Energy expenditure of trans-tibial amputees during ambulation at self-selected pace

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Abstract
The purpose of this investigation was two-fold: 1) to compare the metabolic cost (VO2), heart rate (HR), and self-selected speed of ambulation of trans-tibial amputees (TTAs) with those of non-amputee subjects; and 2) to determine whether a correlation exists between either stump length or prosthesis mass and the energy cost of ambulation at the self-selected ambulation pace of TTAs. Subjects were thirtynine healthy male non-vascular TTAs between the ages of 22 and 75 years (mean ± sd = 47 ± 16). All had regularly used their prosthesis for longer than six months and were independent of assistive ambulation devices. Twenty-one healthy non-amputee males aged 27-47 years (31 ± 6) served as controls. Subjects ambulated at a self-selected pace over an indoor course, with steady-state VO2, HR, and ambulation speed averaged across minutes seven, eight and nine of walking. Results showed that HR and VO2 for TTAs were 16% greater, and the ambulation pace 11% slower than the nonamputee controls. Significant correlations were not observed between stump length or prosthesis mass and the energy cost of ambulation. However, when the TTA subject pool was stratified on the basis of long and short stump length, the former sustained significantly lower steady-state VO2 and HR than the latter while walking at comparable pace. These data indicate that stump length may influence the metabolic cost of ambulation in TTAs.

Conclusion
It was concluded that:
1. Non-vascular TTAs in the present study walked at an average pace of 67.1 m/min and an energy cost of 12.9 ml/kg.min which is comparable to that reported by other investigators.

2. A significant effect of stump length on metabolic cost and speed of ambulation was observed when TTA subjects were stratified by long and short stump length. This indicates that while small differences in amputation level might have minimal impact on metabolic consequences of ambulation in these subjects, sparing as much limb as possible may desirably influence both walking pace and energy utilized during walking.

3. Resting VO2 explained 40% of the variance observed in ambulation VO2, a finding which implicates level of fitness as a major factor influencing the metabolic cost of ambulation. To a lesser extent, age, speed of ambulation, and stump length each represent meaningful factors in predicating energy cost of walking.

4. Prosthesis mass did not significantly alter ambulation VO2, and when controlling for stump length, age, speed of ambulation, and baseline VO2, no significant difference in ambulation VO2 was observed between groups that were segregated by heavy and light prostheses.

5. Absence of a significant effect of prosthesis mass on VO2 may be explained by musculoskeletal adaptation to heavier prostheses. As the mass of the prosthesis does not apparently affect the amount of energy expended during walking this might suggest greater use of accessories such as rotators and multi-axial feet and other componentry that might improve ambulation gait and efficiency.

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