EFFECT OF BACKPACK ON SELECTED GAIT PARAMETERS OF PRIMARY SCHOOL CHILDREN

Shih-Fan Huang[1], Tzu-Lin Wong[1], Jin-Cherng Wang[2] and Ming-Ju Chung[1]
[1]National Taipei Teachers College, Chinese Taipei
[2]National Chia-yi University, Chia-yi, Chinese Taipei

The purpose of this study was to compare the effects of a backpack load of 15% body weight (BW) on selected gait parameters of primary school children. Ten participants were recruited from primary school (age: 10.3 ± 0.48 yrs; ht: 141.3 ± 0 .41 cm; mass: 38.1 ± 6.1 kg). A JVC 9800 (60 hz) video camera synchronized with an AMTI force plate (1200 Hz) were used to collect data. A repeated measure t-test ($p < 0.05$) was used for group comparisons. The backpack load did not affect either the proportionate time of the stance phase, swing phase, or the magnitude of selected vertical and anterioposterior ground reaction force parameters. However, the 15% backpack load did cause a significant increase in proportionate double leg support time.

KEY WORDS: gait, backpack loads, ground reaction force

INTRODUCTION: Walking is a cycle movement and the most frequent movement for human, studying human gait is to analyse limb parameter changes. A cycle begins with a leg touching the groud until it retouchs the ground again.Primary student's backpact loads problem has always been a issue in Biomechanics area. Voll and Klimt (1977) suggested the student's backpack should not exceed 10% backpack loads. Grimmer, Dansie, Milanese, Pirunsan, and Trott (2002) indicate there is no definite evidence shows 10% backpack loads is the ultimate weight. Goh, Thambyah, and Bose indicate 15% backpack loads will increase lumbosacral spine load, and carrying 25% backpack loads will reach the peak force therefore influence trunk angle. Some researches studied posture change on shoulder and neck, in order to stand straight, carrying 15% backpack loads makes students' trunk lean forward then results in low back pain (wilson, Grimmer, & Dansie, 2001). Wang, Pascoe, and Weimar evaluated walking speed turns down when carrying 15% backpack loads, single support time was shortened and the double support time was lengthened. Similar research also suggest 15% backpack loads will cause step frequency, double support time and total support impulse to change, consequently 15% backpack loads could be the critical value for percentage load.(Song, 2003). However, controversy remains regarding whether the critical load for significant modification is 10% or 15%. The purpose of this study is to determine the effects, if any, of carrying a 15% body weight backpack on selected gait cycle and ground reaction force parameters.

METHODS: This research gathered 10 participants from primary school (10.3 ± 0.48 years old, 141.3 ± 2.41 cm in height, 38.1 ± 6.10 kg in weight). Six landmarks were pasted on reference board in order to perform linear transformation, participants performed normal and 15% backpack loads walk (body weight*15%), film were recorded by JVC9800(60 Hz) high speed camera shooting along participant's sagittal plane and datas were gathered at the same time by AMTI force plate (1200 Hz), the film was collected by Video Capture 6.5 software then use APAS motion analyse system by direct linear transformation (DLT) and filter them, finally, raw datas from force plate (DASY Lab 6.0) were filtering by low-pass (10 Hz) and ground reaction force expressed in multiples of bodyweight (B.W.). From this research, repeated measure t-test ($p < 0.05$) method were utilized for statistical analyses the parameters of two kinds of gait.

RESULTS AND DISCUSSION: Backpack loads for elementary students does not influence stance phase nor swing phase time ($p > 0.05$), therefor, backpack loads does not cause time proportion to change which comform to the result from (Song, 2003).

Table 1 Absolute and proportionate length of stance phase and swing phase for both conditions.

	Normal gait	15% backpack loads gait	t-value
stance phase time (sec)	0.62 ± 0.04	0.63 ± 0.08	-0.266
swing phase time (sec)	0.37 ± 0.07	0.36 ± 0.03	-0.480
stance phase (%)	62.66	63.71	-0.379
swing phase (%)	37.33	35.2	0.717

*p < 0.05

About leg supporting time proportion, double supporting time increased from 5.89% to 11.64%, single supporting time decreased from 37.33% to 35.27%(p < 0.05) which comform to the result from Martin(2003); Wang, Pascoe, and Weimar. (2001).Stride length for primary school students is 119.72 ± 5.50 cm, when loading 15% backpack loads makes it decreaseed to 117.99 ± 6.43, which is about 2 cm difference(table 2). Overload is the main reason that causes stride length and support time porportion to change. For Normal and 15% backpack loads gait cycle, the trunk angle of stance phase are 157.48° ± 6.7° and 149.09° ± 9.84° respectively, the trunk angle of swing phase are 170.90° ± 4.74° and 163.87° ± 7.97° respectively, the above statistics indicate when body carry extra weight will cause the trunk to bend forward, the extra weight will lay on lumbosacral joint which leads to low back pain after a period of time, the results comform to Goh, Thambzah, and Bose(1998).

Table 2 Kinematic parameters of gait for both conditions.

	Normal gait	15% backpack loads gait	t-value
Gait cycle (sec)	0.99 ± 0.08	0.98 ± 0.09	.212
Double support time (%GC)	5.89	11.64	-1.558*
Single support time (%GC)	37.33	35.27	-.955*
Stride length (cm)	119.72 ± 5.50	117.99 ± 6.43	1.805
Stance phase trunk angle (°)	157.48 ± 6.70	149.09 ± 9.84	3.073
Swing phase trunk angle (°)	170.90 ± 4.74	163.87 ± 7.97	2.483

*p < 0.05 (%GC: gait cycle percentage).

For vertical ground reaction force (GRF) aspect, table 3 shows maximum GRF appear at both early and later phase of stance phase, the peak force for normal gait was 1.11 ± 0.08 B.W. and 1.05 ± 0.06 B.W. respectively, the peak force for 15% backpack loads gait was 1.11 ± 0.05 B.W. and 1.03 ± 0.12 B.W. respectively, the minimum GRF occurred at middle phase of stance phase, the mean force for nomal gait is 0.63 ± 0.08 B.W. and the mean force for 15% backpack loads gait is 0.62 ± 0.07 B.W., the figure for verticle GRF appeared a double peak but no significance was reached (p > 0.05). in other words the weight load does not influence student's GRF significantly. The 1st peak occurred between heel strike and foot flate, the 2nd peak occurred between heel off and toe off.

For anter-poster ground reaction force (GRF) aspect, table 3 shows maximum for at early phase of stance phase the mean values are 0.21 ± 0.10 B.W. for normal gait and 0.21 ± 0.05 times body weight for 15% backpack loads gait, the later phase also occurred maximum GRF because of the heel striking the ground, the values are 0.24 ± 0.03 and 0.25 ± 0.03 B.W. respectively, but still shows no significance (p > 0.05), therefor, backpack loads does not influence student's GRF when walking.

Table 3 Ground reaction forces for both conditions.

	Normal gait	15%weight load gait	t-value
Max. Vertical GRF of early phase (B.W)	1.11 ± 0.08	1.11 ± 0.05	0.176
Min. Vertical GRF of middle phase (B.W)	0.63 ± 0.08	0.62 ± 0.07	2.105
Max. Vertical GRF of later phase (B.W)	1.05 ± 0.06	1.03 ± 0.12	1.285
Max. anter GRF of early phase (B.W)	0.21 ± 0.10	0.21 ± 0.05	0.284
Max. poster GRF of later phase (B.W)	0.24 ± 0.03	0.25 ± 0.03	-0.320

*p < 0.05 (B.W=body weight, GRF=ground reaction force).

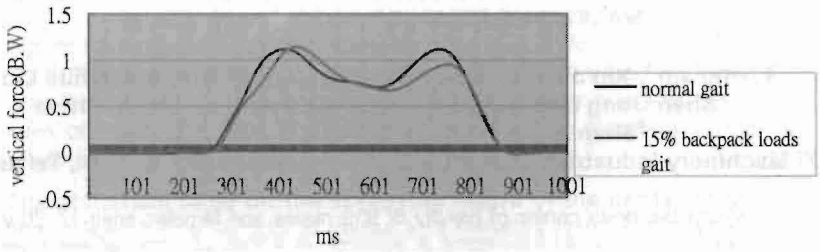

Figure 1 Vertical GRF curves for both conditions.

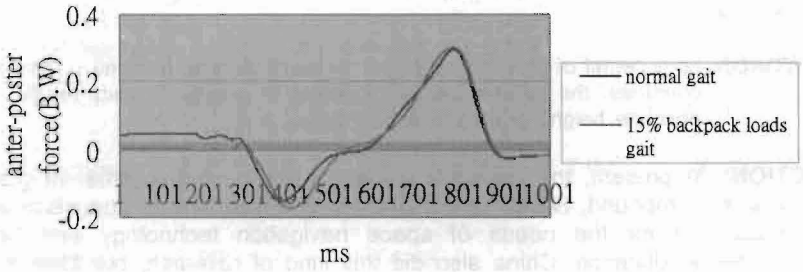

Figure 2 Anterioposterior GRF curves for both conditions.

CONCLUSION: The 15% BW backpack load did not affect either the proportionate time of the stance phase, swing phase, or the magnitude of selected vertical and anterioposterior ground reaction force parameters. However, the 15% backpack load did cause a significant increase in proportionate double leg support time.

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