LOWER EXTREMITY MUSCLE STRENGTH DOES NOT INDEPENDENTLY PREDICT BONE MINERAL DENSITY OF THE PROXIMAL FEMUR IN HEALTHY OLDER ADULTS

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INTRODUCTION

Direct relationships between muscle strength and bone mineral density (BMD) have been widely documented (Nordström et al. 1997, Alfredson et al. 1997). However, there is a general influence of body size on both BMD and muscular strength. Therefore, a question arises as to the extent to which the relationship between BMD and muscle strength is independent of body size.

The purpose of the present study was to determine the extent to which lower extremity muscular strength is an independent predictor of proximal femur BMD in healthy older adults. It was hypothesized that the BMD of the proximal femur in older adults would not be related to the maximum voluntary isometric strength of the hip, knee, and ankle muscles after adjusting for the influence of body weight and height.

METHODS

The present analysis was performed retrospectively on data compiled from a larger study. Fifty women and 29 men (age: 72±5 years; height: 1.64±0.09 meters; mass: 76.0±14.0 kg) participated. These older adults were healthy, independent, community dwellers who, prior to entry into the study, were examined for the presence of exclusionary factors such as cardiovascular, musculoskeletal, or neurological disorders. Because of the strenuous nature of some of the tasks performed in the larger study, subjects were required to have a minimum BMD value of 0.65 g•cm⁻² for entrance into the study. BMD of the right femoral neck was assessed using DXA.

The maximum voluntary isometric strength of the hip, knee, and ankle at multiple joint angles were determined using a Kin-Com isokinetic dynamometer. Flexion and extension strength were measured at each joint. Compensating for passive moments and inertial effects, forces were converted to moments and low-pass filtered at 10 Hz. The maximum angle-specific moment was determined based on a scaled quadratic regression equation that was fit to the population moment-angle data.

An allometric scaling process was used to determine if maximum isometric strength should be scaled, i.e. normalized, due to the influence of body weight and height. Pearson correlations were used to determine the relationship between proximal femoral BMD and isometric strength.
RESULTS

The BMD values of two subjects were greater than four standard deviations above the mean of the sample, thus their data were excluded from the analysis.

The allometric scaling process revealed that it was appropriate to normalize the maximum voluntary isometric hip, knee, and ankle joint moments in each direction of exertion to body weight • height. The relationship between lower extremity strength and the BMD of the proximal femur were reliant on the normalization process. The magnitudes of most (5 of 6) of the correlation coefficients between the non-normalized isometric strength measures and the BMD of the proximal femur were statistically significant (p<0.05, Table 1). However, the magnitudes of the correlation coefficients between the normalized isometric strength measures and the BMD of the proximal femur had a substantially diminished magnitude and failed to achieve significance (p>0.05, Table 1).

The correlation between the subject’s body weight • height and BMD of the proximal femur was significant (p<0.01) with the coefficient of determination (r²) accounting for 25 percent of the shared variation. Furthermore, the correlation coefficient between the subjects’ body weight • height and each of the measures of non-normalized isometric strength were significant (p<0.01).

DISCUSSION

Caution should be used when comparing biological variables (i.e., muscle strength and BMD) such that the influence of anthropometric variables (i.e., body weight and height) does not bias results allowing for misinterpretation of causal relationships. After adjusting muscular strength for the influence of body weight and height, the relationship between BMD and muscular strength was diminished. Thus, the results suggest that lower extremity muscular strength does not independently predict BMD in the proximal femur in healthy older adults.

Table 1: Pearson correlation coefficients between the bone mineral density of the proximal femur and the (A) non-normalized and (B) normalized maximum voluntary isometric strength measures (n=77).

<table>
<thead>
<tr>
<th></th>
<th>(A)</th>
<th>(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plantarflexion</td>
<td>0.203</td>
<td>-0.150</td>
</tr>
<tr>
<td>Dorsiflexion</td>
<td>0.381↑</td>
<td>0.080</td>
</tr>
<tr>
<td>Knee extension</td>
<td>0.395↑</td>
<td>-0.005</td>
</tr>
<tr>
<td>Knee flexion</td>
<td>0.353↑</td>
<td>0.060</td>
</tr>
<tr>
<td>Hip extension</td>
<td>0.252↑</td>
<td>-0.063</td>
</tr>
<tr>
<td>Hip flexion</td>
<td>0.368↑</td>
<td>0.016</td>
</tr>
</tbody>
</table>

↑ p<0.05; † p<0.01

REFERENCES


ACKNOWLEDGMENTS

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