**Supplementary Table 1.** Search strategy (up to January 10\(^{th}\) 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.

<table>
<thead>
<tr>
<th>Study name</th>
<th>Patient characteristics and sample size</th>
<th>Participants (inclusion/exclusion criteria)</th>
<th>Study length</th>
<th>Interventions</th>
<th>Metabolic syndrome risk factors assessed and time points</th>
</tr>
</thead>
</table>
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. | 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/m² 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 |
### Sigal 2007[28]

<table>
<thead>
<tr>
<th>n = 251</th>
<th>RT group = 64</th>
<th>Aerobic group = 60</th>
<th>Combined group = 64</th>
<th>Control group = 63</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Female = 36.2%</td>
<td>RT group = 37%</td>
<td>Aerobic group = 35%</td>
<td>Combined group = 37%</td>
<td>Control group = 35%</td>
</tr>
<tr>
<td>Age (Mean ± SD)</td>
<td>RT group = 54.7 ± 7.5</td>
<td>Aerobic group = 53.9 ± 6.6</td>
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</tr>
</tbody>
</table>

Inclusion: type 2 diabetes for more than 6 months and a baseline hemoglobin A1c value of 6.6% to 9.9%.

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 3 days p/ week for 6 months.

Before randomization, all participants entered a 4-week run-in phase to assess adherence. Combined group: RT + AT.

Training sessions: Individual exercise supervision was

### Control group = 22

All males

Age (Mean ± SD) All participants = 42.6 ± 4.6

Exclusion: Regular medication; plenty of physical activity; smokers; resting blood pressure > 160/105 mmHg; fasting serum cholesterol > 8 mmol L⁺; triglycerides > 4 mmol L⁺; blood glucose > 6.7 mmol L⁺.

RT: 6 exercises; intensity: 60-80% 1RM; dose: 9 S/MG/W. DBP

AT: 60-70% VO₂ max; dose: 135 min/week. WC

Baseline 2 months 8 months 31 months

Control group: advised not to increase physical activity.
<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>Inclusion</th>
<th>Exclusion</th>
<th>Sessions</th>
<th>Intervention</th>
<th>Training sessions</th>
<th>Control group</th>
<th>Baseline</th>
<th>Triglycerides</th>
<th>HDL-C</th>
<th>Fasting Plasma Glucose</th>
<th>SBP</th>
<th>DBP</th>
<th>WC</th>
<th>12 wks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stensvold 2010[8]</td>
<td>43</td>
<td>Patients with metabolic syndrome according to International Diabetes Federation.</td>
<td>unstable angina pectoris, uncompensated heart failure, myocardial infarction during the past 4 wk, complex ventricular arrhythmias, and kidney failure.</td>
<td>3 days per week for 12 weeks.</td>
<td>RT: 7 exercises; intensity: 60-80% 1RM; dose: 9 S/MG/W.</td>
<td>Supervised.</td>
<td>asked to revert to pre-study activity levels.</td>
<td>Baseline</td>
<td>Triglycerides</td>
<td>HDL-C</td>
<td>Fasting Plasma Glucose</td>
<td>SBP</td>
<td>DBP</td>
<td>WC</td>
<td>12 wks</td>
</tr>
<tr>
<td>Saremi 2011[10]</td>
<td>21</td>
<td>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.</td>
<td></td>
<td>3 days per week for 12 weeks.</td>
<td>RT: intensity: 30-85% 1RM; dose: 6-9 SMG/W.</td>
<td>Supervised.</td>
<td>not participate in any regular exercise.</td>
<td>Baseline</td>
<td>Triglycerides</td>
<td>HDL-C</td>
<td>Fasting Plasma Glucose</td>
<td>SBP</td>
<td>DBP</td>
<td>WC</td>
<td>12 wks</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Inclusion</td>
<td>Exclusion</td>
<td>Sessions</td>
<td>Exercise</td>
<td>Control Group</td>
<td></td>
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</tr>
<tr>
<td>Venojarvi 2013[11]</td>
<td>n = 144</td>
<td>age 40-65 years; BMI between 25.1 and 34.9 kg/m²; and fasting plasma glucose between 5.6 and 6.9 mmol/L.</td>
<td>Cardiovascular disease; Musculoskeletal problems; Receiving any other treatments.</td>
<td>3x p/ week for 12 weeks.</td>
<td>RT: 50-85% 5RM; dose: 125 min/wk.</td>
<td>Triglycerides HDL-C Fasting Plasma Glucose SBP DBP WC</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Earnest 2014[7]</td>
<td>n = 262</td>
<td>type 2 diabetes; sedentary (not participating in RT and Aerobic exercise).</td>
<td>history of stroke, advanced neuropathy or retinopathy, or other serious medical condition contraindicated for exercise or that may prevent adherence to the study protocol.</td>
<td>3 days p/ week for 9 months.</td>
<td>RT: 7 exercises; intensity: 10-12 RM; dose: 6-9 S/MG/W.</td>
<td>Triglycerides HDL-C Fasting Plasma Glucose SBP DBP WC</td>
<td></td>
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</tr>
</tbody>
</table>

**Venjarrovi 2013**
- **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/m²;
  - Fasting plasma glucose between 5.6 and 6.9 mmol/L.
- **Exclusion:**
  - Cardiovascular disease;
  - Musculoskeletal problems;
  - Receiving any other treatments.
- **Sessions:** 3x p/ week for 12 weeks.
- **Exercise:**
  - RT: 50-85% 5RM; dose: 125 min/wk.
  - AT: 55-75% of Heart Rate reserve; dose: 103 min/wk.
- **Control Group:**
  - Not participate in any regular exercise.

**Earnest 2014**
- **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.
- **Exercise:**
  - RT: 7 exercises; intensity: 10-12 RM; dose: 6-9 S/MG/W.
  - AT: 65% VO₂peak; dose: 150 min/wk.
- **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).

<table>
<thead>
<tr>
<th>Study</th>
<th>Eligibility criteria specified</th>
<th>Random allocation</th>
<th>Concealed allocation</th>
<th>Groups similar at baseline</th>
<th>Participant blinding</th>
<th>Therapist blinding</th>
<th>Assessor blinding</th>
<th>Adequate follow-up</th>
<th>Intention to treat analysis</th>
<th>Between group comparisons</th>
<th>Point estimates and variability</th>
<th>Total (0-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castaneda 2002</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>6</td>
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<tr>
<td>Dunstan 2002</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>4</td>
</tr>
<tr>
<td>Kukkonen-Harjula 2005</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>5</td>
</tr>
<tr>
<td>Sigal 2007</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Stensvold 2010</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>6</td>
</tr>
<tr>
<td>Saremi 2011</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>4</td>
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<tr>
<td>Venojarvi 2013</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<td>Yes</td>
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<tr>
<td>Earnest 2014</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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<td>Yes</td>
<td>4</td>
</tr>
</tbody>
</table>
### Supplementary Table 4. Quality summary of outcome assessment (GRADE).

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Quality Assessment</th>
<th>Patient, n</th>
<th>Effect</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risk of Bias †</td>
<td>Inconsistency §</td>
<td>Imprecision ¶</td>
<td>RT Group</td>
</tr>
<tr>
<td>Fasting Plasma Glucose</td>
<td>Serious limitation (-1)</td>
<td>No serious inconsistency</td>
<td>Serious imprecision (-1)</td>
<td>202</td>
</tr>
<tr>
<td>Seven studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDL-Cholesterol</td>
<td>Serious limitation (-1)</td>
<td>No serious inconsistency</td>
<td>No serious imprecision</td>
<td>266</td>
</tr>
<tr>
<td>Eight studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triglycerides</td>
<td>Serious limitation (-1)</td>
<td>No serious inconsistency</td>
<td>No serious imprecision</td>
<td>266</td>
</tr>
<tr>
<td>Eight studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic Blood Pressure</td>
<td>Serious limitation (-1)</td>
<td>No serious inconsistency</td>
<td>No serious imprecision</td>
<td>255</td>
</tr>
<tr>
<td>Seven studies</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Systolic Blood Pressure</td>
<td>Serious limitation (-1)</td>
<td>No serious inconsistency</td>
<td>No serious imprecision</td>
<td>255</td>
</tr>
<tr>
<td>Seven studies</td>
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</tr>
<tr>
<td>Waist Circumference</td>
<td>Serious limitation (-1)</td>
<td>No serious inconsistency</td>
<td>No serious imprecision</td>
<td>266</td>
</tr>
<tr>
<td>Eight studies</td>
<td></td>
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</tbody>
</table>

† 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 Evidence Database (PEDro) score <7 points).
§ Substantial $I^2$ (>75%).
¶ Fewer than 400 participants for each outcome.