The Effect of Resistance Training on Bone Strength in Women: A Quantitative Review

Because of its potential for promoting bone growth, physical activity can help prevent osteoporosis (Drinkwater, 1994). Indeed, quantitative reviews find that exercise interventions, including mainly aerobic or weight-bearing activities, are effective in promoting bone growth in both premenopausal and postmenopausal women (Berard, Bravo, & Gauthier, 1997; Kelly, 1998a; Kelly, 1998b; Wolf, et al. 1999).

There is less consensus about the effectiveness of resistance training on bone strength in women (Layne & Nelson, 1999), and no quantitative reviews have been conducted on the topic. Further, reviews have not included unpublished studies in their analysis. Therefore, the goal of this study was to provide a quantitative review of the resistance training and bone strength literature that included both published and unpublished studies.

Method
Studies were located through searches of electronic databases (e.g., MedLine, Sport Disc, Dissertation Abstracts) and reference sections of major reviews on the topic. We determined which studies to include in the analysis based on specific inclusion criteria. Apart from the criteria mentioned above, studies had to include experimental and control groups in a repeated measures design. In addition, since most of the research has been done with women, we limited the analysis to studies including women only or where data specific to women could be obtained.

Once we had identified studies for inclusion, we collected them, coded them for moderator effects, and calculated an estimate of treatment effect. While there are different measures of treatment effect, the effect size, or Cohen’s d, (Cohen, 1988) is the most common indicator used in quantitative reviews and the one we adopted for this analysis. Cohen’s d is the standardized mean difference between the experimental group and control group on some measured outcome. Thus, a d of 1 indicates a change in magnitude equivalent to one standard deviation. According to Cohen (1988), effect sizes can be categorized as small (d = 0.2), medium (d = 0.5), or large (d = 0.8).

Findings
We included 56 studies (45 published, 11 unpublished) that revealed 189 effect sizes in the analysis. The three most frequently measured sites were L2-L4 (spine), the femoral neck (hip), and total body. The effect of resistance training on bone strength as measured at these three sites was significant, but small (see Table 1). Menopausal status moderated the influence of resistance training on total body bone strength in that postmenopausal women experienced significantly larger increases in bone mass density than did premenopausal women.

Conclusion
Resistance training can bring about small increases in bone strength in women of all ages. However, in comparison to the findings of previous reviews, resistance training is not as effective as weight-bearing activities in promoting bone growth or in slowing bone loss. This is particularly the case for the femoral neck. For healthy strong bones, it is recommended that resistance training be used in association with weight-bearing activities.

Table 1. The Effect of Resistance Training on Bone Mineral Density by Bone Site

<table>
<thead>
<tr>
<th>General Location</th>
<th>Specific Site</th>
<th>N</th>
<th>Effect Size (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total body</td>
<td>19</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Spine</td>
<td>L2–L4</td>
<td>31</td>
<td>0.14</td>
</tr>
<tr>
<td>Hip</td>
<td>Femoral neck</td>
<td>25</td>
<td>0.16</td>
</tr>
</tbody>
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John C. Spencer, University of Alberta, & Brendan Humphries, Centre for雄厚.

References