THE INFLUENCE OF STRIDE LENGTH ON IMPACT SHOCK AND METABOLIC COST DURING WALKING IN OBESE WOMEN

Elizabeth Russell, Joseph Hamill
Biomechanics Laboratory, University of Massachusetts, Amherst, MA, USA
E-mail: jhamill@kin.umass.edu

INTRODUCTION

Obesity is associated with many health risks, including knee osteoarthritis (KOA) (Felson et al., 1988). KOA is a degenerative joint disease involving the breakdown of articular cartilage, and develops when the tissues cannot handle the mechanical stresses they undergo (Radin et al., 1982). A higher body weight results in repetitive, high-force loading at the knee that can initiate or progress KOA. The pain and discomfort associated with KOA limits mobility, thus inhibiting weight loss.

At heel strike during walking the body undergoes a rapid deceleration which may be reduced at the knee joint through an alteration in gait kinematics. A decrease in stride length (SL) has been shown to reduce impact shock during locomotion (Hamill et al., 1995). Also, at a constant speed, an increase in SF (decrease in SL) increases the metabolic cost of locomotion (Holt et al., 1991).

The purpose of this study was to investigate the effects of a decreased SL on the impact shock and metabolic cost of walking in obese women. We hypothesized that, at a constant S, a decrease in SL and increase in SF from the preferred walking gait will decrease the impact shock and increase the metabolic cost.

METHODS

Ten (N=10) obese (BMI $\geq$ 30 $kg \cdot m^{-2}$) females participated in this study. Kinetic (1200Hz) measures were taken using an AMTI force platform and uni-axial accelerometer tightly strapped to the distal tibia to record impact shock. Measured variables included impact shock, net impact shock, peak impact force and rate of force loading. A metabolic cart used indirect calorimetry to measure steady state VO_2.

During the preferred condition, subjects walked at a self-selected pace 10 times across 10m of track with a centrally-located force platform. Preferred S, SL and SF were recorded. Mean SF was increased by 15% using a metronome to pace gait. Markings on the floor defined the decreased SL during which locomotor S remained the same as at the preferred SL. All subjects wore the same make and model of footwear.

Preferred treadmill speed (PS) was found by increasing and decreasing speed until the subject consistently selected the same speed. PSF was measured and subjects achieved a steady state VO_2 at the preferred SF and the preferred SF +15%.

Ground reaction force (GRF) and accelerometer data were filtered with a Butterworth low-pass filter with a cutoff of 50 Hz. Impact shock was defined as the peak deceleration value at impact from the accelerometer. Net shock was the product of each subject's mean impact shock and SF for a given condition. Peak impact force was defined as the maximum vertical GRF value during the first 50% of stance and rate of loading was calculated from 10-80% of peak GRF. Steady state VO_2 measures were the average of the final two minutes of steady state.

A repeated measures ANOVA of means assessed differences between two SL conditions. Criterion for significance was set at $P<0.05$. Effect sizes were calculated as per Cohen (1990).

RESULTS AND DISCUSSION

Mean age and BMI were 25.3 ± 9.8 years and 33.1 ± 4.2 $kg \cdot m^{-2}$, respectively. PS, SL and SF were 1.33 ± 0.08 m/s, 0.75 ± 0.06 m and 106.61 ± 4.83 steps/min, respectively. Effect sizes for impact shock and metabolic cost were 0.49 and 0.38, respectively.

A decrease in SL (increase in SF), relative to the preferred gait, did not significantly decrease impact force and impact shock during walking in obese women. It is possible that an increase in SF (and subsequent decrease in SL) greater than 15% is necessary to elicit the expected decrease in the variables negatively affecting the knee joint during locomotion. Previous work investigating the effects of a decreased SL and increased SF used a running gait and a 15% increase in SF during running would likely be a much greater magnitude of increase than during walking. GRF and rate of force loading values were not significantly different between the preferred and experimental conditions.

Steady state VO2 increased significantly ($p>0.05$) with a 15% increase in SF. Therefore, more calories were utilized for the same walking speed as the preferred gait.

The results of this study do not support taking shorter, quicker steps to reduce the risk of developing or progressing KOA in obese women. If altering the kinematics of walking by decreasing SL can reduce the magnitudes of impact shock and impact force, SF must increase by more than 15%. Since decreasing SL did not affect impact shock, net impact shock was significantly greater ($p<0.05$) during the experimental condition when more steps were taken to accomplish the same distance. Therefore, the repetitive loading on the joints was increased. Nevertheless, the results of this study do support using an increased SF to increase the number of calories expended during walking.

SUMMARY/CONCLUSIONS

Impact with the ground may cause injury unless impact forces and accelerations are reduced. Altering the kinematics of walking by increasing the SF 15% (decreasing the SL) while remaining at a constant speed does not appear to decrease the impact shock during initial heel contact with the ground, but does increase the caloric expenditure of walking. However, since more frequent impacts are necessary to accomplish the same distance, the deleterious variables associated with foot contact are increased.

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