ARE THERE INHERENT DIFFERENCES IN HOW MALES AND FEMALES RESPOND TO LIFTING?

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INTRODUCTION

While the evidence is far from conclusive, males appear to be more susceptible to low cost low back injuries (mild low back pain) while females have higher rates of more costly injuries (severe low back pain) [1,2]. Although job requirements do not discriminate between genders, there is reason to expect that the biomechanical effect on the individual may differ as a function of gender. Males are significantly stronger than females [3,4]. Differences in strength and anthropometry between males and females may influence the trunk motions, muscle activities, and subsequent spine loads. Previous work evaluating how males and females respond biomechanically to similar lifting demands provides the evidence that females are not simply proportionally scaled down versions of males [5]. In other words, the differences in spine loading are not just a function of size. Overall, males have significantly greater three-dimensional spine forces than females when lifting. In addition to the differences in spine loading, males and females approached the lifting tasks differently with respect to trunk and hip kinematics as well as muscle recruitment. However, this previous study investigated gender differences but did not control for anthropometic differences. The ***objective*** of the current study was to evaluate males and females performing lifting tasks that were matched on height and body mass.

METHODS

Nine females and nine males were selected from a larger study [6] based on matching anthropometry (within 5 kg and 5 cm). The average weight and height for males was 67.9 kg and 170.5 cm, respectively and for females was 67.5 kg and 168.9 cm, respectively. The experimental tasks consisted of asymmetric lifting of boxes to either a 90° clockwise or a 90° counter-clockwise shelf at two different lift rates—2 and 8 lifts/minute. Boxes weighing 6.8 and 11.4 kg were lifted from conveyor and placed on asymmetric shelf. The three-dimensional trunk kinematics as measured by the lumbar motion monitor, trunk kinetics measured by force platform system, and activity of the ten major trunk muscles were inputted into an EMG-assisted spine load model that predicted the three-dimensional spine loads-compression, lateral shear, and anterior-posterior shear forces. A repeated-measures split-plot analysis of variance was performed for all of the dependent variables with all significant effects being further analyzed using Tukey multiple pairwise comparisons.

RESULTS AND DISCUSSION

Although males and females were virtually identical in body size, significant differences in spine loads still existed between the genders. Males were found to produce significantly greater compression forces—about 650 N than females. The direction of the task asymmetry also plays a role in the spine load responses. A small gender-asymmetry interaction effect was found to be significant for compression (Figure 1). In addition, males were found to have significantly greater lateral shear

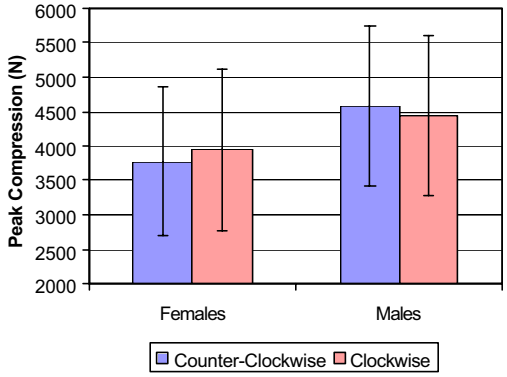

Figure 1: Peak compression for males and females when lifting to counter-clockwise and clockwise shelves.

loads (130 N more) when lifting from the counter-clockwise shelf but significantly lower shear loads (about 70 N) when lifting from clockwise shelf. It is interesting to note that females had greater muscle activity in the right and left latissimus dorsi (about 22% MVC), right and left rectus abdominus (about 5% MVC), and left external oblique (about 11% MVC) muscles. Although this increase in muscle activity appears to be counter-intuitive, females lifted in a different way kinematically than the males, counteracting the muscle activity response. Many trunk kinematic differences were not significant but appear to be biomechanically important. Females were found to utilize their hips more (8° more and 10.5 °/sec faster) during lifting while males relied on more trunk motion (5° more and 6 °/sec faster). Together, the muscle responses and kinematic difference result in different spine load patterns between the genders.

CONCLUSIONS

As with previous less controlled studies [5], the current study revealed that females are not scaled down versions of males. When exposed to the same lifting conditions, females respond with greater muscle coactivity but in a more neutral trunk posture by utilizing more hip motion. As a result, females minimize the loads on the spine during lifting. Thus, an inherent difference exists between males and females that cause the load pattern to be different.

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