Body Basics

A Cognitive Approach to Body Mechanics Training in Elementary School Back Pain Prevention Programs

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The assertion that training in proper body mechanics is essential to ensure the prevention of biomechanical and repetitive motion injuries has gone unchallenged for too long. The relationship between proper body mechanics and low back pain syndromes is well established.[1-4] It is understandable then that considerable time, effort, and expense has been devoted toward training programs designed to teach adults proper techniques for lifting and carrying.[5-8] While the success of such programs has been widely touted, it has recently been pointed out that "back school" approaches may have considerable limitations when it comes to effecting long-term changes in the actual performance skills of workers.[7,9,10,11] Spence, Jensen, and Shepard suggested that attention should be devoted to training young children in proper body mechanics.[12] Their rationale was based on Boulton-Davies' assertion that young children were easier to train in proper body mechanics since they did not have to alter or break inappropriate patterns of movement.[13] While Spence, Jensen, and Shepard were able to demonstrate short-term change in knowledge of students in grades 3 and 5 trained in proper lifting one week following instruction, they could not demonstrate improved lifting behavior at any point, nor could they demonstrate any lasting change in knowledge of those trained.[12]

A more recent study by Robertson and Lee showed that 10–12-year-olds (grades 5–7) were able to change both sitting and lifting behaviors in the classroom when followed by continued instruction and feedback over a six-week period.[14] Long-term data to suggest whether or not changes in behavior can be sustained following the completion of instruction was not part of the experimental design, further complicating the picture for those interested in the efficacy of early body mechanics training. It must be noted that the fundamental assumption of Boulton-Davies is without empirical evidence in spite of being widely accepted as conventional wisdom. It would be wise to exercise healthy skepticism about whether it is easier or more difficult to alter children's body mechan-

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ics than to alter the lifting habits of adults until such time as empirical evidence is available to support this assertion.

Have studies to date regarding body mechanics training of young children provided any useful information? It appears that they have. Spence, Jensen, and Shepard showed that the method of instruction—lecture as compared to discovery learning—did not affect training outcomes.[12] Robertson and Lee have shown that instruction can have a short-term effect on both knowledge and performance of students in grades 5–7.[14]

The Body Basics study discussed in this report provides some additional information to suggest that very young children, including first through fifth graders, can have relatively permanent improvements in knowledge of proper body mechanics and risk factors control for the prevention of back pain syndromes. We also present evidence that it may well be curriculum rather than instructor that determines the extent of learning from our training program. The Body Basics curriculum was designed by Richard Schwartz in San Antonio, Texas, who trained Karen Jacobs via telephone and correspondence to follow the exact curricular sequence of instruction on a separate and unrelated sample of students in Haverhill, Massachusetts.[15] This study demonstrated that as little as an hour of instruction per pupil is sufficient to alter knowledge structures concerning safety and the back, an instructional effort far more economical than that of Robinson and Lee.

PROGRAM PHILOSOPHY

The Body Basics study is remarkable and novel because it is predicated upon an approach to health and safety education that does not assume that those without proper instruction in body mechanics will have higher incidence and greater severity of injuries than those trained in body mechanics. In fact, we can find no study to empirically support this widely held view. Quite the opposite is true if one considers the original date of publication of the National Institute for Occupational Safety and Health *Work Practices Guide to Manual Lifting*, the millions of workers who have been trained to lift properly, and the lack of evidence that the incidence or severity of back injury in America has declined over the past decade.[16] We believe, in diametric opposition to others who have addressed this most serious problem, that *traditional body mechanics training cannot and will not ensure safe lifting behaviors*. Our contention is that even those who are well trained in biomechanically proper lifting, carrying, pushing, pulling, sitting, standing, and other occupational task skills will not be any safer as a result of such training unless they are willing and able to invoke such knowledge during the performance of everyday tasks. That is, it is not sufficient to merely train or teach body mechanics skills; such learning is a necessary, but not sufficient, condition for safe task performance. What has not been appreciated is the realization that effective safety education programs must also alter cognitive structures utilized in moment-to-moment decision making. Everyone knows that one should not exceed the speed limit, that one should not overeat, that one should think before acting. Yet, how often do intelligent persons, both adults and children, choose to ignore what they have learned?

The primary goal of the curriculum described here is to train very young children to make appropriate and safe decisions concerning the use of their bodies. Only a minimal amount of time is spent in actual practice of safe lifting procedures. The major emphasis is on teaching the student to make appropriate body use choices based on a conceptualization of safe lifting as that which minimizes known risk factors for injury. We believe that the purpose of training children should not be primarily to teach methods of lifting, but rather to teach them how to employ general principles of body use under less-than-ideal circumstances. In educational terms, it is important to teach the child cognitive skills that help them plan and decide when to use the knowledge they have acquired. By emphasizing that there are ways to reduce the risk of injury even when circumstances are less than ideal and by training children to make the best choices rather than having them practice any one particular type of lifting, we feel that they will then be able to benefit from any and all task-specific training in the future.

Studies of body mechanics training using grocery warehouse employees as subjects have shown that significant improvements in knowledge, productivity, and reduction of days lost due to back injury can result from as little as a single hour of training.[9,11,17] The Body Basics program was modeled directly after this very successful adult industrial training program.

HYPOTHESES

This investigation was designed to determine whether or not a standard curriculum in elementary school level body mechanics and back pain prevention program could lead to relatively permanent changes in knowledge independent of the trainer or training site. A null hypothesis of no difference in average pretest scores or posttest scores by school was evaluated. We also tested a null hypothesis that there would be no significant differences between pretest and posttest means. A final null hypothesis of no differences in scores by gender was also tested.

METHODS

Subject Selection and Evaluation

This study was conducted using 110 third grade students in San Antonio, Texas, and 31 students grades 1-6 in Haverhill, Massachusetts. The San Antonio students were trained at the request of their third grade teachers, while the Solomon Schechter Day School students were trained at the request of the investigators. No control groups were employed and all subjects received the same educational program.

Procedures

A 10-item multiple choice question evaluation instrument was used to pretest all subjects (Figure 1). Pretesting at least a day prior to training was employed to minimize the possibility that children would remember specific items and focus on these during instruction. At the San Antonio school, children were asked to take this "quiz" independently. At the Solomon Schechter Day School, however, all children were provided with the written instrument to complete while the investigator read the questions orally. The 10-item evaluation instrument had been pretested on third grade elementary school students in a school that did not participate in this study. The original version of the instrument had 15 questions, but 5 questions were eliminated due to poor wording and/or difficulty of the test group with the interpretation of the questions. A third grade teacher reviewed the questions to ensure that they were both appropriate and unambiguous.

The actual instructional sessions were approximately one hour in length. Approximately 25–30 students were trained in any given session and all sessions were conducted on the same day in each school to ensure that there would not be exchange of information between those trained and those waiting to be trained.

The outline, instructional objectives, and teaching methods for the initial Body Basics program are shown in Figure 2. The same molded plastic model of the spine, the same 35 mm slide set, and the same lecture notes were used in the present study. The only modification in the program was to simplify language used in the presentation to ensure it was at an elementary school level. Our conviction, that the goal of instruction in proper body mechanics should be to provide mental structures and knowledge needed to make appropriate body usage decisions in everyday life, also dictated that children would need to have virtually the same information as adults in order to be able to make appropriate body mechanics decisions.

To determine whether changes in knowledge as a result of this curriculum were due primarily to the instructor rather than the content of the program, it was determined that Jacobs would use the materials designed by Schwartz and follow the curriculum explicitly. Slides, lecture notes, and written information

Please answer each question by putting a circle around the best answer. If you do not know the answer you should still make your best guess as to which one is correct. For each question please choose only one (1) answer.

1. Which of the following does not cause back problems?
   A. Bending
   B. Twisting
   C. Smoking or chewing tobacco
   D. Lack of exercise

2. Back pain and back injuries cost Americans about how many dollars each year?
   A. One million dollars
   B. One hundred million dollars
   C. One billion dollars
   D. Fifteen billion dollars

3. Which of the following parts of the back are "living cushions"?
   A. Ligaments
   B. Bones
   C. Discs
   D. Muscles

4. The best way to keep your back from getting tired or sore is to:
   A. Sit for as long as you can at a time.
   B. Alternate lifting light objects with lifting heavy objects.
   C. Try not to move your feet when standing at work.
   D. Change positions frequently when working.

5. Which one(1) of the following sentences is true?
   A. Men have more injuries which are less serious and women have fewer,but more serious, injuries.
   B. Men and women have equal numbers of back injuries.
   C. Women have more injuries than men.
   D. Women have both greater numbers and more serious injuries than men.

6. Which of the following exercises is not good for your back?
   A. Push-ups.
   B. Straight-leg toe touches.
   C. Pull-ups.
   D. Running in place.

7. Where should you put your feet when you lift a heavy object?
   A. Feet close together, far from the object.
   B. Feet close together, close to the object
   C. Feet at shoulder width apart, one foot in front of the other, close to object
   D. Feet wide apart, away from object

8. Which of the following is not a good thing to do if you hurt your back at school ?
   A. Tell the nurse
   B. Stop doing the activity that hurt you.
   C. Rest in bed for 2 days
   D. Be tough and keep working

9. Which of the following back problems/injuries is the most common?
   A. Slipped disc
   B. Broken back
   C. Muscle ache
   D. Stiff back

10. Which of the following positions makes your back work the hardest ?
   A. Sitting
   B. Standing
   C. Kneeling
   D. Lying on your back

Thank you for answering these questions.

Figure 1. Back Pain–Back Injury Prevention Program. Elementary School Version.

Figure 2. Curriculum and Program Objectives of Body Basics: Elementary School Body Mechanics.

Part One (Approximately 20 minutes)

Content: Anatomy and biomechanics of spine and extremities

Methods: Lecture, slides, demonstrations, and model of spine

Objectives: At the completion of this portion of the lesson the student will be able to:
- Describe and explain the function of bones, joints, muscles, tendons, ligaments, and cartilage
- Briefly describe the role of discs, vertebral bodies, facet joints, ligaments, and spinal arteries
- Describe the motions of the extremities and the functions which they are best suited to perform
- Explain the role of spine in the performance of everyday actions

Part Two (Approximately 10 minutes)

Content: Risk factors for injuries

Methods: Lecture, discussion, slides, demonstrations, lab exercise

Objectives: At the completion of this portion of the lesson the student will be able to:
- Explain the four major risk factors (bending, twisting, vibration, and smoking) for back pain/back injuries and tell how these can be minimized

Part Three (Approximately 20 minutes)

Content: Proper body mechanics

Methods: Lecture, slides, discussion, hands-on practice

Objectives: At the completion of this portion of the lesson the student will be able to:
- Demonstrate preferred methods of lifting, carrying, pushing, pulling, and throwing of objects
- Explain how following the methods above will prevent injuries
- Be able to watch others work and describe how they could perform their work better and safer

Questions

concerning the curriculum, the type of model of the spine, and the activities for demonstrations and practice were sent to Jacobs; several phone calls were made to clarify the information to be taught. In both cases, the posttesting of students was delayed for a full four weeks to permit considerable opportunity for forgetting. In this way we attempted to bias results in favor of the null hypothesis of no differences between pretest and posttest scores, thus making it difficult to demonstrate significant changes in knowledge of body mechanics as a result of the brief instructional session. In addition, we felt that if we used a delayed posttest, we might have a better indication of the long-term effects of such training on the students.

RESULTS

Since each subject took the same test as both a pretest and a posttest condition, a two-way analysis of variance for repeated measures was used to test the null hypotheses.

Results showing pretest to posttest comparisons by gender and by school are shown in Tables 1-4. No significant differences in scores between pretest and posttest can be attributed to gender. Likewise, there are no significant differences in the repeated measure that can be attributed to the school variable. The difference in posttest means as compared to pretest are highly significant at the $P < .0001$ level.

Table 1. Pretest to Posttest Comparison by Gender; Two-factor Repeated Measures ANOVA

Source	df	Sum of Squares	Mean Square	F-test	*P* value
Gender (A)	1	0.6	0.6	0.1	0.7206
Subjects w. groups	67	290.8	4.3		
Repeated measure (B)	1	185.5	185.5	104.6	0.0001
AB	1	2.6	2.6	1.5	0.2274
B × subjects w. groups	67	118.9	1.8		

There were no missing cells found. Seventy-two cases deleted with missing values.

Table 2. Pretest to Posttest Comparison by Gender; AB Incidence

Repeated Measure	Pretest	Posttest	Totals
Male	33	33	66
	3.1	5.2	4.1
Female	36	36	72
	3	5.6	4.3
Totals	69	69	138
	3	5.4	4.2

Table 3. Pretest to Posttest Comparison by Schools; Two-factor Repeated Measures ANOVA

Source	df	Sum of Squares	Mean Square	F-test	*P* value
School (A)	1	0.6	0.6	0.2	0.6796
Subjects w. groups	128	470.6	3.7		
Repeated measure (B)	1	278.3	278.3	104.9	0.0001
AB	1	1.7	1.7	0.6	0.4303
B × subjects w. groups	128	339.5	2.7		

There were no missing cells found. Eleven cases deleted with missing values.

Table 4. Pretest to Posttest Comparison by Schools; AB Incidence

Repeated Measure	Posttest	Pretest	Totals
Alamo Hts	99	99	198
	5.3	3.3	4.3
Schechter	31	31	62
	5.4	3	4.2
Totals	130	130	260
	5.3	3.2	4.3

DISCUSSION

It is clear that a brief educational program in body mechanics to prevent back pain and injury can lead to significant improvements in knowledge of those trained. The design of this investigation with a one-month delayed posttest, while making it more difficult to achieve significant pretest to posttest differences in scores, leads us to believe that the cognitive effects of our Body Basics program are relatively long lived. The absence of gender effects comes as no surprise. More noteworthy is the inability to reject the null hypothesis of no differences due to the school variable (and thus the instructor variable). We are pleased that the evidence supports the transportability and effectiveness of this curriculum with different populations of school-aged children. Although there were insufficient numbers of first and second grade students to conduct a separate analysis of age effects on pretest to posttest differences, we have included data from these very young children for the first time in a published study of body mechanics training.

It has been suggested that there is a subgroup of workers who lack the motivation to participate fully in safety programs because they view themselves as "invincible," that is, injuries and other bad things only happen to other people.[18] Unlike affective and motivational factors, which are subject to the daily flux of life events and, therefore, may change rapidly from one situation to the next, self-concept factors are assumed to be relatively stable in adults. We believe that one of the potential benefits of very early training in safety and body mechanics might be that it will serve as a sensitizing factor to convince young children that everyone is potentially at risk for back pain and back injury. It is possible that one of the benefits of early safety training is that it suggests a view of the self that includes the concept of vulnerability to injury. While not explored in the present study, it would be interesting to determine the perceptions of children regarding their risk of back pain and back injury prior to training and following training. If it could be shown that estimates of vulnerability increase with training, the case for early preventive education mediating cognitive restructuring would be even stronger. Our industrial training experience suggests that those who are most concerned about safety benefit the most from training, and those with the least concern for safety, but who need training the most, are often the least able to benefit from body mechanics instruction.

The limitations of this study and the need for further investigation deserves comment. Having used nonrandomized convenience samples, without any true control group, the likelihood of systematic yet uncontrolled variance is problematic. Both populations were drawn from upper-middle-class suburban school districts. Clearly, a more systematic and unbiased sampling procedure is needed to confirm the findings reported here. Age should also be an independent variable so that it can be determined if this curriculum is suitable for first and second grade students. While evidence concerning changes in knowledge on the part of the students has been reported, it would be a far more powerful test of this curricular approach to evaluate behavioral changes as a result of this training. To do so would require an assessment of each child's use of the body while performing standard tasks such as lifting, sitting, or pushing.

CONCLUSION

In these turbulent times of escalating health care costs, it becomes imperative to be proactive. This has led to widespread acceptance of preventive strategies to avoid worker injuries in the first place. In the case of back injuries, however, the introduction of traditional body mechanics training in and of itself has not ensured safe lifting behaviors. We propose that effective education in prevention must also alter cognitive structures which utilize ongoing, daily decision making. The present study supports this proposal and suggests that elementary school-age children can have relatively permanent improvements in knowledge of proper body mechanics and risk factors control with as little as an hour of instruction per child. For those therapists working with children, the incorporation of such a preventive model provides an opportunity to become a proactive service provider. We are hopeful that these endeavors, and the future programs they may generate, will have widespread implications to our future work force. By combining elementary school body mechanics educational programs with widespread adoption of injury prevention and ergonomic design in the workplace, we may look forward to generations of workers with significantly improved rates of back pain and impairment.

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