STYLES AND FEATURES OF BACKPACKS USED BY CHIROPRACTIC STUDENTS

Jonathan Bryson, DC[1], Lori Beth Bryson, DC[1], Brent Russell, MS, DC[2]

ABSTRACT

Objective: The use of backpacks by students may contribute to a number of painful conditions, although there are design features that help make backpacks more ergonomic. The purpose of this study was to investigate styles, features, and weights of backpacks commonly used by chiropractic students.

Methods: DC students who regularly used a backpack as a book bag were invited to complete a survey and have their backpacks inspected. The survey asked for demographic information, perceived comfort level, and about typical backpack load. Backpacks were inspected for frame type, overall condition, and types of features (e.g., hip belts and load-distribution straps.)

Results: Thirty-nine eligible students participated. Their loaded backpacks weighed 6.3 kg, on average. Only 1 had a frame, and only 1 had a hip belt. Several had sternum straps or compression straps, but few students used them. Only 1 student considered ergonomic support in acquiring their backpack; however, only a few reported their packs to be uncomfortable.

Conclusion: While chiropractors, as a profession, have expressed concern over injuries attributable to backpacks, and previous research has suggested structural features to make backpacks more ergonomic, chiropractic students may not apply those suggestions. *(J Contemporary Chiropr 2022;5:259-263)*

Key Indexing Terms: Adult; Equipment Design; Backpacks; Musculoskeletal Pain; Back Injury; Postural Balance; Weight-Bearing.

INTRODUCTION

There has been much written in the popular press about the potential negative effects of students and heavy backpacks used as book bags. More recently, remote learning has been a major focus of attention, so backpacks have received less scrutiny. Yet, with the return to in-person learning, students still use backpacks.

Students in the Doctor of Chiropractic (DC) program at Life University often begin classes at 7:00 am and may remain on campus until 7:00 pm, or later, if they have late afternoon classes and stay to study or attend meetings of student organizations. DC students regularly carry laptops, tablets, phones, food, changes of clothing, textbooks (even in an age of digital learning), and numerous other items in their backpacks. During their training to become doctors concerned with muscular and neurological injury, ergonomics, and health promotion, among other issues, many students appear to use backpacks that are heavily loaded and may cause poor posture.

The effects of load carriage using backpacks has been a topic of multiple investigations. Golriz compiled numerous symptoms and conditions attributed to backpack use, including pain in the low back, neck, thoracic region, and shoulders, as well as upper limb discomfort, brachial plexus lesions, and winged scapulae. (1,2) Blacker commented on neuromuscular impairment following load carriage as likely to have a negative impact on performance of strength, endurance, and motor control tasks. (3) The study noted that additional load increases ground reaction forces, likely resulting in increased mechanical damage to muscle tissue. (3)

Studies of schoolchildren have found that many have backpack-related pain and fatigue (4,5) and undesirable postural attributes. (6-9) Excess load is often blamed, with several studies suggesting more than 10% of body weight (BW) is problematic. (1,5-7,9) Furthermore, reductions in weight carriage have been associated with lower severity of back pain (5) and improvement of posture. (8)

While some studies have focused on elementary and middle school-aged children, Cho reported more than 77% of female college students as having backpack-related musculoskeletal complaints (10) Lehnen studied healthy university students carrying backpacks and observed postural alterations and increased variability in a number of spatio-temporal gait parameters, and suggested that young adults, not just schoolchildren, should limit their loads to 10% BW. (9)

Wettenschwiler found higher forces of shoulder straps significantly contribute to discomfort and that the region where a backpack's hip belt is supported by the upper pelvis

[1] *Private practice of chiropractic, Ocoee, TN*
[2] *Sid E. Williams Center for Chiropractic Research, Life University, Marietta, GA*

was much more tolerant to higher loads. (11) Grimmer commented that most backpack brands and models are limited in selection of sizes and strap adjustments, and lack internal framing or back support, compartments to separate and distribute loads, waist or chest straps, and load compression features. (12) Even then, in 2002, there were backpacks available with ergonomically designed internal frames and a strap system to shift much of the load to the pelvis. In 2018, Oberhofer considered hip belts to have become "state-of-the-art" for backpacks. (13) Hip belts may carry as much as 1/3 of the vertical load (14), can help stabilize backpack load closer to the body (13) and help to coordinate movements of the backpack with those of the trunk. (15)

Our study looks at professional-level college students – specifically chiropractic college students – using backpacks as bookbags. We have casually observed such students often using frameless pack models with little structural support, in which the load is carried on the shoulders. The purpose of this study was to formally investigate styles, features, and weights of backpacks commonly used by chiropractic students.

METHODS

At Life University, DC students take final exams at a central location and have a monitored classroom where they are able to leave personal belongings, including their backpacks. Starting shortly before 2 separate exam sessions on the same day, posters and personal requests were used to invite students to come after their exam to an adjacent classroom to complete a survey and have their backpacks inspected and weighed. Students were considered eligible to participate if they self-declared to regularly use a backpack loaded with books and other items as might be typical for a student book bag, and if they had the backpack with them at the time. The interest of this study was in backpacks designed to be worn symmetrically across the back using 2 shoulder straps; those students with briefcases, messenger bags, or single-strap bags meant to be worn diagonally across the torso were not eligible. A survey instrument was created by the investigators and consisted of a short questionnaire and checklist. Each backpack was inspected for brand, model, frame type, and overall condition, and a number of features were recorded (Table 1.) Each participant was asked about age, gender, height, weight, perceived comfort level with their backpack, and whether they considered their backpack load that day to be typical, or heavier or lighter than usual. For backpacks that had hip belts or other load-distribution straps, participants were asked whether they use them. Additionally, participants were asked why they chose that particular backpack or whether it was received as a gift. Afterward, backpacks were weighed using a hand-held scale designed for weighing fish, hung from a wooden support frame built specifically for the project. Data were compiled from the handwritten questionnaire and checklist forms in an Excel spreadsheet by one investigator and verified by the others. All procedures were approved by the Life University Institutional Review Board.

RESULTS

Thirty-nine eligible students completed the survey process and had their backpacks inspected and weighed. There were 19 females and 20 males, with a mean age of 27.0 (4.6), range of 22 – 43 y. Participants weighed, on average, 80.3 kg (18.7), with backpacks weighing 6.3 kg (1.9), on average. Backpack percentage of body weight averaged 8.2% (2.7). And, although the assessments were done on a final exam day rather than a normal class day, most participants declared their pack weight that day to be "typical," with the remainder evenly split between "heavier" or "lighter."

Only 1 backpack had a true internal frame, and 7 others had stiffening materials that added minimal structural support. Only 1 pack had a hip belt designed to carry load at the top of the pelvis; 15 others had thin straps at the hip level, but only 1 participant reported its use. Nineteen backpacks had sternum straps, but only 7 participants reported using them. Twelve packs provided compression straps, but only 1 participant reported its use. None of the packs had stabilizing load-lifting straps.

Most participants stated that either they found their packs to be comfortable or that they did not notice, with only a few describing their packs as "very comfortable" or "uncomfortable." Participants provided a number of primary and secondary reasons for why they had their particular pack (price, perceived durability, perceived comfort, load capacity, style, appearance, brand name, availability, or received as a gift), but only 1 cited "ergonomic support" as a reason.

DISCUSSION

Most students in the sample had backpacks that lacked features recommended by Grimmer concerning construction – a design capable of keeping the load close to the spine and high, rather than being carried on the buttocks and hips – and adjustability, with internal compartments for load distribution, waist and chest straps, and load compression straps. (12) In other words, most students' backpacks lacked the structural support regarded as useful for minimizing discomfort or injury.

A number of studies have examined complaints of pain in chiropractic students, though generally in the context of whether injuries occur as a result of providing or receiving spinal adjustment procedures. (16-18) Other factors may contribute; keeping within the context of this report, such factors may include non-ergonomic

Table 1. *Results from backpack survey, inspection, and weighing procedure.*

Age & Gender	27.0 (4.6); 20 male, 19 female
Participant weight (kg), mean (SD)	80.3 (18.7)
Pack weight (kg), mean (SD)	6.3 (1.9)
Pack mean % of body weight, mean (SD)	8.2% (2.7)
Support frame	Yes (true frame): 1, Yes (minimal): 6; No: 32
Hip belt	Load bearing: 1, Non-supportive: 15, None: 23 Have and use hip belt: Yes: 1, No: 15
Sternum strap	Yes: 19, No: 20 Have and use sternum strap: Yes: 1, No: 18
Compression straps	Yes: 12, No: 27 Have and use compression strap: Yes: 1, No: 11
Stabilizing, load-lifting straps	Yes: 0, No: 39
Pack weight today compared to everyday?	Lighter: 7, Typical: 25, Heavier: 7
Perceived comfort level	Very Comfortable: 5, Comfortable: 14, Don't notice: 12, Uncomfortable: 8
Primary reason for selection of pack	Price: 9, Durability: 9, Comfort: 7, Load capacity: 5 Style, appearance, brand, availability, or gift: 8, no specific reason: 1
Secondary reason for selection of pack	Durability: 3, Comfort: 2, Load capacity: 2, Ergonomic support: 1, No secondary reason: 31

backpacks. The issue is not trivial – Hodgetts pointed out that injuries to chiropractors early in their careers could have a significant long-term impact on their personal lives and professional careers. (19)

Chiropractors have professional reasons to be concerned about backpacks, and there are structural features recognized as contributing to better backpack ergonomics. So, why don't chiropractic students use better backpacks, such as those with frames? They may not be aware of the issue or the alternatives. Cost and availability would likely be barriers as well. The cost of backpacks with supportive frames and quality hip belts is higher, and big-box retail stores may not have a selection of such packs, if any at all, and sports and outdoors stores that are likely to carry them may not be widely accessible.

It is not difficult to find chiropractic practice websites that warn about the dangers of excessively loaded backpacks and offer recommendations for pain and injury prevention. And the American Chiropractic Association has, at times, endorsed certain brands of backpacks. According to the Vera Bradley company, "The ACA now endorses five of our smart styles for their innovative functionality and body-healthy features." (20) At the time of this writing there are 13 backpacks on the company's online retail site advertised as being endorsed by the ACA. Some, such as the Military Campus Backpack and the XL Campus Backpack, have padded shoulder straps and an adjustable chest strap. The online descriptions of most other models, such as the Campus Backpack and the Grand Backpack, do not include those features. None seem to have a hip belt or other weight distribution features. However, the models with the padded shoulder straps and an adjustable chest strap range in price from $145 to $190 and thus cost as much as some internal frame backpacks.

It seems logical that, if a substantial amount of weight is to be carried, some compensation in posture may be required. Informal observations suggest some postural differences between backpack styles can be seen with the naked eye (Figure 1.) In our experience, even untrained observers have commented that common frameless packs cause a greater degree of overall forward flexion. As a follow-up, we have carried out a formal investigation of movement patterns during walking with ergonomically designed internal frame backpacks as compared to frameless backpacks, which will be reported separately.

Limitations

Our sample size was small. The number of participants recruited was limited by the circumstances, and it would be inappropriate to assume these findings would generalize to other chiropractic institutions or students of other professions. However, the findings were consistent with casual observations.

The survey instrument was created by us specifically for this study and neither its validity nor reliability have been examined.

Carrying out the questionnaire and weighing procedure during final exams was driven by scheduling and accessibility; it would have been preferable to conduct the study during everyday conditions. It cannot be certain that students' subjective impressions were truly typical for daily class conditions, or whether their backpack weights were typical, or heavier or lighter than usual. We expected that pack weight would be lower than usual, during final exams, because students knew they are not allowed to bring personal belongings into the testing center. However, as part of the initial explorations of this project, we had informally weighed several students' packs, finding an average of 6.5 kg (range of 5-10 kg), which was only slightly higher than the final exam weight of 6.3 kg.

Figure 1. *In A and C, the primary authors are wearing the same frameless back. In B and D, they are wearing internal frame backpacks of size appropriate for their respective body heights.*

CONCLUSION

The use of backpacks may contribute to a number of painful conditions. Chiropractors, as a profession, have expressed concern over injuries attributable to backpacks, and previous research has suggested structural features to make backpacks more ergonomic; however, chiropractic students may not apply those suggestions. Better backpacks could potentially contribute to better musculoskeletal health for chiropractic students.

ACKNOWLEDGMENTS

The authors appreciate the literature search assistance provided Alma M. Ayala Diaz.

CONFLICTS OF INTEREST

The study received no funding, aside from internal institutional support, and the authors declare no conflicts of interest.

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