

Backpack Carrying Behaviors & Associated Discomforts Among University Students: A Pilot Study



Ruby Rogers, Bandar Sayyad, & Arijit Sengupta

Occupational Safety and Health Engineering Program, Department of Mechanical & Industrial Engineering
New Jersey Institute of Technology, Newark, NJ 07102

Abstract

This study serves to identify the relationship between backpack weight, carrying frequency and duration, method, and perceived discomfort levels among university students. A survey (n=86), containing 14 questions, was sent out through social media targeting university students, who carry backpacks at least once a week. The average estimated weight of backpacks was 13.4 pounds, and on the average, male students carried 7% of their body weight, and female students carried 9% of their body weight. Backpack weight inversely varied with age. On a 0-5 point scale, the level of muscle tightness, ache, pain or discomfort (MTAPD) during bag carriage was 3 or higher for 46% of the cases. Location of MTAPD was reported in shoulder, lower back, neck, middle back, and upper back region 48%, 18%, 16%, 10% and 8% of times, respectively. Students with backpack positioned on the upper back were least likely to experience MTAPD, but this position reported highest average MTAPD level of 2.9, as compared to positions on lower back, and carrying one sided, 2.5 and 2.6, respectively. Position of backpack may have significant effect on comfort and should be further investigated. MTAPD during the bag carriage was reported by 77% of female students as opposed to 47% male students. Higher percent of female students complained long term MTAPD that lasted few hours (46%), few days (12%), interfered with their ability to pursue academic activity (46%), and interfered with their daily routines (35%). The corresponding figures for males were significantly smaller, 23%, 7%, 45% and 35%, respectively. These results indicate female university students are more vulnerable, and guideline related load limit should be developed based on female students' ability to carry backpack comfortably.

Objective

To study backpack carrying behaviors of university students in terms of weight, duration, frequency, method, and perceived discomfort, and analyze the effect of demographics, such as gender, height, and weight of the students. The desired result of this study is to use this data as a foundation to introduce a new guideline that can reduce the development of muscle tension or muscle pain and recommendations for most effective backpack design.

Method

The survey was distributed through email and social media. The answers were collected through a form created on Google Docs. Many of the questions developed for the survey were based on musculoskeletal discomfort survey from Cornell University's Ergonomics Web <http://ergo.human.cornell.edu/>. In addition, many demographical questions were asked as well. Participants were asked to complete the survey if only they used a backpack on a weekly basis.

Result

Table 1. Characteristics of population (n=86)

Variable	Statistics Mean (Range)
Age, years	23 (18, 28)
Male n, %	60, 70%
Female n, %	26, 30%
Male Height, inches	69 (64, 75)
Female Height, inches	64 (60, 68)
Male Weight, pounds	183 (122, 244)
Female Weight, pounds	143 (99, 187)

Table 2. Relative backpack weight and gender

	Female	Male
Avg. Wt. (lbs)	143	183
Backpack Wt. (lbs)	13	14
% wt.	9%	8%

Table 3. Areas of reported muscle tightness, ache, pain, or discomfort versus the backpack position

Position on back	Shoulders	Neck	Upper Back	Middle Back	Lower Back	Legs
High	5	2	0	1	0	0
Middle	6	1	3	2	6	1
Lower	7	2	1	1	3	0
One sided	4	3	0	1	0	0
Sum	22	8	4	5	9	1
%	45	16	8	10	18	2

Table 4. Bag position and level of muscle tightness, ache, pain, or discomfort (scale 0-5)

Position on back	No		Yes		Pain level
	n	%	n	%	
High	17	59	12	41	2.9
Middle	12	39	19	61	2.9
Lower	2	15	11	85	2.5
One sided	7	54	6	46	2.6

Figure 1. Participants' age versus weight of backpack

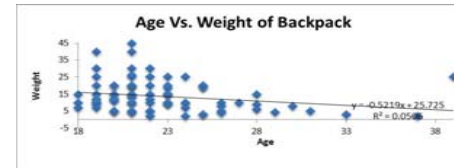


Figure 3. Gender and reported muscle tightness, ache, pain, or discomfort

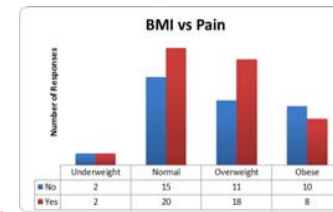


Figure 4. Carrying duration and muscle tightness, ache, pain, or discomfort

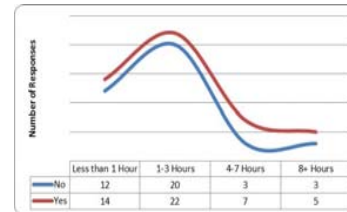


Figure 5. Reported muscle tightness, ache, pain, or discomfort on a 1 - 5 scale

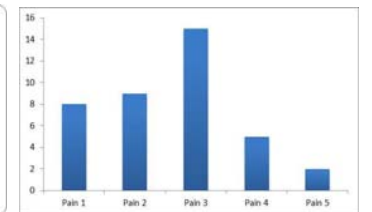


Table 5. Long term discomfort from bag carriage

Response	Female		Male	
	n	%	n	%
Yes, for few hours	12	46	14	23
Yes, for few days	3	12	4	7
None	11	42	42	70

Table 6. Long term discomfort from bag carriage interfering with academic activity

Response	Female		Male	
	n	%	n	%
Yes	9	35	10	17
No	17	65	50	83

Table 7. Long term discomfort from bag carriage interfering with any aspect of daily routine tasks

Response	Female		Male	
	n	%	n	%
Yes, sometimes	15	58	22	37
None	11	42	50	83

Conclusion & Recommendation

- Female participants were 1.7 times more likely to experience discomfort from backpack carriage. This can partially attributed to higher muscle mass in the males over the females, but may also have been influenced by the cultural expectations from society.
- The average level of pain was higher for upper back and middle back as compared to the lower back placement. The area of the body where the most pain was experienced was in the shoulders.
- Use planning and good judgment with regards to how much they really need in their backpacks on a daily basis. Female students' capacity to carry backpack comfortably should be a priority in setting guidelines for the maximum limit of backpack weight.
- A moment-arm reduction, in terms of placement of the backpack on the spine, will result in overall less pain through carrying time. Designers should consider using cushioning, designed specifically to fill in the gaps between the bag and the body, as this may aid in decreasing the impact caused by a backpack repeatedly hitting an individual's spine during use.

References

- Heuschler, Z., Gilkey, D. P., Peel, J. L., & Kennedy, C. A. (2010). The association of self-reported backpack use and backpack weight with low back pain among college students. *Journal of Manipulative and Physiological Therapeutics*, 33(6), 432-437.
- Palmer, K., Bauer, D. H., Bowman, A., & Magleby, J. (2011). The effect of backpack weight and position on subject discomfort and forward trunk lean for college students. Paper presented at the *Proceedings of the Human Factors and Ergonomics Society*, 2005-2009.
- Hung-Kay Chow, D., Kit-Fong Hin, C., Ou, D., & Lai, A. (2011). Carry-over effects of backpack carriage on trunk posture and repositioning ability. *International Journal of Industrial Ergonomics*, 41(5), 530-535.