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THE EFFECT OF BACKPACK LOAD ON THE PELVIC KINEMATICS OF NORMAL ADOLESCENTS

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SUMMARY

Despite evidence linking the load carried in backpacks with the incident of back pain, previous studies have focused on changes in gait pattern rather than the direct effects on the pelvis itself.

The present study investigated the impact of backpack load carried on pelvic kinematics. 10 participants participated in this study. This included dynamic activities where the participant walked on a treadmill with 0%, 17% and 25% bodyweight (BW) loads using 2 backpack options (Ergonomically designed and conventional backpack). The subjects also completed 90 seconds of quiet standing. The results from this study showed significant differences in pelvic tilt kinematics with increased load of backpacks.

INTRODUCTION

The loads carried in backpack by school children is an area of concern with many relating increase load to an increase in musculoskeletal complaints including back pain [1, 2]. Routinely, school bags contain study material including books together with lunch boxes, sport equipment, after school clothes and electronic devices [3]. Past research suggest that such loads lead to significant alterations in gait and posture depending on weight of backpack [2, 4]. These studies have utilized backpack similar to those used in hiking or military. However no studies have analysed the biomechanical compensation during gait using backpacks similar to those carried by students [2, 3]. It has been reported that school children carry a backpack that weighted in average 17% of their body weight and in some cases it reaches to 25% of their body weight [6, 7].

The purpose of this study was to assess pelvic kinematics of the adolescents carrying two different backpacks containing load of 0%, 17% and 25% of participant body weight (BW).

METHODS

Twenty school children aged 13.6 ± 0.70 years, with mass 51.0 ± 6.23 kg and height 162.1 ± 5.59 cm participated in this study. The study was approved by the Imperial College Research Ethics Committee.

Two backpacks were used in this study, one ergonomic backpack (Ergo) designed by Back Care Charity, and one conventional backpack (Conv). Each subject participated in all five trials of 90 seconds quiet standing and 10 minutes walking on treadmill: without the backpack (0% of BW),

Ergo bag of 17% of BW, Ergo bag of 25% of BW, Conv bag of 17% of BW and Conv bag of 25% of BW.

Each subject was asked to walk at a comfortable speed which was 2.7 ± 0.58 Km/h. The static data

A motion Analysis system with 9 high speed MX-13+ cameras was used to track the motion of the pelvis with acquisition rate of 100 Hz. The retro-reflective markers of 14mm in diameter were attached to the posterior superior iliac spines (PSIS) and a marker cluster (consist of three orthogonal markers) on sacrum. The static trial was used to define the position of the anterior superior iliac spines (ASIS) using the tip of pointer with respect to the cluster attached to the sacrum. Anatomical coordinate frame for the pelvis was defined using the calibrated ASISs to define the X axis (medio-lateral axis), Z axis (vertical) was perpendicular to the plane created by the ASISs and PSISs, and the Y axis (anterior-posterior) was the cross product of X and Z axis. The Vicon Nexus and BodyBuilder were used for capturing, processing and analysing the data. The SPSS used for statistical analysis.

RESULTS AND DISCUSSION

The result of this study showed that during quiet standing the pelvic tilt was only altered when carrying a load that was 25% of BW. There was no significant difference between the pelvic tilt for standing with no bag and 17% BW Ergo ($p=0.26$) and Conv ($p=0.09$) bags. There was significant difference between the pelvic tilt in standing with no bag and 25% BW Conv ($p=0.02$) while there were no significant difference between 25% BW Ergo ($p=0.12$) and no bag. As can be observed in Figure 1 the magnitude of pelvic posterior tilt increases as the load of the backpack increased.

Under the 5 conditions, load of 25% BW for Conv bag showed the greatest increase in angular pelvic tilt while the pelvic tilt for Conv bag of 17% BW and Ergo bag of 25% BW were the same and there was no difference between the Ergo bag 17% BW and 0% BW.

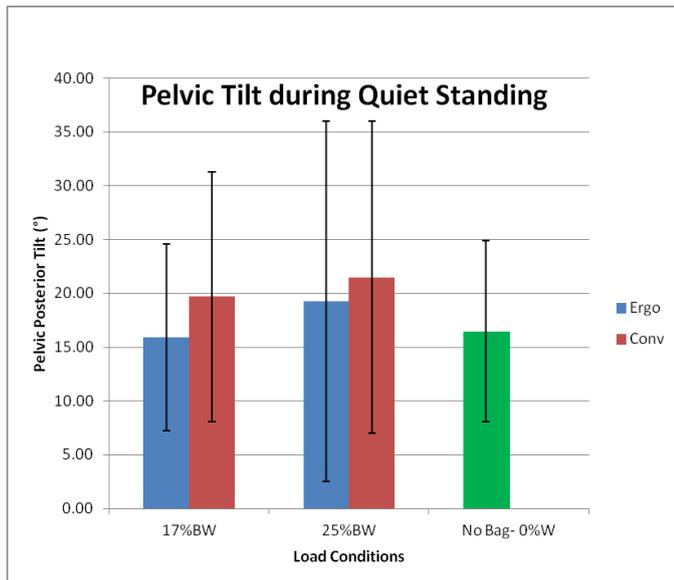


Figure 1: Graph of the pelvic posterior tilt with five different load conditions during standing.

When walking the use of a backpack had an effect on gait and lead to an increase in pelvic range of motion (ROM) and was significantly different from walking with no bag. The increased ROM for pelvic tilt during walking varied between the loading conditions, see Table 1. No significant difference was found between the ROM of the pelvic tilt during walking with no bag and Ergo bag of 17% BW. Even when carrying a reduced load, significant biomechanical compensation occurred. The pelvic tilt increased to keep the subject in an upright, vertical position. Other researchers found increased pelvic tilt when youths wore unframed or framed backpack with different load conditions of 20-60% of the subjects' BW [5].

CONCLUSIONS

Adolescents carrying backpack loaded with 17-25% of their body weight appear to significantly alter their pelvic kinematics. The pelvic tilt was noted to increase while wearing a loaded backpack which may cause postural deviations after long-term or prolonged use. This study also showed that the effect of carriage load on pelvic kinematics was less when subjects wore the ergonomic backpack. However, further research is needed to evaluate the long-term effects from these altered pelvic biomechanics.

Table 1: increased range of motion (degrees ± S.D.) for pelvic tilt during five carrying conditions.

Pelvic tilt	Carrying condition	Increased ROM
	Ergo 17% BW	3.77(0.74)
Conv 17% BW	6.74(1.59)	
Ergo 25% BW	8.12(1.60)	
Conv 25% BW	11.15(2.5)	

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