INTRODUCTION

Individuals who are obese tend to be stronger than healthy-weight individuals in terms of absolute lower limb strength, but weaker in terms of relative strength when strength is normalized to body mass [1-3]. Previous studies on strength differences with obesity have focused on a specific joint or exertion type (e.g. knee extensors). A more comprehensive comparison of lower extremity strength between obese and healthy weight individuals that includes multiple joints and exertion types can provide more complete information on whether the effects of obesity might be joint- or exertion-dependent. Our current interest is in lower extremity capacity, and the purpose of this study was to investigate the effects of obesity on isometric and isokinetic strengths at ankle, knee, and hip among young females.

METHODS

Two groups of young females participated, including 10 healthy weight (HW, age: 21.7 ± 3.3 years, BMI: 22.5 ± 1.8 kg/m²) and eight obese (OB, age: 21.75 ± 2.8 years, BMI: 34.1 ± 3.15 kg/m²) individuals. Participants with a history of neurological, cardiac, or musculoskeletal disorders were excluded, and habitual activity levels were similar for both groups. The study was approved by the local IRB, and written consent was obtained from all participants.

Isometric and isokinetic (concentric and eccentric) maximum voluntary contractions (MVCs) were performed using the right lower extremity, with a Biodex System 3 dynamometer (Biodex Medical Systems, Inc., Shirley, NY), in plantar flexion (PF), dorsiflexion (DF), knee extension (KE), knee flexion (KF), hip extension (HE), and hip flexion (HF). Three isometric MVCs were performed at each of four different angles distributed evenly throughout the range of motion. Four concentric MVCs were performed at 150 deg/s for the knee, and at 120 deg/s for the ankle and hip. Four eccentric MVCs were performed at 75 deg/s for the knee, and 60 deg/s for the ankle and hip. Additional trials were completed to determine passive elastic/gravitational torques, which were subtracted from the isometric and isokinetic data during post-processing. For isometric MVCs, the peak torque over the four angles was determined. For isokinetic MVCs, the peak torque over the isokinetic region was determined. Mean values of absolute and normalized peak torques (to body mass) were compared between groups using Wilcoxon rank-sum tests. Statistical analysis was performed using JMP Pro 10 (SAS Institute, Inc., Cary, NC).

RESULTS AND DISCUSSION

Peak absolute torques tended to be higher in the OB group, but these differences were only statistically significant for concentric DF and eccentric HF MVCs (Figure 1). Peak normalized torque was lower in the OB group for 14 of the 18 testing conditions, with the exceptions being isometric PF, isometric HE, concentric HF, and eccentric PF MVCs (Figure 2).

The effect of obesity on normalized torque was apparent at all three joints, and in both flexion and extension directions, but was not uniform across all three types of contractions. Our results with respect to absolute and normalized concentric KE and KF peak torques were in general agreement with prior work (although prior work reported a significantly higher absolute torque among OB for KE) [1, 3]. Given that the effects of obesity may result, at least in part, from higher chronic physical exposure...
related to higher body mass, it was interesting to observe effects of obesity in muscle groups not as involved with body support (e.g., DF) as well as in muscle groups typically associated with body support (e.g., AP).

CONCLUSIONS

Minimal differences between OB and HW individuals were found in absolute strength, but OB exhibited less strength relative to body mass for most muscle groups and exertion types. Differences between joints, exertion directions, and exertion types may be related to a training effect associated with larger body mass, but this requires further study.

REFERENCES


ACKNOWLEDGEMENTS

This work was supported by grant R01OH009880.