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Effect of the Backpack Load on Students' Discomfort

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ABSTRACT

This study evaluated the effect of backpack loads on the user discomfort on body segments such as neck, shoulder, upper back, lower back, and knee during a walking activity. The user discomfort with 20% load was significantly higher than that with 10% load for all 5 body parts. During the experiment, it was observed that the female participant who weighs in range of 100-120 lbs. experienced most discomfort and could not continue experiment when the weight of the backpack was more than 15% of the total body weight. Whereas the participants with the range of body weight around 160-180 lbs. experienced less discomfort in their neck and shoulder throughout the experiment. In conclusion, the research found that the backpack load significantly affects the user discomfort when student walk carrying the backpack. The research should have practical meaning to decide the appropriate weight of the students' backpack and develop a more user-friendly design.

Keywords: Backpack load, Discomfort, Neck, Shoulder, Lower back

INTRODUCTION

Backpacks are particularly useful in our day-to-day life, work, offices, and school, etc. Especially students carry backpack to school every day with heavy loads of textbooks, notebooks, and laptop etc. There is an increasing concern of students carrying heavy backpacks in the United States, Canada, New Zealand, Holland, Italy, and Greece (June & Karen, 2008). As per the article of Huntsville Hospital, in the United States around 79 million students carry backpack to school. In 2007, more than 23,000 backpack-related injuries were treated at hospital rooms, physician offices and clinics (Huntsville, 2019). A lot of research has been done on young adults who form a significant portion of backpack users (Ikechukwu, Wisdom, Osita, & Arochukwu, 2017). Walking with backpack loads induces additional mechanical stress on the spine and has been identified as a risk factor of lower-back pain. The peak lumbosacral joint compression force increases by 7%, 23%, 31%, and 64% when an adult walks with backpack load at 10%, 15%, 20%, and 30% body weight respectively (Simon S. W. & Daniel H. K., 2019; Tarkeshwar & Michael, 2008; Christa, Ilse, An, Gerlinde, & Arthur, 2007).

As per the study of Cook and Neumann, they have considered 10% and 20% total weight of the body for their experiment. But to get more accurate results, more parameters should be considered such as 10%, 15%, and

20% of the total weight of the body of students/participants (Thomas M. & Neumann, 2007). Study from Lee, Max and Panagiotis, Georgios considered mostly adults aging between 21-35 years old and other research considered children in their experiments. To cover the gap of age, we have selected teenager which are between 18 to 21 years old (Lee, Max C., Joshua, & Mark G., 2019; Panagiotis, Georgios, Spyridon, & Zeiss, 2004).

This study evaluated the effect of backpack loads on the user discomfort during a walking task. In this case, the hypothesis deals with how the variation of load would affect the magnitude of user discomfort during a walking exercise.

MATERIALS AND METHODS

To study the effect of loads of the backpack on the five different body segments, experiments were conducted by using total weight of the student body to the different percentage of weight of backpack. The experiment was taken place on the university campus and defined three rounds for each participant to walk for ten minutes with an interval of five minutes break after each round.

Participants

12 young and healthy college students consisting of both genders (Male and Female) were recruited. The age group of participants was between 18 to 21 years old.

Equipment

Equipment included a backpack, a weighing machine, school material for the load, etc. The load which is exerted by the backpack was the independent variable. As per the research, 15% of the total weight of the body is the standard weight to carry the backpack during walking activity. So, the research considered 10%, 15%, and 20% weight of the backpack to the total weight of the body of participants. The user discomfort was considered as dependent variable.

Experiment Task

Participant were asked to carry the various backpack loads (10%, 15%, and 20% body weight) to walk on defined route for 10 minutes with 5 minutes interval in between each activity on university campus. After each task, participants were asked to fill in a discomfort questionnaire. The same process/experiment will be carried for all the twelve participants. The tasks were completely randomized for each participant.

Experiment Procedure

First, all participants were provided with instructions of the experiment. After that they were provided with pre-experiment questionnaire to receive demographic information such as age, height, weight, gender, physical disability, use of backpack during week, etc. Afterwards participant started walking

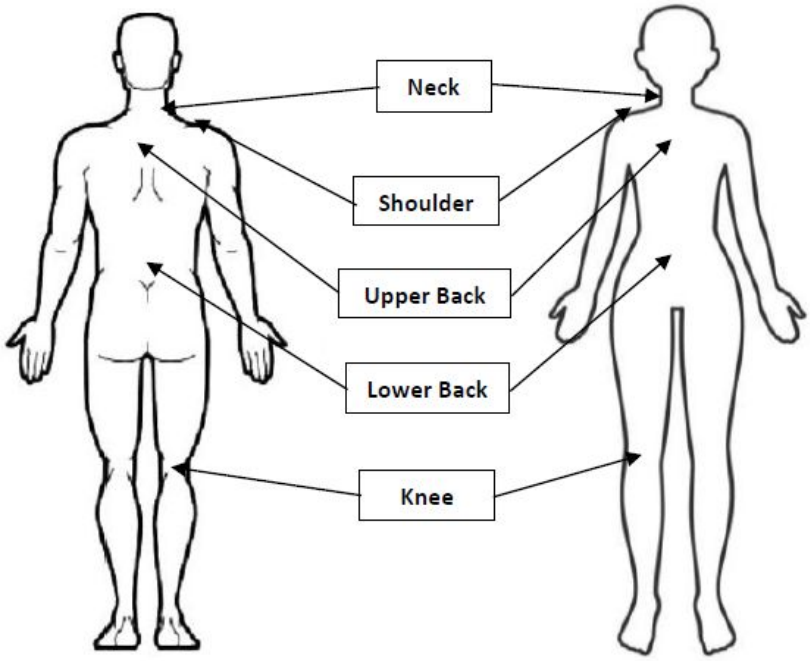

Figure 1: Body segments considered for the experiment.

activity with 10%, 15%, and 20% weight of total body weight of the participant in a random sequence. Each walking activity was succeeded by a minute's break and a questionnaire which gathered discomfort information regarding the body segments like neck, shoulder, upper back, lower back, and knee. During each activity, changes in body posture of each participant were observed. Questions were asked such as are how they feel, if they want to take rest, etc.

The experiment concluded with a final questionnaire to get participants' general feedback. Figure 1 shows the body segments which were considered in this study.

RESULTS

The experiment was a repeated measure and within design. The data were analyzed using ANOVA. The result showed a significant main effect of backpack load on the user discomfort of neck, shoulder, upper back, lower back, and knee. The user discomfort with 20% load was significantly higher than that with 10% load for all five body parts.

Discomfort on Neck

The results showed a significant main effect of weight on neck discomfort ($F2, 22 = 10.67$, $p < 0.0006$). The post hoc test showed that the neck discomfort in 20% ($M = 5.41$, $SD = 2.81$) was significantly higher than that in 10%

(M = 2.83, SD = 2.13). However, there was no significant different of neck discomfort between 10% and 15%.

Discomfort on Shoulder

The results showed a significant main effect of weight on shoulder discomfort ($F2,22 = 18.31$, $p < 0.0001$). The post hoc test showed that the shoulder discomfort in 20% (M = 5.92, SD = 2.57) was significantly higher than that in 15% (M = 4.50, SD = 2.78), which was also significantly higher than that in 10% (M = 2.75, SD = 2.18).

Discomfort on Upper Back

The results showed a significant main effect of weight on upper back discomfort ($F2,22 = 11.58$, $p < 0.0004$). The post hoc test showed that the upper back discomfort in 20% (M = 4.42, SD = 2.57) was significantly higher than that in 15% (M = 3.42, SD = 2.31), which was also significantly higher than that in 10% (M = 1.67, SD = 1.37).

Discomfort on Lower Back

The results showed a significant main effect of weight on lower back discomfort ($F2,22 = 7.50$, $p < 0.0033$). The post hoc test showed that the lower back discomfort in 20% (M = 4.00, SD = 2.56) was significantly higher than that in 10% (M = 2.00, SD = 2.05). However, there was no significant different of lower back discomfort between 10% and 15%.

Discomfort on Knee

The results showed a significant main effect of weight on knee discomfort ($F2,22 = 4.25$, $p < 0.0275$). The post hoc test showed that the knee discomfort in 20% (M = 2.75, SD = 2.53) was significantly higher than that in 10% (M = 1.17, SD = 0.39). However, there was no significant different of knee discomfort between 10% and 15%.

DISCUSSION

The result showed a significant main effect of backpack load on the user discomfort. The user discomfort with 20% load was significantly higher than that with 10% load for all five body parts. The reason behind this is whenever students carry the heavy load of backpack, they lean forward to balance the weight of the backpack and this may cause the discomfort in body segments such as neck, shoulder, upper back, and lower back. Continuous use of the heavy backpack load may cause the injury in the body segment.

The result of this experiment was solely from the measurement data of user discomfort collected by the questionnaires. The scope this study can be enlarged by making use of the changes in the Cervicothoracic angle. This experiment can be done by using image analysis method. This will provide real time deflections in body segments and hence the results will be explicit.

The postquestionnaire showed that participants with an approximate range of body weight 100-120 lbs. experienced the most discomfort in their

neck and shoulder. Whereas participants with the range of body weight around 160-180 lbs. experienced less discomfort in their neck and shoulder throughout the experiment. Almost all the participants did not feel any discomfort in their knees during the experiment. During the experiment, it was observed that one female participant who weighs in range of 100-120 lbs was not able finish the experiment when the weight of the backpack was more than 15% of the total body weight.

CONCLUSION

In conclusion, the research found that the backpack load significantly affects the user discomfort when student walk carrying the backpack. The research should have practical meaning to decide the appropriate weight of the students' backpack and develop a more user-friendly design.

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