

**Supplementary Table 1.** Search strategy (up to January 10<sup>th</sup> 2015).

---

**MEDLINE – Result: 253 studies**

1. 'clinical trial'\*\* OR 'controlled trial'\*\* OR 'randomized controlled trial'\* OR 'randomised controlled trial'\*\* OR 'randomized'\*\* OR 'randomised'\*\* OR 'trial'\*\* OR 'controlled clinical trial'\*\*
2. 'metabolic syndrome'\*\* OR 'metabolic syndrome x'\*
3. 1 and 2
4. 'resisted training'\*\* OR 'resistance training'\* OR 'resisted exercise'\*\* OR 'resistance exercise'\*\* OR 'strength training'\*\* OR 'strength exercise'\*\*
5. 3 and 4
6. Animal
7. 5 not 6

---

**EMBASE – Result: 113 studies**

1. 'clinical trial'\*\* OR 'controlled trial'\*\* OR 'randomized controlled trial'\* OR 'randomised controlled trial'\*\* OR 'randomized'\*\* OR 'randomised'\*\* OR 'trial'\*\* OR 'controlled clinical trial'\*\*
2. 'metabolic syndrome'\*\* OR 'metabolic syndrome x'\*
3. 1 and 2
4. 'resisted training'\*\* OR 'resistance training'\* OR 'resisted exercise'\*\* OR 'resistance exercise'\*\* OR 'strength training'\*\* OR 'strength exercise'\*\*
5. 3 and 4
6. Animal
7. 5 not 6

---

**THE COCHRANE LIBRARY – Result: 46 studies**

1. 'clinical trial'\*\* OR 'controlled trial'\*\* OR 'randomized controlled trial'\* OR 'randomised controlled trial'\*\* OR 'randomized'\*\* OR 'randomised'\*\*
-

OR 'trial'\*\* OR 'controlled clinical trial'\*\*

1. 'metabolic syndrome'\*\* OR 'metabolic syndrome x'\*
2. 1 and 2
3. 'resisted training'\*\* OR 'resistance training'\* OR 'resisted exercise'\*\* OR 'resistance exercise'\*\* OR 'strength training'\*\* OR 'strength exercise'\*\*
4. 3 and 4
5. Animal
6. 5 not 6

**Filter: "trials".**

---

**SPORTDiscus – Result: 15 studies**

1. 'clinical trial'\*\* OR 'controlled trial'\*\* OR 'randomized controlled trial'\* OR 'randomised controlled trial'\*\* OR 'randomized'\*\* OR 'randomised'\*\* OR 'trial'\*\* OR 'controlled clinical trial'\*\*
2. 'metabolic syndrome'\*\* OR 'metabolic syndrome x'\*
3. 1 and 2
4. 'resisted training'\*\* OR 'resistance training'\* OR 'resisted exercise'\*\* OR 'resistance exercise'\*\* OR 'strength training'\*\* OR 'strength exercise'\*\*
5. 3 and 4
6. Animal
7. 5 not 6

---

**PEDro – Result: 45 studies**

Abstract & Title: metabolic syndrome

---

Therapy: strength training

Method: clinical trial

---

*\*Medical Subject Headings (MeSH); \*\*Keywords.*

**Supplementary Table 2.** Characteristics of included studies.

Study name	Patient characteristics and sample size	Participants (inclusion/exclusion criteria)	Study length	Interventions	Metabolic syndrome risk factors assessed and time points
Castaneda 2002[24]	n = 62 RT group = 31 Control group = 31  % Female = 64.5% RT group = 67.7% Control group = 61%  Age (Mean ± SD) RT group = 66 ± 2 Control group = 66 ± 1	Inclusion: Confirmation of diabetes diagnosis by fasting plasma glucose ≥ 7.0 mmol/l or use of diabetic medications.  Exclusion: myocardial infarction (within past 6 months) and any unstable chronic condition, including dementia, alcoholism, dialysis, retinal hemorrhage or detachment, or current participation in resistance training.	3 days p/ week for 16 wks.	RT: 5 exercises; intensity: 60-80% 1RM; dose: 9 S/MG/W;  Training sessions: Supervised.  Control group: continued usual medical care, received Spanish translated diabetes recommendations for self-management, and were not given dietary counseling.	Triglycerides HDL-C Fasting plasma glucose SBP DBP WC  Baseline 16 wks
Dunstan 2002[26]	n = 29 RT group = 16 Control group = 13  %Female = 44.8% RT group = 37,5% Control group = 53,8%  Age (Mean ± SD) RT group = 67.6 ± 5.2 Control group = 66.9 ± 5.3	Inclusion: Overweight and sedentary; had established but not optimally controlled type 2 diabetes, were not taking insulin and were nonsmokers.  Exclusion: history or physical findings suggestive of ischemic heart disease, systemic diseases, uncontrolled hypertension and advanced diabetic neuropathy or retinopathy.	3 days p/ week for 6 months.	RT: 9 exercises; intensity: 50-85% 1RM; dose: 9 S/MG/W;  Training sessions: Supervised.  Control group: offered static stretching exercises.	Triglycerides HDL-C Fasting Plasma Glucose SBP DBP WC  Baseline 3 months 6 months
Kukkonen-Harjula 2005[27]	N = 68 RT group = 26 Aerobic group = 20	Inclusion: Age 35-50 years, BMI range of 30-40 kg/m <sup>2</sup> and waist circumference over 100 cm.	3 days p/ week for 6 months.	All groups performed a 2-month very-low-energy diet before training programs.	Triglycerides HDL-C Fasting Plasma Glucose

Control group = 22	Exclusion: Regular medication; plenty of physical activity; smokers; resting blood pressure > 160/105 mmHg; fasting serum cholesterol >8 mmol L <sup>1</sup> ; triglycerides >4 mmol L <sup>1</sup> ; blood glucose >6.7 mmol L <sup>1</sup> .	RT: 6 exercises; intensity: 60-80% 1RM; dose: 9 S/MG/W.	SBP DBP WC
All males			
Age (Mean ± SD) All participants = 42.6 ± 4.6		AT: 60-70% VO <sub>2</sub> max; dose: 135 min/week.	Baseline 2 months 8 months 31 months
		Training sessions: 1 weekly training session was supervised.	
		Control group: advised not to increase physical activity.	
Sigal 2007[28]	n = 251 RT group = 64 Aerobic group = 60 Combined group = 64 Control group = 63	Inclusion: type 2 diabetes for more than 6 months and a baseline hemoglobin A1c value of 6.6% to 9.9%.	Before randomization, all participants entered a 4-week run-in phase to assess adherence.
	% Female = 36.2% RT group = 37% Aerobic group = 35% Combined group = 37% Control group = 35%	Exclusion: current insulin therapy; participation in exercise 2 or more times weekly or in any resistance training during the previous 6 months; changes during the previous 2 months in oral hypoglycemic, antihypertensive, or lipid-lowering agents or body weight; serum creatinine level of 200 mmol/L or greater; proteinuria greater than 1 g/d; blood pressure greater than	RT: 7 exercises; intensity: 7-9 RM; dose: 6-9 S/MG/W.
	Age (Mean ± SD) RT group = 54.7 ± 7.5 Aerobic group = 53.9 ± 6.6		AT: 60-75% VO <sub>2</sub> max; dose: 45-135 min/week.
		Combined group: RT + AT.	
		Training sessions: Individual exercise supervision was	Triglycerides HDL-C SBP DBP WC  Baseline 3 months 6 months

	<p>Combined group = 53.5 ± 7.3</p> <p>Control group = 54.8 ± 7.2</p>	<p>160/95 mmHg; restrictions in physical activity because of disease; presence of other medical conditions that made participation inadvisable.</p>		<p>provided weekly for the first 4 weeks after randomization and biweekly thereafter.</p> <p>Control group: asked to revert to pre-study activity levels.</p>	
Stensvold 2010[8]	<p>n = 43</p> <p>RT group = 11</p> <p>Aerobic group = 11</p> <p>Combined group = 10</p> <p>Control group = 11</p> <p>% Female = 39.5%</p> <p>Age (Mean ± SD)</p> <p>RT group = 50.9 ± 7.6</p> <p>Aerobic group = 49.9 ± 10.1</p> <p>Combined group = 52.9 ± 10.4</p> <p>Control group = 47.3 ± 10.2</p>	<p>Inclusion: Patients with metabolic syndrome according to International Diabetes Federation.</p> <p>Exclusion: unstable angina pectoris, uncompensated heart failure, myocardial infarction during the past 4 wk, complex ventricular arrhythmias, and kidney failure.</p>	<p>Sessions 3 days p/ week for 12 weeks.</p>	<p>RT: 7 exercises; intensity: 60-80% 1RM; dose: 9 S/MG/W.</p> <p>AT: 70-95% HR<sub>peak</sub>; dose: 129 min/week.</p> <p>Combined group: RT (1x p/wk) + AT (2x p/wk).</p> <p>Training sessions: Supervised.</p> <p>Control group: was instructed not to change their dietary patterns or physical activity levels during the study period.</p>	<p>Triglycerides</p> <p>HDL-C</p> <p>Fasting Plasma Glucose</p> <p>SBP</p> <p>DBP</p> <p>WC</p> <p>Baseline</p> <p>12 wks</p>
Saremi 2011[10]	<p>n= 21</p> <p>RT group = 11</p> <p>Control group = 10</p> <p>All male</p> <p>Age (Mean ± SD)</p> <p>All participants = 45,25 ±</p>	<p>Inclusion: Males with the metabolic syndrome (based International Diabetes Federation); Low physical activity level (less than 30 minutes of physical activity per day); Aged between 20-60.</p>	<p>Sessions 3 days p/ week for 12 weeks.</p>	<p>RT: intensity: 30-85% 1RM; dose: 6-9 SMG/W.</p> <p>Training sessions: Supervised.</p> <p>Control group: not participate in any regular exercise.</p>	<p>Triglycerides</p> <p>HDL-C</p> <p>Fasting Plasma Glucose</p> <p>WC</p> <p>Baseline</p> <p>12 wks</p>

	4,3	Exclusion: Cardiovascular disease; Musculoskeletal problems; Receiving any other treatments.			
Venojarvi 2013[11]	n = 144 RT group = 49 Aerobic group = 48 Control group = 47  All males  Age (Mean ± SD) RT group = 54 ± 6.1 Aerobic group = 55 ± 6.2 Control group = 54 ± 7.2	Inclusion: age 40-65 years; BMI between 25.1 and 34.9 kg/m <sup>2</sup> ; and fasting plasma glucose between 5.6 and 6.9 mmol/L.  Exclusion: earlier detection of IGT and engagement in prescribed diet or exercise programs, engagements in regular and physically very rigorous activities and usage of medication affecting glucose balance.	Sessions 3x p/ week for 12 weeks.	RT: 50-85% 5RM; dose: 125 min/wk.  AT: 55-75% of Heart Rate reserve; dose: 103 min/wk.	Triglycerides HDL-C Fasting Plasma Glucose SBP DBP WC  Baseline 12 wks
Earnest 2014[7]	n = 262 RT group = 73 Aerobic group = 72 Combined group = 76 Control group = 41  %Female = 62.2% RT group = 59% Aerobic group = 62% Combined group = 64% Control group = 68%  Age (Mean ± SD) RT group = 57 ± 9 Aerobic group = 54 ± 9 Combined group = 55 ± 8 Control group = 59 ± 8	Inclusion: type 2 diabetes; sedentary (not participating in RT and Aerobic exercise).  Exclusion: history of stroke, advanced neuropathy or retinopathy, or other serious medical condition contraindicated for exercise or that may prevent adherence to the study protocol.	Sessions 3 days p/ week for 9 months.	RT: 7 exercises; intensity: 10-12 RM; dose: 6-9 S/MG/W.  AT: 65% VO <sub>2peak</sub> ; dose: 150 min/wk.	Triglycerides HDL-C Fasting Plasma Glucose SBP DBP WC  Baseline 9 months
				Combined group: 2x p/wk of RT and 3-5x p/wk of aerobic training.  Training sessions: Supervised.  Control group: Offered weekly stretching and relaxation classes.	

---

**RT:** Resistance Training; **AT:** Aerobic Training; **RM:** Repetition Maximum; **CHD:** Coronary Heart Disease; **BMI:** Body Mass Index; **HDL-C:** High Density Lipoprotein Cholesterol; **SBP:** Systolic Blood Pressure; **DBP:** Diastolic Blood Pressure; **WC:** Waist Circumference; **IGT:** Impaired Glucose Tolerance; **S/MG/W:** Sets for each muscle group per week; **HR:** Heart rate.

---



**Supplementary Table 3.** Risk of bias of included studies (PEDro).

Study	Eligibility criteria specified	Random allocation	Concealed allocation	Groups similar at baseline	Participant blinding	Therapist blinding	Assessor blinding	Adequate follow-up	Intention to treat analysis	Between group comparisons	Point estimates and variability	Total (0-10)
Castaneda 2002	No	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes	6
Dunstan 2002	Yes	Yes	No	Yes	No	No	No	No	No	Yes	Yes	4
Kukkonen-Harjula 2005	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	5
Sigal 2007	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	8
Stensvold 2010	Yes	Yes	Yes	Yes	No	No	No	Yes	No	Yes	Yes	6
Saremi 2011	Yes	Yes	No	Yes	No	No	No	No	No	Yes	Yes	4
Venojarvi 2013	Yes	Yes	No	Yes	No	No	No	No	No	Yes	Yes	4
Earnest 2014	No	Yes	No	Yes	No	No	No	No	No	Yes	Yes	4

Supplementary Table 4. Quality summary of outcome assessment (GRADE)

Outcomes	Quality Assessment			Patient, n		Effect	Quality
	Risk of Bias ‡	Inconsistency §	Imprecision ¶	RT Group	Control Group	MD† (95% CI)	
Fasting Plasma Glucose: Seven studies	Serious limitation (-1)	No serious inconsistency	Serious imprecision (-1)	202	168	0.04 (-0.12, 0.20)	Low
HDL-Cholesterol Eight studies	Serious limitation (-1)	No serious inconsistency	No serious imprecision	266	231	-0.00 (-0.05, 0.04)	Moderate
Triglycerides Eight studies	Serious limitation (-1)	No serious inconsistency	No serious imprecision	266	231	0.03 (-0.14, 0.20)	Moderate
Diastolic Blood Pressure Seven studies	Serious limitation (-1)	No serious inconsistency	No serious imprecision	255	221	1.39 (-0.19, 2.98)	Moderate
Systolic Blood Pressure Seven studies	Serious limitation (-1)	No serious inconsistency	No serious imprecision	255	221	4.08 (1.33, 6.82)	Moderate
Waist Circumference Eight studies	Serious limitation (-1)	No serious inconsistency	No serious imprecision	266	231	1.09 (-0.12, 2.30)	Moderate

† Mean Difference (MD) of the resistance training group compared with the control group

‡ More than 25% of participants from studies with low methodological quality (Physiotherapy (Pilot) and Diet (Pilot)).

§ Substantial (>75%).

¶ Fewer than 100 participants for each outcome.