FORCES APPLIED BY A BACKPACK ON THE SHOULDERS

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INTRODUCTION

While the physiological responses of individuals to load carrying have been studied (Bloom et al., 1987; Evans et al., 1983), there is still a lack of information on biomechanical research focused on the forces applied to the trunk and the shoulders. The aim of this work is to present a way of measuring forces applied by a backpack to the shoulders when the subject walks for 30 min on a treadmill.

MATERIALS AND METHODS

Twelve subjects volunteered to participate in the experiment, four were hikers (>20 trekslyear: expert), four were occasional hikers (<10 trekking1 year: medium), and four had never used this type of load-carriage (no trekking experience: novice). Two force transducers were placed on the posterior part of shoulder-straps (P. S.) and two on the anterior part of shoulder-straps (A. S.). The load was increased (10kg, 15kg, 20kg at respectively 20 min, 25 min, 30 min). The subjects walked up a 5% inclined treadmill at 3.6 km/h during the last 15 min. Measurements were made during the last 30 s of each stage.

RESULTS

The results demonstrated that total forces measured on the different straps were affected by the increasing load but there was no difference between novice, medium and experts. (Figure 1)

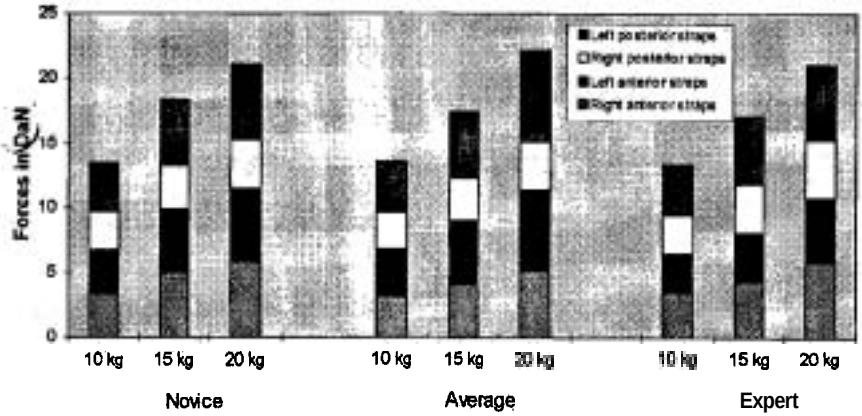

Figure 1. Effect of load increase on the different transducers according to practice level

The force measured on the straps showed sinusoidal fluctuations with about 1.2 s period. (Figure 2)

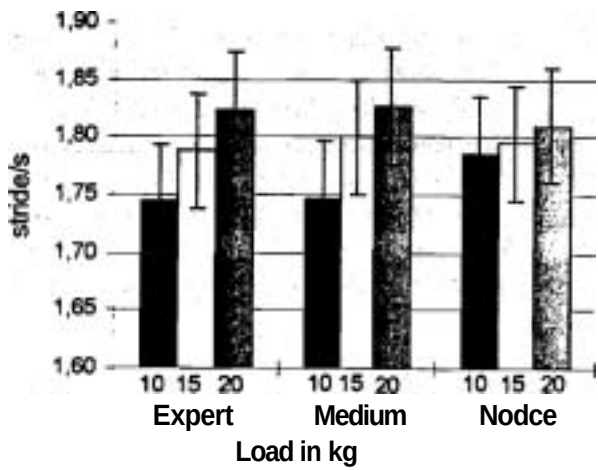

Figure 2. Typical sinusoidal fluctuation force on the left posterior part of the shoulder.

The sinusoidal fluctuation force is related to the stride rate. The sinusoidal fluctuations were higher for the novices (about 8%) than for the experts. Expert and medium subjects adapted their stride in accordance to the load increase; whereas, the novices did not adjust (Figure 3). As walking velocity was controlled in this study, the results for stride rate reflected the changes which occurred in stride length.

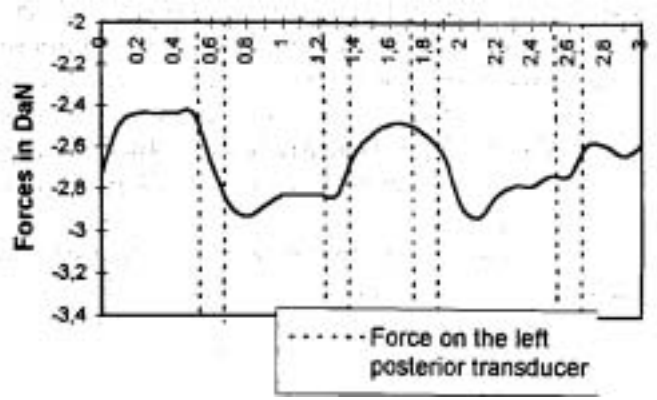

Figure 3. Effect of load and stride rate according to practice level

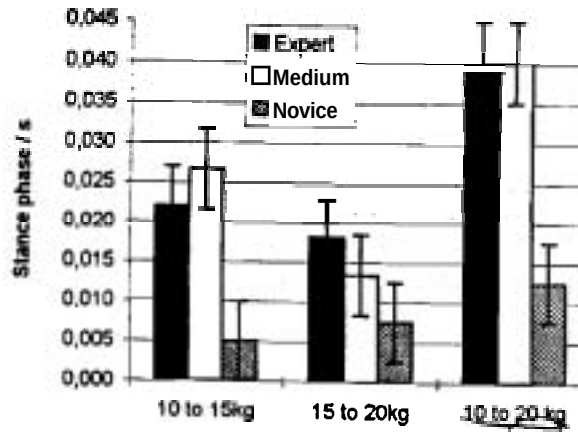

Figure 4. Number of stance phases per second.

CONCLUSION

A backpack induces tension in the anterior and posterior straps over the shoulders. This tension appears to be a limiting factor in load carriage (Holewijn, 1990). A way of reducing force fluctuation and strain applied on the shoulders is to reduce step length as shown by experts.

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