35	932 ± 415	1059 ± 414	**-0.30 [-0.77; -0.17]**$^{+}$	35	892 ± 430	961 ± 414	-0.16 [-0.63; 0.31]	0.23 [-0.23; 0.70]
Helmhout et al., 2008	10 wks	MIBE Torque (n · m)	59	214 ± 64	223 ± 62	-0.14 [-0.56; 0.28]	47	212 ± 65	247 ± 73	**-0.50 [-0.91; -0.09]**$^{+}$	-0.04 [-0.42; 0.34]
Fear-Avoidance Beliefs about physical activity											
Gibbs et al., 2022	8 wks	FABQ (0-24)	32	10.0 ± 4.4	5.3 ± 4.4	**1.06 [0.54; 1.57]**$^{+}$	32	10.3 ± 5.2	6.8 ± 5.1	**0.67 [0.17; 1.17]**$^{+}$	-0.31 [-0.80; 0.18]
Mannion et al., 1999	12 wks	FABQ (0-24)	44	13.7 ± 4.7	11.4 ± 5.5	**0.45 [0.04; 0.85]**$^{+}$	47	13.7 ± 6.2	12.0 ± 5.7	0.28 [-0.12; 0.69]	-0.11 [-0.51; 0.30]
Pain catastrophizing											
Gibbs et al., 2022	8 wks	PCS (0-52)	32	16.0 ± 10.3	8.5 ± 9.6	**0.74 [0.24; 1.25]**$^{+}$	32	18.0 ± 11.7	8.9 ± 8.5	**0.88 [0.37; 1.39]**$^{+}$	-0.04 [-0.53; 0.44]

Outcomes are presented as Mean ± SD; Every outcome scale is presented with its name, range and/or unit of measure
Within and between group changes are reported as standardized mean difference (Hedges' g) and 95% Confidence Interval

* = Evenly divided outcomes of the shared group, to allow the inclusion in the statistical synthesis; **+** = Significant difference; Color coding: '**red**' = Favors the Resistance Training Group; '**blue**' = Favors the Unloaded Exercise Group

Legend: ITT: Intention-to-Treat; PPT: Per-Protocol; VAS: Visual Analog Scale; NPRS: Numeric Pain Rating Scale; RMDQ: Roland and Morris Disability Questionnaire; ODI: Oswestry Disability Index; MIBE: Maximal isometric back-extension; FABQ: Fear-Avoidance Belief Questionnaire; PCS: Pain Catastrophizing Scale; NR: not reported

Table 3 - Follow-up Post-Washout period (**PW**) – **After 6 months**

			Resistance Training Group				Unloaded Exercise Group				
Study or Outcome	**Follow-up duration**	**Scale**	**n**	**Baseline**	**Post-Intervention**	**Within RTG change**	**n**	**Baseline**	**Post-Intervention**	**Within UEG change**	**PW post-intervention between-group difference**
Pain											
Aasa et al., 2015	12 mo	VAS (0-100)	35	4.3 ± 2.4	2.4 ± 2.7	**0.74 [0.25; 1.22]$^{+}$**	35	4.7 ± 2.8	2.5 ± 2.2	**0.86 [0.37; 1.36]$^{+}$**	-0.04 [-0.50; 0.42]
Aasa et al., 2015	24 mo	VAS (0-100)	35	4.3 ± 2.4	2.7 ± 2.7	**0.62 [0.14; 1.10]$^{+}$**	35	4.7 ± 2.8	3.0 ± 2.9	**0.59 [0.11; 1.07]$^{+}$**	-0.11 [-0.57; 0.36]
Cai et al., 2017 (a)	6 mo	NPRS (0-10)	26	3.48 ± 1	0.12 ± 0.33	**4.44 [3.40; 5.49]$^{+}$**	13*	3.62 ± 1.13*	0.5 ± 0.58*	**3.36 [2.11; 4.62]$^{+}$**	**-0.87 [-1.55; -0.19]$^{+}$**
Cai et al., 2017 (b)	6 mo	NPRS (0-10)	24	3.44 ± 0.87	0.24 ± 0.52	**4.39 [3.31; 5.47]$^{+}$**	12*	3.62 ± 1.13*	0.5 ± 0.58*	**3.35 [2.04; 4.66]$^{+}$**	-0.47 [-1.16; 0.22]
Gibbs et al., 2022	6 mo	VAS (0-10)	32	5.6 ± 2.1	4.1 ± 2.6	**0.63 [0.12; 1.13]$^{+}$**	32	5.8 ± 2.2	4.0 ± 3.0	**0.68 [0.17; 1.18]$^{+}$**	0.04 [-0.45; 0.52]
Mannion et al., 1999	6 mo	VAS (0-10)	44	4.2 ± 1.8	2.8 ± 2.1	**0.71 [0.28; 1.14]$^{+}$**	47	4.1 ± 1.8	3.1 ± 2.3	**0.48 [0.07; 0.89]$^{+}$**	**2.87 [1.70; 4.04]$^{+}$**
Nambi et al., 2020_2 (a)	6 mo	VAS (0-10)	8*	7.3 ± 0.5*	1.9 ± 0.3*	**12.38 [7.34; 17.4]$^{+}$**	15	7.1 ± 0.6	0.8 ± 0.4	**12.02 [8.68; 15.36]$^{+}$**	**-4.92 [-6.61; -3.23]$^{+}$**
Nambi et al., 2020_2 (b)	6 mo	VAS (0-10)	7*	7.3 ± 0.5*	1.9 ± 0.3*	**12.26 [6.8; 17.7]$^{+}$**	15	7.3 ± 0.6	4.2 ± 0.5	**5.46 [3.82; 7.11]$^{+}$**	-0.13 [-0.54; 0.27]
Disability											
Aasa et al., 2015	12 mo	RMDQ (0-24)	35	7.2 ± 4.3	3.6 ± 4.2	**0.84 [0.35; 1.33]$^{+}$**	35	7.1 ± 3.9	3.3 ± 3.6	**1.00 [0.50; 1.50]$^{+}$**	0.08 [-0.39; 0.54]
Aasa et al., 2015	24 mo	RMDQ (0-24)	35	7.2 ± 4.3	3.8 ± 3.9	**0.82 [0.33; 1.31]$^{+}$**	35	7.1 ± 3.9	3.6 ± 3.7	**0.91 [0.42; 1.40]$^{+}$**	0.05 [-0.41; 0.52]
Gibbs et al., 2022	6 mo	ODI (0-100)	32	18.8 ± 7.8	12.78 ± 10.3	**0.65 [0.15; 1.15]$^{+}$**	32	15.4 ± 8.7	12.9 ± 10.4	0.26 [-0.23; 0.75]	-0.01 [-0.50; 0.47]
Helmhout et al., 2008	8 mo	RMDQ (0-24)	57	8.3 ± 4.8	3.2 ± 4.3	**1.11 [0.72; 1.51]$^{+}$**	37	7.9 ± 4.4	2.7 ± 3.8	**1.25 [0.76; 1.75]$^{+}$**	0.12 [-0.29; 0.53]
Helmhout et al., 2008	14 mo	RMDQ (0-24)	61	8.3 ± 4.8	2.6 ± 4.4	**1.23 [0.84; 1.62]$^{+}$**	45	7.9 ± 4.4	2.5 ± 3.9	**1.29 [0.84; 1.74]$^{+}$**	0.02 [-0.36; 0.41]
Mannion et al., 1999	6 mo	RMDQ (0-24)	44	8.0 ± 5.1	5.7 ± 4.8	**0.46 [0.04; 0.88]$^{+}$**	47	7.7 ± 4.7	5.4 ± 4.4	**0.50 [0.09; 0.91]$^{+}$**	0.06 [-0.34; 0.47]
Muscle endurance											
Aasa et al., 2015	12 mo	Biering-Sørensen (s)	35	1.47 ± 0.733	1.817 ± 0.75	-0.46 [- 0.94; 0.01]	35	1.25 ± 0.583	1.47 ± 0.6	-0.37 [-0.84; 0.10]	0.18 [-0.29; 0.64]
Maximal strength											
Aasa et al., 2015	12 mo	Lift Strength (n)	35	932 ± 415	1177 ± 456	**-0.56 [-1.03; -0.08]$^{+}$**	35	892 ± 430	902 ± 501	-0.02 [-0.49; 0.45]	**0.57 [0.09; 1.04]$^{+}$**
Helmhout et al., 2008	8 mo	MIBE Torque (n · m)	57	214 ± 64	264 ± 64	**-0.78 [-1.16; -0.39]$^{+}$**	37	212 ± 65	254 ± 73	**-0.60 [-1.07; -0.13]$^{+}$**	0.15 [-0.26; 0.56]
Helmhout et al., 2008	14 mo	MIBE Torque (n · m)	61	214 ± 64	267 ± 62	**-0.84 [-1.21; -0.47]$^{+}$**	45	212 ± 65	249 ± 74	-0.53 [-0.95; 0.94]	0.27 [-0.12; 0.65]
Fear-Avoidance Beliefs about physical activity											
Gibbs et al., 2022	6 mo	FABQ (0-24)	32	10.0 ± 4.4	6.23 ± 4.6	**0.83 [0.32; 1.33]$^{+}$**	32	10.3 ± 5.2	8.1 ± 4.8	0.43 [-0.06; 0.92]	-0.39 [-0.88; 0.10]
Mannion et al., 1999	6 mo	FABQ (0-24)	44	13.7 ± 4.7	10.7 ± 5.3	**0.59 [0.18; 1.00]$^{+}$**	47	13.7 ± 6.2	10.1 ± 6.5	**0.56 [0.15; 0.97]$^{+}$**	0.10 [-0.30; 0.50]
Pain Catastrophizing											
Gibbs et al., 2022	6 mo	PCS (0-52))	32	16.0 ± 10.3	9.8 ± 10.1	**0.60 [0.11; 1.10]$^{+}$**	32	18.0 ± 11.7	10.8 ± 10.5	**0.64 [0.14; 1.14]$^{+}$**	-0.10 [-0.58; 0.39]

Outcomes are presented as Mean ± SD; Every outcome scale is presented with its name, range and/or unit of measure
* = Evenly divided outcomes of the shared group, to allow the inclusion in the statistical synthesis
Within and between (post-intervention) group changes are reported as standardized mean difference (Hedges' g) and 95% Confidence Interval
+ = Significant difference; Color coding: '**red**' = Favors the Resistance Training Group; '**blue**' = Favors the Unloaded Exercise Group
Legend: ITT: Intention-to-Treat; PPT: Per-Protocol; VAS: Visual Analog Scale; NPRS: Numeric Pain Rating Scale; RMDQ: Roland and Morris Disability Questionnaire; ODI: Oswestry Disability Index; MIBE: Maximal isometric back-extension; FABQ: Fear-Avoidance Belief Questionnaire; PCS: Pain Catastrophizing Scale; NR: not reported

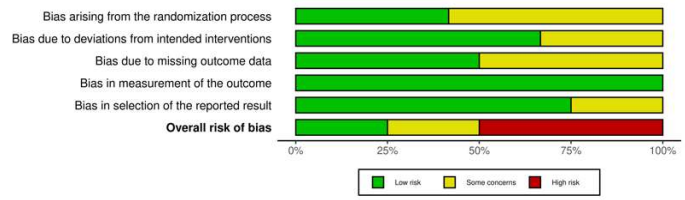
Appendix E - Risk of Bias assessment tool 2 (ROB 2)

Primary outcomes

Pain – ROB 2 – Traffic light plot

Study ID	D1	D2	D3	D4	D5	Overall
Aasa et al., 2015 (1)	+	+	+	+	+	+
Cai et al. 2017 (2)	-	-	+	+	+	x
Calatayud et al., 2020 (3)	+	+	-	+	+	-
Castro et al., 2022 (4)	-	-	-	+	-	x
Gibbs et al., 2022 (5)	+	+	+	+	+	+
Kell et al., 2009 (7)	-	+	-	+	+	x
Mannion et al., 1999 (8)	-	+	+	+	+	-
Nambi et al., 2020 (a) (9)	-	+	-	+	-	x
Nambi et al., 2020 (b) (10)	-	+	-	+	-	x
Santos et al., 2022 (11)	+	-	-	+	+	-
Sertpoyraz et al., 2009 (12)	+	+	+	+	+	+
Smith et al., 2011 (13)	-	-	+	+	+	x

Pain – ROB 2 - Summary plot



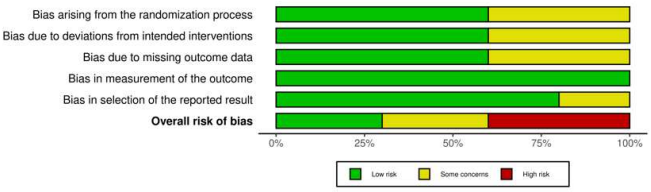
Judgement

High
Some concerns
Low

Disability – ROB 2 – Traffic light plot

Study ID	D1	D2	D3	D4	D5	Overall
Aasa et al., 2015 (1)	+	+	+	+	+	+
Calatayud et al., 2020 (3)	+	+	-	+	+	-
Castro et al., 2022 (4)	-	-	-	+	-	x
Gibbs et al., 2022 (5)	+	+	+	+	+	+
Helmhout et al., 2008 (6)	+	-	+	+	-	x
Kell et al., 2009 (7)	-	+	-	+	+	x
Mannion et al., 1999 (8)	-	+	+	+	+	-
Santos et al., 2022 (11)	+	-	-	+	+	-
Sertpoyraz et al., 2009 (12)	+	+	+	+	+	+
Smith et al., 2011 (13)	-	-	+	+	+	x

Disability – ROB 2 - Summary plot



Judgement

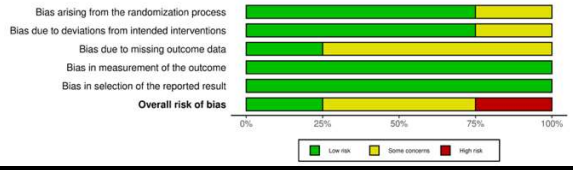
High
Some concerns
Low

Secondary outcomes

Endurance – ROB 2 – Traffic light plot

Study ID	D1	D2	D3	D4	D5	Overall
Aasa et al., 2015 (1)	+	+	+	+	+	+
Calatayud et al., 2020 (3)	+	+	-	+	+	-
Kell et al., 2009 (7)	-	+	-	+	+	x
Santos et al., 2022 (11)	+	-	-	+	+	-

Endurance – ROB 2 - Summary plot



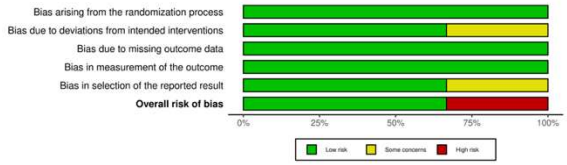
Judgement

x High
\- Some concerns
\+ Low

Maximal strength – ROB 2 – Traffic light plot

Study ID	D1	D2	D3	D4	D5	Overall
Aasa et al., 2015 (1)	+	+	+	+	+	+
Helmhout et al., 2008 (6)	+	-	+	+	-	x
Sertpoyraz et al., 2009 (12)	+	+	+	+	+	+

Maximal strength – ROB 2 - Summary plot



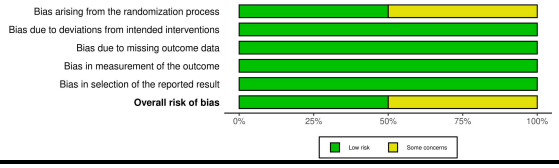
Judgement

x High
\- Some concerns
\+ Low

Fear-avoidance beliefs – ROB 2 – Traffic light plot

Study ID	D1	D2	D3	D4	D5	Overall
Gibbs et al., 2022 (5)	+	+	+	+	+	+
Mannion et al., 1999 (8)	-	+	+	+	+	-

Fear-avoidance beliefs – ROB 2 - Summary plot



Judgement

x High
\- Some concerns
\+ Low

Pain Catastrophizing – ROB 2 – Traffic light plot

Study ID	D1	D2	D3	D4	D5	Overall
Gibbs et al., 2022 (5)	+	+	+	+	+	+

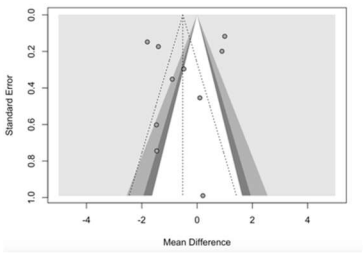
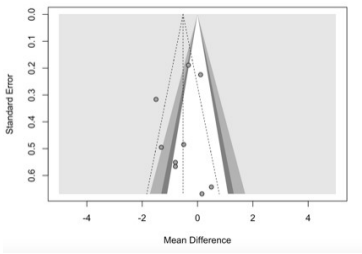
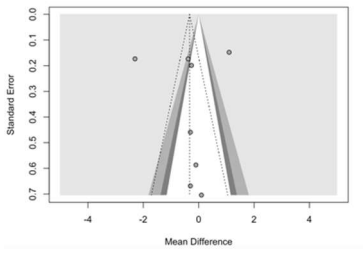
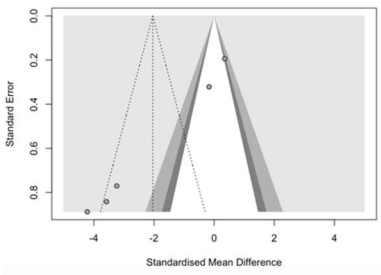
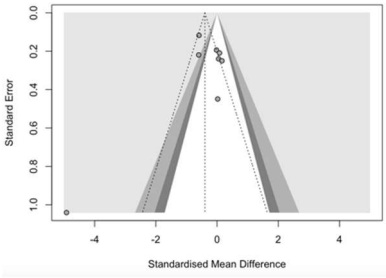
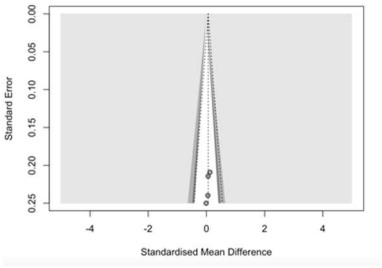
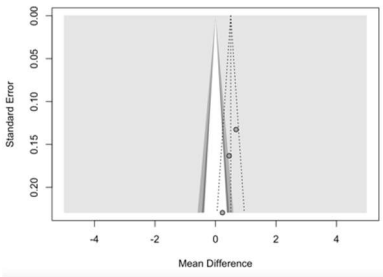
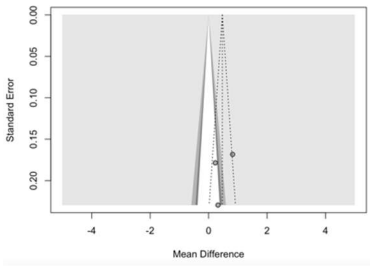
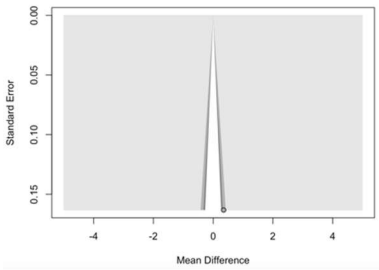
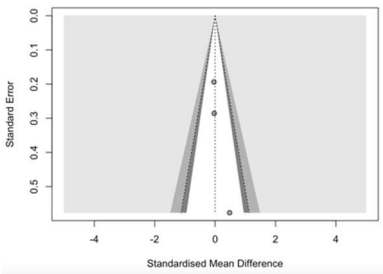
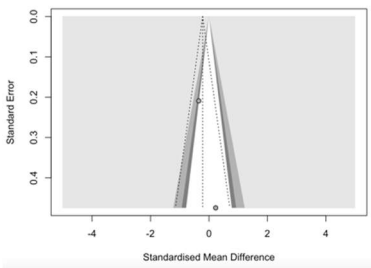
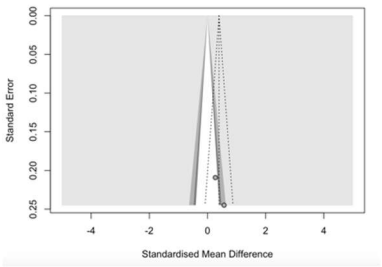
Appendix F – Post-hoc subgroup analysis

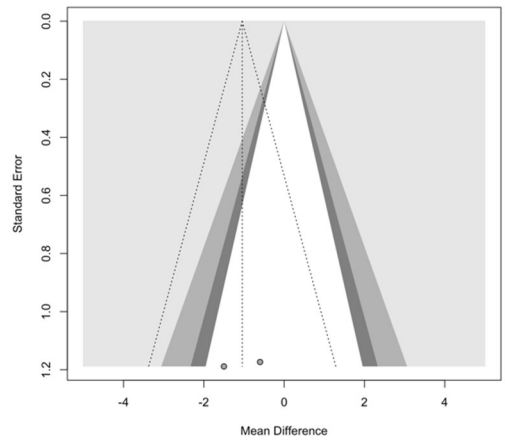
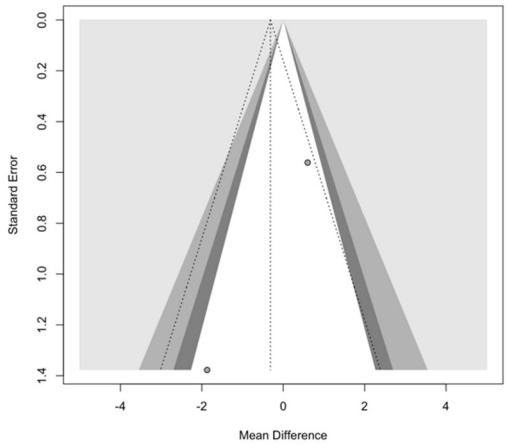
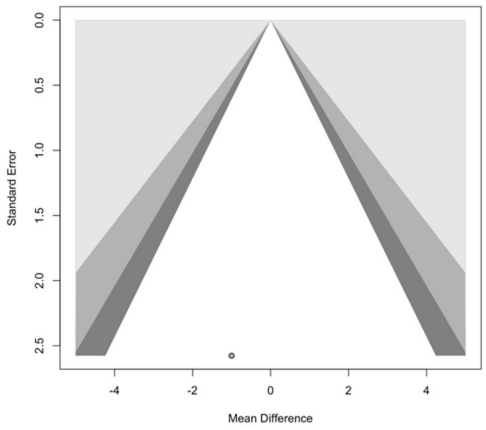
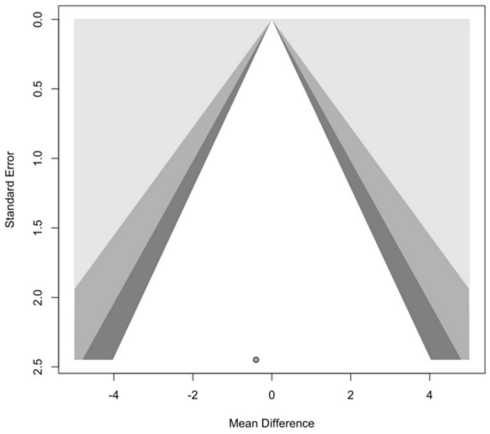
Subgroup analysis - **Risk of bias**					
Outcome or subgroup	**C**	**IV Random, 95%CI, MD/SMD [LL - UL]**	**I^2**	**Tau^2**	**Test for subgroup differences**
Pain - Short Training Programs (STP)					
High risk of bias	7	-0.3836 [-1.2514; 0.4842]	98%	1.2386	Q:0.42; df: 1; p:0.5171
Low risk/ Some Concerns	3	-0.8484 [-1.9551; 0.2583]	65.3%	0.6027	
Disability - Short Training Programs (STP)					
High risk of bias	2	-1.3676 [-4.8824; 2.1473]	95.1%	6.1285	Q:0.28; df: 1; p:0.5951
Low risk/ Some Concerns	3	-2.5463 [-5.1035; 0.0109]	93.2%	4.5924	
Pain - Extended Training Programs (ETP)					
High risk of bias	5	-0.5806 [-1.2598; 0.0985]	81.3%	0.4569	Q:0.07; df:1; p:0.7891
Low risk/ Some Concerns	4	-0.4621 [-1.0038; 0.0797]	0%	<0.0001	
Disability - Extended Training Programs (ETP)					
High risk of bias	4	-1.2058 [-3.2951; 0.8834]	88.4%	4.2492	Q:1.08; df:1; p:0.2996
Low risk/ Some Concerns	4	-0.0842 [-0.4350; 0.2666]	59.5%	0.0757	
Pain – Post-Washout (PW)					
High risk of bias	4	-0.4586 [-1.8315; 0.9142]	98.7%	1.9321	Q:0.13; df:1; p:0.7166
Low risk/ Some Concerns	4	-0.0847 [-0.4357; 0.2663]	0%	0	

Subgroup analysis - **Baseline pain (PMM)**					
Outcome or subgroup	**C**	**IV Random, 95%CI, MD/SMD [LL - UL]**	**I^2**	**Tau^2**	**Test for subgroup differences**
Pain - Short Training Programs (STP)					
"Acceptable" pain	3	-0.2670 [-0.7592; 0.2252]	0%	0.0102	Q:0.60; df: 1; p: 0.4383
"High" pain	7	-0.6792 [-1.5978; 0.2394]	98.1%	1.3958	
Disability - Short Training Programs (STP)					
Not available	1	0.3500 [-0.0300; 0.7300]	-	-	
"High" pain	3	-3.6348 [-4.5729; -2.6967]	0%	0	**Q:59.55; df: 2; p< 0.0001***
"Acceptable" pain	1	-0.1700 [-0.8000; 0.4600]	-	-	
Pain - Extended Training Programs (ETP)					
"Acceptable" pain	6	-0.3602 [-0.7667; 0.0463]	43.8%	0.1073	Q:0.31; df:1; p: 0.5767
"High" pain	3	-0.7023 [-1.8324; 0.4279]	75.1%	0.7426	
Disability - Extended Training Programs (ETP)					
Not available	1	-0.0200 [-0.4000; 0.3600]	-	-	
"High" pain	3	-1.6370 [-4.5840; 1.3101]	91.9%	6.4176	Q:1.32; df:2; p:0.5164
"Acceptable" pain	4	-0.0842 [-0.4350; 0.2666]	74.7%	0.1036	
Pain – Post-Washout (PW)					
"Acceptable" pain	5	-0.3156 [-0.5526; -0.0786]	0.0%	0	Q:0.00; df:1; p: 0.9468
"High" pain	3	-0.3861 [-2.4444; 1.6721]	99.1%	29.7995	

Subgroup analysis – Resistance Type					
Outcome or subgroup	**C**	**IV Random, 95%CI, MD/SMD [LL - UL]**	**I^2**	**Tau^2**	**Test for subgroup differences**
Pain - Short Training Programs (STP)					
External resistance only	5	-0.2468 [-1.4051; 0.9115]	98.7%	1.6869	Q:0.71; df: 1; p:0.3985
Internal and external resistance	5	-0.7762 [-1.1861; -0.3662]	6.7%	0.0119	
Disability - Short Training Programs (STP)					
External resistance only	2	0.1532 [-0.3411; 0.6475]	47.9%	0.064	**Q:49.02; df: 1; p< 0.0001***
Internal and external resistance	3	-3.6348 [-4.5729; -2.6967]	0%	0	
Pain - Extended Training Programs (ETP)					
External resistance only	5	-0.4764 [-1.0962; 0.1433]	37.0%	0.1820	Q:0.05; df:1; p: 0.8172
Internal and external resistance	4	-0.5877 [-1.2985; 0.1231]	83.3%	0.4215	
Disability - Extended Training Programs (ETP)					
External resistance only	6	-0.0966 [-0.3823; 0.1892]	70.4%	0.0749	Q:1.38; df:1; p:0.2393
Internal and external resistance	2	-2.6402 [-6.8672; 1.5868]	93.9%	8.7655	
Pain – Post-Washout (PW)					
External resistance only	6	-0.3245 [-1.3391; 0.6901]	97.8%	1.3715	Q:0.0; df:1; p: 0.9945
Internal and external resistance	2	-0.3282 [-0.5845; -0.0719]	0.0%	0	

Appendix G - Funnel Plots

Pain		
Short Training Programs (STP)	***Extended Training Programs (ETP)***	***Post-Washout (PW)***
		
Disability		
Short Training Programs (STP)	***Extended Training Programs (ETP)***	***Post-Washout (PW)***
		
Endurance		
Short Training Programs (STP)	***Extended Training Programs (ETP)***	***Post-Washout (PW)***
		
Maximal Strength		
Short Training Programs (STP)	***Extended Training Programs (ETP)***	***Post-Washout (PW)***
		

Fear-avoidance beliefs	
Extended Training Programs (ETP)	***Post-Washout (PW)***
	
Pain Catastrophizing	
Extended Training Programs (ETP)	***Post-Washout (PW)***
	

Appendix H – Grading of Recommendations, Assessment, Development and Evaluation (GRADE) assessment and Summary of Findings (SoF) Tables

Pain - SoF Table

Outcomes	**Anticipated absolute effects*** (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
Pain - Short Training Programs (Pain STP) Assessed with: VAS; NRS Scale from: 0 to 10 Follow-up: median 6 weeks	MD **0.48 /10 lower** (1.15 lower to 0.18 higher)	282 (6 RCTs)	⊕◯◯◯ Very low [a,b,c]	The evidence suggests that a loaded exercise (RT) program lasting ≤ 6 weeks may have minimal to no impact on pain compared to an unloaded exercise (UE) program.
Pain - Short Training Programs - Nambi removed (Pain - STP - Nambi removed) Assessed with: VAS; NRS Scale from: 0 to 10 Follow-up: median 6 weeks	MD **0.53 /10 lower** (1.06 lower to 0.01 lower)	177 (4 RCTs)	⊕⊕◯◯ Low [a,d]	The two studies by Nambi et al. reported unreliable results, and their exclusion from the STP analysis significantly reduced heterogeneity. Although this outlier-adjusted meta-analysis indicates a statistically significant effect, a loaded exercise (RT) program lasting ≤ 6 weeks may have minimal to no impact on pain compared to an unloaded exercise (UE) program, as the calculated mean difference (MD) does not exceed the minimal clinically important difference (MCID: 1.5/10).
Pain - Extended Training Programs (Pain ETP) Assessed with: VAS; NRS Scale from: 0 to 10 Follow-up: median 12 weeks	MD **0.52 /10 lower** (0.97 lower to 0.07 lower)	474 (7 RCTs)	⊕◯◯◯ Very low [c,e,f]	Although the meta-analysis indicates a statistically significant effect, a loaded exercise (RT) program lasting > 6 weeks may have minimal to no impact on pain compared to an unloaded exercise (UE) program, as the calculated mean difference (MD) does not exceed the minimal clinically important difference (MCID: 1.5/10).
Pain - Post-Washout period (Pain PW) Assessed with: VAS; NRS Scale from: 0 to 10 Follow-up: median 6 months	MD **0.36 /10 lower** (1.18 lower to 0.47 higher)	345 (5 RCTs)	⊕◯◯◯ Very low [e,g]	Six months after the initiation of a loaded exercise (RT) program, pain levels appear comparable to those observed 6 months after the initiation of an unloaded exercise (UE) training program. This suggests that RT may have little to no effect on pain following a washout period when compared to UE.
Pain - Post-Washout period - Nambi removed (Pain PW) Assessed with: VAS; NRS Scale from: 0 to 10 Follow-up: median 6 months	MD **0.31 /10 lower** (0.55 lower to 0.07 lower)	300 (4 RCTs)	⊕⊕◯◯ Low [c,e]	The study by Nambi et al. reported unreliable results, and its exclusion from the STP analysis significantly reduced heterogeneity. Although this outlier-adjusted meta-analysis indicates a statistically significant effect, RT may have little to no effect on pain after a washout period (≥ 6 months) when compared to UE, as the calculated mean difference (MD) does not exceed the minimal clinically important difference (MCID: 1.5/10).

CI: confidence interval; **MD:** mean difference

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Explanations

a) The majority of the included studies were rated as having 'Some concerns' in relation to Bias arising from the randomization process (D1) and Bias due to missing outcome data (D3).
b) The results reveal substantial variation among the estimates, with minimal - no overlap of confidence intervals (CIs) and statistical indicators suggesting significant heterogeneity (P < 0.05; I^2 = 97%). A considerable portion of this heterogeneity appears to stem from the studies by Nambi et al., 2020 (Heterogeneity without Nambi et al., 2020: P = 0.04; I^2 = 58%)."
c) The studies included a limited number of participants, and the confidence intervals encompass both potential benefits and drawbacks of using resistance training in the treatment of partecipants with chronic low back pain
d) The studies included a limited number of participants
e) Although half of the included studies were rated as having 'Some concerns' in relation to Bias arising from the randomization process (D1) the studies with the highest number of participants did not.
f) The unexplained heterogeneity among the studies is moderate (P < 0.01; I^2 = 67%), and the different estimated effects indicate potential benefits from both loaded and unloaded exercises.
g) The results reveal substantial variation among the estimates, with minimal - no overlap of confidence intervals (CIs) and statistical indicators suggesting significant heterogeneity (P < 0.01; I^2 = 97%). This heterogeneity appears to compleatly stem from the study by Nambi et al., 2020 (Heterogeneity without Nambi et al., 2020: P = 0.98; I^2 = 0%)."

Disability - SoF Table

Outcomes	Anticipated absolute effects* (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
Disability - Short Training Program (Disability STP) assessed with: ODI; RMDQ Scale from: 0 to 100 follow-up: median 6 weeks	SMD **2.04 SD lower** (3.92 lower to 0.16 lower)	206 (3 RCTs)	⨁◯◯◯ Very low[a,d,e,f]	The effect of a RT program lasting ≤ 6 weeks on disability, compared to UE, remains highly uncertain.
Disability - Extended Training Programs (Disability ETP) assessed with: ODI; RMDQ Scale from: 0 to 100 follow-up: median 12 weeks	SMD **0.4 SD lower** (1 lower to 0.2 higher)	505 (7 RCTs)	⨁◯◯◯ Very low[a,c,g]	The effect of a RT program lasting > 6 weeks on disability, compared to UE, remains highly uncertain.
Disability - Extended Training Programs - Kell Removed (Disability ETP - Kell Removed) assessed with: ODI; NRS Scale from: 0 to 100 follow-up: median12 weeks	SMD **0.17 SD lower** (0.44 lower to 0.1 higher)	487 (6 RCTs)	⨁◯◯◯ Very low[a,c,h]	The effect of a RT program lasting > 6 weeks on disability, compared to UE, remains highly uncertain.
Disability - Post Washout period (Disability PW) assessed with: ODI; RMDQ Scale from: 0 to 100 follow-up: mean 12 weeks	SMD **0.06 SD higher** (0.16 lower to 0.28 higher)	331 (4 RCTs)	⨁⨁◯◯ Low[b,i]	Loaded exercises (RT) may result in little to no difference in disability compared to unloaded exercises (UE) after a washout period (≥ 6 months).

CI: confidence interval; **SMD:** standardised mean difference

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Explanations

a) The studies included a limited number of participants, and the confidence intervals encompass both potential benefits and drawbacks of using resistance training in the treatment of partecipants with chronic low back pain
b) The studies included a limited number of participants
c) Although half of the included studies were rated as having 'Some concerns' in relation to Bias arising from the randomization process (D1) the studies with the highest number of participants did not.
d) Extremely high effect size estimated with the mean and standard deviation reported in the studies Kell et al. 2009 and Santos et al., 2022
e) The included studies were rated as having 'Some concerns' in relation to Bias arising from due to deviations from intended interventions (D2) and and Bias due to missing outcome data (D3)
f) The results reveal substantial variation among the estimates, with no overlap of confidence intervals (CIs) and statistical indicators suggesting significant heterogeneity ($P < 0.01$; $I^2 = 93\%$)
g) The results reveal substantial variation among the estimates, with no overlap of confidence intervals (CIs) and statistical indicators suggesting significant heterogeneity ($P < 0.01$; $I^2 = 82\%$)
h) The unexplained heterogeneity among the studies is moderate ($P < 0.01$; $I^2 = 69\%$), and the different estimated effects indicate potential benefits from both loaded and unloaded exercises.
i) The studies with the highest number of participants were rated as having 'Some concerns' in relation to bias arising from the randomization process (D1) and bias due to deviation from the intended interventions (D2)

Endurance - SoF Table

Outcomes	Anticipated absolute effects* (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
Endurance - Short Training Programs (Endurance STP) assessed with: Biering-Sørensen Scale from: 0 to ∞	MD **0.5 min higher** (0.26 higher to 0.74 higher)	56 (2 RCTs)	⊕⊕⊕◯ Moderate [a,b,c]	Loaded exercises (RT) are likely to result in an increase in back muscle endurance after a training duration of ≤ 6 weeks compared to unloaded exercises (UE).
Endurance - Extended Training Programs (Endurance ETP) assessed with: Biering-Sørensen Scale from: 0 to ∞	MD **0.47 min higher** (0.09 higher to 0.85 higher)	173 (3 RCTs)	⊕⊕⊕◯ Moderate [a]	Loaded exercises (RT) are likely to result in an increase in back muscle endurance after a training duration of > 6 weeks compared to unloaded exercises (UE).
Endurance - Post-Washout period (Endurance PW) assessed with: Biering-Sørensen Scale from: 0 to ∞	MD **0.35 min higher** (0.03 higher to 0.67 higher)	70 (1 RCT)	⊕◯◯◯ Very low [d]	The effect of a loaded exercise (RT) program on back muscle endurance after a washout period of ≥6 months, compared to an unloaded exercise (UE) program, remains uncertain.

CI: confidence interval; **MD:** mean difference

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Explanations

a) The studies included a limited number of participants
b) The included studies were rated as having 'Some concerns' in relation to Bias due to missing outcome data (D3)
c) MD is equal to the Minimal Detectable Change estimated (Weir JP. 2005; doi: 10.1519/15184.1) with the data reported in the studi Latimer J. et al., 1999 (doi: 10.1097/00007632-199910150-00004.)
d) Information provided only by one study (Aasa et al., 2015)

Maximal Strength - SoF Table

Outcomes	Anticipated absolute effects* (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
Maximal Strength - Short Training Program (Maximal Strength STP) Assessed with: Maximal isometric back-extensors torque (n · m); Lift Strength (n)	SMD **0 SD** (0.3 lower to 0.3 higher)	150 (2 RCTs)	⊕⊕◯◯ Low[a,b]	The evidence suggests that a loaded exercise (RT) program may results in little to no difference in maximal strength compared to an unloaded exercise (UE) program after a training duration of ≤ 6 weeks.
Maximal Strength - Extended Training Program (Maximal Strength STP) Assessed with: Maximal isometric back-extensors torque (n · m); Lift Strength (n)	SMD **0.22 SD lower** (0.7 lower to 0.26 higher)	176 (2 RCTs)	⊕⊕◯◯ Low[a,b]	The evidence suggests that a loaded exercise (RT) program may results in little to no difference in maximal strength compared to an unloaded exercise (UE) program after a training duration of > 6 weeks.
Maximal Strength - Post-Washout period (Maximal Strength - PW) Assessed with: Maximal isometric back-extensors torque (n · m); Lift Strength (n)	SMD **0.4 SD higher** (0.08 higher to 0.71 higher)	176 (2 RCTs)	⊕⊕◯◯ Low[b]	Loaded exercises (RT) may lead to a slight increase in maximal strength after a washout period of ≥ 6 months compared to unloaded exercises (UE)

CI: confidence interval; **SMD:** standardised mean difference

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Explanations

a) The studies included a limited number of participants
b) One of the 2 included RCT was rated as having 'Some concerns' in relation to Bias due to deviations from intended interventions (D2)

Fear-Avoidance - SoF Table

Outcomes	**Anticipated absolute effects** (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)	Comments
Fear-avoidance - Extended Training Programs (FAB ETP) *Assessed with*: FABQ physical activity section *Scale from*: 0 to 24 *Follow-up*: median 8 weeks	MD **1.04 /24 lower** (2.68 lower a 0.59 higher)	155 (2 RCT)	⊕⊕◯◯ Low [a,b,c]	The incorporation of external loads into an exercise program lasting at least 6 weeks is likely to result in little to no difference in fear-avoidance beliefs among individuals with chronic low back pain.
Fear-avoidance - Post Washout period (FAB PW) *Assessed with*: FABQ physical activity section *Scale from*: 0 to 24 *Follow-up*: median 6 months	MD **0.31 /24 lower** (2.65 lower to 2.02 higher)	155 (2 RCT)	⊕⊕◯◯ Low [a,b,c]	The evidence suggests that loaded exercises (RT) does not reduce fear-avoidance after a washout period of ≥ 6 months compared to unloaded exercises (UE)

CI: confidence interval; **MD:** mean difference

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Explanations

a. The studies included a limited number of participants
b. The RCT with the highest number of participants was rated as having "Some Concerns" in the risk of bias arising from the randomization process (D1)
c. The unexplained heterogeneity among the studies is moderate ($P < 0.01$; $I^2 = 64\%$), and the different estimated effects indicate potential benefits from both loaded and unloaded exercises.

Pain Catastrophizing - SoF Table

Outcomes	**Anticipated absolute effects** (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)	Comments
Pain Catastrophizing - Extended Training Programs (PC ETP) *Assessed with*: *Assessed with*: Pain Catastrophizing Scale (PCS) *Scale from*: 0 to 52 follow up: median 8 weeks	MD **0.4/52 lower** (4.84 lower to 4.04 higher)	64 (1 RCT)	⊕◯◯◯ Very low [a,b]	The effect of a loaded exercise (RT) program compared to an unloaded exercise (UE) program on pain catastrophizing after a training program of at least 6 weeks remains uncertain.
Pain Catastrophizing - Post-Washout (PC PW) *Assessed with*: Pain Catastrophizing Scale (PCS) *Scale from*: 0 to 52 *Follow-up*: median 8 weeks	MD **1.0/52 lower** (6.05 lower a 4.05 higher)	64 (1 RCT)	⊕◯◯◯ Very low [a,b]	The effect of a loaded exercise (RT) program on pain catastrophizing after a washout period of ≥6 months, compared to an unloaded exercise (UE) program, remains uncertain.

CI: confidence interval; **MD:** mean difference

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Spiegazioni

a. Information provided only by one study (Gibbs et al., 2022)
b. The effect size (MD) of the included study has shown very large 95%CI

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