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Effect of Backpack Load on Gait Speed During Walking among University Student: A Pilot Study

[1]Taufik Eko Susilo
[1]Program Studi Fisioterapi, Fakultas Ilmu Kesehatan, Universitas Muhammadiyah Surakarta
Email : tes325@ums.ac.id
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ABSTRACT

Nowdays, the backpack is designed multipurpose to carry all human needs. However, the excessive load on the backpack could lead to the postural problem that disturbs the human activities. People carry various loads of backpack in different positions every day and it tends to significant changes in physical performances such as walking speed and cadence. Carrying backpacks can cause the undesired posture which in turns can cause muscle fatigue, back pain, and spinal deformity eventually for the severity case. Standing and walking with backpacks may affect both static and dynamic balances which induce postural instability.

Purpose: To identify the effect of 10% backpack load on gait speed during walking among university students

Methodology: This observational study used repetitive experimental measured.

Results: in backpack load comparison in the 10-meter walkway, the gait speed was significantly different between walking with and without load ($p< 0.001$). In 3-meter gait speed, there were significant different speed among normal, fast, and slow gait in each walking condition, with and without backpack load ($p <0.05$), respectively. For *pos-hoc* analysis, there were significantly different in normal and fast gait speed ($p = 0.001$), and fast and slow gait speed ($p = 0.007$), but there were significant differences of normal and slow gait speed ($p = 0.314$) in walking 3m without backpack load. Then, there were significantly different in normal and fast gait speed ($p = 0.007$), and normal and slow gait speed ($p = 0.038$), but there were significant differences of fast and slow gait speed ($p = 0.445$) in walking 3m with backpack load.

Applications/Originality/Value: this study was the pilot study that tested the gait speed among university student who uses the backpack

Keywords*: backpack, load, gait speed*

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INTRODUCTEAION

A backpack is a useful tool for modern people to carry the items everywhere, especially for the student to carry the school items. On a typical day, the backpack is designed multipurpose to carry all human needs. However, the excessive load on the backpack could lead to the postural problem that disturbs the human activities. People carry various loads of backpack in different positions every day and it tends to significant changes in physical performances such as walking speed and cadence (Chow et al., 2005). Carrying backpacks can cause the undesired posture which in turns can cause muscle fatigue, back pain, and spinal deformity eventually for the severity case. Standing and walking with backpacks may affect both static and dynamic balances which induce postural instability (Singh & Koh, 2009).

The postural alteration due to backpack load is often associated with a back pain problem. The previous studies (Drzał-Grabiec et al., 2015; Eum et al., 2013; Ozgül et al., 2012) found that the excessive backpack load increased spinal flexion, reduce pelvic motion, and abdominal muscle activity by electromyograph activity. The study of Bahar Ozgul et al in 2012, reported that the effect of unilateral backpack load on kinematic gait parameters in which the carried backpack weighted 15% of body weight (BW) and showed a significant increase in the ankle dorsiflexion on the unloaded side and it was decreased on the loaded side (Ozgül et al., 2012). Backpack weight can be considered heavy as in compared with the BW, sometimes it reaches up to 20% BW. The habitual backpack loads carriage of 10% BW and more are common among the college-aged adults which additionally can lead to lower limb injury and low back pain (Dames & Smith, 2015)

The study of Song Q et al, reported that 15% increase in backpack load can lead to further instability of posture (Song, Yu, Zhang, Sun, & Mao, 2014). One study investigated that the influence of backpack carriage on gait initiation on high school children and found differences in centre of pressure (COP) and ground reaction force (GRF) on three different conditions: no backpack, unilateral backpack, and bilateral backpack load (Vieira et al., 2016). Previous studies examined the effect of load on kinematic parameters is compared with unloaded and loaded side quantitatively and showed that asymmetrical backpack carriage can alter kinematic parameters biomechanically. Although the effect of backpack load in children and adolescents have been studied largely, the effect of backpack load on university students have received little attention.

The purpose of the current study was to identify the effect of 10% backpack load on gait speed during walking among university students. To specify the perturbation, three types of speeds of gait (normal, fast, and slow) were measured with two conditions of backpack load (no backpack load and unilateral backpack load). We expected that walking with a backpack load would decrease the gait speed.

METHOD

Instruments

Ten healthy adults (3 males and 7 females, BW 60.1 ± 14.57 kg, 10% load 6.01 ± 1.45 kg, age 24.7 ± 14.57 years) were recruited and underwent normal walking and walking with backpack in sequence. The researcher used the 10 Meter Walkway to test the walking speed. Then, to explore the alteration during walking with backpack load, subjects walked along the walkway with three speeds of walking; normal, fast, and slow in every 3 meters as well as in every 0.5 meters for changing of gait speed among the 3 meters, in a total of the walkway was 10 meters. A load of the backpack was set by 10 percentage of body weight and it was attached in the asymmetrical side of the body; the observer set the 10 meters walkway and marked in every 3 meters. Thus, the camera was set and recorded the motion that can capture 10 meters of distance. The subjects were asked to standing behind the starting line, while the observer prepared the instruction.

Firstly, the subjects walked in normal speed with a self-selective comfortable speed in the first 3-meter. Next, they were needed to change their speed faster and slower in the following of the 3-meter part, consequently. While the subjects were walking, the other observer counted the walking time (seconds) by stopwatch in each walking and put the speed formula to count the walking speed (meter/second) interpreted into quantitative data. Hence, the observers watched the videos to determine the value of subjects' walking.

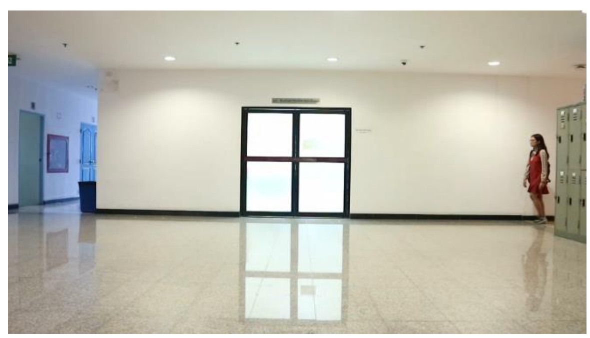


Figure 1. 10-meter walking setting

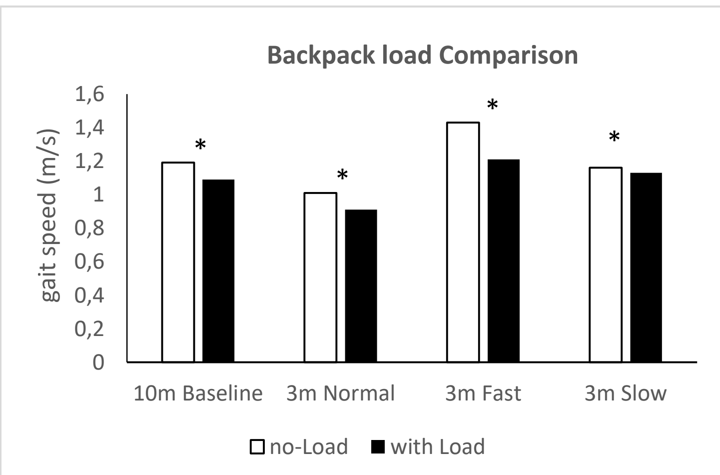
Data Analysis

The data processing was conducted in IBM SPSS Statistic 23. The data of walking with and without load was categorized as normal distribution and was tested by the One-Way Repeated Measure ANOVA with the Pairwise Test to find the significant value. To compare the significant difference in the level of walking between normal and loading, the Paired T-test was applied. The level of significant p-value was set with an α level of 0.05.

Results

Comparison gait speed between with and without backpack load

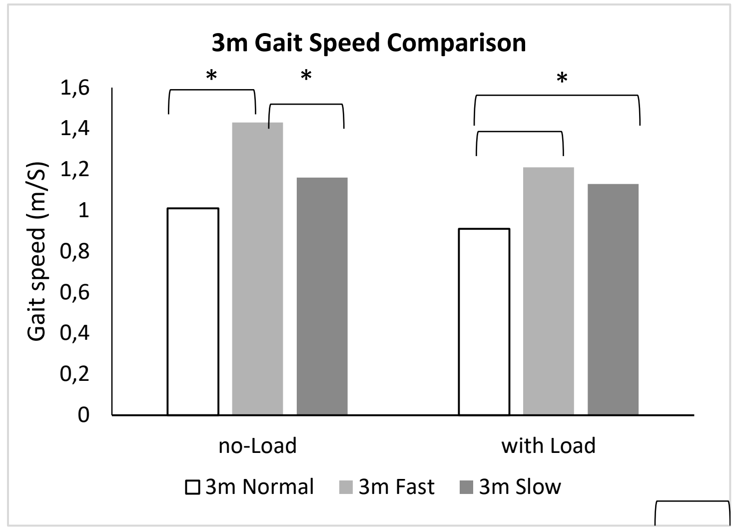
In backpack load comparison there were significantly different in 10-meter baseline ($p < 0.001$), 3-meter normal speed ($p < 0.001$), 3-meter fast speed ($p < 0.001$), and 3-meter slow speed ($p < 0.001$) in walking with and without backpack load, respectively. (**Figure 2**)



*significant effect tested by Paired t-Test, p< 0.05

Figure 2. Backpack load comparison among gait speed

In walking without backpack load, there were significant effects speed among normal, fast, and slow gait in 3 meters ($F[2,18] = 16.971$, $p < 0.001$). The pos hoc analysis show that there were significantly different between normal and fast ($p = 0.001$), fast and slow ($p = 0.007$), but there was no significant difference between normal and slow ($p = 0.314$) gait in 3 meters. Moreover, in walking with backpack load, there were significant effects different among normal, fast and slow gait with load backpack walking in 3 meters ($F[2,18] = 11.171$, $p = 0.001$). Pairwise comparison with pos hoc Bonferroni shown that there was significantly different between normal and fast gait in 3 meters ($p = 0.007$), normal and slow gait in 3 meters ($p = 0.038$), but there was no significant difference among fast and slow ($p = 0.445$), respectively. (see **Figure 3**)



*pos hoc analysis tested by Bonferroni, p< 0.05

Figure 3. gait speed comparison in each backpack load condition

Discussion

The objective of the present study was to investigate the effect of load on gait speed during walking in adults. This study showed the gait speed at 10 meters was significantly different between with and without load at 10% BW. Besides, there was a significantly different change in gait speed during normal, fast, and slow in the subjects when walked without load. On the other hand, there was a significantly different change in gait speed between normal and fast gaits without load. Also, there was a significantly different change in gait speed between fast and slow gaits with the load. So, in this study, it seems that load at 10% BW can affect the change of gait speed in healthy adults.

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The results showed that there was no significant difference between with and without loads when walking with slow gait speed. In this result, slow gait speed related to more stability in walking. In the study by Chow et al., (2005) studied the effect of backpack load on the gait of normal adolescent girls. They found that increase in backpack load resulted in a decrease in walking speed (Chow et al., 2005). Also, our finding supports the study from Drzał-Grabiec et al in 2015, found the effect of an asymmetrical backpack with load could increase the degree of kyphosis (Drzał-Grabiec et al., 2015), which the greater kyphosis has potential to lead the poor mobility performance (Eum et al., 2013).

Furthermore, this present study used the gait speed by 10-meter walk, divided into 3 part which is 3-meter normal walk, 3-meter fast walk and 3-meter slow walk and recorded by a video camera. All gait speed in 3 meters normal, fast and slow walk shown a significant difference between walking with load and without load. Quantitative parameter by gait speed can provide useful various variable such as Spatio-temporal parameter that can detect and clearly to demonstrate the gait performance analysis in any situation. Also, this method can provide the real-time of the situation. However, the range of gait speed in our study about 0.96 – 1.21 m/s which was categorized as the normal speed walking in young adults (Bohannon, 1997; Middleton, Fritz, & Lusardi, 2015) This founding interpret that using backpack could alter the gait speed with acceptable walking.

In conclusion, walking speed is an essential sign to monitor functional activity (Middleton et al., 2015). Moreover, in this study, 3 divided parts applied to determine how higher brain level works during instruction. We assumed that this setting could be similar to university student activity where move fast in some condition bringing the back. While the observer instructed "fast" and "slow", the participants changed their pace following the instruction which indicates there is higher brain level to recognize by auditory input that is accepted by the cognitive process to modify the walking (Takakusaki, 2017). According to the finding, the speed perturbation was instructed by a complex cognitive process.

On the other hand, our finding also revealed no significant differences in fast and slow in 3 meter walking. According to the study from Drzał-Grabiec, J. et al (2015) that study asymmetric backpack load during walking with EMG signal, the ipsilateral spinal muscle was no changing by the load (Drzał-Grabiec et al., 2015). This study also discussed how the participant adjusted their backpack, and it could be assumed that the spinal muscle compensated the weight by some loads (Drzał-Grabiec et al., 2015). Moreover, a university student was categorized as young adult level, who has good physical to adopt the load during walking. In line with a study from Bovonsunthonchai et al in 2020 that young adult has typical walking that adapts the perturbation (Bovonsunthonchai et al., 2020). It could be concluded that backpack is the acceptable load during walking.

Our study has a limitation in women participants were more dominant than man, and we did not identify the force during walking as well as we did not control the Body Mass Index (BMI). For further study, those limitations could enhance the details result of walking with backpack load. However, the history of backpack usage could be one of the information for a patient who suffers the back pain and gait disturbance in young adult. In conclusion, the alteration of gait speed has indicated the load on backpack influence the walking by the young adult.

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