**Supplementary Table 1.** Detailed search strategy in each database.

|  |
| --- |
| **PUBMED** |
| (("Resistance training"[tiab] OR "resistance exercise"[tiab] OR "strength training"[tiab] OR "strength exercise"[tiab] OR "weightlifting"[tiab] OR "weight exercise"[tiab] OR "weight training"[tiab]) AND ("Muscle action"[tiab] OR "concentric"[tiab] OR "eccentric" [tiab] OR "contraction"[tiab] OR "contractile properties"[tiab] OR "shortening"[tiab] OR "lengthening"[tiab]) AND ("Muscle tissue"[tiab] OR hypertrophy[tiab] OR "muscle thickness"[tiab] OR "cross-sectional area"[tiab] OR "CSA"[tiab] OR "fascicle length"[tiab] OR "pennation angle"[tiab] OR "muscle strength"[tiab] OR strength[tiab])) |
| **SCOPUS** |
| (("Resistance training" OR "resistance exercise" OR "strength training" OR "strength exercise" OR "weightlifting" OR "weight exercise" OR "weight training") AND ("Muscle action" OR "concentric" OR "eccentric" OR "contraction" OR "contractile properties" OR "shortening" OR "lengthening") AND ("Muscle tissue" OR hypertrophy OR "muscle thickness" OR "cross-sectional area" OR "CSA" OR "fascicle length" OR "pennation angle" OR "muscle strength" OR strength)) |
| **Web Of Science** |
| (("Resistance training" OR "resistance exercise" OR "strength training" OR "strength exercise" OR "weightlifting" OR "weight exercise" OR "weight training") AND ("Muscle action" OR "concentric" OR "eccentric" OR "contraction" OR "contractile properties" OR "shortening" OR "lengthening") AND ("Muscle tissue" OR hypertrophy OR "muscle thickness" OR "cross-sectional area" OR "CSA" OR "fascicle length" OR "pennation angle" OR "muscle strength" OR strength)) |
| **SPORTDiscus** |
| (("Resistance training" OR "resistance exercise" OR "strength training" OR "strength exercise" OR "weightlifting" OR "weight exercise" OR "weight training") AND ("Muscle action" OR "concentric" OR "eccentric" OR "contraction" OR "contractile properties" OR "shortening" OR "lengthening") AND ("Muscle tissue" OR hypertrophy OR "muscle thickness" OR "cross-sectional area" OR "CSA" OR "fascicle length" OR "pennation angle" OR "muscle strength" OR strength)) |
| **EMBASE** |
| ('resistance training':ab,ti OR 'resistance exercise':ab,ti OR 'strength training':ab,ti OR 'strength exercise':ab,ti OR 'weightlifting':ab,ti OR 'weight exercise':ab,ti OR 'weight training':ab,ti) AND ('muscle action':ab,ti OR 'concentric':ab,ti OR 'eccentric':ab,ti OR 'contraction':ab,ti OR 'contractile properties':ab,ti OR 'shortening':ab,ti OR 'lengthening':ab,ti) AND ('muscle tissue':ab,ti OR hypertrophy:ab,ti OR 'muscle thickness':ab,ti OR 'cross-sectional area':ab,ti OR 'csa':ab,ti OR 'fascicle length':ab,ti OR 'pennation angle':ab,ti OR 'muscle strength':ab,ti OR strength:ab,ti) |

**Supplementary Table 2.** Information on where the data was extracted in each selected article.

|  |  |
| --- | --- |
| **Authors** | **Data extracted from:** |
| Baptista et al | Table 1; VL Muscle Thickness (mm) |
| Benford et al | Table 2; Muscle volume (cm3) |
| Blazevich et al | Pag. 1570: "There was no statistical difference in the changes in muscle thickness between Con and Ecc groups [ΔCon=+25.4±12.6 mm (11.8%); ΔEcc=+18.4±10.4 mm (8.3%)]" |
| Buker et al | Table 2; Rectus femoris (cm); Δchange (%) |
| Cadore et al | Table 3; MT (mm) |
| Coratella et al | Pag. 4: "Compared with pretraining, within-group analysis showed that *vastus lateralis* thickness increased at posttraining in CONC (7.8%,10.1 to 15.2; ES: 0.61, 0.01 to 1.21), ECC (9.6%,12.0 to 17.2; ES: 0.83, 0.06 to 1.55)" **Confidence interval (95%) was transformed into SD** |
| Duhig et al | Pag. 772: A significant increase in MT was shown for both the ECC (mean difference= 0.19cm(7%); 95% CI= 0.10–0.27; p<0.001; d=0.73) and CON groups (mean difference= 0.11cm (4%); 95% CI= 0.02–0.21;p= 0.005;d=0.43) |
| Farthing et al | Figure 3 - Mid site |
| Farup et al (WP) | Figure 2 - (b) relative change in sum cross-sectional area |
| Farup et al (PLA) |
| Franchi et al | Pag. 647: "a significant difference wasfound in both mid portion (EG=71%, andCG=111%,P<0.01)" |
| Hakkinen et al | Table 4; sum of all; Pre-Post Training Change % |
| Higbie et al | Table 3; pretest and posttest |
| Jones et al | Table 2. Cross-sectional area (cm2) |
| Kidgel et al | Table 1; Muscle thickness (cm) |
| Kim et al | Table 2; MT (cm) |
| Maeo et al | Figure 5; D) Muscle volume % |
| Moore et al | Figure 2; Muscle CSA |
| Quilan et al (Young) | Figure 2; Wk0 and Wk8 |
| Quilan et al (Old) |
| Ruas et al (Quadriceps) | Table 1; Q MT and H MT |
| Ruas et al (Hamstrings) |
| Sato et al a | Figure 4; dMuscle Thickness (%pre) of Trained Arm |
| Sato et al b | Figure 2; dMuscle Thickness (%pre) |
| Seger et al | Figure 2; midpoint |
| Shibata et al | Figure 1; CSA50 |
| Timmins et al | Figure 2; C; Baseline and End intervention |
| Unlu et al | Table 5; pre and post-test (cm3) of FE and FC groups |
| Vikne et al | Pag. 1776: "The mean anatomical elbow-flexor cross-sectional area (mean of one-to four-eighths Lh) of 26.8T4.9cm2 of the CON group did not change during the training period (+0.7T1.1 cm2, +3%;P= 0.1). For the ECC group, the mean area of 25.4T3.4cm2 rose by 2.8T1.4cm2 (11%; PG0.001) during the training period" |

**Supplementary Table 3.** Sensitivity analyses, which meta-analyses were performed without the cited studies.

| ***Authors*** | **ES [95%CI] and p-value** | **Total Heterogeneity** |
| --- | --- | --- |
| Baptista et al | 0.298 [-0.139, 0.735] (*p*=0.181) | I² = 85% |
| Benford et al | 0.295 [-0.142, 0.732] (*p*=0.185) | I² = 85% |
| Blazevich et al | 0.318 [-0.110, 0.746] (*p*=0.145) | I² = 85% |
| Buker et al | 0.288 [-0.150, 0.725] (*p*=0.198) | I² = 85% |
| Cadore et al | 0.298 [-0.137, 0.734] (*p*=0.180) | I² = 85% |
| Coratella et al | 0.360 [-0.026, 0.747] (*p*=0.067) | I² = 81% |
| Duhig et al | 0.284 [-0.155, 0.722] (*p*=0.205) | I² = 85% |
| Farthing et al | 0.177 [-0.137, 0.491] (*p*=0.270) | I² = 73% |
| Farup et al (WP) | 0.285 [-0.131, 0.701] (*p*=0.179) | I² = 84% |
| Farup et al (PLA) | 0.285 [-0.131, 0.701] (*p*=0.179) | I² = 84% |
| Franchi et al | **0.367 [0.004, 0.731] (*p*=0.048)** | **I² = 80%** |
| Hakkinen et al | 0.258 [-0.172, 0.689] (*p*=0.240) | I² = 85% |
| Higbie et al | 0.293 [-0.145, 0.730] (*p*=0.190) | I² = 85% |
| Jones et al | 0.299 [-0.134, 0.732] (*p*=0.176) | I² = 85% |
| Kidgel et al | 0.262 [-0.170, 0.693] (*p*=0.234) | I² = 85% |
| Kim et al | 0.295 [-0.139, 0.729] (*p*=0.183) | I² = 85% |
| Maeo et al | 0.238 [-0.180, 0.657] (*p*=0.265) | I² = 84% |
| Moore et al | 0.292 [-0.144, 0.727] (*p*=0.190) | I² = 85% |
| Quilan et al (Young) | 0.301 [-0.156, 0.758] (*p*=0.197) | I² = 86% |
| Quilan et al (Old) | 0.301 [-0.156, 0.758] (*p*=0.197) | I² = 86% |
| Ruas et al (Quadriceps) | 0.247 [-0.205, 0.699] (*p*=0.284) | I² = 86% |
| Ruas et al (Hamstrings) | 0.247 [-0.205, 0.699] (*p*=0.284) | I² = 86% |
| Sato et al a | 0.257 [-0.172, 0.686] (*p*=0.241) | I² = 85% |
| Sato et al b | 0.252 [-0.176, 0.680] (*p*=0.249) | I² = 85% |
| Seger et al | 0.300 [-0.132, 0.732] (*p*=0.173) | I² = 85% |
| Shibata et al | 0.302 [-0.133, 0.736] (*p*=0.174) | I² = 85% |
| Timmins et al | 0.300 [-0.135, 0.734] (*p*=0.177) | I² = 85% |
| Unlu et al | 0.301 [-0.133, 0.734] (*p*=0.174) | I² = 85% |
| Vikne et al | 0.234 [-0.182, 0.649] (*p*=0.270) | I² = 84% |

**Supplementary Table 4.** Summary of findings: GRADE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Summary of findings:** | | | | |
| **Eccentric versus concentric muscle actions on hypertrophy** | | | | |
| **Patient or population**: Healthy adults  **Intervention**: Resistance training  **Comparison**: Eccentric vs concentric muscle actions | | | | |
| **Outcome**  **№ of participants**  **(studies)** |  | **Anticipated absolute effects (95% CI)** | **Certainty** | **Findings** |
|  | **Intervention**  **(Difference)** |
| **Hypertrophy**    № of participants: 682  (26 studies) |  | SMD **0.285 higher**  (-0.131 to 0.701) | ⨁◯◯◯  **VERY LOW**  Due to serious inconsistency..  Due to serious imprecision.  Upgraded because all plausible confounding would suggest a spurious effect. | No difference between eccentric vs. concentric muscle actions |
| **Subgroup analysis** | | | | |
| **Adults (18-59 years)** | | | | |
| **Hypertrophy**  № of participants: 619  (25 studies) |  | SMD **0.308 higher**  (-0.150 to 0.766) | ⨁◯◯◯  **VERY LOW**  Due to serious inconsistency.  Due to serious imprecision.  Upgraded because all plausible confounding would suggest a spurious effect. | No difference between eccentric vs. concentric muscle actions |
| **Older adults (≥60 years)** | | |  |  |
| **Hypertrophy**  № of participants: 63  (2 studies) |  | SMD -**0.011 lower**  (-0.505 to 0.483) | ⨁◯◯◯  **VERY LOW**  Due to serious inconsistency.  Due to serious imprecision.  Upgraded because all plausible confounding would suggest a spurious effect. | No difference between eccentric vs. concentric muscle actions |
| **Muscles analyzed** | | | | |
| **Upper limbs** | | | | |
| **Hypertrophy**  № of participants: 152  (7 studies) |  | SMD **1.436 higher**  (0.179 to 2.692) | ⨁⨁◯◯  **LOW**  Due to serious inconsistency.  Due to serious indirectness.  Due to serious imprecision.  Upgraded because all plausible confounding would suggest a spurious effect. | Superior hypertrophy was found in eccentric muscle actions |
| **Lower limbs** | | |  |  |
| **Hypertrophy**  № of participants: 530  (20 studies) |  | SMD **-0.005 lower**  (-0.339 to 0.330) | ⨁◯◯◯  **VERY LOW**  Due to serious inconsistency.  Due to serious imprecision.  Upgraded because all plausible confounding would suggest a spurious effect. | No difference between eccentric vs. concentric muscle actions |
| **Training duration** | | | |  |
| **≤8 weeks of intervention** | | | | |
| **Hypertrophy**  № of participants: 393  (14 studies) |  | SMD **0.472 higher**  (-0.122 to 1.065) | ⨁◯◯◯  **VERY LOW**  Due to serious inconsistency.  Due to serious imprecision.  Upgraded because all plausible confounding would suggest a spurious effect. | No difference between eccentric vs. concentric muscle actions |
| **>8 weeks of intervention** | | |  |  |
| **Hypertrophy**  № of participants: 289  (13 studies) |  | SMD **0.066 higher**  (-0.544 to 0.677) | ⨁◯◯◯  **VERY LOW**  Due to serious inconsistency.  Due to serious imprecision.  Upgraded because all plausible confounding would suggest a spurious effect. | No difference between eccentric vs. concentric muscle actions |
| \***The risk in the intervention group** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI). **Nº:** Number; **CI:** Confidence interval; **SMD**: Standardized Mean Difference | | | | |