EFFECTS OF A BACK PAIN PREVENTION EDUCATION PROGRAM ON KNOWLEDGE OF PROPER BACK CARE AMONG FIFTH GRADE ELEMENTARY STUDENTS

by

Susan Leigh Heiser

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy in Human Performance

Middle Tennessee State University
May 2014

Dissertation Committee:

Dr. Don Belcher, Chair

Dr. Mark Anshel

Dr. Dana Fuller

I dedicate this paper to my family who has supported my goal of completing this degree and my dream of being a teacher. I thank God for providing the joy and abilities for this career field and for guiding my path in pursuit of this academic achievement. Teaching is what I love to do.

ACKNOWLEDGMENTS

I would like to thank my committee members, Dr. Belcher, Dr. Anshel, and Dr. Fuller for their expertise and participation on the committee. I would like to give special thanks to Dr. Belcher and Dr. Veal for leadership in completing this project and for guidance during my educational journey.

I would also like to thank my family for their support and affirmation in pursuit of this dream. Their patience and never ending understanding has allowed me the time I needed to accomplish this goal. I especially want to thank my precious parents for never wavering in support and encouragement as I pursued my goal. My teaching career is a continuation of their legacy.

ABSTRACT

Back pain is a common disorder that affects 50 – 80% of the population at some point in their lives (Cardon, De Clercq, & De Bourdeaudhuij, 2000). Of greater concern is the increasing rate of low back pain (LBP) in children that could potentially reoccur into adulthood (Jones et al., 2003). Back Pain Prevention (BPP) should begin proactively in the elementary schools where it could reach a large population, but few programs currently exist (Cardon et al., 2002). The purpose of this study was to determine if physical educators could improve BPP knowledge of fifth grade students by infusing back care principles into their regular curriculum. The participants were 135 students in three public elementary schools. The education group performed better on the written knowledge test and on the practical assessment as compared to the control group that did not experience the instructional treatment. There was no significant difference in the written knowledge scores between the three instructional groups, and there was no significant difference between the mean score gains of the three groups on the practical assessment. There was a positive but weak correlation between the education group's mean scores on the written knowledge test and on the practical assessment scores, r (98) = .307, p = .02. Overall, students in the education groups showed significant improvement in BPP knowledge and back care practice over the control group. Further research is needed to test student long-term retention of this information.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I: INTRODUCTION

Statement of the Problem

Low back pain (LBP) has a significant impact on society, affecting 50-80% of adults at some point in their lives (Cardon, De Clercq, & De Bourdeaudhuij, 2000). Of particular concern is the increasing rate of LBP in children. Jones, Watson, Silman, Symmons, and Macfarlane (2003) propose that "the adult back pain 'career' may begin at least as early as adolescence" (p. 827). Whether this is a true increase in adolescent back pain or just greater awareness of the problem, research studies are becoming more prevalent in identifying risk factors of LBP in children (Smith & Leggat, 2007).

Because of the prevalence of back pain and its rising risk factors among families and work environments, it would appear that back pain prevention (BPP) education is needed in the public education system where it can reach a higher percentage of the population who suffer from or will eventually experience LBP. Research examining the effect of prevention education in the elementary schools, however, is sparse (Cardon, De Bourdeaudhuij, & De Clercq, 2002). Usually, BPP is taught as part of a person's rehabilitation after experiencing an injury instead of as a proactive preventive measure. While BPP is mainly directed toward adults, it is particularly important to provide BPP instruction before these individuals develop bad habits or inefficient lifting patterns that lead to LBP. Establishing correct lifting techniques and movement patterns in early childhood may be a more reasonable proactive method of prevention (Sheldon, 1994).

Significance of the Study

BPP education should address risk factors associated with back injuries, particularly in childhood. Specific program guidelines for mastery of this information in childhood, however, are rare. Only a limited number of programs for elementary school students have been developed (Cardon et al., 2000). When Calvo-Munoz, Gomez-Conesa, & Sanchez-Meca (2012) conducted a meta-analysis of back care programs for children and/or adolescents from 1984 to 2012, 23 studies met their selection criteria of a preventive LBP treatment group, control group, statistical data, and sample size of five or greater. Only three studies were conducted after 2009, and only two were conducted in the United States. Six of those studies were conducted by Cardon, De Clercq, and De Bourdeaudhuij.

The programs adopted by Cardon et al. in their 2000 and 2002 studies were patterned after the German Back School literature. The curriculum addressed risk factors for back pain such as improper lifting, carrying, backpack weight and positioning, posture, and lack of physical activity. The instructors in these programs were physical therapists who taught six 60 minute sessions at one week intervals. In the Cardon et al. (2000) study, the intervention group showed an improvement in back knowledge and practical skill assessment over the control group at one week and three month posttest intervals. In their 2002 study, Cardon et al. showed that back knowledge was maintained one year after instruction.

The results of other studies have indicated statistically significant improvement in back education knowledge or practice. For example, Sheldon (1994) tested lifting techniques in sixth and eighth graders. Sheldon, a physical therapist, used one

instructional session that included verbal instruction, demonstration, and hands-on practice for the students. He found improvement in lifting mechanics and back care knowledge seven weeks after instruction. Spence, Jensen, and Shepard (1984) compared two different types of teaching methods – lecture/video and interactive guided discovery on proper lifting techniques among third and fifth graders. Based on one session of instruction, they found that the students in both groups significantly improved their back care knowledge over the control group that received no instruction posttest. In addition, the researchers did not find a significant difference between teaching methods on the practical assessment. In another study, however, Park and Kim (2011) did find improvement in spinal health knowledge and practice in a comparison of two teaching methods – a Web-based program and traditional face-to-face instruction.

In a different study, Goodgold and Nielsen (2003) tested proper backpack weight and positioning in sixth and seventh graders. Goodgold, a physical therapist, instructed two physical education teachers in proper backpack use. These two instructors presented the material to their students during specific physical education classes. They found 42% of the students changed how they wore their backpacks after instruction.

While these studies show the benefit of BPP in an elementary school setting, program guidelines are rare, and vary depending upon the research focus (Cardon et al., 2000; Goodgold & Neilsen, 2003). Many studies used physical therapists or blocked one hour sessions for presenting the back education. While using skilled clinicians and blocks of time are highly desirable, lack of funding or time constraints might make these options impractical for many schools.

Due to the increased pursuit for academic excellence, teachers face pressing demands on their time (Goodgold & Neilsen, 2003). It is difficult to add blocks of instruction time to the schedule. Infusing back prevention education into the existing curriculum would be more manageable and still be beneficial. In early physical education curriculum, posture received high focus and was taught as a component of back care. As the curriculum shifted in the mid 1980's to a heart health focus, instruction concerning posture was no longer dominant (Tinning, 2001). Back care still falls under the physical education national and state standards but is not a focus in the elementary school system.

The National Association for Sport and Physical Education published national standards to help guide the development of physical education curriculum, instruction, and assessment (NASPE, 2004). The Tennessee Department of Education (2007) supported these principles and included them in their physical education state standards. Standard One states a physically educated person will be competent in motor skills and movement patterns needed to perform physical activities. A desired outcome of this standard includes demonstrating "…good posture while lifting and carrying an object" (NASPE, 2004, p. 17). NASPE's Standard Four promotes student responsibility in achieving and maintaining a health enhanced level of physical fitness that leads to a healthy and active lifestyle**.** This standard includes flexibility and muscular strength which researchers note are both components of a proper back pain prevention program (Garfin & Garfin, 2002; Jones, Stratton, Reilly, & Unnithan, 2007). Iowa's state standards specifically mention body mechanics as a component of the physical education curriculum, although this is commonly ignored in elementary school (Thomas, 2003).

Physical education teachers may be the most qualified instructors to teach back pain prevention programs because of physical education national and state standards and their advanced knowledge of human anatomy, exercise implementation, and muscle use principles. BPP principles should be included in normal physical education lessons. The information could then be repetitive and presented throughout the school year and throughout the elementary years for better retention. Many researchers advocate for long term instruction and promotion of back care principles (Cardon et al., 2000; Jones et al., 2007; Sheldon, 1994).

Purpose of the Study

The purpose of the study was to evaluate the effectiveness of infusing BPP principles into the physical education (PE) curriculum on the back knowledge and practical performance of proper back care among fifth grade elementary students as opposed to the regular PE curriculum that did not include BPP principles.

Hypotheses

Education and control group posttest scores were compared in this study to determine whether scores differed by instructor, and to determine whether written back knowledge test and practical assessment scores were related. The following outcomes were expected:

1. H_1 – The education program group will achieve a significantly superior average mean score on the written back knowledge test than the control (no intervention) group.

2. H_2 - The education program group will exhibit significantly better performance on the practical assessment than the control (no intervention) group.
3. H_3 - The group test means will not be significantly different between participants in the intervention groups instructed by the three different physical educators.
4. H_4 – There will be a positive correlation between the written back knowledge and practical assessment scores of the education program group.

Operational Definitions of the Study

For the purpose of this study, back pain was defined as discomfort between the thoracic and lumbar region that occurs from a sprain, a strain, repetitive motion, or insidious onset. Back pain prevention (BPP) education was defined as instruction in and implementation of ergonomic principles and proper body mechanics that are needed to reduce the risk factors associated with back pain and to promote back health.

Limitations of the Study

Due to the sparse research that has been conducted regarding elementary BPP education, there were no specific guidelines for this program. Few studies address the infusing of back education principles into the standard physical education curriculum. Therefore, components of this program were combined from previous research studies and from this author's background as a physical therapist assistant and physical education instructor.

Another limitation of the study was the education program length of six weeks due to the school calendar. Programs of six weeks or less have been shown to be of

sufficient length. Cardon et al. (2000) found significant improvement in fourth and fifth graders' back care knowledge and practical assessment three months after a 6-week back education program. In a separate study, Cardon et al. (2002) found retention of back care knowledge in 9 to 11-year old students one year after the original 6-week educational intervention. Even using one session of back education was found to have an impact (Sheldon, 1994; Spence et al., 1984). Spence et al. found improvement in back care knowledge in third and fifth grade students but not in practical assessment. Sheldon found significant improvement in back care knowledge and practical performance in sixth and eighth grade students that was retained seven weeks after instruction. Although programs of 6-weeks or less have been shown to be of sufficient duration, researchers still advocate for future studies to evaluate programs of greater length (Cardon et al., 2000; Heyman & Dekel, 2008; Jones et al., 2007; Sheldon, 1994; Spence et al., 1984).

Delimitations of the Study

This study focused only on fifth grade elementary students from a city public school system in the southeastern United States. BPP principles could also be taught by other classroom teachers, but for the purpose of this study, only physical education instructors that work in the school system and include the material into their curriculum were targeted.

Summary

Back pain is a common disorder that affects 50 – 80% of the population (Cardon et al., 2000). There has been an increased rate of LBP among children that could potentially reoccur into adulthood (Jones et al., 2003). Most BPP education occurs in a rehabilitation setting and is directed at adults suffering the consequences of years of bad

habits, including ineffective lifting patterns. Sheldon (1994) recommends using BPP principles in early childhood as a proactive method of prevention of back pain.

BPP should begin proactively in the elementary schools where it could reach the greatest number of individuals. Relatively few programs currently exist, however, for this purpose (Cardon et al., 2002). Specific guidelines are also lacking for setting up these programs.

Many schools face budget and time constraints, and have difficulty adding time blocks or after school programs to the curriculum. The purpose of this study was to evaluate the effects of infusing BPP principles into the PE curriculum on the back knowledge and back care practice of fifth grade students.

The physical educator is knowledgeable in the area of anatomy, muscle use principles, and exercise. Therefore, this study targeted the physical educator as the instructor of the back care principles. Those principles include many different risk factors which will be discussed in depth in CHAPTER II.

CHAPTER II: LITERATURE REVIEW

According to Patel and Everett (2003), low back problems are now the most common musculoskeletal disorder. Back pain carries a disturbing prognosis due to the probability that even if symptoms eventually resolve, many patients will have a reoccurrence of back pain 70% to 90% of the time (Patel & Everett, 2003). Of further concern is that LBP is occurring at an earlier age and becoming more common in children and adolescents as well. Jones et al. (2003) concluded there is "a prevalence approaching what is reported in adults, and some authors have demonstrated a cumulative incidence of 74% by 20 years of age" (p. 822). Because the occurrence of back pain is so prevalent, it would appear that back pain prevention programs are needed.

One of the difficulties with back pain education; however, is that it does not encompass just one principle or concept. Several different risk factors exist that can potentially contribute to back pain. It is important to understand these risk factors in order to develop an appropriate prevention program. The literature review structure gives an overview of general back anatomy and then focuses on risk factors that are now present in the elementary school setting. BPP principles designed to reduce these risks are also reviewed.

General Back Anatomy

One of the problems associated with accumulative back pain is the lack of innervation in the innermost part of the lumbar intervertebral disc. The nucleus pulposus forms the inner 40% of the disc and is a gel like substance of collagen fibers. The annulus fibrosis surrounds the nucleus pulposus and is made of approximately 10-12 layers of concentric collagen fibers aligned in an oblique fashion. Each adjacent layer is angled in

a cross directional position. The nucleus pulposus and the inner two-thirds of the annulus fibrosis do not contain any nerve endings. Only the outer one-third of the annulus fibrosis is innervated primarily by the lumbar sinuvertebral nerves (Aaron, Beazell, Lucido & Boyd, 2005).

With repetitive motion over time, this allows the nucleus pulposus to protrude through the layers of the annulus fibrosis undetected until pressure is applied to the outer innervated layers. Continued pressure can cause the disc to herniate or even rupture compressing the spinal nerve roots and resulting in further increased pain or impaired nerve conduction (Salter, 1984). Because it may take months or even years for back pain to develop, damage to the disc may occur undetected through risk factors that increase intradiscal pressure such as faulty body mechanics, loss of strength and flexibility, and poor posture caused by slumped sitting or standing (Saunders, 1992).

Causes of Back Pain

Back pain can be the result of a single blunt trauma, but the majority of back injuries are cumulative in nature. Some of the risk factors that plague adults are now present in the elementary school setting. These concerns include improper lifting or body mechanics, backpack positioning and weight, poor posture, and incorrect computer station set up. Months to years of exposure to these risk factors can contribute to back injury, pain, and disability.

Lifting techniques. Pressure on the spinal intervertebral discs is affected by external loading as well as by body positioning. Alf Nachemson (1963), a pioneer in the field of spinal loading, showed when a load was applied vertically to a disc specimen, the nucleus pulposus primarily supported the load, but when pressure was applied at a tilt, the

intradiscal pressure was significantly increased. Nachemson and Morris (1964) also showed a correlation between increased body weight or holding eternal weights and intradiscal pressure. This further substantiates the reason for keeping a load close during lifting. Holding the load at arm's length or bending from the hips and not the knees to pick up a load increases the force on the back tenfold (Saunders, 1992). The low back becomes the fulcrum of the lift and must maintain the force from the body weight as well as the load. Forces from external loads may contribute to cumulative back trauma, especially if the loads are picked up or carried with a flexed or extended posture that results in increasing the intradiscal pressure in the lumbar spine.

Proper lifting technique includes using a wide base of support and bending from the knees and not the waist to reduce adding the weight of the upper body to the lift. The spine is maintained in a neutral position with the natural curves aligned. The load is also held close to minimize force on the low back (Cardon et al., 2000; HealthSouth, 2000).

Backpack weight. Carrying overloaded backpacks can be a contributing factor of back pain in students. The extra weight can cause numbness in the arm from pressure on the brachial plexus or back musculoskeletal pain from postural changes (Shasmin, Abu Osman, Razali, Usman, & Wan Abas, 2007).

Cardon et al. (2000) recommends that backpack weight should not exceed 10% of the student's body weight. In 2009, The American Occupational Therapy Association (AOTA) recommended a backpack not exceed 15% of a student's body weight (Hoffman, 2009). Currently, however, for their annual "National School Backpack Awareness Day," the AOTA now promotes a more conservative number of less than 10% like Cardon et al. (AOTA, 2014). The American Physical Therapy Association (APTA)

recommends the maximum backpack weight not exceed 15% of the student's body weight (APTA, 2009). While there is some difference in the recommended maximum weight limit, professionals in the field still agree that an overloaded backpack can contribute to back pain in school children.

When attempting to balance a heavy load, many backpack wearers resort to compensatory movements. Shasmin et al. (2007) studied the ground reaction force and trunk inclination from 9 to 11 year old boys wearing a backpack with 10%, 15%, and 20% of body weight. At 20% body weight, the students' trunk forward flexion was over 45 degrees as they attempted to compensate for the heavy load. Ground reaction forces during foot strike or stance also increased in the medial-lateral plane with the heavy weight. The authors found that the safe backpack weight limit for students under 12 years of age was a maximum of 15% of body weight.

Jones et al. (2003) did not find a correlation between low back pain and backpack mechanical load when using weights equating 9.9% of the student's body weight. This supports the previous studies. Though not statistically significant, the Jones et al. (2003) study did reveal a clear trend that students carrying backpacks who walked to school or did not use a locker had higher risk of low back pain than students who were driven to school or used a locker. Motmans, Tomlow, and Vissers (2006) list time spent wearing a loaded backpack as an additional risk factor for musculoskeletal symptoms.

Backpack positioning. Along with maintaining an appropriate weight level in the backpack, instruction regarding the proper way to wear a backpack is also warranted. For example, Motmans et al. (2006) showed activation of the contralateral trunk musculature when wearing a shoulder bag or using only one strap on a regular backpack. Long term

asymmetrical backpack use could result in harmful stresses to the back musculature over time.

The APTA and the AOTA both recommend that students wear a backpack with two well-padded shoulder straps (APTA, 2009; Hoffman, 2009). Goodgold and Nielsen (2003) explain that using two straps helps decrease pressure on the shoulder nerves. They also recommend adjusting the backpack straps snugly to decrease straining the back muscles, and placing the bottom of the backpack in the lumbar curve close to the waistline to balance the load. The AOTA recommends the backpack never rest more than four inches below the waist.

Posture. Poor posture is another factor that can lead to back pain. Once a person has been sitting for a few minutes, the musculature tends to relax and the ligaments bear the strain as the lumbar spine assumes a flexed position (McKenzie, 1989). If the position is maintained for a prolonged period, it may become painful. Kratenova, Zejglicova, Maly, and Filipova, (2007) completed a study in the Czech Republic to determine the occurrence of poor posture and the resulting risk factors in children ages 7, 11, and 15 years of age. Poor posture occurred in 38.3% of the 3520 subjects. The prevalence of poor posture was greater in the older children – 7 year olds (32.9%), 11 year olds (40.6%) and 15 year olds (40.3%). The higher incidents of low back pain occurred in the children with poor posture. There was also a higher occurrence of poor posture in students that did not participate in sports although no causal relationship was implied in the study. The authors do suggest that "the younger school age is optimal for the implementation of preventive activities that can help to compensate for poor posture and prevent the posture problems using appropriate exercise programs" (p. 136).

Nachemson and Morris (1964) tested intradiscal pressure during specific postural positions to determine when pressure increases occurred. They found that intradiscal pressure increased the most during sitting. Pressure was 30% less in standing, and 50% less in reclining compared to sitting. Additional testing showed sitting in a slumped position increased pressure more than standing in a forward bent posture. Adding weights to these postures further increased intradiscal pressure (Saunders & Saunders, 1993).

Proper posture aligns the three natural curves in the back in an "S" shape to act as a spring and absorb shock (HealthSouth, 2000). The shoulders are aligned over the hips with the pelvis in a neutral position to maintain the proper balance (Saunders, 1992).

Computer work station set up. One contributing factor to poor posture is the use of poorly designed computer work stations. In many elementary schools, students of varying heights will generally use the same standard classroom desk and chair as a computer work station. This set up will only correctly fit a portion of the students. Budget restrictions may prevent the purchase of ergonomically designed or adjustable furniture. However, with a proper understanding of correct work station set up, the teacher can improvise with the use of footrests, pillows, boxes, or other items to improve a nonadjustable station. Dr. Alan Hedge (2007), a professor of ergonomics at Cornell University, describes a proper work posture as one with the back supported at ≥ 90 degrees, the elbows at ≤ 90 degrees with the forearms below horizontal, and the wrists are neutral at ≤ 15 degrees.

Back Pain Prevention Education

An effective back care program needs to address the causes of back pain and reduce the many risk factors. This section provides a description of specific back care

principles designed to protect the back from injury. These include the use of proper body mechanics and lifting techniques, the correct method for loading and wearing a backpack, and the use of good standing or sitting posture. Using proper body mechanics is one of the most significant ways to treat as well as to prevent back injuries.

The following principles are components of proper body mechanics: 1) maintain a neutral spine by keeping the natural "S" curve versus "C" curve in your back, 2) keep a wide base of support, 3) keep the load close when lifting, 4) bend the knees and not the back, 5) carry loads close to the body, 6) move your feet versus twisting your back, 7) use both straps on the backpack, 8) do not carry more than 10% body weight in the backpack, 9) balance your load, and 10) use good posture in sitting and standing (Aaron, 2005; Cardon et al., 2000; HealthSouth, 2000; McKenzie, 1989; Saunders, 1992).

Maintain a neutral spine. Proper lifting or carrying techniques are designed to reduce the external forces on the trunk musculature. The neutral position for the spine is in maintaining the natural "S" curve. Attempting to lift heavy objects in a slouched or rounded position places extra force on the trunk muscles increasing the potential risk (Saunders, 1992; Spence et al., 1984).

Use a wide base of support. A wide base of support increases stability during the lift (Aaron, 2005; Spence et al., 1984). With a narrow base of support, trunk musculature must compensate for the lack of assistance from the lower extremities.

Keep the load close. The optimal position for lifting or carrying an object is with the load close to the body. The forces needed to maintain balance and control of the load increase as the load is held further from the body (Saunders, 1992). Keeping the load

close also assists the body in maintaining the neutral spine position (Aaron, 2005; Cardon, et al. 2000).

Bend the knees, not the back. When the back is used as the fulcrum, the larger quadriceps muscles are not optimized while the smaller trunk extensors attempt to support body weight and the weight of the load (Fortunato, 2008). Geldhof, Cardon et al. (2007) recommend using a squat position as a more favorable biomechanical lifting technique. The spine is able to stay in a preferred neutral position when the knees bend during lifting (Cardon, 2000; Sheldon, 1994; Spence et al., 1984).

Pivot, do not twist. Twisting places the back musculature in a stretched and potentially harmful position (Aaron, 2005: Fortunato, 2008). Muscles are stronger at mid-range versus end range of motion. When the lifter pivots or steps with the feet to pick up and transfer a load, the spine can remain in a neutral position with the trunk musculature in a position of power.

Backpack weight and position. Using two straps on a backpack allows the weight to be equally balanced. Contralateral shifting occurs when only one backpack strap is used (Motmans et al., 2006). Additional compensatory forces can occur if the backpack weight is over 15% of body weight (Shasmin et al., 2007).

Balance the load. This follows the same principle as proper use of a backpack. When a load is placed on one side of the body, the contralateral side must contract to compensate for the uneven weight and maintain balance. When possible, heavy loads should be reduced to two smaller equal loads and carried on both sides of the body (Aaron, 2005).

Use good posture. Nachemson and Morris (1964) showed that sitting or standing in a slumped position increased pressure on the intervertebral discs. Slouching also places more pressure on the ligaments, forcing them to do the work of the muscles. Prolonged static sitting in a poor posture may impede blood circulation and decrease nutrition to the discs (Geldhof, De Clercq et al., 2007).

Similar principles were successfully used during inclusive back education programs (Cardon et al., 2000). Through insurance company sponsorship, this program was able to offer physical therapy experts as the instructors for the back education. This option will not be available to many school districts.

Physical Education and Back Pain Prevention

Austria and New Zealand consider health education and physical education as formally linked. In the United Kingdom and United States, however, physical education and health are recognized as separate curricula with no explicit national standard link between the subjects in the elementary curriculum (Tinning, 2001). Physical education is required in many elementary schools, but health education is usually taught as a partial component within many different academic areas.

Physical education is directly related to health. Both subjects are part of the focus of the Alliance for Health, Physical Education, Recreation, and Dance. Under that organization, NASPE Standard 4 states the student "achieves and maintains a health-enhancing level of physical fitness" (NASPE, 2004, p. 33). This complements health standards that promote understanding how the body systems interact and the relationship of physical activity to healthy living.

With expert knowledge of exercise and muscle use principles, physical education instructors are well equipped to teach BPP to their students. Flexibility and strengthening exercises are an important part of BPP education. Garfin and Garfin (2002) encourage flexibility exercises to improve trunk, abdominal, and lower extremity strength to prevent low back injuries. Faigenbaum & Mediate (2006) encourage the use of medicine balls to promote trunk stabilization and strengthen rotation muscles such as the multifidi. Heyman and Dekel (2008) do acknowledge the link between ergonomics and physical education and encourage college teacher programs to include additional training in ergonomics in the curriculum. By including BPP principles into the regular physical education curriculum, teachers have the opportunity to repeatedly reinforce proper body mechanics and promote healthy backs through knowledge retention.

Summary

The research review shows that back pain may affect 50-80% of Americans in their lifetime (Cardon et al., 2000). This disorder is also becoming more common in youth (Jones et al., 2003). Because the occurrence of back pain is so prevalent, it would appear that back pain prevention programs are needed.

Back pain can be caused by a single blunt trauma but is generally cumulative in nature. Because of the lack of nerve endings in the inner two-thirds of the intervertebral disc, damage to the disc may be undetected for months or even years due to the use of risk factors that increase intradiscal pressure (Aaron et al., 2005). Some of these risk factors are now present in the elementary school setting; they include improper lifting techniques or backpack use, poor posture, and incorrect computer station set up.

Exposure to these risk factors can contribute to back injury and significant levels of pain and disability.

The research review shows that early back education needs to address these risk factors and include components such as proper body mechanics. Kratenova et al. (2003) advocated for body mechanics training focused on preventing poor posture to also decrease injury occurrences.

Other components of BPP include appropriate exercise programs. Flexibility and specifically targeted trunk or core strengthening exercises were encouraged in the role of preventing the recurrence of low back pain (Garfin & Garfin, 2002). Back health falls under the physical education and health education standards and should be a component of the physical education program.

Knowledgeable instructors are needed to provide BPP information in the school setting. The physical educator is the most qualified instructor to teach effective ergonomic training. This instruction needs to occur repeatedly during the regular physical education curriculum to promote retention of the information. Including BPP in the elementary school and teaching students to reduce back pain risk factors could have long-term beneficial effects on their physical health. This study will evaluate the effectiveness of infusing BPP education into the physical education curriculum of public school fifth grade students.

CHAPTER III: METHOD

Participants

The participants were 135 fifth grade students who attended one of three elementary schools located in one public school district in the southeastern United States. Classes in two of the schools participated in the education program, and one of the schools served as the control group. The students, all of whom volunteered to engage in this study, attended one of eight classes in the schools, - six of which consisted of the intervention group that received the BPP instruction (n = 100 students), and two of which were assigned to the control group (n = 35 students) that did not receive the additional instruction. The back pain prevention education information was presented as part of the physical education curriculum for the education group while the control group continued with their regular PE curriculum. The control group instructor received the BPP instruction after the six week intervention period.

Institutional Review Board (IRB) approval (Protocol 11-277) was obtained from the university Institutional Review Board. Further approval was obtained from the city school system's director of schools, the school principals, and the teachers involved in the study. Each participating student signed an assent form, and his or her parent/guardian signed a consent form prior to participation. Of the 169 consent forms sent home, 135 students (80%) returned the signed forms and participated in the study. A small food incentive (pizza or ice cream) was offered to all students for returning the assent and consent forms regardless of their decision to participate in the study. No monetary compensation was given for participation in this study. Since the BPP was part of the regular physical education curriculum, students who did not return their consent

forms participated in the instructional phase of the program; however, their data were not utilized in the study.

As indicated earlier, two elementary schools received the education program, and a third school with similar curriculum and structure in the same district served as the control group. The education group and the control group were not housed in the same facility to reduce the chance that students in the treatment group and control groups would interact and disclose their respective treatments, which could potentially confound treatment effects (Thomas, Nelson, & Silverman, 2005). Instructor groups were randomly chosen from the available intact fifth grade classes that participated in physical education by use of a drawing.

Instruments

Written test. The test instrument was developed to evaluate back care knowledge for Cardon et al. in their 2000 study. For reliability, a pilot study (N = 90) was conducted to test the original instrument prior to use in their study. For this present study, 10 questions were used from the original 13 question multiple choice test version used by Cardon et al. Three questions were removed from the test concerning knowledge areas such as pushing and pulling that were not covered in the intervention sessions. The written knowledge test had a possible score of 0 to 10 points. Cardon et al. (2000) deducted points for incorrect responses to discourage guessing; however, this method results in students losing overall points for material they understood or doubting their choices and choosing not to answer. This current study followed the pass/fail scoring procedure used by Sheldon (1994) to not unduly penalize students for their responses. A copy of the revised test instrument is located in Appendix A.

As an indicator of content validity, the instrument and practical assessment were tested with a small sample of students *(N* = 18) to determine if students understood the questions and could follow directions for the assessment. No additional revisions were made to the test instrument.

Practical assessment. A practical test was conducted to evaluate performance of back care principles. The test was also based on the assessment developed for Cardon et al.'s 2000 study. Interrater reliability in their study ranged from .79 to .98. The test included the following: 1) sitting at a workstation and performing a task, 2) lifting a 10 pound crate from the floor, 3) carrying the crate a distance of 10 feet, 4) placing the crate on a table, 5) picking up a pencil from the floor, 6) moving a ten pound crate from one table to a second table, 7) picking up a backpack from the floor, and 8) loading and wearing the backpack.

Cardon et al. (2000) did not find a significant time effect for the task of taking off shoes. This item was not included in this assessment. The practical assessment consisted of eight tasks assessed on a range of 0 to 48 points. The initial assessment sheet consisted of a specific criteria list with 0 points for not fulfilling the criteria and two points for correct completion of the task component. After review of several videos, the practical assessment rubric was revised to include one point for partial fulfillment of the task. This category was utilized to provide more consistency in scoring the videos. A copy of the practical assessment criteria is listed in Appendix B, and the practical assessment rubric is listed in Appendix C.

BPP principles instructor manual. The training manual was developed for the present study from current literature, physical therapy back courses, and the researcher's

experience in teaching BPP techniques as a licensed physical therapy assistant (PTA) and PE instructor. BPP principles for lifting, carrying, sitting, standing, and wearing a backpack were addressed. The manual also includes suggestions for adding these principles into the physical education curriculum. The manual is listed in Appendix E.

Procedures. BPP instruction was provided by three licensed physical education teachers. The researcher conducted a two hour training session for participating teachers prior to the intervention. The session included instruction and demonstration of the BPP principles with hands-on practice of sitting, standing, lifting a load, carrying a load, transferring a load, packing a backpack and correctly carrying a backpack. A review of the anatomy of the spine focused on the three natural curves in the spine and the importance of maintaining an "S" curve versus a "C" curve during manual tasks. The practical assessment was also reviewed and practiced with each instructor.

During the training, teachers in the intervention groups received an instruction manual containing the BPP techniques including methods for infusing information about these techniques into a physical education lesson. For example, when students line up to leave the gym, the instructor explained how to use proper posture to stand tall. Students could try to maintain this posture balancing a beanbag on their heads while walking to the door. Instructors could teach lifting principles when students were assisting with equipment clean up or transitions. Other examples were reviewed with the instructors and are found in the training manual.

The control group instructor was only given instruction in administering the written and practical assessments. The written BPP manual was provided to the instructor of the control group after the students completed their participation in the study.

To verify that the education program was implemented, lessons were tape recorded using Sony IC Recorders (Models ICD-UX200 and ICD-PX820). These tapes were reviewed by the researcher to verify what principles were taught. The teachers in the intervention groups were also given a checklist to monitor which BPP principles were mentioned during the physical education lessons. The tapes were reviewed by the researcher to verify the frequency that each specific BPP principle was mentioned by the three different instructors.

All students in the intervention and control groups completed the written test and the practical assessment as a pretest and again as a posttest after the educational program. Video cameras (Samsung SC-DC175) were placed in the testing area to record each participant's performance for the practical assessment. The physical education instructor at each school served as the test administrator for both the written and practical assessments.

The physical education instructors taught their regular curriculum but added BPP principles into their existing lessons. For example, one instructor taught lifting techniques during a tennis lesson when her students were picking up rackets or retrieving the tennis balls. Another instructor taught the lifting and carrying techniques when students assisted in dismantling and picking up the tennis nets and frames. Students were taught proper sitting techniques when they were sitting on the floor during the lesson introduction. Standing posture was addressed during soccer, tennis, and step bench lessons and also while waiting in line at the end of class.

All practical assessment test videotapes were evaluated by the researcher. Assessments were viewed through frequent use of slow motion and repeat mode to

optimize scoring. For intertester reliability, the researcher compared scores with another tester on three separate occasions until an 86.7% reliability rating was achieved. In addition, the researcher randomly chose assessment videotapes that had already been coded and coded them again without reference to the original coding. The results were compared item by item until all ambiguities were clarified (Lipsey & Wilson, 2001).

Data analysis. Data was analyzed using IBM SPSS Statistics 21 software to determine the written knowledge level and practical performance level of each student. Each test item was scored for correct or incorrect responses. Descriptive statistics were calculated for the intervention and control groups. Independent sample *t*-tests were used to determine if the intervention group mean scores were significantly different ($p \leq .05$) from the control group mean scores on the written test and on the practical assessment test.

Since three different instructors were used in the study, a one-way ANOVA test was used to determine if there was any significant difference between the participants' test scores from the three different instructors. A Tukey's HSD Post hoc test multiple comparisons analysis was used to find which groups differed from each other.

The posttest mean scores for the written knowledge test were compared to the posttest practical assessment mean scores. A Pearson Moment correlation test was completed to determine the correlation between student scores on the written knowledge test and the student scores on the practical test on posttest mean scores.

CHAPTER IV: RESULTS

The written knowledge test consisted of 10 questions covering different aspects of BPP. Three of the questions concerning bending your knees when lifting, balancing a load between two hands, and using two straps on a backpack were answered correctly at higher rates than the other questions. Table 1 shows the percentage of correct answers on the pretest and posttest from the written knowledge test.

Question 1, "*When lifting a heavy box off the floor: (You should bend your knees)"* was answered correctly on the posttest by 83 of 100 students (83%) in the education group. The education group had a 19% increase in mean gain on question 1 which was the largest gain on any specific test item.

Question 2, "*The best way to carry your groceries is: (In two bags)"* was answered correctly by 88 of 100 students (88%) in the education group on the pretest and 93 of 100 students (93%) on the posttest. Question 2 was the second highest scoring question on the written knowledge test.

Question 3, "*Which is the best way to carry your book bag? (Over two shoulders)"* was answered correctly by 95 of 100 students (95%) on the pretest and 98 of 100 students (98%) on the posttest. This item scored high on the practical assessment and among the control group as well, with 135 of 135 education and control group students (100%) using two straps when wearing the backpack during the posttest.

The education group showed large mean gains on three other test questions related to handling a load. There was a 16% improvement on question 4, *"When carrying a box, it is best to carry it: (As close as possible to your body)*, and a 17% improvement on question 5, *"If you pick up books from a pile on the floor and put them on a table:*

(You should move your feet each time).” The education group scores also improved by 14% on question 9, *“Which book bag is loaded in the best way?”*

Positive mean gains were noted on all other questions on the written knowledge test except question 8, “*During playtime, it’s best for your back if you (Move a lot).”* On the pretest, 62 of 100 students (62%) in the education group answered this correctly while only 54 of 100 students (54%) answered it correctly on the posttest. Answers chosen instead were “*Sit down”* or *“Stand still.”*

Table 1

Correct Question Responses by Percentage

	Pretest %		Posttest %		Change %	
Question	Control	Education	Control	Education	Control	Education
Question 1	83	64	80	83	-3	19
Question 2	83	88	91	93	8	5
Question 3	91	95	94	98	3	3
Question 4	34	60	29	76	-5	16
Question 5	37	29	31	46	-6	17
Question 6	23	21	17	24	-6	3
Question 7	46	12	40	17	-6	5
Question 8	80	62	80	54	0	-8
Question 9	43	38	17	52	-26	14
Question 10	9	16	20	26	11	10
Mean	52.9	48.5	49.9	56.9	-3	8.4

Students also had difficulty with this concept on *question* 6, "*The hardest position for your back is (Sitting).*" Only 24% of the education group chose sitting as the correct answer while 36% of this group chose "*Laying on your side*" as more difficult. This concept was addressed briefly on the teacher tapes from Instructor 1 but was not emphasized repeatedly during the classes. Posture misconceptions will be further discussed in CHAPTER V.

An Independent *t* test (See Table 2) was used to analyze the groups means (*M*) for the written knowledge test and the practical assessment test. On the written test, the education group had a 1 point mean gain in test scores increasing from 4.89 to 5.89

Table 2

Descriptive Statistics and Mean Differences for Posttest Written and Practical Assessments

Groups	*N*	*M*	*SD*	Mean Difference	Sig. (2-tailed)	95% Confidence Interval Of the Difference Lower	Upper
Written Test							
Education	100	5.89	1.61	0.83	.010	.201	1.47
Control	35	5.06	1.66				
Practical Test							
Education	100	25.28	5.26	6.34	.000	4.84	7.84
Control	35	18.94	3.22				

points, while the control group actually had a negative mean gain decreasing from 5.23 to 5.06 points. The posttest group means for both tests were compared between the education group (n = 100, M = 5.89, SD = 1.61) and the control group (n = 35, M = 5.06, SD = 1.66). A significant difference was found between the education and control group posttest means, t (133) = 2.61, p = .01.

An Independent t test was also used to compare the means of the education group (n = 100, M = 25.28, SD = 5.26) and control group (n = 35, M = 18.94, SD = 3.22) for the practical assessment (See Table 2). A significant difference was found between the education and control group posttest means, t (98.0) = 8.37, p < .001).

Table 3

ANOVA for Instructors on Posttest Scores

Source	*SS*	*DF*	*MS*	*F*
Written Test				
Between	4.46	2	2.23	0.85
Within	253.34	97	2.61	
Total	257.80	99		
Practical Test				
Between	345.76	2	172.88	7.00*
Within	2396.40	97	24.71	
Total	2742.16	99		

*p < .05

The BPP principles were taught by three different instructors. A one-way ANOVA (See Table 3) was used to determine if there was any significant difference

between the instructions given by these instructors. There was no significant difference when comparing the written test scores between participants in the intervention group, F (2,97) = 0.85, p = .43. However, there was a significant difference when comparing the practical test scores between the three instructors, F (2,97) = 7.00, p = .001.

Since a significant difference did exist between the instructors for the practical test scores, a Tukey's HSD Post hoc test multiple comparison analysis was completed to find which groups differed from each other (See Table 4). There was not a significant difference in practical test scores between Instructor 1 (n = 37, M = 24.46) and 2 (n = 38, M = 23.97), but there was a significant difference when comparing the test scores for Instructor 3 (n = 25, M = 28.48) to Instructor 1 and to Instructor 2. The difference will be discussed further in CHAPTER V.

Table 4

Tukey Multiple Comparisons for Practical Test Posttest Scores

Instructor		*MD*			95% Confidence Interval	
(I)	(J)	(I – J)	*SE*	Sig.	Lower	Upper
1	2	.486	1.15	.906	-2.25	3.22
3	1	4.02	1.29	.007	0.96	7.08
3	2	4.51	1.28	.002	1.46	7.55

The difference in the practical test scores was not in the mean score gains between the educational instructors. Based on a one-way ANOVA test, there was no significant difference, F (2,97) = 3.82, p = .66, noted when comparing the mean score gains between Instructor 1 (n = 37, M = 10.59), Instructor 2 (n = 38, M = 9.34), and Instructor 3

($n = 25$, $M = 10.28$). The mean score gains were similar between all three educational groups.

The difference lies in the initial pretest mean scores. There was a significant difference, $F(2,97) = 12.23$, $p \leq .001$) between the starting scores of Group 3 ($n = 25$, $M = 18.12$) compared to Group 1 ($n = 37$, $M = 13.81$) and to Group 2 ($n = 38$, $M = 14.63$). Group 3's pretest scores were initially 3.5 to 4.3 points higher than the other two groups, and the posttest scores were 4.02 to 4.51 points higher after the intervention. Overall, all three groups showed similar gains in their performance.

Instructor 1 and Instructor 2 were from the same school in this district. Instructor 3 was from a school located in the same district, but the students in this school were at a higher academic achievement level when compared to the other two schools. The control group was from a third school in the district to minimize the education group interacting with the control group and affecting the results.

The fourth hypothesis in the study was to evaluate if there was any correlation between results on the written assessment and performance of the practical skills for the education group. Questions from the written test that directly related to specific items on the practical assessment were used in this analysis. The following questions were included: question 1 (lifting a box), question 3 (carrying a backpack), question 4 (carrying a load close), question 5 (moving feet versus twisting), and question 9 (loading a backpack). There was a positive but weak correlation between the written back knowledge scores and the practical assessment scores, $r(98) = .307$, $p = .002$, for the education group.

The relationship between posttest knowledge and posttest performance of practical skills was also evaluated for each instructor since there were differences in performance among the instructor groups. The correlation between knowledge and performance was significantly different from 0 for Instructor 1, r (35) = .476, p = .003, but not for Instructor 2, r (36) = .191, p = .251, or Instructor 3, r (23) = .136, p = .517.

Fisher's r to z transformation calculations were conducted to determine whether the correlations differed significantly from each other. The correlation for Instructor 1 was similar to the correlations for Instructor 2 (Z = 1.39, p > .05) and Instructor 3 (Z = 1.35, p > .05). The correlation for Instructor 2 was also similar to Instructor 3 (Z = 0.21, p > .05). This will be discussed further in CHAPTER V.

Table 5

Correlations Among Practical Lifting Tasks for the Education Group (n = 100)

	Crate			Pencil			Backpack		
Tasks	WB	BK	BS	WB	BK	BS	WB	BK	BS
Crate									
Wide Base	1	.018	.121	-.013	.073	.062	.258*	-.026	-.038
Bent Knee			.290*	.019	.028	.138	.175	.111	.158
Back Straight				.096	.212*	.361*	.191	.277*	.354*
Pencil									
Wide Base					-.028	.134	.270*	-.073	.027
Bent Knee						.073	.018	.284*	.115
Back Straight							.125	.211*	.381*
Backpack									
Wide Base								.044	.016
Bent Knee									.236*
Back Straight									

* p = .05 (WB = wide base, BK = bent knees, BS = back straight)

Additional analyses were used to compare similar lifting techniques completed on the performance test. The practical assessment included three different lifting tasks – lifting a crate, picking up a pencil, and lifting a backpack from the floor. A Pearson's correlation test was used to compare components of these tasks with each other (See Table 5). Each of the tasks in the assessment involved using a wide base of support, bending the knees, and keeping the back straight during the lifting phase.

There is a significant but weak correlation between using a wide base of support when lifting a crate compared to picking up a backpack (r = .258). This was similar to the correlation between using a wide base of support when lifting a pencil compared to lifting a backpack (r = .270).

The correlation for bending the knees when picking up a pencil and lifting a backpack was .284. There was also a positive but weak correlation between keeping the back straight when lifting a crate compared to bending the knees when lifting a backpack.

Slightly higher correlations occurred when maintaining a straight back posture. Keeping the back straight correlated with bending the knees when lifting the crate (r = .290). A correlation was noted for keeping the back straight when lifting a crate compared to picking up a pencil (r = .361) and lifting a backpack (r = .354). There was also a correlation (r = .381) for keeping the back straight when comparing picking up a pencil with lifting a backpack. These correlations will be discussed further in CHAPTER V.

CHAPTER V: DISCUSSION AND CONCLUSIONS

The purpose of the present study was to evaluate the effectiveness of an instructional program about infusing BPP principles to prevent lower back discomfort into the physical education curriculum of fifth grade elementary students.

Hypotheses

This study tested the following hypotheses:

1. H_1 – The education program group will achieve a significantly superior average mean score on the written back knowledge test than the control (no intervention) group.
2. H_2 - The education program group will exhibit significantly better performance on the practical assessment than the control (no intervention) group.
3. H_3 - The group test means will not be significantly different on the written back knowledge and practical assessment scores between participants in the three intervention groups.
4. H_4 – There will be a positive correlation between the written back knowledge and practical assessment test scores of the education program group.

The results of this study indicated that the education (intervention) group performed better on the written knowledge test as compared to the control group that did not experience the instructional treatment.

In this study, the education group's knowledge about proper back care for one's lower back improved by 10%, while the control group showed no improvement about

lower back care. These results support a study by Carden et al. (2002) in which the intervention group's knowledge about back care improved by 15%, while the control group did not improve.

The question on the written knowledge test that was answered with higher frequency on the pretest and the posttest was question 3, "*Which is the best way to carry your book bag? (Over two shoulders).*" This was answered correctly by 97 of 100 students (97%), while all (100%) of the students used both backpack straps during the practical assessment. It was assumed in this study that most students had a moderate degree of knowledge regarding proper use of a backpack, and knew that they should use both straps. It is questionable, however, that this proper technique is regularly performed. Cardon et al. (2001) recommends using a "candid camera" procedure as an evaluation tool to measure if back care principles carry over into daily back care habits. Further study is suggested in this area to see if students continue to use this principle in everyday use of a backpack.

The only question that showed a negative percent change (- 8%) in the education group was question 8, "*During playtime, it's best for your back if you (Move a lot).*" Answers chosen instead were "*Sit down"* or *"Stand still."* It is assumed in this study that students had a misconception that sitting or standing was better for the back than movement. This was evident on question 6 as well. Only 24 of 100 students (24%) in the education group correctly chose sitting as the hardest position on the back. Further explanations about disc pressure and posture may be needed during instruction in future lessons to assist students with this principle.

The education group also performed better than the control group on the practical assessment, which was the expected outcome. Other studies found similar results (Cardon et al., 2001; Cardon et al., 2000; Sheldon, 1994). For example, Cardon et al., 2001 showed higher scores for the education group over the control group after participating in six (60 minute) sessions of basic back care practices. Spence et al. (1984); however, only found improvements in written back knowledge and no improvement in the performance of proper lifting techniques.

The instruction in this study was given by three different physical education teachers. One group attained superior scores on the practical assessment. This group did attend a higher academically achieving school and performed better on the initial pretest than the other two education groups. When comparing the mean gains in performance, however, all three education groups had similar results showing that instruction was effective in both a higher achieving and regular school environment.

The relationship between knowledge and performance of practical skills was evaluated for each instructor. The correlation for Instructor 1, r (35) = .476, p = .003, was significantly different from 0, but not for Instructor 2, r (36) = .191, p = .251 or Instructor 3, r (23) = .136, p = .517. Although, the education group as a whole performed better than the control group on the practical assessment, BPP training time prior to the intervention may need to increase on future studies to improve the correlation between knowledge and BPP practice.

Some of the main principles emphasized on the teacher tapes involved lifting with a wide base of support, bending the knees, and keeping the back straight. These principles were mentioned at higher frequencies over the six week intervention than any

other skills. It appeared easier to interweave these ideas into several lessons versus principles on sitting, standing, or using a backpack. Lifting was mentioned during tennis lessons when picking up a ball from the ground, during paddleball with equipment tear down, or during dance lessons when lifting the step benches. Students had practice picking up light objects (tennis balls, bean bags, etc.) and heavier objects (net stands, step benches, etc.) so it was expected that there would be a correlation between the three main principles of lifting (wide base of support, bending the knees, keeping the back straight) when lifting a crate, pencil, and backpack.

The correlations between proper techniques when lifting a crate, pencil, or backpack were significant but weak. A correlation existed between bending the knees during lifting both lighter items (r = .284) but not compared to lifting the heavier crate. This was the same with maintaining a wide base of support. Even when students used a wide base of support to lift the heavier crate, they did not maintain this wide base when lifting the lighter pencil or the backpack (r = .258). Students did slightly better at maintaining a straight back position when lifting a crate compared to a lighter item (r = .361). The back care principles are the same when lifting all three items (crate, pencil, and backpack) so stronger correlations were expected.

Students should maintain proper techniques regardless of the weight of the object they lifted; however, this outcome was not always achieved. Students who used a partial knee bend or a narrow base of support during lifting had difficulty maintaining a straight back posture. This forced the student to bend the trunk further to reach for the item since the knee bend was insufficient. Some students would use a proper knee bend and wide base during the crate lift but change to a partial bend or a narrow base when lifting the

lighter items. Although students did practice lifting light and moderately weighted items during physical education class, further reinforcement of this principle during instruction is needed.

Summary

Back pain is a common disorder that affects a majority of the population at some point during their lives (Cardon et al., 2000). The rising rate of LBP in children causes greater concern potentially leading to back pain reoccurrences in adulthood (Jones et al., 2003). BPP should proactively begin in elementary schools where it could reach a large population (Cardon et al., 2002), yet, many schools face budget and time constraints and have difficulty placing further demands on the curriculum.

The purpose of this study was to evaluate the effectiveness of combining BPP principles into the existing PE curriculum of fifth grade students. There was a significant difference between the groups with the education group performing better on the written knowledge test and the practical assessment than the control group. There was no significant difference in the written knowledge scores between the three instructional groups, and there was no significant difference between the mean score gains of the three groups on the practical assessment. There was a slight but weak correlation between the education group's mean scores on the written knowledge test and on the practical assessment. Positive but weak correlations also existed between back care knowledge and performance of back care principles. Overall, the instructors were able to teach the BPP principles, and the education group did perform better on the BPP tests than the control group.

Implications for Teaching Physical Education

Due to the physical educator's knowledge of exercise and muscle use principles, physical educators are well equipped to understand and teach BPP to their students. Heyman and Dekel (2008) recognized the link between ergonomics and physical education and encouraged additional training in ergonomics. This study showed that two hours of instruction in BPP resulted in markedly improved knowledge about the sources of lower back pain and ways in which fifth grade students can prevent back injury and discomfort. Additional training in back care should result in further improvements. In a meta-analysis, Calvo-Munoz et al. (2102) concluded that better results occurred when knowledge and practical teachings were combined. They also analyzed that the study with the largest intervention time (19 hours) showed the largest effect size (d = 13.033). This would suggest that better results would occur with longer interventions.

BPP principles should be infused into the existing curriculum as evidenced by inclusion into lessons on tennis, dance, and paddleball. Students can be taught to run "tall" when jogging or to sit "tall" during instruction to promote proper posture. Lifting techniques (wide base, bent knees, and straight back) were mentioned more frequently than any other principles and can be taught when students are lifting heavier (nets, steps) or lighter objects (balls, racquets).

Elementary students are exposed to many risk factors in the school setting (improper work stations, heavy backpacks, carrying and lifting heavy objects, etc.). BPP is needed early in the elementary setting to reduce these risk factors.

The physical educator is in a unique position over classroom teachers and generally sees students for several years during their elementary education. This would

allow the educator to begin adding BPP principles at a younger age and potentially reinforce those principles over several years. Researchers advocate for long term intervention (Jones et al., 2007; Heyman & Dekel, 2008).

Cardon et al. (2001) also advocates for observation of students during regular lessons and playtime. Educators would teach the principles but also observe whether students incorporate the principles into their daily habits. This could be more effective than a six week study and significantly improve back care in elementary students.

Limitations and Future Directions

The study was conducted over a six week period with students attending one physical education class per week for 45 minutes. Although gains were noted in the students' knowledge about sources of back pain, some of the correlations between lifting techniques were relatively weak. Further research is needed to determine if higher gains can be made with longer educational sessions or different instructional strategies.

Many students who participated in the present study advanced to middle school the following year. Long term retention is difficult to assess with this age group. Future studies are needed to assess the ability of younger students to retain and practice back care principles over a longer period of time. Since physical educators frequently teach their students for several years during their early elementary learning, future studies should address infusing BPP principles into the PE curriculum.

Physical education instructors are better equipped to teach BPP to their students than general education classroom teachers; however, they too may require additional ergonomic training for proper implementation of this task. Providing PE teacher

candidates with BPP principles during their university coursework is instrumental in preparing them to teach the principles at the elementary level.

Calvo-Munoz et al. (2012) concluded that combining theoretical teaching with postural training or practical teaching was more effective that theoretical teaching alone. Future studies need to include BPP knowledge as well as practical or performance based back care practice.

REFERENCES

Aaron, G. (2005, July). Back education and functional activities training program. Course handout presented at the TPTA Approved Course # 740, Nashville, TN.

Aaron, G., Beazell, J., Lucido, M., and Boyd, J. (2005, July). Evaluation and management of the lumbar spine. Course material presented at the TPTA Approved Course # 740, Nashville, TN.

American Occupational Association. (2014). Backpack Facts: What's All the Flap About? Retrieved from http://www.aota.org/-/media/Corporate/Files/Backpack/Whats%20All%20the%20Flap%20About.pdf

American Physical Therapy Association. (2009). Is your child's backpack making the grade? Physical therapists give the A-B-C's of smart backpack use. Retrieved from http://www.apta.org/AM/PrinterTemplate.cfm?Section=Media&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=57741

Calvo-Munoz, I., Gomez-Conesa, A., & Sanchez-Meca, J. (2012). Preventive physiotherapy interventions for back care in children and adolescents: a meta-analysis. *BMC Musculoskeletal Disorders,* 13:152.

Cardon, G., De Clercq, D., & De Bourdeaudhuij, I. (2000). Effects of back care education in elementary schoolchildren. *Acta Paediatrica*, *89*, 1010-7.

Cardon, G., De Bourdeaudhuij, I., De Clercq, D. (2001). Generalization of back education principles by elementary school children: evaluation with a practical test and a candid camera observation. *Acta Paediatrica*, *90*, 143-50.

Cardon, G., De Bourdeaudhuij, I., De Clercq, D. (2002). Knowledge and perceptions about back education among elementary school students, teachers, and parents in Belgium. *Journal of School Health*, *72*,100.

Faigenbaum, A. & Mediate, P. (2006). Medicine ball for all: A novel program that enhances physical fitness in school-age youths. *JOPERD – The Journal of Physical Education, Recreation, & Dance,* 77(7), 25-30, 45.

Fortunato, B. (2008). Back safety short course. Retrieved from the Brookhaven National Laboratory website: http://www.bnl.gov/esh/shsd/PDF/Back%20Safety%20Course-Short%20Classroom%20Version.pdf

Garfin, J. & Garfin, S. (2002). Low back pain: Exercises to prevent recurrence. *Consultant,* 42, 357-361.

Geldhof, E., Cardon, G., De Bourdeaudhuij, I., Danneels, L., Coorevits, P., Vanderstraeten, G., & De Clercq, D. (2007). Effects of back posture education on elementary schoolchildren's back function. *European Spine Journal, 16,* 829-839.

Geldhof, E., De Clercq, D., De Bourdeaudhuij, I., & Cardon, G. (2007). Classroom postures of 8-12 year old children. *Ergonomics, 50,* 1571-1581.

Goodgold, S.A., & Nielsen, D. (2003). Effectiveness of a school-based backpack health promotion program: Backpack intelligence. Work, *21*, 113-123.

Healthsouth Corporation. (2000). Your best moves: Back injury prevention. *Ergonomics* [CD]. Birmingham, AL: HealthSouth Corporation.

Hedge, A. (2007). Work ergonomics: Guidelines for computer use by children. Retrieved June 2, 2008 from http://www.spineuniverse.com/displayarticle.php/article3147.html

Heyman, E. & Dekel, H. (2008). Ergonomics for children: An educational program for elementary school. *Work, 31,* 253-257.

Hoffman, A. (2009). Backpack awareness: One of many ways that occupational therapists serve students. Retrieved from The American Occupational Therapy Association website: http://www.aota.org/News/Consumer/Backpack08.aspx?css=print

Jones, G., Watson, K., Silman, A., Symmons, D., & Macfarlane, G. (2003). Predictors of low back pain in British schoolchildren: A population-based prospective cohort study. *Pediatrics, 111*, 822-828.

Jones, M. A., Stratton, G., Reilly, T., & Unnithan, V. B. (2007). Recurrent non-specific low-back pain in adolescents: The role of exercise. *Ergonomics*, 50, 1680-1688.

Kratenova, J., Zejglicova, K., Maly, M. & Filipova, V. (2007). Prevalence and risk factors of poor posture in school children in the Czech Republic. *Journal of School Health, 77*(3), 131-137.

Lipsey, M. & Wilson, D. (2001). *Practical Meta-Analysis.* Thousand Oaks, CA: Sage.

Mckenzie, R. (1989). *The lumbar spine: Mechanical diagnosis and therapy.* Wellington, New Zealand: Spinal Publications Limited.

Motmans, R., Tomlow, S., & Vissers, D. (2006). Trunk muscle activity in different modes of carrying schoolbags. *Ergonomics, 49,* 127-138.

Nachemson, A. (1963). The influence of spinal movements on the lumbar intradiscal pressure and on the tensile stresses in the annulus fibrosus. *Acta Orthopaedica, 33*, 183-207.

Nachemson, A. & Morris, J. (1964). In vivo measurements of intradiscal pressure: Discometry, a method for the determination of pressure in the lower lumbar discs. *The Journal of Bone & Joint Surgery*, *46*, 1077-1092.

National Association for Sport and Physical Education. (2004). *Moving into the Future: National Standards for Physical Education (2nd* ed.). Reston, VA: NASPE Publications.

Park, Jeong-hwan & Kim, Jin-Sun (2011). Effects of spinal health educational programs for elementary school children. *Journal for Specialists in Pediatric Nursing*, 16, 121-129.

Patel, R. K. & Everett, C. R. (2003). Low back pain: 20 clinical pearls: Managing a chronic disorder, its exacerbations, and its remissions. *The Journal of Musculoskeletal Medicine, 20,* 452-460.

Salter, R. (1984). *Textbook of disorders and injuries of the musculoskeletal system* (2nd ed.). Baltimore, MD: Williams & Wilkins.

Saunders, H. (1992). *Self Help Manual: For your back*. Minneapolis, MN: Educational Opportunities: A Saunders Group Company.

Saunders, H. & Saunders, R. (1993). *Evaluation, treatment and prevention of musculoskeletal disorders: Spine* (3rd ed., Vol. 1). Bloomington, MN: Educational Opportunities.

Shasmin, H. N., Abu Osman, N. A., Razali, R., Usman, J. & Wan Abas, W. A. B. (2007). The effect of load carriage among primary school boys: A preliminary study. *Journal of Mechanics in Medicine and Biology, 7*, 265-274.

Sheldon, M. R. (1994). Lifting instruction to children in an elementary school. *Journal of Orthopaedic & Sports Physical Therapy, 19*, 105-110.

Smith, D., & Leggat, P. (2007). Back pain in the young: A review of studies conducted among school children and university students. *Current Pediatric Reviews*, *3*, 69-77.

Spence, S., Jensen, G., & Shepart, K. (1984), Comparison of methods of teaching children proper lifting techniques. *Physical Therapy, 64,* 1055-1061.

Tennessee Department of Education. (2007). Physical education: Grades 3-5. *Curriculum Standards*. Retrieved April 14, 2007 from http://state.tn.us/education/ci/ standards/pe/pe_35.shtml

Tinning, R. (2001). Physical education and back health: Negotiating instrumental aims and holistic bodywork practices. *European Physical Education Review, 7,* 191-205.

Thomas, E. (2003). Chapter 12: A brief look at Iowa's K-12 physical education content standards. Retrieved from the IAHPERD website: http://www.iowaahperd.org /journal/j03f_chap12thomas.html

Thomas, J. R., Nelson, J. K., & Silverman, S. J. (2005). *Research Methods in Physical Activity* (5th Ed.). Champaign, IL: Human Kinetics.

APPENDICES

APPENDIX A

Back Knowledge Pre and Posttest

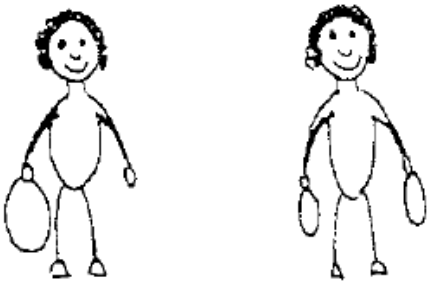
Back Education
Multiple Choice Test

Instructions:
Please circle one correct answer for each question:

Name: _____

1. When lifting a heavy box off the floor:
   a) You should keep your feet as far apart as possible.
   b) You should do most of the work with your back.
   c) You should bend your knees.
   d) You should keep the box on one side of your body.

2. The best way to carry your groceries is:



In one big bag In two bags

3. Which is the best way to carry your book bag?

Over one shoulder Over two shoulders In one hand

4. When carrying a box, it is best to carry it:

As close as possible to your body A little further from your body As far as possible from your body

5. If you pick up books from a pile on the floor and put them on a table:
   a) You should not move your feet and just turn your body.
   b) You should move your feet each time
   c) You should move your feet just a little and then turn your body.

6. The hardest position for your back is:


a) Standing


b) Laying on your side


c) Lying on your back


d) Sitting

7. A spine:
   a) Has no curves.
   b) Has 2 curves.
   c) Has 3 curves.
   d) Has 4 curves.

8. During your playtime, it's best for your back if you:
   a) Sit down
   b) Move a lot
   c) Stand still

9. Which book bag is loaded in the best way?

10. How much should the maximum weight of your book bag be?
   a) Your own weight
   b) Your bodyweight, divided by 2
   c) Your bodyweight, divided by 5
   d) Your bodyweight, divided by 10

Revised from *G Cardon et al.* ACTA PÆDIATR 89 (2000)

APPENDIX B

Practical Assessment

Post Practical Assessment **Number**_____

Task	No - 0	Partial - 1	Yes - 2	
Sitting at a table:				
▪ Straight, not slouched				
▪ Feet on the floor				
▪ Use of ring binder				
▪ No twisting				
Pick up the crate:				
▪ Wide base of support				
▪ Load close				
▪ Bend knees				
▪ Back straight				
▪ No twisting				
Carry the crate:				
▪ Back straight (not swayed)				
▪ Load close/elbows bent				
Set the crate down on the table:				
▪ Bend knees				
▪ Load close				
Pick up a pencil (regular or golfer's lift):				
Regular Lift:				
▪ Wide base of support				
▪ Bend knees				
▪ Back straight				
Golfer's Lift:		*or*		
▪ Front knee bent				
▪ Back leg up for balance				
▪ Back straight				
Move the crate:				
▪ Back straight				
▪ Load close & in front				
▪ Step/pivot not twist				
Backpack:				
▪ Load correctly (order)				
▪ Handling the bag (bend knees)				
▪ Handling the bag (wide base)				
▪ Handling the bag (back straight)				
▪ Carrying the bag – 2 straps				
Total Score				

Revised from *G Cardon et al.* ACTA PÆDIATR 89 (2000)

APPENDIX C

Practical Assessment Rubric

Practical Assessment Rubric

Task	No - 0	Partial - 1	Yes - 2
Sitting at a table:			
▪ Straight, not slouched	Rounded. Shoulder may drop. Leaning on elbow.	Leaning forward from hips.	Straight. Shoulders level.
▪ Feet on the floor	1 on floor, legs crossed, or sitting on leg(s).	Both feet on the floor. None or 1 foot flat.	Both feet are flat on the floor.
▪ Use of ring binder	No.		Yes.
▪ No twisting	Knees not in line with the chest.		Knees under the desk in line with the chest.
Pick up the crate:			
▪ Wide base of support	Feet or knees are touching.	Narrow base (knees/feet < shoulder width). Feet not flat.	Feet/knees ≥ shoulder width apart. Feet flat.
▪ Load close	Load is not between the feet but in front.	1 foot is beside the crate.	The crate is between the base (1 or 2 feet). Load touches the body.
▪ Bend knees	Bent at the hip not the knee.	Bent at the waist and slight to mild bend at the knees.	Bent at the hip and knees (roughly over 75 degrees).
▪ Back straight	Rounded, slouched.		Straight.
▪ No twisting	Twisted. Handles not in line with the chest.		Without twisting.
Carry the crate:			
▪ Back straight (not swayed)	Rounded, slouched, or leaning back. Shoulders rounded.		Straight.
▪ Load close/elbows bent	Elbows < 90 degrees with load low. Or load far from body.	Elbows at ≥ 90 degrees. Load is held slightly away from the body.	Elbows close to 90 degrees. Load touches body.
Set the crate down on the table:			
▪ Bend knees	Bent from the waist or swayback. Ride load to table.		Bend knees until load reaches the table.
▪ Load close	Pushing the load away from the body before reaching the table.	Elbows at 90 degrees but the load is held away from the body.	The load is touching the body until it is placed on the table.

Pick up a pencil (regular or golfer's lift):			
Regular Lift:			
▪ Wide base of support	Feet or knees are touching.	Narrow base (feet/knees less than shoulder width apart).	Feet/knees ≥ shoulder width apart.
▪ Bend knees	Bent at the hip not the knee.	Bent at the waist and slightly bent at the knees.	Bent at the hip and knees (roughly over 75 degrees).
▪ Back straight	Rounded, slouched.		Straight.
Golfer's Lift:	*or*		
▪ Front knee bent	Bent at the hip or only minimal knee bend.		Moderate knee bend to reach item.
▪ Back leg up for balance	Leg is below height of opposite calf.	Leg is between height of opposite calf and knee.	Leg is above height of opposite knee.
▪ Back straight	Rounded, slouched.		Straight.
Move the crate:			
▪ Back straight	Upper or lower back rounded, slouched. Leaning forward.		Straight.
▪ Load close & in front	Load not touching the body. Load is not in line with hips.		Load is touching the body. Load is in line with hips.
▪ Step/pivot not twist	Twisting. No step or pivot.	Step or pivot but still twisting.	Step or pivot with no twist.
Backpack:			
▪ Load correctly (order)	No.		Yes (smallest book is in front).
▪ Handling the bag (bend knees)	Bent at the hip not the knee.	Bent at the waist and slightly bent at the knees.	Bent at the hip and knees (roughly 90 degree angles).
▪ Handling the bag (wide base)	Feet or knees are touching.	Narrow base (less than shoulder width apart).	Feet slightly more than shoulder width apart.
▪ Handling the bag (back straight)	Rounded, slouched.		Straight.
▪ Carrying the bag – 2 straps	No.		Yes.
Total Score			

APPENDIX D

Instructor Checklist

Instructor Back Pain Prevention Principles Checklist

Instruction Method	Verbal	Student Practice
Standing Posture:		
▪ Stand tall		
▪ Ear/shoulder/hip/knee/ankle		
▪ Belly button pulled in		
Sitting Posture:		
▪ Back straight		
Pick up the crate:		
▪ Wide base of support		
▪ Load close		
▪ Bend knees		
▪ Back straight		
Carry the crate:		
▪ Back straight (not swayed)		
▪ Load close/elbows bent		
Set the crate down on the table:		
▪ Bend knees		
▪ Load close		
Pick up a pencil:		
▪ Bend knees or golfer's lift		
Move the crate:		
▪ Back straight		
▪ Load close & in front		
Backpack:		
▪ Load correctly		
▪ Handling the bag		
▪ Carrying the bag – 2 straps		

Additional Comments:

_____

_____

_____

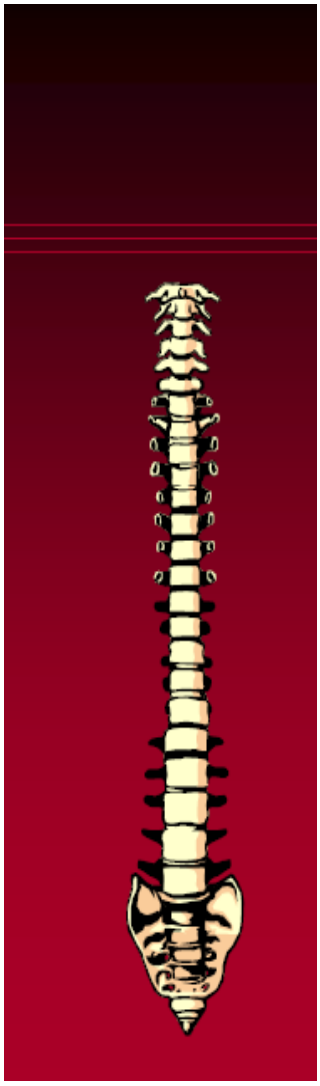
_____

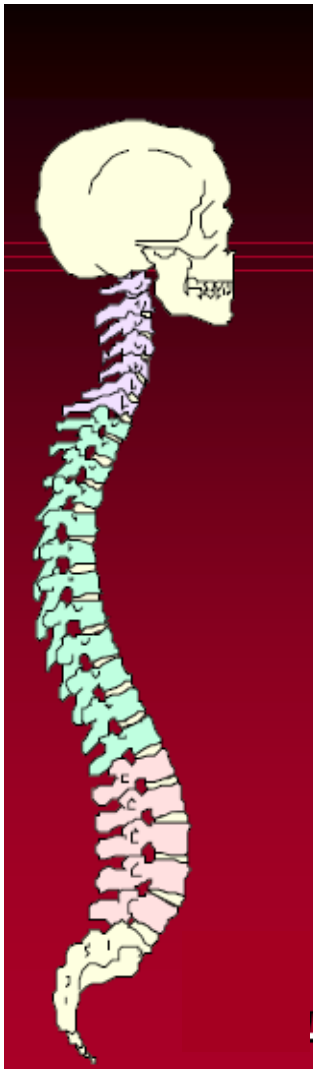
_____

APPENDIX E

Instructor Training Manual

Back Pain Prevention Principles
Teacher Instructor Manual





Infusing BPP Principles into the Physical Education Curriculum

Overview of the Study

Low back pain (LBP) has a significant impact on society, affecting 50-80% of adults at some point in their lives (Cardon, De Clercq, & De Bourdeaudhuij, 2000). Children are now facing some of the same risk factors faced by adults.

Because of the rising risk factors, it would appear that back pain prevention (BPP) education is needed in the public education system where it can reach a higher percentage of the population. Usually, BPP is directed toward adults and taught during rehabilitation after an injury instead of being provided before these individuals develop bad habits or inefficient lifting patterns. Establishing correct lifting techniques and movement patterns in early childhood may be a more reasonable proactive method of prevention (Sheldon, 1994).

Even with the benefits of BPP education, teachers face pressing demands on their time and would have difficulty adding blocks of instruction to the schedule. Infusing back prevention education into the existing curriculum would be more manageable and still be beneficial.

The physical educator is also the most qualified individual to teach these principles due to knowledge in the area of anatomy, muscle use principles, and exercise. NASPE's national physical education standards also address BPP and list "…good posture while lifting and carrying an object" (NASPE, 2004, p. 17) as an outcome of Standard One. Using physical educators as the instructors, the purpose of the study is to evaluate the effectiveness of infusing BPP principles into the physical education curriculum on the back knowledge of fifth grade elementary students.

General Back Anatomy

One of the problems associated with accumulative back pain is the lack of innervation in the innermost part of the lumbar intervertebral disc. The nucleus pulposus forms the inner 40% of the disc and is a gel like substance of collagen fibers. The annulus fibrosis surrounds the nucleus pulposus and is made of approximately 10-12 layers of concentric collagen fibers aligned in an oblique fashion. Each adjacent layer is angled in a cross directional position. The nucleus pulposus and the inner two-thirds of the annulus fibrosis do not contain any nerve endings. Only the outer one-third of the annulus fibrosis is innervated primarily by the lumbar sinuvertebral nerves (Aaron, Beazell, Lucido & Boyd, 2005).

With repetitive motion over time, this allows the nucleus pulposus to protrude through the layers of the annulus fibrosis undetected until pressure is applied to the outer innervated layers. Continued pressure can cause the disc to herniate or even rupture compressing the spinal nerve roots and resulting in further increased pain or impaired nerve conduction (Salter, 1984). Because it may take months or even years for back pain to develop, damage to the disc may occur undetected through risk factors that increase intradiscal pressure such as faulty body mechanics, loss of strength and flexibility, and poor posture caused by slumped sitting or standing (Saunders, 1992).

The Basic BPP Principles

Back Pain Prevention Education

An effective back care program needs to address the causes of back pain and reduce the many risk factors. This section provides a description of specific back care principles designed to protect the back from injury. These include the use of proper body

mechanics and lifting techniques, the correct method for loading and wearing a backpack, and the use of good standing or sitting posture. Using proper body mechanics is one of the most significant ways to treat as well as to prevent back injuries.

Body mechanics. The following principles are components of proper body mechanics: 1) maintain a neutral spine by keeping the natural "S" curve versus "C" curve in your back, 2) keep a wide base of support, 3) keep the load close when lifting, 4) bend the knees and not the back, 5) carry loads close to the body, 6) move your feet versus twisting your back, 7) use both straps on the backpack, 8) do not carry more than 10% body weight in the backpack, 9) balance your load, and 10) use good posture in sitting and standing (Aaron, 2005; Cardon et al., 2000; Healthsouth, 2000; Mckenzie, 1989; Saunders, 1992).

Maintain a neutral spine. Proper lifting or carrying techniques are designed to reduce the external forces on the trunk musculature. The neutral position for the spine is in maintaining the natural "S" curve. Attempting to lift heavy objects in a slouched or rounded position places extra force on the trunk muscles increasing the potential risk (Saunders, 1992; Spence, 1984).

Use a wide base of support. A wide base of support increases stability during the lift (Aaron, 2005; Spence, 1984). With a narrow base of support, trunk musculature must compensate for the lack of assistance from the lower extremities.

Keep the load close. The optimal position for lifting or carrying an object is with the load close to the body. The forces needed to maintain balance and control of the load increase as the load is held further from the body (Saunders, 1992). Keeping the load

close also assists the body in maintaining the neutral spine position (Aaron, 2005; Cardon, et al. 2000).

Bend the knees, not the back. When the back is used as the fulcrum, the larger quadriceps muscles are not optimized while the smaller trunk extensors attempt to support body weight and the weight of the load (Fortunato, 2008). Geldhof, Cardon et al. (2007) recommend using a squat position as a more favorable biomechanical lifting technique. The spine is able to stay in a preferred neutral position when the knees bend during lifting (Cardon, 2000; Sheldon, 1994; Spence, 1984).

Pivot, do not twist. Twisting places the back musculature in a stretched and potentially harmful position (Aaron, 2005: Fortunato, 2008). Muscles are stronger at mid-range versus end range of motion. When the lifter pivots or steps with the feet to pick up and transfer a load, the spine can remain in a neutral position with the trunk musculature in a position of power.

Backpack weight and position. Using two straps on a backpack allows the weight to be equally balanced. Contralateral shifting occurs when only one backpack strap is used (Motmans et al., 2006). Additional compensatory forces can occur if the backpack weight is over 15% of body weight (Shasmin et al., 2007).

Balance the load. This follows the same principle as proper use of a backpack. When a load is placed on one side of the body, the contralateral side must contract to compensate for the uneven weight and maintain balance. When possible, heavy loads should be reduced to two smaller equal loads and carried on both sides of the body (Aaron, 2005).

Use good posture. Nachemson and Morris (1964) showed that sitting or standing in a slumped position increased pressure on the intervertebral discs. Slouching also places more pressure on the ligaments, forcing them to do the work of the muscles. Tilting a notebook at the edge of the desk and using that as a writing surface allows the student to sit up straight as they write. Prolonged static sitting in a poor posture may impede blood circulation and decrease nutrition to the discs (Geldhof, De Clercq et al., 2007).

Teacher Instruction

- Randomly choose two intact fifth grade classes to participate in the study (Place all class names in a container and draw out two names).
- Have students sign the assent form and send consent forms home for parent signatures (An incentive of ice cream will be given to all students who return the form regardless of their decision).
- Since the BPP education will be included in the regular physical education curriculum, all students will participate in the pre-test, instruction, and post-tests. If consent is not obtained, the data from those students will not be utilized in the study.
- Administer the Back Education Multiple Choice Test to all students.
- Administer the Practical Assessment to all students. Each assessment will be videotaped for evaluation.
- Begin adding BPP principles into your lessons. Each class, use the Instructor Checklist and check when the principle is mentioned or practiced by the students. Any ideas for implementing the principles are welcomed and encouraged. Write a brief summary of these ideas on the checklist during or after each class. Over the 6 weeks, discuss each principle a minimum of 2 times.
- Use the digital voice recorder to record each lesson. Email this file to Susan Heiser [redacted] each week.
- Keep a copy of the checklist, but send the original weekly to Susan Heiser at [redacted] through the courier.
- Email or call with questions. I will be contacting you weekly to assist with any issues or offer assistance.

Teaching Cues

Maintain a neutral spine:

- There are 3 natural curves in your back (neck, upper back, and lower back).
- Keep the "S" curve.
- Avoid the "C" curve for good posture.

Lifting:

- Keep your feet apart (use a wide base of support like a defensive stance).
- Bend your knees and not your waist.
- Keep the load close to your body.
- Keep your back straight (don't let the back round like a "C").
- Push up with your legs.

Carrying:

- Keep the load close.
- Bend your knees to set the load down (on a table or floor).

Picking up a Load from a Table:

- Pivot or move your feet, do not twist.
- Keep the load close.

Wearing a Backpack:

- Use 2 straps.
- Tighten both straps to keep the pack above your waist.
- Balance the load so the heaviest books are closer to your back.
- Don't carry more than 10% of your body weight (your weight divided by 10).

Balance the load:

- Use 2 smaller bags instead of 1 large bag.
- Carry items in both hands.

Sitting posture:

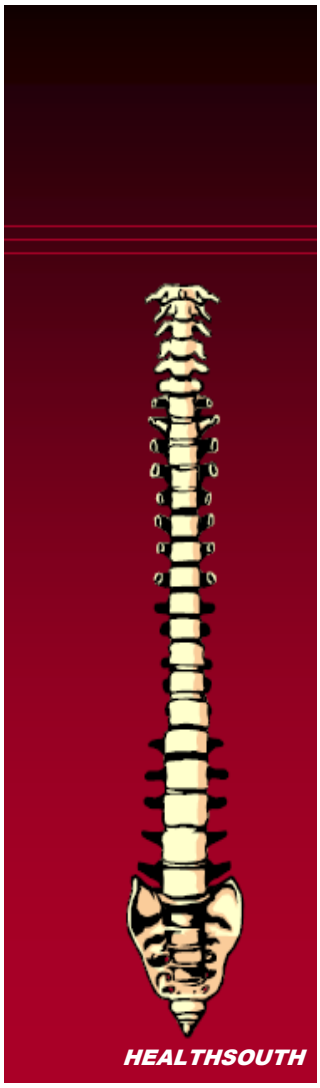
- Sit up straight. Avoid slouching forward.
- Keep both feet on the floor.
- Roll side to side to feel the "sit bones."
- Tilt a notebook at the edge of the desk and use that surface to write on versus leaning over the desk.
- Sitting places more pressure on your back than standing or lying down.

Standing posture:

- Stand up straight like a stack of bricks.
- Line up your ear – shoulder – hip – knee – ankle.
- Pull in your belly button to tuck the hips in correctly.
- Roll your shoulders back (like putting your shoulder blades in your back pocket).

Back Pain Prevention Principles

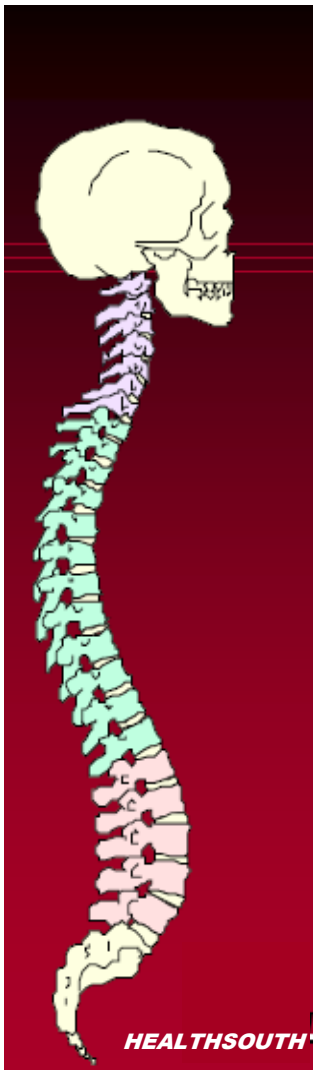
Spine



Neck →

Upper Back →

Lower Back →



There are 3 natural curves in your spine

Keep the “S” Curve in your back.

Slouching makes a “C” Curve.

Balance Your Load

It is better to carry items in both hands.

Putting items in 2 smaller bags is better than using 1 large bag.

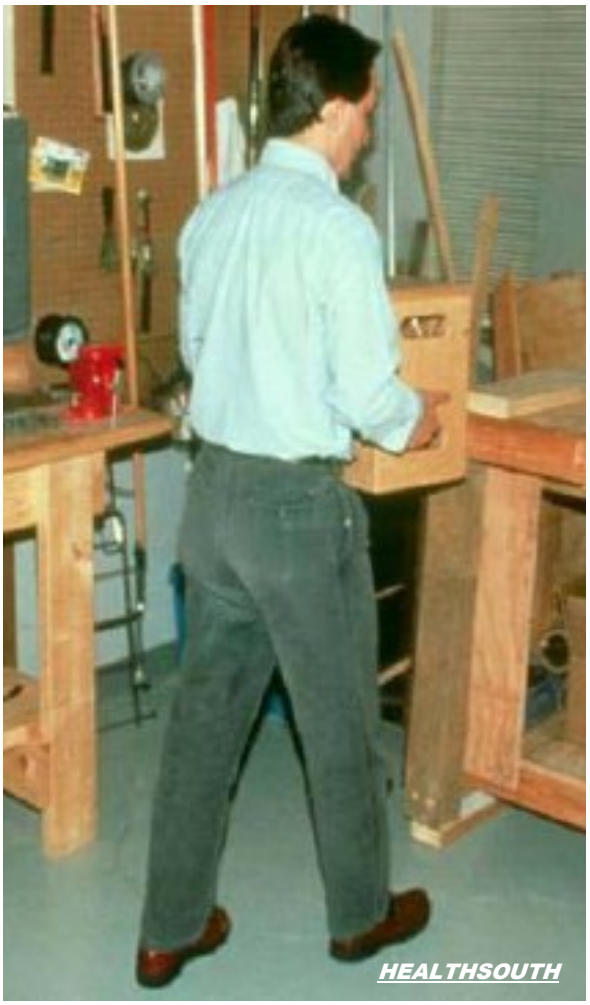
Lifting a Heavy Box

The WRONG Way

The RIGHT Way

Keep your feet apart (Make a strong base of support).
Bend your knees and not your waist.
Keep the box close to your body.
Keep your back straight and look forward.
Push up with your legs.

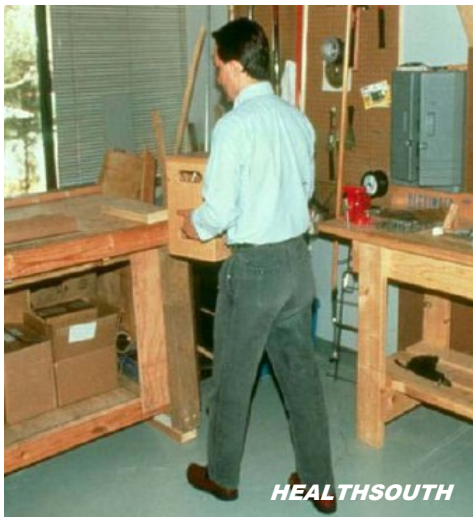
Carrying a Box

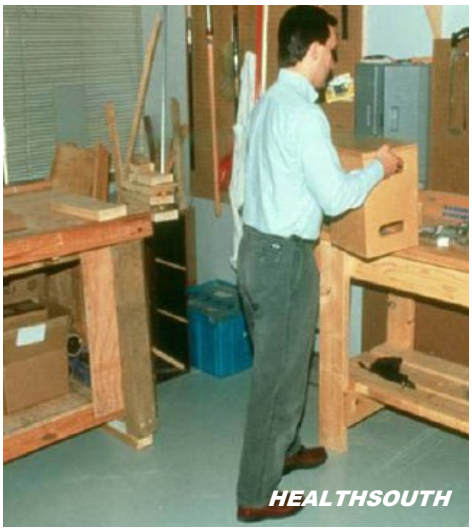


Keep the box as close to you as possible.

Moving a Box from a Table

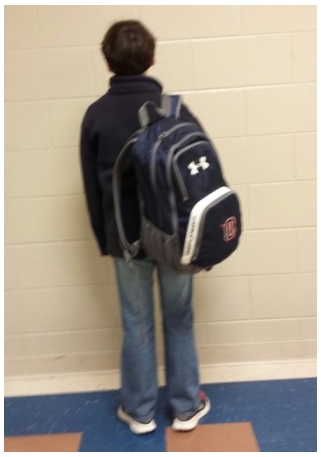
DON'T TWIST



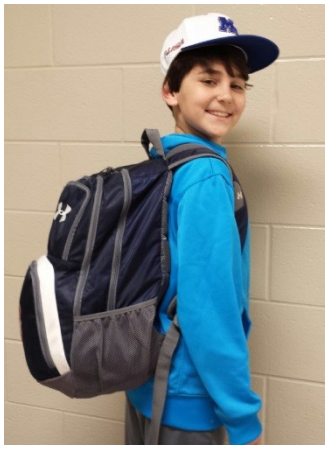


Keep the box close and move your feet.

Wearing a Backpack



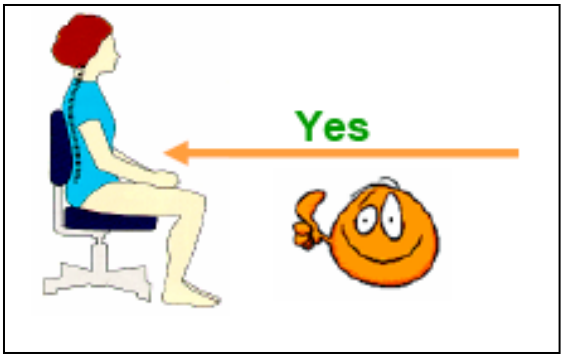
- Using 1 strap causes you to lean to balance.



- Using 2 straps is better.
- Tighten both straps to keep the pack close to your back.
- Don't let the pack ride below your waist.
- Balance the load in your backpack so the heaviest book is close to your back.
- Don't carry more than 10% of your body weight (your weight divided by 10).

Good Posture

Sitting is hard on your back.



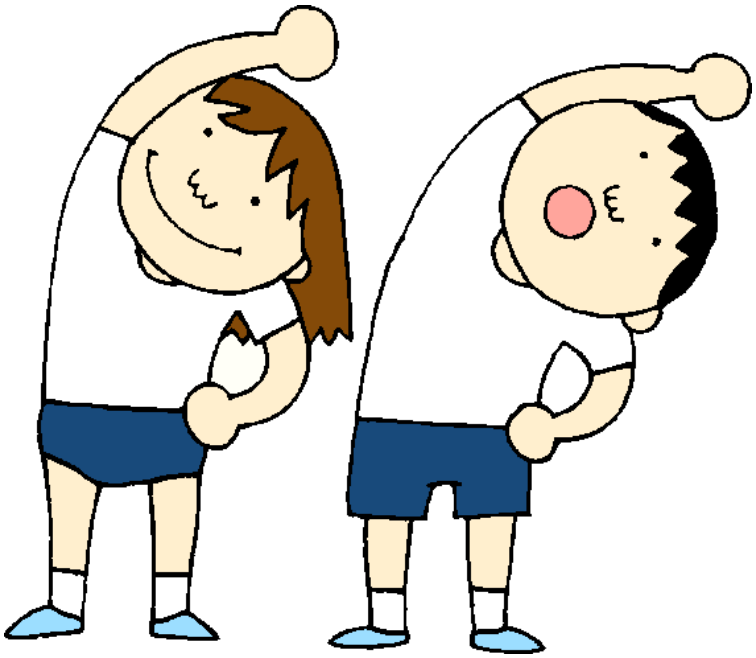
Sit up straight with your shoulders back.
Keep your feet on the floor.

Standing

Ear
↓
Shoulder
↓
Hip
↓
Knee
↓
Ankle

Stand up straight like a stack of bricks.

Your Back Likes to Move



Stretch and play.

Do not stay in one position too long.

Your back muscles need exercise.

Incorporating Back Pain Prevention Principles Into Physical Education

The following suggestions are provided as examples of how to add the principles into physical education. Instructors are encouraged to look for teachable moments and add the principles into their own curriculum whenever possible.

Standing Posture:

- Have the student stand tall (Stack the knee, hip, shoulder, and ear over the ankle. Roll shoulders back simulating putting the shoulder blades into the back pockets. Pull belly button toward the spine).
- Maintain this posture while walking with a beanbag on your head.
- When lining up to leave, challenge students to maintain the posture for 30 second intervals.
- Posture Police – challenge students to check each other for proper posture.
- Use the Center of Balance games from the Wii during fitness station rotation.

Sitting Posture:

- Have students sit in a slouched posture. Have them roll side to side. Then have them sit up straight and repeat the process. Students should now feel the ischial tuberosities or the "sit bones."
- Remind students to maintain the proper sitting posture when waiting during activities. Challenge students to maintain the posture during set and close instructions.

Lifting Techniques:

- Use the lifting techniques for equipment clean up or transition.
- Teach the principle using basketballs or any other easily accessible item to represent the load.
- Use the golfer's lift for items that can be picked up with one hand.
- If items can be carried in two small loads, balance the load between both hands.
- Base of support – teach this principle by teaching the defensive stance. Let students practice using a narrow and wide base of support while a partner applies gentle pressure to push the student off balance. Ask students which position is more stable.

Carrying Techniques:

- Keeping the load close – let students hold a light object away from their bodies and time their endurance. Then let students hold the item close and see if they can beat their own time.
- Hold a basketball and use the pivot or step to teach not twisting from the waist with the load.

Backpack Techniques:

- Schedule students to wear their backpacks to class one day. Instruct students in loading the backpack correctly and in adjusting the straps correctly.
- Have a fast walk relay with students correctly loading their backpack and wearing it properly adjusted to the finish.
- Wear the backpacks on a hike around the school.
- Wear the backpacks during an orienteering lesson.

Back Strengthening and Flexibility Exercises:

- Incorporate core strengthening with the plank, superman, and quad runner exercises during warm up or cool down.
- Use the medicine ball or stability ball exercises in a fitness station circuit.
- Use dynamic hamstring flexibility exercises after warm-up.
- Remind students to maintain pelvic tilt by pulling the belly button toward the spine during abdominal exercises.

References

Aaron, G. (2005, July). Back education and functional activities training program. Course handout presented at the TPTA Approved Course # 740, Nashville, TN.

Aaron, G., Beazell, J., Lucido, M., and Boyd, J. (2005, July). Evaluation and management of the lumbar spine. Course material presented at the TPTA Approved Course # 740, Nashville, TN.

Cardon, G., De Clercq, D., & De Bourdeaudhuij, I. (2000). Effects of back care education in elementary schoolchildren. *Acta Paediatrica*, *89*, 1010-7.

Cardon, G., De Bourdeaudhuij, I., De Clerq, D. (2002). Knowledge and perceptions about back education among elementary school students, teachers, and parents in Belgium. *Journal of School Health*, *72*,100.

Fortunato, B. (2008). Back safety short course. Retrieved from the Brookhaven National Laboratory website: http://www.bnl.gov/esh/shsd/PDF/Back%20Safety%20Course-Short%20Classroom%20Version.pdf

Geldhof, E., Cardon, G., De Bourdeaudhuij, I., Danneels, L., Coorevits, P., Vanderstraeten, G., & De Clercq, D. (2007). Effects of back posture education on elementary schoolchildren's back function. *European Spine Journal, 16,* 829-839.

Healthsouth Corporation. (2000). Your best moves: Back injury prevention. *Ergonomics* [CD]. Birmingham, AL: Healthsouth Corporation..

Mckenzie, R. (1989). *The lumbar spine: Mechanical diagnosis and therapy.* Wellington, New Zealand: Spinal Publications Limited.

Motmans, R., Tomlow, S., & Vissers, D. (2006). Trunk muscle activity in different modes of carrying schoolbags. *Ergonomics, 49,* 127-138.

Nachemson, A. & Morris, J. (1964). In vivo measurements of intradiscal pressure: Discometry, a method for the determination of pressure in the lower lumbar discs. *The Journal of Bone & Joint Surgery*, *46*, 1077-1092.

National Association for Sport and Physical Education. (2004). *Moving into the Future: National Standards for Physical Education (2nd* ed.). Reston, VA: NASPE Publications.

Salter, R. (1984). *Textbook of disorders and injuries of the musculoskeletal system* (2nd ed.). Baltimore, MD: Williams & Wilkins.

Saunders, H. (1992). *Self Help Manual: For your back*. Minneapolis, MN: Educational Opportunities: A Saunders Group Company.

Shasmin, H. N., Abu Osman, N. A., Razali, R., Usman, J. & Wan Abas, W. A. B. (2007). The effect of load carriage among primary school boys: A preliminary study. *Journal of Mechanics in Medicine and Biology, 7*, 265-274.

Sheldon, M. R. (1994). Lifting instruction to children in an elementary school. *Journal of Orthopaedic & Sports Physical Therapy, 19*, 105-110.

Smith, D., & Leggat, P. (2007). Back pain in the young: A review of studies conducted among school children and university students. *Current Pediatric Reviews*, *3*, 69-77.

Spence, S., Jensen, G., & Shepart, K. (1984), Comparison of methods of teaching children proper lifting techniques. *Physical Therapy, 64,* 1055-1061.

PRACTICAL ASSESSMENT INSTRUCTIONS:
(Please read these instructions to the student as they are ready to perform the task).

- Please sit at the table and write your number on the piece of paper.
- Pick up the crate and carry it.
- Place the crate on the table.
- Pick up the pencil.
- Move the crate from table A to table B.
- Pick up the backpack.
- Place the books in the backpack.
- Put the backpack on your back, and walk to the cone.
- Take the backpack off and put it back on the floor.

APPENDIX F

Assent and Consent Forms

Middle Tennessee State University Institutional Review Board
Proposal for Research Using Human Participants
Assent Document for Research Study

PI: Susan Heiser **Version Date:** 3/24/11
Title of Study: Effect of a Back Pain Prevention Education Program on Back Knowledge of Fifth Grade Elementary Students
Institution: Middle Tennessee State University

(This assent document applies to 5th grade students in the [redacted].

Name of participant _____ Age_____

Below are the answers to some of the questions you may have. If you have any questions about what is written below or have any other questions about this research, please ask them. You will be given a copy of this consent form.

Many adults and children have had back pain some time in their lives. Research studies help us learn new things. In this study, we are testing to see what students can learn about taking care of their backs. We are asking you to be in this study because we want to learn more about stopping the causes of back pain.

For the next eight weeks, during your physical education (PE) class, your teacher will show you some ways to take care of your back. The PE teacher for the control group will receive the information after we complete the tests. You will take a short written test and be videotaped using the skills you learn. We will use your scores if you choose to participate. If you do not choose to participate, we will not use your scores but all students will still take the tests and participate in PE class like you normally would do.

Being in a study is voluntary. You may say 'Yes' or you may say 'No' for us to use your scores. Whatever you decide is okay, and you may change your mind even after you say 'Yes.' No one will be upset with you.

We do not expect you to be hurt during this study. We also don't plan on sharing your personal information or telling anyone if you join this study. The researcher will use a number instead of your name to identify your tests. We will use your information to see if the education works, but your name will not be shared.

Participating in this study may help you and other students learn how to take care of your backs. You may even be able to show your parents some helpful ideas that you learn. Using your scores and videotapes will help us learn how to teach better, but if you don't want to be in the study, you don't have to be.

If you have any questions, you may ask your PE instructor or you may contact Susan Heiser at [redacted] I am the PE teacher at [redacted] Elementary School.

_____ _____
Date Signature of student/volunteer

Consent obtained by: _____ _____
Signature Printed Name and Title

MTSU IRB Approved Date 3-25

6. **Anticipated benefits from this study:** Your child will be learning principles that could hold lifelong health benefits. Research shows that children are beginning to have back pain at rates as high as adults due to risk factors that are now present in schools (lifting or carrying heavy objects, overloaded back packs, poor computer workstations, poor sitting or standing posture). Students will learn how to take care of their backs and will help us evaluate the most effective way of teaching these principles. Many times adults only receive this information during rehabilitation after an injury has occurred. Teaching students during childhood is a more reasonable proactive method for learning how to prevent back pain.

7. **Alternative treatments available:** Since the instruction will occur during the regular PE class, there is no alternative treatment available.

8. **Compensation for participation:** No compensation will be offered for participation in the study. Participation is voluntary. Students will be offered a small incentive (ice cream) for returning the signed parental consent form regardless of whether the student participates or not.

9. **Circumstances under which the Principal Investigator may withdraw your child from study participation:** If the teacher or principal investigator is concerned about safety, your child may be withdrawn from the study.

10. **What happens if you choose to withdraw from study participation:** Both, you or your child are free to withdraw from the study at any time. No one will be upset with you or your child should you choose to not participate in the study.

11. **Contact Information.** If you should have any questions about this research study or any risks, please feel free to contact Susan Heiser at [redacted] Elementary School [redacted]

12. **Confidentiality.** All efforts, within reason, will be made to keep the personal information (name) in your child's research record private. A number will be assigned to identify your child on the data forms. Videos will be destroyed after the study is completed. Your child's information may be shared with MTSU or government agencies with responsibilities to oversee research studies (MTSU Institutional Review Board, etc).

13. **STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY**
I have read this informed consent document and the material contained in it has been explained to me. I understand each part of the document, all my questions have been answered, and I give permission for my child to participate in the study.

	Date	Signature of parent/legal guardian
Consent obtained by:	Date	Signature / Printed Name and Title

Middle Tennessee State University Institutional Review Board
Parental Informed Consent Document for Research

Principal Investigator: Susan Heiser
Study Title: Effect of a Back Pain Prevention Education Program on Back Knowledge of Fifth Grade Elementary Students
Institution: Middle Tennessee State University

Name of participant: _____ Age: _____

The following information is provided to inform you about the research project and your child's participation in it. Please read this form carefully and feel free to ask any questions you may have about this study and the information given below. You will be given an opportunity to ask questions, and your questions will be answered. Also, you will be given a copy of this consent form.

Your child's participation in this research study is voluntary. He or she is also free to withdraw from this study at any time. In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study.

For additional information about giving consent or your rights as a participant in this study, please feel free to contact the MTSU Office of Compliance at (615) 494-8918.

1. **Purpose of the study:**
   Your child is being asked to participate in a research study because we are testing the effectiveness of including back pain prevention principles in the physical education (PE) curriculum. Over 50-80% of adults will experience back pain some time in their lives. By helping students learn safe ways to take care of their backs, they may reduce their chances of having a back injury.

2. **Description of procedures to be followed and approximate duration of the study:**
   The study will take place for the next eight weeks in your child's regular PE class. The PE teacher has been taught how to add back care principles into her lessons. Your child will participate in PE class and will take a written test and be videotaped performing the skills they have learned. Since the ideas will be included in the regular class instruction, each child will receive the instruction. The PE teacher for the control group will receive the instruction after the testing has been completed. Should you or your child choose not to participate, your child's scores and tapes will not be included in the study. Videos will be destroyed when the study is completed. Only the researcher, assistant, and her advisor will analyze the videos.

3. **Expected costs:** There is no cost to participate.

4. **Description of the discomforts, inconveniences, and/or possible risks that can be reasonably expected as a result of participation in this study:** There are no anticipated injuries or risks expected with this study. Students will simply participate during PE class as they normally would.

5. **Compensation in case of study-related injury:** There are no anticipated injuries expected during this study. MTSU will not provide compensation in the case of study related injury.

APPENDIX G

IRB Approval Form

April 4, 2011

Susan Heiser
Department of Health and Human Performance

Protocol Title: "Effects of a back pain prevention education program on back knowledge of fifth grade elementary students"

Protocol Number: 11-277

Dear Investigator(s),

The MTSU Institutional Review Board, or a representative of the IRB, has reviewed the research proposal identified above. The MTSU IRB or its representative has determined that the study poses minimal risk to participants and qualifies for an expedited review under 45 CFR 46.110 Category 4 and 7.

Approval is granted for one (1) year from the date of this letter for 160 participants.

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. **If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance (c/o Emily Born, Box 134) before they begin to work on the project.** Any change to the protocol must be submitted to the IRB before implementing this change.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918.

You will need to submit an end-of-project form to the Office of Compliance upon completion of your research located on the IRB website. Complete research means that you have finished collecting and analyzing data. **Should you not finish your research within the one (1) year period, you must submit a Progress Report and request a continuation prior to the expiration date.** Please allow time for review and requested revisions. Your study expires **April 4, 2012**.

Also, all research materials must be retained by the PI or faculty advisor (if the PI is a student) for at least three (3) years after study completion. Should you have any questions or need additional information, please do not hesitate to contact me.

Sincerely,

Emily Born
Compliance Officer
Middle Tennessee State University

APPENDIX H

Copyright Permission Requests

From: "Greet Cardon" <greet.cardon@---------->
To: susanheiser@----------
Sent: Thursday, October 31, 2013 5:08:00 PM
Subject: Re: Permission to use Survey Instrument

Thank you for your interest. I approve that you use the questionnaire and thank you in advance for stating a reference to my work when you publish on this.
I wish you lots of luck with your study and I'm honoured that my work will be used in Tennessee , where I stayed for one year in 1993.

Kind regards,
Greet

Prof. Greet Cardon
Department of Movement and Sports Sciences
Ghent University
Belgium

Verstuurd vanaf mijn iPhone

Dr. Cardon,

I am a doctoral student from Middle Tennessee State University writing my dissertation tentatively titled "Effects of a Back Pain Prevention Education Program on Back Knowledge of Fifth Grade Elementary Students" under the direction of my dissertation committee chaired by Dr. Belcher. The research study involves teaching physical education teachers back pain principles that will be infused into their regular curriculum.

I would like your permission to use an adapted version of the survey instrument and practical performance test published in your 2000 study:

Cardon, G., De Clercq, D., & De Bourdeaudhuij, I. (2000). Effects of back care education in elementary schoolchildren. *Acta Paediatrica*, *89*, 1010-7.

I would like to use and print your survey under the following conditions:

I will use this survey only for my research study and will not sell or use it with any compensated or curriculum development activities.

I will also include the copyright statement on all copies of the instrument used in the study and in the dissertation.

If these are acceptable terms and conditions, please indicate so by returning this email with your approval.

Sincerely,

Susan Heiser

Doctoral Candidate

From: "Alan Evans" <evansa@---------->
To: susan@----------
Sent: Monday, June 24, 2013 7:38:33 AM
Subject: RE: Dissertation Reference Material Request

Hi Susan and thanks for reaching out. You are correct – these materials, while compiled by George, are the intellectual property of Select Medical. As such I am happy to grant you the permission to include them in your dissertation.

Let me know if we can support you in any other way. Good luck!

Alan

Alan Evans PT OCS MOMT FAAOMPT MCSP

Director of Education
Select Medical - Outpatient Division

From: susan@----------
Sent: Monday, June 24, 2013 1:29 AM
To: Evans, Alan
Cc: Heiser, Susan
Subject: Dissertation Reference Material Request

Alan,

My name is Susan Heiser, and I am a PTA at Select Physical Therapy in [redacted]. I am also an elementary school Physical Education Teacher, and I am working on completing a doctorate in Human Performance. My dissertation title is the "Effects of a Back Pain Prevention Education Program on Back Knowledge of Fifth Grade Elementary Students." The idea was to instruct other Physical Education Teachers in Back Education and then have them infuse those principles into their regular lessons when appropriate (i.e. using a proper lift to pick up the tennis net, etc.). I referenced some material that George Aaron used in a Continuing Education Course that he taught in Nashville in 2005 (#740). I am attaching the 2005 Back School Slides and Slide Descriptions that he used.

I designed an instruction manual for the teachers that included some of George's pictures and back information. He is referenced at the end of the material. I would like to include the teacher manual in the appendix of my dissertation. I have tried to contact George but he does not come up on email. I am assuming, however, that the rights to the material now belongs to Select's Continuing Education Department.

I would like to have permission to include the information in my dissertation. The reference I will use is listed at the back of the teacher's manual. Please let me know by email if this is acceptable or if there is someone else I need to contact. Thank you for your help. Please contact me if you have any questions.

Sincerely,

Susan Heiser, PTA
