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# A Systematic Review with Meta-Analysis of the Effect of Resistance Training on Whole-Body Muscle Growth in Healthy Adult Males

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## Abstract

We performed a systematic review and meta-analysis to study all published clinical trial interventions, determined the magnitude of whole-body hypertrophy in humans (healthy males) and observed the individual responsibility of each variable in muscle growth after resistance training (RT). Searches were conducted in PubMed, Web of Science and the Cochrane Library from database inception until 10 May 2018 for original articles assessing the effects of RT on muscle size after interventions of more than 2 weeks of duration. Specifically, we obtain the variables fat-free mass (FFM), lean muscle mass (LMM) and skeletal muscle mass (SMM). The effects on outcomes were expressed as mean differences (MD) and a random-effects meta-analysis and meta-regressions determined covariates (age, weight, height, durations in weeks...) to explore the moderate effect related to the participants and characteristics of training. One hundred and eleven studies (158 groups, 1927 participants) reported on the effects of RT for muscle mass. RT significantly increased muscle mass (FFM+LMM+SMM;  $\Delta 1.53$  kg; 95% CI [1.30, 1.76],  $p < 0.001$ ;  $I^2 = 0\%$ ,  $p = 1.00$ ). Considering the overall effects of the meta-regression, and taking into account the participants' characteristics, none of the studied covariates explained any effect on changes in muscle mass. Regarding the training characteristics, the only significant variable that explained the variance of the hypertrophy was the sets per workout, showing a significant negative interaction (MD; estimate: 1.85, 95% CI [1.45, 2.25],  $p < 0.001$ ; moderator: -0.03 95% CI [-0.05, -0.001]  $p = 0.04$ ). In conclusion, RT has a significant effect on the improvement of hypertrophy (~1.5 kg). The excessive sets per workout affects negatively the muscle mass gain.

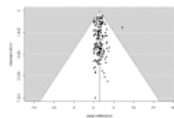
**Keywords:** fat-free mass; hypertrophy; lean muscle mass; resistance training; skeletal muscle mass.

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## Figures



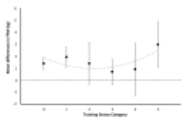
**Figure 1** Prisma flow diagram for the...



**Figure 2** Test for funnel plot asymmetry...



**Figure 3** Mean differences exploration comparing the...



**Figure 4** Mean differences exploration comparing the...

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