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The effect of backpack weight on the height of middle school students

Barbara Dixon Shuman

THE EFFECT OF BACKPACK WEIGHT ON THE HEIGHT OF MIDDLE SCHOOL STUDENTS

A Thesis

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in

Nursing

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ABSTRACT

Backpacks have been implicated as a cause for an increased incidence of back pain in children (Negrini, Carabalona, & Paolo, 1999). The literature reflects inconsistencies relating back pain and backpack weight and recommendations for safe backpack weight vary. This quantitative, non-experimental study of 60 middle school students compared height, with and without backpacks, to determine if backpack weight caused significant change in height in a sample of 6^{th}, 7^{th}, and 8^{th} graders whose average age was 12.3 years. Two sets of weight and height measurements were collected from each participant, with each student completing a demographic questionnaire between measurements. Measurements revealed an average backpack weight of 4.62 kg or 9% of body weight. Average height of participants without backpacks measured 156.23 cm, average height with a backpack measured 155.385 cm. A paired t-test demonstrated a significant difference ($p < .05$) in height with and without a backpack. The average backpack weight did not differ significantly between girls and boys ($p = .402$), however, boys demonstrated a greater decrease in height ($p = .012$) than girls. This study adds to the growing body of evidence to limit backpack weight to 10% of body weight or less.

ACKNOWLEDGMENTS

It is with highest regard I recognize California State University San Bernardino Nursing Department Chair Marcia Raines, Susan Lloyd, Masters Program Coordinator, Ellen Daroszewski, Thesis Chair, and all other faculty members whose countless hours of work and dedication have come together to produce an excellent educational program that challenges the spirit and intellect of students to churn, ponder, develop and transform into well prepared Advanced Practice Nurses.

I express deep gratitude to my thesis committee members, namely, Ellen Daroszewski, Thesis Chair, Susan Lloyd, and Anita Kinser. In particular I thank Ellen, who through great theory and research instruction ultimately inspired me to embark on a research adventure that produced a meaningful piece of scholarly work and who taught me volumes. Thank-you for committing hours of review, guidance, and support, without which, this would not have been possible.

Thanks to Murrieta Valley Unified School District Pupil Services Director Alan Young, for approving this study, and Thompson Middle School Principal Dale Velk, Assistant Principal David Ciabattini, for help and support in securing a site for my data collection. I especially thank the students who participated in this study and their teachers who helped it happen.

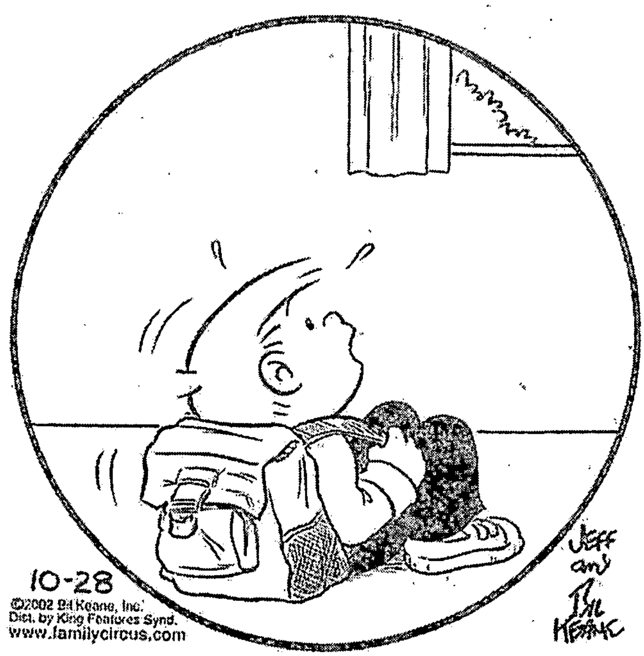
Special thanks to Mr. James R. Cavett of King Features Syndicate for waiving regular reprint fees, and granting permission to use a "Family Circus" cartoon in this thesis that speaks clearly about the current backpack issue.

I thank my friends and family members for endless support and critical discussions about this backpack study, especially Badsie who listened, suggested, and brought me food. Elizabeth and Kathryn, to my daughters with love, may this thesis inspire achievement in your own lives. Lastly, Debbie Toten (Debs) thanks for sharing the experience and keeping me on task, you're awesome.

DEDICATION

I dedicate this piece of scholarly work to my Dad, whose patience, broad mind, and intellect always inspired me to pursue knowledge, gain understanding, and achieve the greatest possibilities.

Family Circus



"My backpack is too full. Will somebody help me stand up?"

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CHAPTER ONE

INTRODUCTION

Backpack Issues

Where once back pain was predominantly an adult experience, current surveys predict as many as 51% of all school children will suffer with back pain (Schenck, 2003). Much literature suggests backpack weight as a cause for the dramatic rise in complaints of childhood back pain. Repetitive loading of the spine such as repeated carrying of backpacks is a risk factor for low back pain in children (Negrini, Carabalona, & Sibilla, 1999).

At one time, back pain in children was thought to indicate serious pathology such as malignant tumors or infection. However, currently in nearly half of children with back pain, clinical evaluation demonstrates that back pain originates from musculoskeletal trauma, strain, or fracture with pain sufficient to wake children from their sleep, (Selbst, Lavelle, Soyupak, & Markowitz, 1999) thus interrupting important daily life activities.

There has been extensive discussion in lay literature about the potential for back pain and spinal problems with backpack use. Epidemiologic studies have identified risk factors associated with adolescent back pain and daily use of a heavy backpack (Mackenzie, Sampath, Kruse, & Sheir-Neiss, 2003).

Out of 12,688 backpack injuries reported by the National Electronic Injury Surveillance System (NEISS), Wiersema, Brent, Wall, and Foad (2003) identified only 27 back injuries in children aged six through 20, caused by backpacks. Many studies have shown up to 40 to 51 percent of children who carry backpacks report back pain (Iyre, 2001; Schenck, 2003; Troussier, Davoine, de Gaudemaris, Fauconnier, & Phelip, 1994). Although back pain is common in adolescents, and despite high rates of disability, medical attention is rarely sought (Watson et al., 2002).

There are definite physical responses to backpack weight; in particular, a forward lean posture change occurs when the backpack is placed symmetrically over both shoulders (Flack & Jackson, 1997; Grimmer, Dansie, Milanese, Pirunsan, & Trott, 2002; Pascoe, Pascoe, Youg, Shim, & Kim, 1997). Evaluating low back pain in adults has shown the most common contributing factor to pain is postural lean. A 10 degree forward lean increases intradiscal pressure at L3-4 and L4-5 by 100 percent and 500 percent respectively. A moderate lean can have a great effect upon the lumbar spine (Sodorff, 2002).

Preventing back problems in children is important because of the potential of childhood back pain to progress to adult low back pain, which has been estimated by Duggleby and Kumar, to be as high as 60-80 percent prevalence in a lifetime (Steel, Grimmer, Williams, & Gill, 2001). Back pain is the most common disability for people under the age of 45, and this number is increasing. Medical and surgical care for back pain accounts for nearly 24 billion dollars each year, (Reis & Flegel, 1996). An assessment of back pain in young adults revealed virtually all students in the sample were placing unbalanced pressure on their necks, shoulders, and backs by carrying their backpacks exclusively on one shoulder, and clearly revealing a knowledge deficit regarding back health and back care (Reis & Flegel, 1996).

Back pain causes disruptions in a child's life that prevents them from participating in school (Selbst et al., 1999). Absenteeism contributes to poor academic performance in children and adolescents with illness. They experience more academic difficulty than healthy peers and report falling behind in school work (Thies, 1999).

After many backpack studies, recommendations for safe backpack weights have not been prescribed. Research continues to focus in this area that may bring evidenced-based answers. From a health perspective it is desirable to limit backpack weight because of the evidence that backpack weight contributes to back pain in children and represents a modifiable risk which if controlled can impact academic success and long term back health implications.

The Backpack Question

When a backpack is placed on the back, carried symmetrically, with both straps over the shoulders, the body attempts to counter balance the force by assuming a forward lean posture (Grimmer et al., 2002; Pascoe, Pascoe, Youg, Shim, & Kim, 1997). This posture change creates increased pressure on the lumbar vertebrae that strains and stresses the musculoskeletal system, contributing to pain (Sodorff, 2003). Erect human posture is thought to have the least amount of physical activity and minimizes stresses on the joints of the body. This occurs in the unloaded state, such as without a backpack, the body is aligned with a vertical reference. When an external force such as a backpack, is applied to the body, posture commonly deviates from this vertical alignment. Posture deviating from this alignment, has been associated with spinal pain (Grimmer et al., 2002). Students are carrying excessive backpack weights that exceed occupational standards for adults causing them pain and discomfort (Negrini, Carabalona, & Sibilla, 1999).

Back pain has short and long term negative consequences. To prevent the potential consequences of carrying heavy backpacks including interference with learning and to minimize morbidity and health care expense, it is desirable to determine a recommendation for safe backpack weight. Despite the variety of backpack studies investigating various physical effects in children, there remains no scientifically established recommendation for safe backpack weight. The literature reflects inconsistencies. The Academy of Orthopedic Surgeons recommends children carry no more than 15 percent of total body weight (Galley, 2001) while the American Chiropractic Association recommends no more than five to 10 percent of total body weight be carried on the back (Van Tine, 2001). This study will evaluate the effect of backpack weight on change in height. This study predicts that if a backpack weight causes a forward lean posture change, it will result in a measurable height change.

The research question to be answered by this study is does backpack weight cause a significant change in the height of middle school students?

Hypothesis

The hypothesis for this study predicts that backpack weight will cause a height change in middle school students.

Purpose of the Study

This study investigates the effect backpack weight has on the height of middle school students. It provides data about the effects of backpack weight on height that has not previously been determined. This study aims to contribute information to a growing body of evidence which supports the limitation of backpack weight for children to be no more than 10% of body weight.

Theoretical Framework

This study utilizes a theoretical framework which was developed from research and other literature to describe the effects of backpack weight on a number of other variables. Figure 1 the Dixon Model, illustrates the proposed relationship between the variables that results in an interruption of learning in children. The proposed model begins with the use of a backpack. The amount of backpack weight that children carry varies. Some children have been reported to have carried as much as 30 percent of their body weight in their backpack (Negrini et al., 1999), while other children have been reported to have carried backpacks weighing less than 10 percent of their total body weight. Grimmer et al. (2001) measured posture changes in adolescents with backpack weights as small as three percent total body weight demonstrating that increasing backpack load caused anatomical points above the ankle to move progressively anterior. Further, at any anatomical point on the back any posterior load (such as a backpack), produces different horizontal position from ankle up (Grimmer et al., 2002). These observations support the proposed relationship between the first and second variable of the model, that backpack weight causes a forward lean posture change.

Posture changes vary depending on the way a backpack is carried, i.e. over one shoulder, over both shoulders, or diagonally. This study focuses on a symmetric carriage, where backpack straps are over both shoulders which cause a forward lean posture change (Pasco et al., 1997).

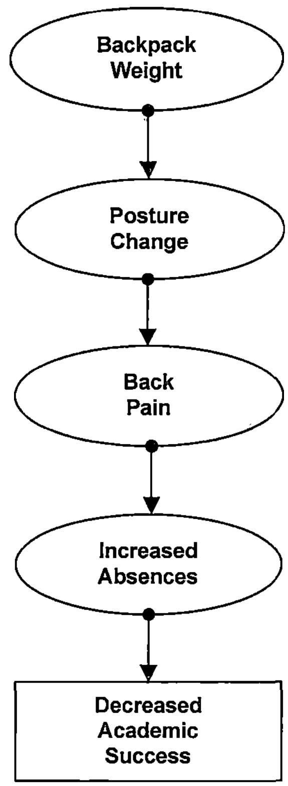

Figure 1. The Dixon Model Illustrating Effects of Increased Backpack Weight on Pain and Academic Success

Forward lean posture is associated with low back pain (Grimmer et al., 2002; Sodorff, 2002). Good posture is important in preventing low back pain. Poor posture and muscle imbalance fatigues the body and places extra stress on the spine that leads to muscular aches and pains. When the body is aligned it is balanced and able to absorb stress evenly and efficiently (Strahl, 1998).

Bennett, Huntsman, and Lilley (2001) found 82 percent of 43 children who experienced chronic pain reported multiple locations, the head being the most common pain location followed by the back and the stomach. Studies have shown adolescents with chronic musculoskeletal pain can have extremely high pain-related disability (Bennett et al., 2001).

Bennett et al., asked parents about the pain their child experienced. The majority of parents reported that their child's pain problem had persisted for over two years and on average their child experienced pain at least two to four days of the week. Further, parents reported that their child's pain, on a visual analogue scale ranging from zero (no pain) to 10 (severe pain) was 6.45, where a score of three in previous studies, has been reported to be clinically significant (Bennett et al., 2001).

Pain can be very debilitating. Fifty-eight percent of students with chronic conditions regularly miss school. Children missing 30 percent of days within a grading period are more likely to fail (Thies, 1999).

Falling behind academically requires catching up which takes time away from keeping up. Many subjects are built on previous knowledge. Falling behind can result in decreased self confidence which can undermine achievement (Thies, 1999).

Figure 1 represents the theoretical framework for this study. It emphasizes the relationship between backpacks and a posture change that occurs with backpack carriage (Grimmer et al., 2001; Pascoe et al., 1997). Posture change is associated with pain (Sodorff, 2002), and chronic pain contributes to absenteeism in school children (Thies, 1999). Defining a safe backpack weight for children to carry may reduce absenteeism by reducing pain experienced by children and thereby promote academic success.

Healthy People 2010 is a national health policy designed to reduce morbidity and improve quality of life. This initiative has set a goal to reduce the number of individuals, 18 and above, with chronic back problems experiencing limitations in activity from 32 per 1000 to 25 per 1000 by the year 2010 (U.S. Department of Health and Human Services, [USDHHS], 2003). Since back pain in children increases the risk of adult back pain (Steel et al., 2001) determining safe backpack loads for children may help prevent the development of chronic back conditions decreasing the burden placed on the health care system.

Healthy People 2010 defines health determinants as critical areas of influence that affect the overall health of individuals and communities. Relevant determinates in this study are individual behaviors, and policies and interventions (USDHHS, 2003). Once determined, safe backpack weight recommendations may influence behavior through the development of specific policies and interventions.

Limitations of the Study

Sixty students were selected from eight first period explore (non-academic) classes at Thompson Middle School in Murrieta, California. This represents a small sample size from one site. The findings in this study are not generalizable outside of the study sample. This limits the application of the results of this study to populations outside this sample.

There were mechanical limitations introduced by the measuring instrument. The platform scale was stable; however there was slight movement (approximately two millimeters) in the horizontal arm of the stadiometer which may have introduced height measurement error. The height rod had one millimeter graduations, and height was recorded to the nearest millimeter; the measurements of height change were small making this error potentially significant.

Demographic items on the questionnaire asked participants to make estimates. These estimates may not represent actual times and distances. Participants were asked to estimate home distance from school, and time required to get to school. There were four different methods of transportation; time and distances did not correlate ($p = 0.48$).

Definition of Terms

Loaded was a term used to indicate the backpack is on the child.

Unloaded was a term used to indicate the child is without a backpack.

Weighted a term synonymous with loaded; the child has a backpack on.

Unweighted a term synonymous with unloaded; the child is not carrying a backpack.

Carriage was used to indicate the child is carrying a backpack.

Mid-back backpack was used to describe that the location of the backpack rested in the middle of the back.

CHAPTER TWO

LITERATURE REVIEW

Back health may be compromised because of heavy loads carried by school children during the day; however, there are no long-term studies to show permanent damage as a result of such exposure. The literature reflects inconsistencies in the recommended weight children can safely carry on their backs. Based on research findings some authors conclude no more than 10 percent of body weight should be carried; however, additional research is needed in this area.

Backpack Weight

Weights carried by children vary. Whittfield, Legg, and Hedderley (2001) noted only a few studies have investigated the weight and use of schoolbags in students. They studied children at five schools in New Zealand and finding that out of 70 sixth graders and 70 third graders, half girls, third grade students carried 13.2 percent of their body weight. Sixth graders carried 10.3 percent of their body weight. Height, body weight, and backpack weight of each student was measured followed by a short questionnaire that asked about backpack type, preferred mode of carriage, how long backpacks were carried, and whether lockers were available.

Heights between third graders and sixth graders differed significantly; 70 percent of students carried their backpack on both shoulders and single shoulder carriage was 10.7 percent. Eighty-nine percent of students carried a backpack while others carried sports bags, shoulder bags, and cloth carry bags. This study found third graders, despite smaller stature, carried heavier backpacks for a longer period of time than sixth graders.

An earlier study done in Italy investigated the backpack weight children carried because of increasing complaints of back pain (Negrini et al., 1999). Out of 273 children, (119 girls); mean age being 11.6 years, they found the average daily weight carried by school children was 9.3 kilograms, (about 20.5 pounds).This represented about 22 percent of bodyweight.

Additionally they found that 35 percent of Italian children carry more than 30 percent of their body weight at least once during the week. Negrini et al. (1999) pointed out that weight limits are set for adults and adolescent workers, but no limits have been developed for application in schools. Although scientifically yet unsupported, the limits usually proposed for children are ten to 15 percent of body weight. Proposed limits are widely exceeded in everyday life and rates of back pain in children are approaching those seen in adults. For these reasons evidenced-based backpack weight limits are strongly urged (Negrini et al., 1999).

Body Responses to Backpack Weight

Not surprising, studies have shown that body responses increase as the weight of a backpack increases. The following research investigates body responses to backpack weight. These responses include gait, posture, respiratory function, cardiovascular system, and energy expenditure.

Posture and Gait

Pascoe, Pascoe, Wang, Shim, and Kim' (1997) examined the impact of different methods of carrying book bags on static posture and gait kinematics of youths aged 11 to 13 years. The investigators felt the use of backpacks and side carried athletic bags may have represented an overlooked daily stress. Weight bearing induced stress, often applied asymmetrically, is serious when considering children and youths that are experiencing physical growth and motor development (Pasco et al., 1997).

Pascoe et al. (1997) randomly selected 61 students and collected age, height, weight, shoulder width, arm length, and backpack weight. Means were calculated and then ten subjects from the original group, who best represented the means, were selected to participate. Filming recorded changes in posture and kinematics that occurred while carrying a 17.7 pound book bag in symmetric and asymmetric carriage.

The study found that gait, the frequency of gait, and posture were affected differently depending upon the way the weight was carried. When a backpack was worn symmetrically, (over both shoulders), the resulting posture was kyphosis, (a forward lean posture). When the weight was worn asymmetrically, such as over one shoulder, it caused a functional scoliosis to develop. The stride length was reduced and the stride frequency increased regardless of carriage.

Respiratory Function

Lai and Jones (2000) investigated the effect of backpack weight on forced expiratory lung volumes in 43 primary school children, mean age 9.6. They measured lung volumes under three weighted (10, 20, and 30 percent of body weight), and one unweighted condition (the control), and compared these measurements to the measurements taken during an assumed kyphotic posture. Findings in this study provide evidence that the forced expiratory volume measured in one second's time (FEV-1) and the forced vital capacity (FVC) were compromised (reduced) five to 10 percent when school bag weight increased to 20 percent of body weight. Similar restrictive effect was demonstrated in the assumed kyphotic posture.

Five to 10 percent reduction in respiratory function may seem small but the impact on children with existing respiratory conditions such as asthma may make a significant difference in their ability to get around. In this study Lai and Jones concluded that backpack weight should not exceed 10 percent of body weight, since lung function was not compromised when the school bag was 10 percent of body weight.

Cardiovascular Effects

Hong and Jing (2000) reported on the physiological effects of the body in response to carrying 10, 15, and 20 percent of body weight loads. The purpose was to differentiate the physiological effects of carrying different weights on children by simultaneous measurement of, expired air, heart rate, and blood pressure. They hoped that this information would produce guidelines on approved school bag weight.

This study examined effects of load carriage on the heart rate, blood pressure, and energy expenditure of 15 male primary school children aged 10 that were most representative of average body mass index for the school. Three parameters were measured; energy expenditure, heart rate, and oxygen uptake on each student weighted with a mid-back backpack, carrying 0, 10, 15, and 20 percent of their body weight. The main findings demonstrated that walking for 20 minutes when carrying loads equal to 15 and 20% of body weight induced longer recovery periods for blood pressure than for the 0 and 10% body weight loads. Also at 20 percent of body weight, there was a significant increase in metabolic cost, believed due to more muscle usage.

This study demonstrated that subjects had to work harder to carry backpacks of 20 percent body weight. The relative work intensity in 20 percent body weight load was significantly greater than that in 0 percent body weight load condition. Based on previous studies the increased metabolic cost likely resulted from more muscles being involved in working (Pasco et al., 1997). This is thought to be due to trying to bring the center of gravity back over the base of support. The change in posture causes the subjects to use additional muscle units to alter the gait to carry the load. The inclined body position and the altered locomotion biomechanics on a daily basis would increase the stresses on the back and leg muscles. For young children, these stresses might be harmful and influence their normal musculoskeletal developmental growth (Hong & Jing, 2000).

Etiology of Back Pain in Children

Review of Hospital Findings

Traditional pediatric orthopedic practitioners are taught that a child with back pain has a tumor or infection until proven otherwise. A change in the diagnosis among children with spine complaints has occurred and represents a change in society (Combs & Caskey, 1997).

Selbst, Lavelle, Soyupak, Sureyya, and Markowitz (1999) identified causes and epidemiology of back pain in children. Over a period of one year all children who presented to the emergency department whose chief complaint was back pain were evaluated and examined with a standard questionnaire. Most questionnaires (48 percent) were completed at the time of the visit and 52 percent were completed with in 48 hours.

Key questions asked about back pain during the examination included, "Where is it located?", "Does it radiate?", "When did the pain begin?", "How long does the pain last?", "What is the pain like?", Does the pain interfere with sleep, daily activity?", "Recent history, triggering factors?", Associated symptoms such as fever, dysuria, vomiting, weakness, in the past week?", "Recent life stresses, including death of a friend or family, moved, school problems?", "Past medical history?", "Family history?"

This study found children with back pain frequently did not have serious underlying organic causes as was once thought. Although back pain was still an uncommon reason for children presenting to the hospital emergency department, when they did it was for musculoskeletal reasons 48 percent of the time. Fifty-nine percent of children experienced acute back pain (less than or equal to two days), and chronic back pain (greater than or equal to four weeks) was reported 11.6 percent of the time. Forty-five percent of children described pain originating in the lumbosacral area. Although the etiology was rarely serious, back pain interrupted the daily activities of symptomatic children and also caused them to miss school (Selbst et al., 1999).

Impact of Pain on Children

Parent Perception

Bennett et al. (2000) investigated the impact of chronic pain in children and adolescents. This study provided a descriptive account of parents' perceptions of their children's experience of chronic pain. A questionnaire was given to parents to survey their description of their child's pain, related disability such as missing school, utilization of the health care system for assessment and treatment and other strains on the family. Parents were used as the information source because they were expected to have more accurate recall.

Of 43 children, 17 were referred for arthritis, 13 diagnosed with idiopathic musculoskeletal pain, 11 for headache (unspecified), seven for migraine, seven with abdominal pain and one for chronic fatigue. Children were included regardless of identifiable organic basis for their pain.

Bennett et al. (2001) found parents reported the second most frequent location of pain was the back and 91 percent of parents reported that pain interfered with school attendance. Forty-two percent of children reportedly missed between eight and 30 days of school and 26 percent of students missed more than 30 days in a school year. Parents also reported concern that the child had to miss even more school to attend healt appointments. Sixty-three percent reported their child's pain had persisted for greater than two years.

Bennett et al. reported children experienced moderate to severe levels of pain and disability for a prolonged period of time evidenced by school absence and disruption of normal day activities. Missing out on normal childhood activities due to pain may reduce chances for academic and social success and could influence life patterns of adjustment and productivity. There is a compelling need for effective treatments for children and adolescents with chronic pain that specifically target prevention and the reduction of disability (Bennett et al., 2000).

Literature Summary

The literature reviewed indicates there is a wide range of backpack weight that children carry. Physical changes occur in response to backpack weight. It is possible to measure changes in respiratory function when backpack weight is 20 percent or more of body weight. Cardiovascular effects and energy expenditure are also significantly increased when a backpack is 20 percent of total body weight. It is important to realize studies measure isolated effects of a backpack while in the child they are combined, i.e. respiratory function is decreased while cardiovascular demand is increased.

A forward lean posture is associated with low back pain (Sodorff, 2002). Back pain in children is likely to be musculoskeletal in origin. When children experience chronic pain it can be very disabling causing interruption of daily activities, such as missing school. Long term daily disruptions have implications toward academic success and future societal success.

Backpacks have been implicated as a cause for increased incidence of back pain in children. Further research is needed to determine safe backpack guidelines for children. Long-term studies are needed to investigate the impact of repetitive backpack exposure.

CHAPTER THREE

METHODOLOGY

Study Variables and Target Population

This study used a non-experimental, descriptive design to compare the height of Thompson Middle School students under two conditions, with and without their backpacks. The target population for this study was middle school children. Students who reported a history of spinal illness or injury, or those who did not use a backpack were excluded from this study.

Location

There are close to 11,000 students attending Murrieta Valley Unified School District in Murrieta, California. The district support center is located on MacAlby Court in Murrieta. Thompson Middle School is one of three middle schools in the district and has a population of 1,654 with girls comprising 49 percent of the student body. Twenty-nine percent of students at Thompson Middle School are sixth graders, 31 percent are seventh graders and eighth graders represent 39.6 percent of the population (MVUSD database, 2003).

Procedure

Permission was obtained to complete the study from the Director of Pupil Services at Murrieta Valley Unified School District support center, and the site Principal at Thompson Middle School. This study was approved through the Institutional Review Board of California State University, San Bernardino.

A convenience sample of Thompson Middle School students was selected by sending a packet containing a parent information letter; sample questionnaire, sample debriefing statement, and sample student consent, home with students in eight, first period, explore classes (see Appendix A and B). Parents reviewed the information and students returned a signed informed consent from those parents granting permission for their child to participate. Teachers collected the forms granting permission to participate and turned them into the health office.

There were 80-signed consents returned. Consents were numbered one through 80 and 60 students were selected to participate by randomly drawing numbers. A second selection of alternates was determined, since some students moved out of town, had schedule changes, or no longer used a backpack.

Teachers were given a list of students that were to be sent to the multipurpose for data collection the next morning. Students were sent to the multipurpose room before they entered class and removed their backpacks.

Upon arrival, all participating students were wearing backpacks with a double strap carriage, where the straps were placed correctly over each shoulder. The backpacks were soft, flexible and without frame supports, none used hip supports and backpacks hung at varying heights on their backs. When all participating students had arrived the procedure was described and they were informed their weight and height would be taken twice, the first time with a backpack, the second time without a backpack. Following an explanation of the procedure the students were asked if they would like to participate. All students readily consented. When students were asked about a history of disease or current injury, all students denied such history and current injury.

Once student consent was given, they were asked to remove their shoes. Between sets of measurements students were asked to fill out a questionnaire containing demographic data. After all data were collected for the group, a short debriefing was given and questions were answered.

Data collection was taken individually, in private. Students were asked to step on the Seca 780 digital scale, platform model and told to look straight ahead. Weight (kg) was recorded after turning on the instrument and allowing itself to calibrate. Height (cm) measurement was collected by lowering the Seca 220 telescopic height rod's horizontal measuring arm to gently make contact with the crown of the head. Measurements were made to the nearest millimeter. Average group size was about 10, data were collected over 7 days, and the entire procedure took about 40 minutes each day.

CHAPTER FOUR

RESULTS AND DISCUSSION

Results

Demographic and quantitative data were collected from Thompson Middle School located in the city of Murrieta in Riverside County, California. The school includes grades 6^{th}, 7^{th}, and 8^{th}, with a student population of 1,654 students (MVUSD database, 2003). The ethnic distributions of Thompson Middle School (TMS) and the community are listed in Table 1. Ethnic proportions vary as the population size increases.

Table 1. Ethnic Distributions for Riverside County, Murrieta, and Thompson Middle School

	Riverside County*	Murrieta♦	TMS Population❖	TMS Study Sample
White	33.1%	64.1%	68.3%	70%
Hispanic	36.2%	23%	18.7%	20%
Black	7.0%	1.1%	5.8%	3.3%
Asian	4.6%	4.2%	2.7%	1.7%
Other	21.2%	7.6%	3.6%	5.0%

*County demographics from Inland Empire Data and Resources Web Site Retrieved 4/15/03 @ http://www.healthycities.com/data_demog.htm
♦City distribution numbers retrieved from University of California, Riverside, City of Murrieta Economic and Demographic Data Web Site. Retrieved 4/15/03 @ http://www.murrieta.org/development/survey/demograp/demograp.html
❖TMS population demographics obtained from Murrieta Valley Unified School District Aries Database on 4/15/03

Population

There were 60 participating students with an average age 12.3 years. Girls represented 51.7% of the participants. Thirty-three point three percent of the participants were sixth graders, 25% were seventh graders, and 41.7% were eighth graders. Eighty-five percent of participants reported they carried backpacks daily. Most participants arrived at school by car (65%), followed by bus (20%), bicycle (8.3%), and walking (6.7%). Participants reported the time it took to get to school was an average of 11.8 minutes. Average distance from school reported by participants was 4.3 miles. The average weight of backpacks was 4.62 kg. Average body weight was 51.460 kg which indicates backpack weight was 8.98% body weight. Most participants reported removing their backpacks in class (96.7%). On data collection days, 38.3% of participants perceived their backpacks to be heavy, and 35% reported their backpacks to feel uncomfortable. Participants estimated average daily carry time to be 3.14 hours, and at the time of data collection, (beginning of first period), they estimated they had already carried backpacks for an average of 1.55 hours.

The primary focus of this study was to investigate the effect of backpack weight on the height of middle school students. There were other noteworthy findings. Table 2 summarizes the weight and height measurements obtained from the participants. The data were analyzed using SPSS Graduate Version statistical software.

Table 2. The Summary of the Participant Weight and Height Measurements

	N	Min	Max	Mean	Std. Deviation
Ht w (cm)	60	134.3	174.6	155.385	9.0576
Ht w/o (cm)	60	135.5	175.0	156.227	8.8616
Wt w (kg)	60	36.1	87.9	56.080	13.5266
Wt w/o (kg)	60	29.6	84.2	51.460	13.7421
Ht Change (cm)	60	-.7	3.8	.842	.8677
Backpack wt (kg)	60	1.9	7.9	4.620	1.2766

Findings

The ratio of average backpack weight divided by average body weight determined backpack weight represented 8.98% body weight. The maximum backpack to body weight ratio was 15.4% while the minimum was 3.5%. A paired t test demonstrated a statistically significant difference in height ($p = .000$) and weight ($p = .000$) with and without backpacks.

Using analysis of variance (ANOVA), additional statistically significant differences were demonstrated for gender, grade, age, and ethnicity. Height loss between girls and boys was significantly different (p = 0.12). Girls lost an average 1.128 cm while boys lost .574 cm. There were statistically significant differences in backpack weight by grade. Sixth graders on average carried a backpack weight of 11.8 percent of body weight while seventh and eight grader backpack weights were 8.56 percent and 7.44 percent respectively. In addition, it was not surprising to find differences in height and body weight between grades. Sixth graders were significantly shorter than seventh (p = .006) and eight graders (p = .000). There was no significant height difference between seventh and eight graders (p = .147). Another difference between grades was weight with and without backpacks. With a backpack, sixth and seventh graders did not differ significantly (p = .167) while sixth and eight graders did (p = .022). Weights without backpacks followed the same pattern, sixth and seventh did not differ (p = .126) while sixth and eight graders did (p = 0.11).

Overall ethnic groups differed in height with (p = .033) and without (p = .023) backpacks. Groups that differed were not identified because four of the ethnic groups had fewer than two individuals.

The ages of the participants ranged from 11 to 14, age findings were similar to grade findings however there was crossing over between age and grade.

Table 3. Years - Participant Age and Grade Cross Tabulation

		Grade			
		6	7	8	Total
Years	11	13	0	0	13
	12	7	12	0	19
	13	0	3	20	23
	14	0	0	5	5
Total		20	15	25	60

Statistically significant differences in height with and without backpacks, and weight with and without backpacks were found between ages. Eleven year olds differed in height in nearly all other ages both with and without a backpack. Eleven and 12-year-old height differed with ($p = .001$) and without ($p = .000$) a backpack. Eleven and 13 year olds height differed with ($p = .000$) and without ($p = .000$) a backpack, and 11 and 14 year olds height differed with ($p = .006$) but did not without a backpack ($p = .007$).

Statistically significant differences in weight with and without a backpack were found between age groups.

Eleven year olds differed significantly from 12 year olds in weight with ($p = .022$) and without ($p = .015$) a backpack, and 13 year olds weight with ($p = .002$) and without ($p = .001$). Backpack weights nearly differed between 11 and 13 year olds ($p = .051$).

The data show backpack weight has an effect on the height of middle school students. The difference in average height with a backpack compared to average height without a backpack was statistically significantly different.

Discussion

The deviations indicate a large variation in height change. There were uncontrolled variables within this study that may have contributed to the variation in height change. While backpacks were worn symmetrically, (straps over both shoulders), backpack straps were not adjusted to place the backpack in a standardized location on the back. Some were worn higher, some lower. Physical attributes and body styles were not considered.

Psychological influences associated with climbing onto a scale for height measurement were not identified or considered, however they may be insignificant, since individual psychological influences would be present during each measurement.

Instrument limitations were identified but there were difficulties with measuring height. Backpack weights varied. Several students had to be asked to move forward while on the weight platform because the horizontal measuring arm that contacted the crown of the head fell short and required repositioning the student. A better orientation may have been a lateral stand rather that a frontal stand. Spiked hair and hair ornaments created additional challenges in determining the crown of the head.

These uncontrolled variables may have augmented or diminished height change responses to backpack weight. It is possible that each student has a unique and individual response to backpack weight, and regardless of how well variables are controlled, large variation in height change may be likely.

Although small, the difference in average height with and without a backpack was statistically significant. The data indicate that backpacks do affect the height of middle school students. Students are significantly shorter while wearing their backpacks. However, beyond the fact that backpacks on average decrease height in middle school students, individual height change is found to be highly variable, i.e. average height loss was 0.84 cm (.868 = standard deviation). Differences between gender, grade, age, and ethnic groups should be interpreted with caution.

The change in height between gender was significant (p = 0.12). Girls lost an average 1.128 cm while boys lost .574 cm, however validity of these numbers is questionable since the standard deviation was greater than the mean. This indicates inconsistency and large variation in height change within subjects making the height change unreliable for valid conclusions to be drawn.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study demonstrates that backpack weight affects the height of middle school students. Average height with a backpack compared to average height without a backpack was significantly decreased. This study supports the hypothesis that backpack weight causes a significant decrease in the height of middle school students.

The data from this study contributes to an increasing body of evidence supporting recommendations for safe backpack weight. Accordingly, if backpacks weighing on average nine percent of body weight, can cause a significant decrease in height, which has been associated with forward lean and low back pain (Grimmer et al., 2002), it also suggests that safe backpack weight should be less than the frequently recommended 10 percent. The recommended weight of less than 10 percent may be too heavy for medically fragile populations who suffer chronic conditions such as asthma or arthritis. Those populations which are often excluded from studies may be more affected by backpack weight.

Recommendations

Additional Research

More research is needed to determine safe backpack weights for children. Current studies as well as this study could be repeated to increase external validity and improve generalizablility.

Since forward lean posture occurs in response to backpack weight and it is associated with low back pain (Sodorff, 2002), one research question to ask is whether there is a percentage of total body weight that can be carried by a child that would not cause the body to respond posturally. Research demonstrates postural change to be a central theme in the negative physiologic effects that occur in children, i.e. decreased respiratory function and kyphosis (Lai & Jones, 2000), increasing cardiovascular demand that is required to balance a load off center (Hong & Jing, 2000; Pascoe et al., 1997). Determining a backpack weight that does not cause a postural change would relieve other negative physiologic responses.

Very few longitudinal studies have been done. As a result little is know about how repeated mechanical loading exposure affects the outcome of spine development in children. The basic structure of the skeleton is genetically determined, but its final mass and architecture is influenced by mechanisms sensitive to mechanical loading (Bailey, 2000). This raises serious questions about the long term effects of mechanical loading on growing bones and if posture changes potentially become permanent.

Improving this Study

This study does not have strong external validity based on the small sample size and participants selected from a single location. For these reasons the findings cannot be generalized nor can conclusions be drawn for populations outside this study sample. To increase external validity sampling should include many locations and a larger sample size.

Controlling variables that influence height and reduce error introduced by limitations of the measuring instrument would improve the internal validity of this study. Indirect height measurement such as measuring shadows that fall on a scale affixed to the wall would eliminate instrument error; i.e. the student might move perpendicular through a light beam, stop on a designated mark on the floor, so that the shadow falls on the scale mounted to the wall. This represents a more natural setting to collect data and may increase measurement accuracy. Individual height change in response to backpack weight varied greatly. If individual height change is to be investigated, controlling the backpack weight and location on the back standardize two uncontrolled variables and provide a clearer picture of individual height change.

Prevention and Education

School Nursing is committed to promoting health, well being, and academic success in children. Promoting academic success requires identifying barriers that interrupt learning and decrease academic success. Back pain is a potential barrier to academic success in that it potentially causes absences. To the extent backpacks cause back pain in children, it represents a risk that can be controlled to prevent back pain, promote health, and improve academic success. Preventing health problems is much less costly than treating health problems.

A general knowledge deficit has been found regarding back care among college students. Most are neglectful of their posture, lifting, and carrying techniques (Reis & Flegel, 1996). Part of improving the outcome of long term health care implications of back pain is to design and implement early health education programs. To promote education goals at the middle school information could be made available for students at health assemblies or by providing classroom lectures. Parents can be provided health information through parent-teacher meetings and organizations.

Considering costs and disability secondary to back pain there is a compelling need to target early prevention programs (Bennett et al., 2000). There is evidence that back care education benefits children. A back education program for Belgian elementary school students found children gained and retained knowledge about back care, body mechanics, and correct posture based on good understanding of basic back care principles. Since such education can affect self efficacy and self behavior, it supports the development of early back education (Cardon, De Bourdeaudhuij, & De Clercq, 2002). It is important to remain vigilant in the quest to determine safe backpack recommendations while educating children about posture and how to wear backpacks.

Conclusion

This study demonstrates that backpack weight affects the height of middle school students. On average children are shorter when they wear their backpacks. Additional research is needed to increase external validity of this, and other existing studies and to continue collecting evidence that supports limiting backpack weight to no more than 10 percent of body weight. Backpack weight represents a controllable risk; through education and preventive measures long and short term backpack related back pain may be reduced. Early back care education can favor healthy behavior and potentially prevent back pain (Cardon et al., 2002) thus promoting academic success in children.

APPENDIX A

INFORMED CONSENT PACKET

Parent/Guardian Information Letter

Section EC 51513 of the California Education Code requires parental notification and consent when information about their child will be used in any research study. With your approval, your child ***may*** participate in a study designed to investigate the relationship between the weight of a child's backpack, and his/her height. The title of this study is "The Effect of Backpack Weight on the Height of Middle School Students". This study is being conducted by Barbara Shuman, RN, MSN(c), School Nurse, with the Murrieta School District, under the supervision of Dr. Ellen Daroszewski, RN, PhD, professor of Nursing at California State University of San Bernardino. Barbara Shuman can be reached at 909-696-1600 x4592, and Dr. Daroszewski can be reached at 909-880-7238. This study has been reviewed and approved by the Institutional Review Board of California State University San Bernardino.

Not every student will be measured; although you may give permission, it is possible your child will not be selected to participate. The study gathers data on 45 students. If you allow you child to participate, and he or she is randomly selected, two sets of height and weight measurements will be collected, and he or she will be asked to answer a short questionnaire. The questionnaire is attached to this information packet for your review.

Height and weight measurements will be collected confidentially in the multi-purpose room at Thompson Middle School, privately, where only the investigator can read the numbers. The numbers will be recorded on a sheet next to the students assigned number, and only the investigator will know what student the numbers belong to. This study will collect data at the beginning of first period explore class. The data will be collected on random days during the months of January and February 2003. Only the investigator will know what days these are.

The selected students will be sent to the multi-purpose room. Upon entering, the investigator will verbally ask your child if they would like to participate in the study. The verbal information given to you child is included for your review. If your child decides to participate, he or she will remove their shoes and their height and weight will be measured with backpacks on. Then they will remove their backpack, be seated, and complete the questionnaire. When the questionnaire has been completed, a final weight and height measurement will be taken before the student's backpack is retrieved (without their backpacks on). The entire procedure will take approximately 5 minutes.

There are no risks participating in this study. If a child feels upset after participating, he or she may have their information removed from the study. The counselor or school psychologist is available for students to speak with if there is a need. Please be assured that any information provided will be held in strict confidence. At no time will your child's name be reported. All data will be reported in a group form only. At the conclusion of this study, you may receive a report of the results.

Please understand that your child's participation in this research is totally voluntary. You are free to withdraw your consent, or to have your child's data removed from this study at any time during this study without penalty. If you allow your child to participate, please sign the colored informed consent below and have your child return the consent to his/her teacher by December 16, 2002. Please do not discuss the details of the study with your child until after their measurements have been taken.

Student Informed Consent

Hi I am Mrs. Shuman, your school nurse. I would like to take your weight and height while you are carrying your backpack, and then again, after you take it off. Nobody will see the numbers but me. In between the measurements, I would like you to answer some questions on this paper. I am collecting this information to write a paper for my school, California State University San Bernardino.

When I write the paper, your names will not be used. Nobody, except myself will know which measurements belong to you. If you choose not to be in my study you do not have to. It will not affect any part of school or your grades in anyway. I don't mind if you say no, and I won't feel upset. I don't want you too either. If you do feel upset at any time during this study, please tell me. You can talk to a counselor or the school psychologist if you want.

There are no risks to participating in this study. If you choose not to be in this study, it will not affect any part of school or your grades. The information from this study might benefit other middle school students by giving us information about backpacks and how they affect students.

Informed Consent

I allow my child to participate in the study "The Effect of Backpack Weight on the Height of Middle School Students" as described above in the information letter.

Student's name: ____

Explore Teacher name: ____

Parent/Guardian Signature: ____________________________________

Please have your child return this consent to his/her first period explore teacher no later than December 16, 2002.

APPENDIX B

DEBRIEFINGS STATEMENT

Debriefings Statement

I am doing a study for California State University San Bernardino and want to see if your height changes when you wear your backpack. That is why I measured your height twice; once with you wearing your backpack, and again after you took it off. I also measured your weight twice, once with your backpack on, and again with it off. By subtracting these two weights I found the weight of your backpack (pretty cool?).

If you do not want your measurements to be in my study, that's okay. If you say it's okay but later change your mind please come and tell me and I will remove them. You may change your mind at anytime and I will not be sad or upset. If you decide to have your measurements removed, it does not affect school or your grades in any way. It's important for me to know that you feel okay about helping me with my university study, so if you feel upset in any way please let Mrs. Landrum the school counselor, or Mrs. Rhines the school psychologist know.

If you would like a copy of the information I collected please come and see me near the end of the school year. It is best if you don't talk to your friends about the study until the end of February.

APPENDIX C

INSTITUTIONAL REVIEW BOARD

APPROVAL LETTER

CALIFORNIA STATE UNIVERSITY
SAN BERNARDINO

5500 University Parkway, San Bernardino, CA 92407-2397

November 22, 2002

CSUSB
INSTITUTIONAL
REVIEW BOARD
Full Board Review
IRB# 02035
Status
APPROVED

Ms. Barbara Shuman
c/o Professor Ellen Daroszewski
Department of Nursing
California State University
5500 University Parkway
San Bernardino, California 92407

Dear Mr. Shuman:

Your application to use human subjects, titled, "The Effect of Backpack Weight on the Height of Middle School Students" has been reviewed and approved by the Institutional Review Board (IRB). Your informed consent statement should contain a statement that reads, "This research has been reviewed and approved by the Institutional Review Board of California State University, San Bernardino."

Please notify the IRB if any substantive changes are made in your research prospectus and/or any unanticipated risks to subjects arise. If your project lasts longer than one year, you must reapply of approval at the end of each year. You are required to keep copies of the informed consent forms and data for at least three years.

If you have any questions regarding the IRB decision, please contact Michael Gillespie, IRB Secretary. Mr. Gillespie can be reached by phone at (909) 880-5027, by fax at (909) 880-7028, or by email at mgillesp@csusb.edu. Please include your application identification number (above) in all correspondence.

Best of luck with your research.

Sincerely, *Joseph Lovett by mg*

Joseph Lovett, Chair
Institutional Review Board

JL/mg

cc: Professor Ellen Daroszewski, Dept. of Nursing

APPENDIX D

SCHOOL DISTRICT

APPROVAL LETTER

Murrieta Valley Unified School District

Dr. Chet M. Francisco
Superintendent

District Support Center
41870 McAlby Court
Murrieta, CA 92562
(909) 696-1600
Fax: (909) 696-1641
www.murrieta.k12.ca.us

MURRIETA VALLEY UNIFIED SCHOOL DISTRICT
DEPARTMENT OF PUPIL SERVICES
MEMORANDUM

DATE: November 4, 2002

TO: Committee on the Protection of Human Subjects
California State University, San Bernardino

FROM: Alan Young, Director of Pupil Services

SUBJECT: Barbara Shuman / Backpack Weight Study

Please be advised that Barbara Shuman has obtained permission to conduct her study, "The Effect of Backpack Weight on the Height of Middle School Students" at Thompson Middle School in Murrieta Valley Unified School District, during January through February 2003.

Alan Young, Director of Pupil Services

Dale Velk, Principal Thompson Middle School

APPENDIX E

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FEATURES DIST

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To: bshuman@murrieta.k12.ca.us
Sent: 12/16/2002 9:31 AM
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December 16, 2002

Barbara Shuman, RN
MVUSD
24040 Hayes Ave.
Murrieta, CA 92562

Thanks Barbara:

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Thank you.
Sincerely,

James R. Cavett

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APPENDIX F

STUDENT QUESTIONNAIRE

Student Questionnaire

1. Number: ________________

2. Ethnicity:
   White ____________________ African-American __________
   Hispanic ________________ Asian __________________
   Native American __________ Not sure _________________

3. Birth date: _______________

4. Age: ____________________

5. Boy ________ Girl ________

6. Grade?
   6th _________ 7th _________ 8th _________

7. How do you get to school?
   Walk____________________ bus ____________________
   car ride__________________ bicycle __________________
   skateboard _______________ other ____________________

8. How many minutes does it take you to get to school? ________ minutes

9. How many miles do you live from school? _______ miles

10. Did you carry your backpack to school today? Yes _____ No _____

11. Do you carry a backpack everyday? Yes _____ No _____

12. How many hours have you been carrying your backpack, up until now, today?
    ______ hours

13. Do you take your backpack off during class time? Yes ______ No _____

14. How many hours in a day (at school) do you think you carry your backpack?
    ______ hours

15. Is your backpack heavy to carry today? Yes _____ No ______

16. Is your backpack uncomfortable to carry today? Yes ______ No ___

APPENDIX G

HEIGHT AND WEIGHT SUMMARY

Ht w	Ht w/o	Wt w	Wt w/o	Ht chg	Wt chg
140.9	142.5	47.7	43.0	1.6	4.7
142.0	144.0	40.2	35.2	2.0	5.0
150.5	151.6	46.0	41.2	1.1	4.8
150.1	151.0	46.4	40.1	.9	6.3
157.0	157.1	84.4	78.0	.1	6.4
144.6	146.0	53.0	48.7	1.4	4.3
152.0	154.4	50.0	44.6	2.4	5.4
152.0	151.3	39.7	35.8	-.7	3.9
164.0	164.0	55.2	50.9	.0	4.3
160.3	161.3	65.1	61.1	1.0	4.0
159.0	161.1	53.6	49.4	2.1	4.2
166.4	166.8	65.5	58.9	.4	6.6
174.6	175.0	87.9	84.2	.4	3.7
154.7	155.8	55.6	51.7	1.1	3.9
144.3	145.1	44.2	38.6	.8	5.6
146.7	146.9	71.5	66.4	.2	5.1
154.0	157.0	39.9	35.1	3.0	4.8
142.6	145.3	40.7	37.3	2.7	3.4
146.0	146.4	47.0	41.9	.4	5.1
146.4	150.2	54.5	49.7	3.8	4.8
145.3	146.3	48.3	42.4	1.0	5.9
147.5	148.5	41.4	36.7	1.0	4.7
150.1	149.9	60.1	56.4	-.2	3.7
164.4	164.5	63.6	57.8	.1	5.8
152.6	153.5	48.0	43.8	.9	4.2
160.2	161.3	56.8	53.6	1.1	3.2
160.3	160.4	53.5	45.8	.1	7.7
165.5	166.6	74.9	69.5	1.1	5.4
151.8	154.2	49.8	47.6	2.4	2.2
160.2	160.6	75.2	70.9	.4	4.3
159.2	159.0	48.9	45.2	-.2	3.7
161.7	163.0	66.4	61.4	1.3	5.0

162.9	164.0	65.6	61.5	1.1	4.1
164.3	164.3	69.5	64.1	.0	5.4
145.8	146.0	42.7	37.1	.2	5.6
137.7	138.2	38.4	30.5	.5	7.9
161.7	162.0	85.5	80.3	.3	5.2
156.2	157.3	61.8	57.1	1.1	4.7
154.1	154.5	50.7	47.1	.4	3.6
169.0	169.0	55.3	52.0	.0	3.3
159.5	159.2	52.5	49.2	-.3	3.3
161.1	161.9	63.3	55.9	.8	7.4
145.9	145.7	61.0	57.8	-.2	3.2
156.5	156.7	48.3	42.9	.2	5.4
152.6	153.3	41.2	37.7	.7	3.5
134.3	135.5	36.1	29.6	1.2	6.5
162.0	163.9	65.6	62.3	1.9	3.3
167.7	168.0	76.7	72.6	.3	4.1
164.0	165.4	63.0	58.9	1.4	4.1
169.6	170.0	87.2	83.4	.4	3.8
151.0	151.0	46.5	44.6	.0	1.9
150.5	151.8	41.9	36.5	1.3	5.4
146.7	147.7	38.5	34.4	1.0	4.1
160.9	162.3	57.2	52.5	1.4	4.7
163.3	163.0	61.9	58.3	-.3	3.6
157.2	157.9	49.3	45.0	.7	4.3
170.2	171.0	67.5	65.1	.8	2.4
171.5	172.2	76.9	74.2	.7	2.7
147.1	147.9	36.5	31.1	.8	5.4
152.9	153.3	49.2	43.0	.4	6.2

APPENDIX H

DESCRIPTION SECA WEIGHT SCALE

AND STADIOMETER DATA

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The seca 780 Beam Buster Digital Scale

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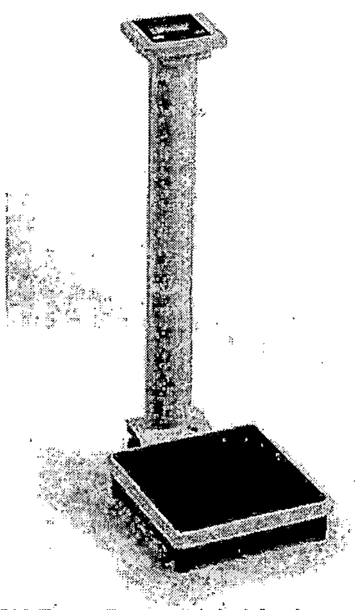
The 780 Beam Buster Digital Scale has a weight capacity of 400 lbs with accurate increments down to 0.2 lbs and complete mobile on two wheels. A height rod can be attached to the seca 780 for a complete weighing and measuring instrument.



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PC COMPATIBLE

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Features of the seca 780	
Capacity	180 kg / 400 lbs
Graduation	100 g / 0.2 lbs
Dimensions (HxWxD)	32 ½" x 11½" x 15¼"
Weight	16 lbs.
Power Supply	4 x AA alkaline batteries
Warranty	1 Year

220 Classic Height Rod
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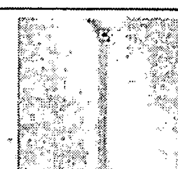

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-- Products List --

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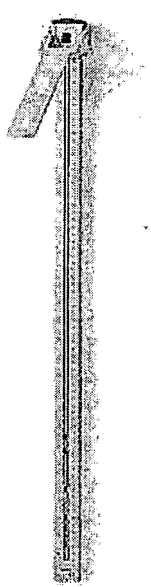
The seca 220 Telescopic Height Rod

The seca 220 Telescopic Height Rod is a classic favorite and world-wide best seller. The headpiece of the seca 220 Telescopic Height Rod is secured on both sides for accuracy and folds down for a greater degree of safety. In addition, the seca 220 Height Rod is double-graduated in inches and centimeters.

When the seca 220 telescopic height rod is added to a seca scale, the height rod becomes a precision weighing and measuring package. This telescopic height rod is also available in an extended version as the seca 221 which is twelve inches longer in length.



Features of the seca 220	
Measuring Range	23½" - 78½" / 60 -200 cm
Graduation	1/8" / 1 mm
Product Dimensions (HxWxD)	31" x 2"x 11¼"
Weight	1 lb
Warranty	Limited 1-year

220 Telescopic Height Rod
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In Stock
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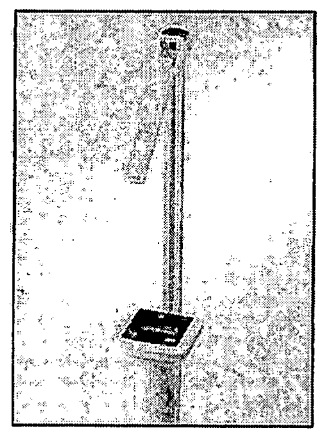

The seca 220 telescopic measuring rod can be added to the following seca scale models for a complete measuring device:

seca 707	seca 706	
seca 781	seca 780	seca 782

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