# Backpack Intelligence: Implementation of a Backpack Safety Program with Fifth Grade Students

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## INTRODUCTION

Backpack use by children is a prominent school health issue in the United States and other Western countries. Many children are carrying heavy backpack loads that proportionally exceed legal occupational limits established for adults.[1-4] Although the link between backpack use and injury has not been definitively established, the incidence of pediatric back pain is approaching rates seen in adults.[5] This translates into a pediatric public health concern since a history of back pain is a predictor of future episodes, and adults with back problems experience high medical costs, lost wages, and personal suffering.[6-8]

Over the past 5 years, there has been a plethora of media coverage on the potentially harmful effects of backpack use by children. This has heightened parental concerns, which in turn has precipitated the formation of school backpack committees and requests to school administrators for action. Legislators in the United States also have been moved into action, and several states, following California's lead, are proposing laws limiting backpack loads.

Schools are an optimal environment for addressing pediatric public health issues, and it is appropriate for physical therapists to take a leadership role in this arena. Physical therapists have the unique educational background to evaluate postural alignment, musculoskeletal dysfunction, and risk of injury as well as teach injury prevention and wellness educational programs for children and adolescents. Therefore, the purpose of this article is to describe a backpack educational program and its implementation with a class of fifth grade students.

## *Backpack Intelligence* CONTENT

*Backpack Intelligence* is an injury prevention educational program, developed by the author who is a licensed physical therapist, educator, and researcher with 30 years of pediatric experience. Its content is based on pertinent research literature on the effects of backpack use,[9-27] theories of behavior change,[28-31] and learning.[32-34] *Backpack Intelligence* consists of 3 areas of student education: (1) recognition when a backpack is too heavy, (2) identification of desirable backpack features, and (3) instruction in the proper way to wear and pack a backpack. It is adapted to the developmental level of the students and revised regularly to reflect new research elucidating the effects of school-related backpack use.

The educational program can be implemented in one or more educational sessions, and can be integrated into the physical education or health education curriculum. Another option is to integrate the programming into the math or science curriculums by incorporating calculation of percent body weight (the percent the backpack weighs in relation to the weight of the child), work or energy expenditure, statistical analyses, and graphing into existing learning modules.

Facilitating substantive and long-lasting changes in behavior is challenging. Students need to believe that there is a risk of serious injury, have the knowledge and the resources to reduce that risk, and believe that changes in their behavior will make a difference.[28-31] The school and home environment also need to support and supplement these changes. Physical therapists, therefore, need to work cooperatively with school officials and parents. For success, the *Backpack Intelligence* program needs to be integrated with school infrastructure policies and active support from teachers and parents.

### Recognizing When Your Backpack is Too Heavy

Since experts do not agree on a maximum safe backpack weight for children to carry and percent body weight does not take into account the child's height, body fat, or muscle strength, the *Backpack Intelligence* program teaches children to recognize warning signs that their backpack is too heavy. Five warning signs are presented that reflect difficulty handling the backpack load. These include: (1) struggling to put on or take off the backpack, (2) pain when wearing the backpack, (3) tingling or numbness, (4) red marks, and (5) noticeable changes in posture. Within this module, basic body and backpack biomechanics are explained through discussion, demonstration, and handouts. Students learn how postural changes are compensatory mechanisms for changes in their center of gravity and how a heavy backpack load may cause postural malalignment, muscle fatigue, and impaired shock absorption leading to increased risk of injury.[12-14,22-27] In addition, students are taught how the combination of a too heavy backpack and shoulder straps that are too wide or not contoured can cause compression to the brachial plexus, resulting in upper extremity tingling or numbness.[11]

### Choosing Desirable Backpack Features

Most backpack companies have a variety of backpack models developed for school use, each with different features for enhanced safety and comfort. Children are taught to match the size of their backpack to the length of their torso, and that backpack shoulder straps need to allow free arm movement. Since it is tempting to fill backpacks to their full capacity, students are cautioned about backpacks with extra large capacity.

Desirable backpack features are displayed using a backpack that has all of the recommended features. A padded back is recommended to reduce pressure on the back and enhance comfort. Two contoured and padded shoulder straps reduce pressure on the shoulders, and permit free movement of the arms. While the one-strap diagonal shoulder bag is not problematic when the load is light, 2 straps are required when the backpack is heavier to distribute the weight more broadly and promote symmetrical posture. Hip and chest belts, rarely worn by children or adolescents outside of hiking, are highly recommended when the load is heavy because they transfer part of the backpack weight from the back and shoulders to the hips and torso. Multiple compartments not only enhance access to the contents, but they better distribute the weight in the backpack, and keep items secure. A key feature, not standard on backpacks, is compression straps. These are cinch straps that compress and stabilize the contents, and thereby shift the load as close to the back as possible.

Students are also warned not to hang items from the back of the backpack, since items have become caught in doors and escalators, causing serious injuries. Another safety feature is reflective material to enhance visibility of the students to drivers at night. Also, for wheeled backpack use, it is important that the wheels pivot 360° for safe turning and that they are sufficiently large so that the backpack does not topple. For tall adolescents, the handle needs to extend sufficiently to prevent trunk flexion and rotation, a position in which the back is particularly vulnerable to injury.[6] Last, students are cautioned that a wheeled backpack is heavier than a canvas one, so it is not desirable if the student will often need to lift and carry the backpack on stairs or narrow areas like bus aisles.

**Wearing & Packing Your Backpack Properly**

To enhance postural symmetry and distribute weight of the backpack evenly, students are taught to use both shoulder straps and wear the backpack close to the back.[1,2,4,6,9,10,12,26] As stated previously, hip and/or chest belts are recommended to transfer part of the weight of the backpack from the back and shoulders to the hips and or chest. This also makes the backpack more stable. Since a flexed and rotated posture has been associated with the highest incidence of adult occupational back injury,[6] proper lifting and lowering of the backpack during donning and doffing should be included in the program.

Many children in the United States prefer to wear their backpack very low on their torso. It is easier to don and doff the backpack when the shoulder straps are in this lengthened position, and weight felt over the back is reduced. One recent study reported that trunk forward flexion was reduced when the backpack was worn in a lower position compared with a high placement near C7.[17] The dependent measure was posture during standing, with a maximal backpack weight of 10% body weight. This weight is below that typically worn by children in the United States,[13] and it has been shown that trunk forward flexion is a nondose dependent, compensatory strategy.[12,14] Therefore, posture alone should not be used to judge safe load limit. Also, research is needed to examine if the low backpack position places increased stress on low back musculature or shoulders, or if the backpack is less stable when the child walks or runs.

Until definitive research is available, the *Backpack Intelligence* program encourages students to raise their backpack to a more stable, mid-back position with both shoulder straps to distribute the weight evenly. A 'see-saw' example is used as an analogy to help students understand the dynamics. Students are asked to recall when they played on a see-saw. The same physics that affected their ability to lift the other child by moving backwards on the board is at work when a backpack is worn. In addition, when packing the backpack, students are instructed to place the heaviest items closest to the back.[1,2,4] This moves the weight of the backpack closer to the child's base of support. Last, students are advised to limit the backpack weight to what they can carry comfortably.[20,24,25]

**IMPLEMENTATION**

Concerned about backpack safety, a fifth grade teacher from a Massachusetts suburban public elementary school contacted the author and requested that her class participate in the program. This was approved by the teacher's school principal and the town's superintendent. Twenty-two 5th grade students, consisting of 15 boys and 7 girls ranging in age from 10.5 to 11.5 years, participated in the *Backpack Intelligence* program. All children volunteered to participate in the class, and had signed consent forms from their parents to be photographed and videotaped during the session.

Students actively participated in their *Backpack Intelligence* session by completing worksheets on recognizing warning signs that the backpack is too heavy, desirable backpack features, and how to wear and pack a backpack (Appendix 1). To enhance learning, the information was introduced to the children in a manner that made it fun, given their developmental age, and completion of the worksheet was interactive. Children actively participated by raising their hands based on their responses to the worksheet questions, demonstrating backpack use, and sharing personal experiences or problems encountered when using their backpacks. Students also weighed themselves with and without their backpack using standard analog scales. To integrate math into this experience, calculators were provided by the classroom teacher. Students were taught the formula for percent body weight, and assistance in calculating this score was provided as needed. To enhance reliability, scales were calibrated prior to the session. In addition, to assure privacy, the scales were placed strategically in the room and only one student was allowed to weigh himself at a time. To enhance validity of the weight in the backpacks, the program was scheduled during the first period in the morning. As soon as students arrived at school, they were instructed to not unpack their backpacks.

After completing the worksheet, students tallied their answers, and used the *Backpack Intelligence* scoring guide to assess their knowledge (Appendix 2). Although only one student volunteer was requested, all of the students wanted to have 'before' and 'after' pictures taken, showing how they learned the correct way to use their backpacks. The photographs and key *Backpack Intelligence* content were organized into a poster using Microsoft PowerPoint. The poster was hung outside of the school's main office, and standard letter-size copies were distributed to the children to bring home to share with their parents. The class also was videotaped by the teacher, and aired on their local cable station.

***Backpack Intelligence* WORKSHEET RESULTS**

Nearly three-quarters of the students, 73%, reported 3 or more warning signs that their backpack was too heavy (Figure 1). The 3 most frequently reported 'red flags' were changes in posture, pain, and red marks. While the majority of students had backpacks with multiple compartments (95%) and a padded back (82%), only 27% had compression straps. Also, only 50% of students had backpacks with contoured shoulder straps.

When asked how they used their backpack, most students reported to use both straps (Figure 2). However, few students reported use of hip or chest belts, and less than a quarter of the students reported to wear their backpack between the bottom of their neck and the curve of their low back. In addition, only a little more than half of the students reported to organize the articles with the heaviest items closet to their backs.

Mean backpack weight for the students on the day of the program was 15 pounds. In spite of the fact that all of the children have the same teacher and same homework assignments, there was a wide range in backpack weight from 3 pounds to 35 pounds. Two-fifths of the students, 41%, were carrying backpacks weighing greater than 15% of their body weight, the maximum weight limit recommended by many health professionals. It was troubling to find that at their young age, 6 of the 22 children had already sustained a back injury serious enough to require them to see a physician, miss school, or refrain from sports participation. Further, 5 of these 6 children, reported recurrence of the problem.

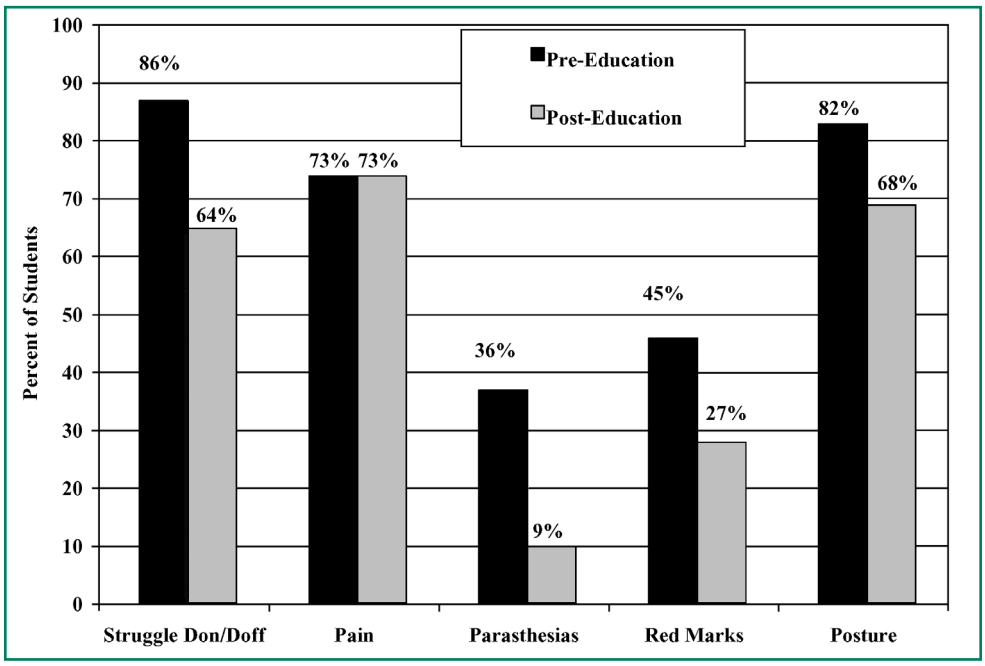


**Figure 1. Warning signs that backpack is too heavy.**

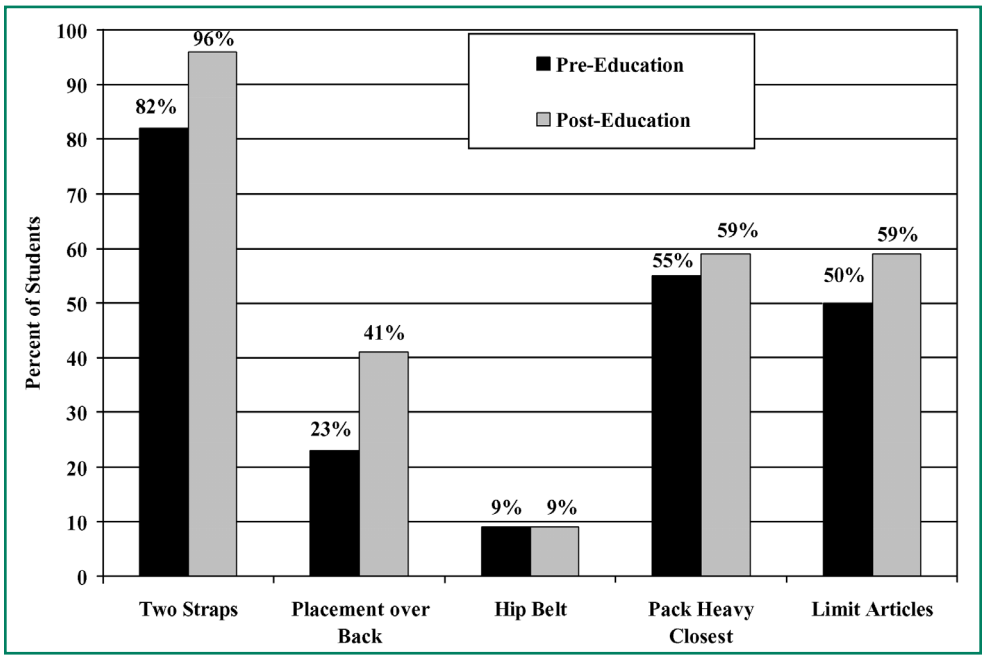


**Figure 2. Backpack usage.**

## PROGRAM EVALUATION

To evaluate the effectiveness of the *Backpack Intelligence* program, students completed a post-education survey at school a few weeks later. The questionnaire included demographic information, current backpack usage, history of back pain and recurrence, self-reported knowledge of backpack safety, behavior changes as a result of the programming, and belief that improper backpack use can cause injury.

All of students reported to be knowledgeable about backpack safety post-education, an increase of 55%, and the majority, 77%, reported that they believed improper backpack use could cause injury. There also was a 23% reduction in the number of warning signs indicating that their backpacks were too heavy (Figure 1). Reductions were noted for every warning sign except for pain.

All but 2 students reported that they changed or planned to change the way they used their backpack as a result of the educational session. The 3 most commonly reported changes in behavior, in order of frequency, were lifted backpack higher or closer to back, packed heaviest items closest to back, and reduced backpack weight by prioritizing items carried. As seen in Figure 2, students improved in safe use of their backpack in every area except for use of a hip belt.

## DISCUSSION

Research findings have revealed that school-aged children are carrying heavy backpack loads, that backpacks are uncomfortable to carry, and that the incidence of back problems in school-aged children is high.[13,25] Therefore, the purpose of this article was to describe a school-based backpack injury prevention program and its implementation in a fifth grade setting. Supporting the need for a backpack safety program, nearly three-quarters of the students reported 3 or more warning signs that their backpack was too heavy and about half of the students reported that they did not know how to safely use their backpacks.

*Backpack Intelligence* was well received by the students, teacher, principal, and parents. Many students gained knowledge, heeded advice, and changed their backpack behavior. All of the students felt knowledgeable about backpack safety post-education, and all but 2 students changed or planned to change how they used their backpack.

Backpack safety requires a broad health perspective. Substantive changes can not be expected to be long lasting through one isolated, educational session, and it is unsound to put the full burden of backpack safety on children. Institutional policies that support backpack safety need to be implemented, school staff need to value injury prevention and wellness promotion, health professionals need to be informed and involved, and for elementary school-aged children, parental involvement is a key component.

## COLLABORATION WITH SCHOOLS AND PARENTS

Strategies that supplement *Backpack Intelligence* include a second set of textbooks for the classroom, reduction in daily supplies that children are required to carry, use of folders rather than binders, increased time for locker use at the middle and high school levels, and paperback rather than hardcover texts or texts in volumes. If volumes are used, costs for books can be further reduced by teachers within a grade alternating use of particular volumes. Availability of texts on CD is limited at this time, but in the future, this may be a viable strategy. Parents can further support backpack safety efforts by helping their children choose backpacks with desirable ergonomic features. In addition, parents can monitor proper packing of the backpack so that the heaviest items are closest to the back and items needed that day only are carried.

Some of the recommended strategies require additional funding and others require teacher flexibility and administrative support. School-based backpack health promotion interventions need to take into consideration the challenges faced by the school's principal and teachers. These include striving for academic excellence which often increases texts and supplies required for homework and decreases time for locker use. In addition, at the middle and high school levels, schools may lack a sufficient number of lockers due to overcrowding, or in some cities, lockers have been removed as a violence prevention strategy. Formation of a school backpack committee, teaming parents, school officials, and health professionals, provides an excellent forum for education and planning of backpack safety initiatives.

**CONCLUSIONS**

Physical therapists, in cooperation with school personnel and parents, are compelled to safeguard the health of our children and provide backpack safety programs. These programs should be based on the best research evidence available, designed using behavior change and learning theories, and adapted to the developmental age of the target audience. *Backpack Intelligence* is an example of a program that meets these criteria, and physical therapists are encouraged to assume leadership in school-based injury prevention and wellness promotion.

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**Appendix 1. Backpack Intelligence Worksheet**

**Section A: How heavy is your backpack?**

**Check the box to answer "Yes."**

- ❑ Do you struggle to put on or take off your backpack?
- ❑ Do you have back, neck or shoulder pain when you are wearing your backpack?
- ❑ Do you have tingling or numbness down your arm or hand?
- ❑ Do you get red marks on your shoulders from the backpack?
- ❑ Do you have to change your posture (lean forward or to the side) to keep your balance when you're wearing the backpack?

How many questions did you answer 'Yes"? _____

**Section B: Which backpack features do you have?**

**Check the box to answer "Yes."**

- ❑ Two contoured (curved) shoulder straps that allow your arms to move freely as you walk, and that are wide and padded to disperse the weight of the backpack across your shoulders.
- ❑ Padded back for comfort.
- ❑ Multiple compartments to better distribute the weight.
- ❑ Hip or chest belt to transfer the weight from your shoulders to your torso/hips, and to stabilize the backpack.
- ❑ Compression straps to secure and stabilize the articles in your backpack.
- ❑ Reflective stripping to enhance your visibility at night so drivers can see you.

How many features do you have? _____

**Section C: How do you wear your backpack?**

**Check the box to answer "Yes."**

- ❑ Do you always use both straps of your backpack?
- ❑ Does your backpack rest on your back, between your neck and the curve of your low back?
- ❑ Do you use a hip belt?
- ❑ Do you use a chest belt?
- ❑ Do you organize the articles in the backpack so that the heaviest/biggest articles are closest to your back?
- ❑ Do you only carry the articles that you are required to have that day?

How many questions did you answer "Yes"? _____

**Appendix 2. Backpack Intelligence Scoring Guide**

**Is my backpack too heavy?**

There are 5 red flags to help you recognize when your backpack is too heavy: (1) Struggling to get the backpack on or off, (2) Pain when wearing the backpack, (3) Tingling or numbness, (4) Red marks, and (5) Changes in posture. Individuals with high backpack IQ recognize when their backpack is too heavy. If you answered 'yes' to questions in Section A, then your backpack is probably too heavy. That means, you need to LIGHTEN the backpack!

**Is my backpack well designed?**

If you answered 'yes' to the questions in Section B, then your backpack is well designed for comfort and safety. When it is time to go shopping for a new backpack, individuals with high backpack IQ look for these ergonomically designed features. Bring along the books etc. that you usually carry in your backpack. Try on the backpacks with the typical weight & articles that you usually carry, so you will know for sure how it feels and if the articles fit in. Resist buying a backpack that is extra large, because you'll be tempted to carry more than you really need to. Use the compression straps to keep articles stable inside the backpack. These are the ergonomic features to look for:

- Two contoured (curved) shoulder straps to allow your arms to move freely as you walk and to disperse the weight of your backpack across both shoulders.
- Padded back for comfort.
- Multiple compartments to better distribute the backpack weight.
- Hip and or chest belts to transfer the weight from your shoulders to your torso & hips, and to stabilize the backpack.
- Compression straps to secure & stabilize the articles in backpack, and bring the weight/contents in backpack closer to the back.
- Reflective stripping for visibility at night.

**Am I wearing my backpack correctly?**

Individuals with high backpack IQ wear their backpack correctly to promote wellness and prevent injury. The more questions that you answered 'yes' to in Section C, the higher your backpack IQ. Remember to:

- Use both straps of the backpack to keep your spine symmetrical (straight).
- Place the backpack between the bottom of the neck and the curve of the low back so that the largest, strongest back muscles are used. If you currently wear your backpack very low, raise the backpack a little bit at a time.
- Organize articles in the backpack so that the heaviest items are closest to your back to reduce muscle work. Lighter articles, like lunch or clothing can be placed on top of books or in compartments further away from your back.
- Bend your knees when lifting your backpack, and do not swing the backpack to put it on or take it off because this can hurt others that are nearby and or cause torsion injuries to your back.
- Do not let straps or items hang from the back of the backpack. These can get caught in car/bus doors, escalators or electric closing doors, and have resulted in tragic accidents.

Backpack Safety. Backpacks come in all sizes, colors, fabrics, and shapes and help kids of all ages express their own personal sense of style. And when used properly, theyâ€™re incredibly handy. Many packs feature multiple compartments that help students stay organized while they tote their books and papers from home to school and back again. Compared with shoulder bags, messenger bags, or purses, backpacks are better because the strongest muscles in the body â€” the back and the abdominal muscles â€” support the weight of the packs. When worn correctly, the weight in a backpack is evenly distribute Alexa, fifth grade, 5.5 pounds â€“ Alexa, a fifth-grade student at Westminster Lower School, said art is her favorite class and it doesn't require her to carry many supplies. She wishes she could stop carrying her physical education clothes, especially while they're working on swimming. Hide Caption. 12 of 33. Photos: What's inside those backpacks? Caroline, fifth grade, 8.6 pounds â€“ Caroline, a fifth-grade student at Westminster Lower School, said she uses the book she's reading for fun more than anything else.Â  CNN asked dozens of students to share what's inside their backpacks. Occupational therapist: A backpack should weigh no more than 10% of a child's body weight. (CNN).

A prominent school health issue in the United States is the use of backpacks, however, there is a paucity of literature on the effectiveness of backpack safety programs. The purpose of this paper is to describe a school-based backpack health promotion program: Backpack Intelligence, report on its effectiveness, and suggest avenues for future research. Three-hundred-seventy-two 6th and 7th grade students participated in the program which was integrated into their physical education curriculum. Of those students, 242 completed post-education surveys to assess its effectiveness. Pre-education, 44 Back to school is an exciting time for you and your kids. Itâ€™s also one of the most important times to think about safety, especially when it comes to choosing the right backpack. The style and weight of a backpack, as well as how itâ€™s packed and worn, are key components of back to school safety. Backpack Safety Tips to Protect Your Child This Back to School Season. Why is backpack safety important? Why is backpack safety important? The Consumer Product Safety Commission reports that heavy or improperly-worn backpacks cause over 14,000 injuries annually, with close to half of those injuries re Backpack 1 Unit 1 students book - Free download as PDF File (.pdf), Text File (.txt) or read online for free. Unit 1 backpack 1 students book second edition.Â  Max has a magic backpack. And out of his backpack come. five brown rulers and nine green pens! Five brown rulers! says Max.