Heavy strength training has been shown to positively affect bone mineral density in both young and elderly subjects. Load magnitude seems to be a primary determinant of the osteogenic response (1) and can be manipulated by the choice of exercise and the external load. Strength training volume has also been related to the osteogenic response (2) and can be manipulated by training frequency or the training volume in each workout. The purpose of this study was to evaluate the effects of external load, type of exercise and training volume on regional bone mineral content (BMC) and density (BMD) in healthy young men.

Twenty-nine young adult males (20-40 years) participated in two different strength training projects. In the training volume study (VOL) all subjects performed the same exercises and trained with the same intensity (7-10RM sets), but the number of sets per exercise differed (1 vs. 3 sets). In the training load study (LOAD) the two groups performed either deep-squats or shallow-squats with the same relative intensity (3-10 RM sets). However, the external load was approximately twofold higher in the shallow-squat group than in the deep-squat group. In both studies all subjects performed 3 workouts per week. In the LOAD-study (12 weeks), only the squat exercise was performed. In the VOL-study (11 weeks) all subjects performed 3 leg exercises and 5 upper-body exercises in each workout. BMC and BMD were measured with whole body DEXA scans. Values are given as mean±SE.

Total BMC and BMD were not significantly altered in the LOAD-study, but in the VOL-study total BMD increased by 0.8±0.3% (p<0.05). In the VOL-study, significant changes in BMC were found for L2-L4 (2.0±0.9%) and femur (1.4±0.6%), and in BMD for arms (3.8±1.7%) and femur (1.4±0.5). There were no significant differences between groups in the VOL study for BMD or BMC for any measures in the lower body, but in upper body the group performing 3 sets per exercise had significantly larger increase in BMD of L2-L4 than the 1-set group (1.5±0.9% vs. -0.5±0.3% respectively, p=0.05). In the LOAD-study, both groups increased BMD in L2-L4 (2.1±0.5% and 1.7±0.6% for the shallow- and the deep-squat group respectively, p<0.05). The change in leg BMC was significantly different between groups with a significant reduction in the deep-squat group and no significant change in the shallow-squat group (-1.0±0.4% vs. +0.4±0.3% respectively, p<0.05).

In conclusion, in the VOL-study a larger training volume positively affected the osteogenic response to strength training in the upper body, but no impact of training volume was found for the changes in lower body bones. In the LOAD study both deep- and shallow-squats positively affected the osteogenic response in the spine. Surprisingly the deep-squat group experienced reduced leg BMC, while no change was observed in the shallow-squat group.


Keywords: Strength Training, Bone Mass, Bone Mineral Density