THE EFFECT OF TIGHTNESS OF FIT OF A BACKPACK ON ENERGY COST, LUNG FUNCTION AND POST-JUMP BALANCE

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INTRODUCTION: The carriage of heavy loads by military personnel is associated with increased energy consumption, fatigue and discomfort. Together these may reduce performance. In extreme cases, injuries can occur. Since movements of the body are a consequence of bipedal gait, any load carried on the body also moves. As walking speed increases, the displacement of the body, particularly in the vertical axis, increases. Previous studies (Legg & Mahanty, 1985, Legg *et al*, 1992, Soule *et al*, 1978) found increases in walking speed had a greater impact on energy consumption than increases in load. Studies into different modes of carrying loads have shown no significant effect on cardiorespiratory and metabolic costs. One way to minimise the energy consumption of load carriage might be to provide a suspension system that minimises the excursion of the load being carried. However, there are insufficient data to indicate whether such a system, even if it could be built, would significantly reduce energy consumption and thus maintain desired performance. The purpose of this study was to investigate whether changing the tightness with which a backpack was fitted to the torso had any consequence on the energy consumption and biomechanics of gait.

METHODS: Twelve male volunteers were recruited to participate in this study. Each subject visited the laboratory on 4 occasions; visit 1, subjects underwent subject characterisation and completed an incremental treadmill test to determine maximal oxygen uptake and maximum heart rate. Visit 2, subjects were fitted with a 15 kg backpack (Karrimor Jaguar SA back) which was adjusted by the subject until 'comfort fit' (CF) was achieved. From CF the straps were loosened by 2 cm to achieve 'loose pack' (LP) and tightened by 2 cm from CF to achieve 'tight pack' (TP). Subjects' lung function was tested in the no pack, LP and TP conditions. Visit 3, subjects performed a voluntary jump from 0.4 m onto a floor-mounted force plate (Kistler 9281B). The time taken to regain balance after landing (defined as the time taken for the vertical component of force curve to decay to within 5% of body weight) was determined. Visit 4, oxygen consumption and heart rate were measured whilst subjects walked (5.5 kmh^{-1}) then ran (7.5 kmh^{-1}) on a powered treadmill. This was completed in the LP and TP conditions in a balanced design. During treadmill exercise retro-reflective markers were fitted to the shoulders, hips and backpack and the subject filmed. By tracking the markers during gait, the relative movement of the pack and torso was determined. In addition, surface electrodes were fitted bilaterally over the lumbar, thoracic and cervical regions of the subject's back to record muscle electromyogram (EMG).

RESULTS: It was hypothesised that a TP would be associated with higher energy consumption, and decreased balance compared with a LP. Initial results showed that the addition of *either* pack significantly reduces lung function ($p<0.05$), with no significant difference between a TP or a LP ($p>0.05$). Post-jump balance and EMG data is still being analysed.

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