THE EFFECT OF STATIC STRETCHING ON HAMSTRING AND LOWER BACK FLEXIBILITY IN ELEMENTARY SCHOOL CHILDREN

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CHAPTER I

INTRODUCTION

"The increasingly widespread acceptance of exercise as an integral component of a healthy lifestyle and the growth of adult participation in fitness activities have had a profound impact on physical education programs" (Pate, Corbin, 1981, p. 9). There has been a change in the approach to physical fitness in our schools. Since World War II the focus has been on motor skills related to performance. According to Pate and Corbin (1981) "...many signs indicate the physical fitness pendulum has swung back toward greater health-related fitness" (p.36). The specific reasons for this change have yet to be defined. One of the reasons could be increased dismay in the concept that "...if you want to be physically fit, you must be fast, agile, and powerful as well as strong and enduring" (Pate, 1983, p. 80). These characteristics are usually associated with the successful athlete.

Despite the national fitness craze, recent studies indicate that children are becoming less fit (Kraus, 1988, NCYFS, 1987). The National Children and Youth Fitness Study II (NCYFS II) suggests that current physical education programs may not be providing the necessary elements to promote lifetime fitness (Ross and Pate, 1987). Others take an even stronger stance on the current research on children's fitness. "The bleakness of the elementary physical education programs and the dismal physical condition of elementary students are probably two of the best kept secrets in education" (Lemlech, 1981, p.5). If one assumes truth in these two statements then those associated with the fitness of our nation's youth are faced with more than one problem.

The correlation between lack of exercise and disease has been documented for decades. Research indicates that insufficient exercise can contribute to coronary heart disease, high blood pressure, adult onset diabetes, gastrointestinal disorders and emotional stress (Kraus, 1988). It is also known that degenerative diseases, such as atherosclerosis, may not only manifest itself in middle aged adults but commence in childhood as well. The beginning signs of coronary heart disease is now being found in children six to thirteen years of age (Gilliam, 1977, 1978).

"Normal childhood development is dependent on regular physical activity" (Koch, Galioto, P. Vaccaro, J. Vaccaro, Buckenmeyer, 1988, p. 139). Exercise should begin in early childhood. Physical exercise started after adolescence may improve physical condition but may never completely compensate for early neglect (Kraus, 1988). Therefore, it is very important that exercise habits are established in children as young as six years of age.

Regular exercise should include methods to increase flexibility, which has been determined to be an important health-related fitness component (AAHPERD, 1980). Adequate flexibility is needed for effective movement. Limited flexibility or range of motion prevents participation in exercise, sports, or daily living activities. Flexibility is particularly important because there is a relationship between lack of hamstring and lower back flexibility and lower back pain (Blair, Falls, Pate, 1983). If increasing lower back and hamstring flexibility can deter the onset of lower back pain later in life, it is important to start flexibility exercise as early as possible. If a flexibility program is started with young children, adolescents and adults who maintain this program may not have to be as concerned about compensating for early neglect.

The acceptance of lower back and hamstring flexibility as a health-related fitness component and the association of lower back pain with limited flexibility in that region of the body challenge physical educators to develop objectives that will lead to greater frlexibility in their students. The 1980 document, Promoting Health/Preventing Disease: Objectives for the Nation (1980) establish physical fitness and exercise objectives for boys and girls 10 to 17 years of age. The document states that by 1990, 90 percent of the 10 to 17 year old students will participate in regular cardiorespiratory activity, 60 percent will be enrolled in daily physical education, and 70 percent will participate in regular fitness testing. Greater attention focused on elementary students will increase the prospects of reaching older children and adolescents (Powell, Spain, Christenson, Mollencamp, 1986).

Physical educators, pediatricians, exercise physiologists, and physical therapists have contributed to the development of several physical fitness tests to measure fitness levels in children. Unfortunately, there is not a unanimous decision on any particular test and its components. "The selection of test items has too often been the result of political compromise rather than measurement processes" (Franks, Morrow, Plowman, 1988, p. 187).

Fitness tests emphasizing motor ability came into wide use over fifty years ago. The Kraus-Webber Tests for Minimum Muscular Fitness showed the nation that the American youth were far below their European counterparts (Kraus, 1954). In 1980, the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) developed the Health-Related Fitness Test consisting of cardiorespiratory fitness, body composition, muscular strength and endurance, and flexibility components (AAHPERD, 1980). In 1980, the flexibility component was added to their 1958 Youth Fitness Test which was equated with motor fitness. The AAHPERD considers lower back and hamstring flexibility to be an important health-related fitness component. In support, Keim (1983) stated that:

> Substantial clinical evidence indicates that low back pain is associated with fitness deficiencies in the

> lower trunk region. Specifically, weakness of the abdominal muscles and lack of flexibility in the low back/hamstring musculature have been precursors of low back pain. (p. 14).

A considerable amount of research has been done on the most effective methods of increasing flexibility (Cornelius and Hinson, 1980, Hardy, 1985, Hartley-O'Brien, 1980). There are contradictions concerning the type of flexibility exercises and the duration of such exercises that will provide the most successful results. There are also contradictions concerning the type of flexibility exercises that are appropriate for a particular age group.

The assumption that young children are generally more flexible than adults is true (Brantam, Haubenstrickler, Seefeldt, 1984). Although research indicates that flexibility can be improved with stretching, research findings on adolescents cannot be inferred to younger children. There is a need for further research concerning the effect of a prescribed stretching program for the purpose of increasing hamstring and lower back flexibility in boys and girls six through eleven years of age. The need for further research related to flexibility in younger children initiated the selection of the problem of this study.

Statement of the Problem

The purpose of this study was to determine if significant differences existed in hamstring and lower back flexibility in the comparison of males and females, six through eleven years of age and in the comparison of treatment and control groups after completing an eight-week, two days a week static stretch program.

Hypotheses

1. There will be no significant difference in hamstring and lower back flexibility in a treatment group completing an eight-week, two days a week static stretch program when compared to a control group receiving no static stretch exercise as measured by the Sit and Reach component of the AAHPERD Health Related Fitness Test in boys six through eleven years of age.

2. There will be no significant difference in hamstring and lower lack flexibility in a treatment group completing an eight-week, two days a week static stretch program when compared to a control group receiving no static stretch exercise as measured by the Sit and Reach component of the AAHPERD Health Related Fitness Test in girls six through eleven years of age.

3. There will be no significant difference in hamstring and lower back flexibility in the comparison of boys and girls six through eleven years of age after a treatment group completes an eight-week, two days a week static stretch program and a control group receives no static stretch exercise as measured by the Sit and Reach component of the AAHPERD Health Related Fitness Test.

Assumptions

This study was based upon the following underlying assumptions:

1. Students who participated in this study were of normal physical health as indicated on the passive consent form.
2. The parameter selected for the various sub-groups accurately defined the subjects within each group, i.e., male-female and grouped by age.
3. The students who served as subjects were students at Mildred Dean Elementary School in Newport Public Schools.
4. The students who served as subjects performed the static stretch exercises when instructed.
5. Students who served as subjects only performed static stretch exercise during designated time of study.

Delimitations

This study was subject to the following delimitations:

1. A total of 317 subjects, 156 males and 161 females.
2. Males and females, six through eleven years of age.
3. The 1990-91 school year.
4. The use of the Sit and Reach box as the measurement tool.
5. Two, 45 minute physical education classes each week for eight weeks.

Limitations

This study may be limited by:

1. The effort of each subject when performing each static stretch exercise.

2. The effort of each subject during the pretest and posttest measurements.

3. The absence of a subject from school.

4. The imbalance in the number of subjects at the end of the study in any of the sub-groups due to a subject moving or excessive absences from school.

5. The honesty of the subjects to only perform static stretch exercise during the designated time of the study.

Definition of Terms:

The following is a list of terms as they pertain to this study:

Flexibility: The degree of motion around a joint.

Static Stretch: A stationary position in which the muscle is extended at a greater than resting length.

Sit and Reach Test: A test that measures flexibility of the lower back and hamstring muscles.

Fitness: The ability to perform strenuous physical activity with vigor and without excessive fatigue.

This study was approved by the Oklahoma State University Institutional Review Board for Human Subjects. A copy of the approval can be found in Appendix A.

CHAPTER II

REVIEW OF LITERATURE

Introduction

To ensure adequate coverage of all topics related to this study, the review of literature will include information in several areas. These areas are: flexibility, flexibility exercises, measurement devices, flexibility studies, flexibility and fitness, flexibility and lower back pain, and fitness tests and flexibility. This chapter is organized to the above topics.

Flexibility

There has been a considerable amount of research on the topic of flexibility (Cornelius and Hinson, 1980, Hardy, 1985, Hartley-O'Brien, 1980). Flexibility is a highly important and often overlooked component of muscular performance. Flexibility refers to the degree of motion of a joint and is highly specific to that joint (Koslow, 1988). To better understand flexibility, it is important to have a basic understanding of the associated physiological factors.

The relative contributions of soft tissue that may reduce limitations on a joint during movement were determined by Wright and Johns (1962): joint capsule (47%), muscle and its facia (41%), tendons and ligaments (10%), and skin (2%). Efforts to improve flexibility should focus on improving these structures. The primary target of flexibility exercises is the connective tissue surrounding the joint. The magnitude, duration and temperature of the connective tissue are directly related to the elongation of the tissue. There is a need to better understand the physical properties of connective tissue. According to Cornelius (1984):

> Connective tissue is made up of collagen fibers embedded in a protein-polysaccharide matrix. Collagen has a very high tensile strength and resistance to stretch. These collagenous tissues are organized into many different structures, including tendons, ligaments, joint capsules, and facia (p. 3).

Sapeqa (1981) suggests that muscles are not predominately connective tissue as are tendons and joint capsules. When a relaxed muscle is stretched, most of the resistance to stretch is derived from the connective tissue and sheathing surrounding the muscle.

Since connective tissue is the most important target when stretching a muscle, it is important to understand the mechanical reaction of connective tissue during different types of stretching. Elastic stretch represents a "spring-like" motion that causes the tissue to elongate temporarily. In fact, "elasticity" means to return to normal length. Plastic stretch occurs when the viscous properties allow the elongation of the connective tissue to remain extended. Magnitude, duration and temperature affect elastic and plastic stretch. Elastic stretch requires a high stretch magnitude, a short duration and a normal or "cold" tissue. Plastic stretch requires a more permanent lengthening process involving a lower stretch magnitude, a longer stretch duration and a warmer tissue temperature (Cornelius, 1984).

Two sensory mechanisms that are manipulated in effective stretch techniques are muscle spindle receptors and Golgi tendon organs. When stretching occurs, the Golgi tendon sensory mechanisms within the muscle react, based on the type of stretching being performed. Quick, abrupt stretching will cause the spindle receptors in the muscle to "fire" or signal the muscle to contract. This is known as the "stretch reflex". This reflex is important since it can prevent connective tissue from being overstretched. Slow, deliberate stretching, however, allows non-interference of the muscle spindal recepters. Connective tissues are vulnerable to strain because of the magnitude or the force created during quick, abrupt stretching (Cornelius, 1984). Muscle reflex contraction must be minimized if effective stretching is to be accomplished.

Factors that influence flexibility are the amount and duration of applied force and the temperature of the muscle tissue. "The time required to stretch the tissue a specific amount is inversely related to the forces applied" (Moffatt, 1988, p. 265). The amount of elongation after low-force, longer duration stretching is greater than high-force, shorter duration stretching. Deep muscle temperature significantly influences the mechanical behavior of connective tissue under force. Lehmann (1970) found there was a 20 percent increase in elongation when the muscle temperature was 102 to 110 degrees Fahrenheit, rather than stretching at muscle temperature before exercise. Warming a muscle before exercise significantly reduces the structural weakening of the connective tissue. The "stretch reflex" is minimized more than when the muscle is at a colder temperature, thus allowing more effective stretching to occur. Mild exercise, such as brisk walking, lasting a minimum of five minutes should preceed stretching.

Flexibility Exercises

To improve the range of motion (ROM) at the joint effectively, the length of time the stretch position is held should be increased for each repetition (Moffatt, 1988). Since flexibility is specific to each joint, specific exercises need to be designed to improve flexibility. Therefore, it is important to address the effectiveness of the most common methods used for improving ROM.

Static stretch: The static flexibility technique incorporates a stationary position in which the connective tissue and muscles are held at greater than resting length. Moffatt (1988) states:

> The static technique involves stretching the muscles and connective tissue of the joint passively at the extreme end of the ROM. At this point, torque is slowly applied to the muscle to produce further stretching (p. 266).

Static stretching allows the muscle spindle receptors to adapt to the lengthened position, thereby reducing the "stretch reflex" and allowing the muscle to relax and stretch further. Static stretching produces low muscle tension because of the controlled manner in which it is performed. Thus, static stretching reduces the danger of exceeding the limit of the muscle and connective tissue by reducing the chance of tearing any tissue involved. The energy requirements are also lower than ballistic stretching. Static stretching actually relieves soreness by releasing inert muscle tension and increasing the blood circulation to remove excessive lactic acid in the affected tissue (Cooper, 1978). Because of low incidence of injury to the muscle, the ease in which it can be performed, and its effectiveness, static stretch is recommended for the non-athletic individual (Cornelius, 1984).

Ballistic stretch: The ballistic stretch technique utilizes a repeated bouncing or bobbing action. A person who reaches for his toes in a repeated, quick and forceful movement is performing a ballistic stretch. This type of stretch should be avoided since the "stretch reflex" occurs, causing protective muscle contraction. Although increased flexibility can be achieved with ballistic stretching (Lucas and Koslow, 1984, Sady, Wortman, Blanke, 1982), it is often accompanied with injury and soreness. The connective tissue, including the tendon and ligaments can be over stretched, causing tearing of the tissue.

Proprioceptive Neuromuscular Facilitation (PNF):

Another common stretching method is PNF. By using a contract-relax sequence, muscle relaxation occurs through spinal reflex mechanisms. Holt (1976) states that "the PNF technique is based on the concept of reciprocal inhibition" (p. 44). An isometric contraction of the muscle group being stretched is followed by slow static stretching of the same muscles. The induced reflex facilitation and contraction of the agonist suppresses contractile activity during the static phase. By using PNF techniques, muscle spindles are inhibited thus causing less resistance to muscle elongation. Likewise, Golgi tendon receptors are stimulated allowing muscle tissue to be further elongated. Although some research supports PNF as a more successful technique for increasing flexibility (Holt, 1980, Cornelius, 1980, Sady, Wortman, Blanke, 1982), there is no scientific evidence specifically targeted to a particular gender or age. However, Hartley-O'Brien (1980) and Moore (1980) contradicted these findings and found that PNF was no more effective than static and ballistic stretching.

Measurement Devices

There are several methods and tools used for evaluating flexibility and range of motion (ROM). One measurement tool is the Sit and Reach Box. The dimensions of the box and how measurements are obtained are discussed in Chapter III. Research shows that the Sit and Reach Test is a reliable measurement (r of .95) for hamstring flexibility (Safrit and Wood, 1987, Harvy and Scott, 1967). Other measurement tools include the goniometer and the Leighton flexometer. It is important to have a basic understanding of various measurement tools used in the cited flexibility studies.

Direct measurement of static flexibility can be measured by the goniometer to determine the joint angle at both extremes of the range of motion (ROM). The goniometer is a protractor-like-device with two arms. One arm is stationary at the zero line of the protractor while the other arm is movable.

> The goniometer is centered over the axis of the joint being measured. The arms of the device are aligned with the longitudinal axis of each moving body segment (Moffatt, 1988, p. 264).

ROM is the difference between the joint angles at the beginning and end of the movement.

A more commonly used device to measure static flexibility is the Leighton flexometer. It consists of a pointer that is weighted at one end to keep it vertical and a weighted 360 degree dial that rotates with respect to the pointer during movement of the body part. The flexometer is strapped onto the body segment and records ROM with respect to the downward pull of gravity.

Flexibility Studies

Moeller, Ekstrand, Oeberg and Gillquist (1985) determined the effect of PNF on range of motion in lower extremities. The eight male volunteers were already participating in a moderate fitness program. The procedure was performed as one isometric contraction, followed by relaxation and then a passive extension of the adductors, hamstrings, iliopsoas, gastrocnemius, soleus and rectus femoris muscle groups. ROM was measured before exercise and 0, 30, 60, and 90 minutes after exercise. A goniometer and Leighton flexometer were used to measure flexibility. Except for hip flexion, significant differences in ROM from pre-exercise to post-exercise were found in all areas at each time interval, 90 minutes after stretching.

Koch and associates (1988) evaluated the effects of a structured rehabilitation program on the strength and flexibility of children with corrected congenital heart disease. Twelve children participated in the one hour exercise classes, two days a week for 12 weeks. Results showed a 25 percent increase in lower extremities, including hamstring and lower back flexibility.

Hubley, Kozey and Stanish (1984) compared the effects of static stretching and stationary cycling on ROM of the hip immediately after exercise and 15 minutes after cycling. Thirty individuals, age 14 to 60 were randomly chosen from a sport medicine clinic. The subjects were assigned to one of five groups. Different combinations of cycling and stretching were used. The experiment included 15 minutes of stretching the quadriceps and hamstrings and 15 minutes of cycling 50 revolutions per minute at 300 kpm. Static stretching and cycling were found to be equally effective in increasing ROM.

Hartley-O'Brien (1980) evaluated six exercises for gains in hip flexibility. The 119 female subjects with a mean age of 20.19 years of age and participated in a four week active and passive stretching program. Pretests and posttests were performed by a Leighton flexometer. Gains of 15 or more degrees were recorded in all areas. However, active and passive stretching were not found to be significantly different.

DeVries (1962) studied the effects of static stretching for improving flexibility. A total of 57 males were divided into two groups. One group was trained with ballistic stretching while the other trained with static stretching in seven, 30 minute periods. Static stretching was found to be more effective.

Shephard, Berridge and Montelpare (1990) researched the sit and reach flexibility of men and women 45-75 years. The Canada Fitness Survey and a goniometer were used to evaluate head rotation, shoulder rotation, hip flexion and sit and reach. Age-related flexibility decreases were apparent in the shoulder and hip joints.

Greer (1983) studied the effect of two flexibility warm-up activities: rope jumping and static stretching on the performance of the sit and reach test for flexibility. Initial testing, subsequent treatments and posttesting were performed within a two-week period. The sit and reach box was used for all measurements. Each group participated in five minutes of rope jumping or static stretching before flexibility measurement. The results showed significant increases in flexibility for both activities. However, static stretching resulted in significantly higher gains in demonstrated flexibility.

Branta, Haubenstrickel and Seefeldt (1984) studied the changes in motor performance during childhood and adolescence. A total of 110 boys and girls were tested on seven motor performance skills and flexibility. The sit and reach test was used to measure hamstring and lower back flexibility. The results showed the girls superior to boys in all ages comparisons. The mean values for the girls remained relatively constant from age five to eleven. The boys showed an increase from five to age nine, then a decrease until age 12 followed by an increase after age 13. The authors hypothesize that the decrease in flexibility in boys from age nine to 12 may be due to the continued rapid growth of the lower extremities in relation to growth of the trunk.

Lucas and Koslow (1984) compared the effects of static, dynamic (ballistic), and proprioceptive neuromuscular facilitation (PNF) stretching on hamstring and lower back flexibility in 63 college women. Subjects were assigned to one of three groups and received treatment three days a week for seven weeks. A pretest, midtest and posttest was administered using the Sit and Reach measurement. The findings indicated that all three methods produced significant improvements when pretest and posttest scores were compared. However, there was no significant difference in the comparison of PNF, static, and dynamic stretching exercise.

Starring, Gossman, Nicholson and Lemons (1988) examined the effects of cyclic versus sustained passive stretching on hamstring muscle flexibility. A total of 44 men and women, 20-40 years of age were randomly assigned to one treatment group. The stretching was performed for 15 minutes on five consecutive days. A mechanical device was used that maintained 50 percent of the maximum angle of the hamstring muscles during stretching. The researchers defined cyclic stretching as stretching that was increased by a certain percentage (15%) each of the five days of exercise. Sustained passive stretching referred to stretching that remained consistent during the five days. A follow-up examination of the subject's hip ROM was made one week posttreatment using a goniometer. The results revealed that initial ROM, gender, and treatment method significantly contributed to increases in ROM from the first day to the follow-up examination. The cyclic stretching resulted in a greater gain in ROM when the other variables were considered.

Fitness and Flexibility

"Youth fitness programming in America was founded to achieve health-oriented goals" (Pate, 1983, p. 78). The earliest physical education programs were in the 1860's and pioneered by physicians who believed in the health benefits of vigorous activity. Eventually, physical education programs were adopted in public school by 1900. The focus on the first physical education programs was calisthenics and gymnastic activities emphasizing flexibility and muscular strength. Development of strength was viewed as the most important component of fitness.

After 1900, the goals of youth fitness changed from health promotion to a greater emphasis on motor performance. From 1900-1940 the traditional physical education curriculum diversified considerably. The promotion of fitness came secondary to game and sport skills. There was also an emphasis in social benefits of physical education. This movement in sport skills coincided with the organized sports movement in public schools.

During the World War II era, fitness and physical training regained prominence in physical education programs in secondary schools and colleges. The military approach became widely accepted, reinforcing the motor fitness philosophy.

After the war, the muscular strength and flexibility study by Kraus and Hirschland (1954) concluded that American youth were less physically fit than their European counterpart (Ross, 1987). It was the only national effort to test young elementary school age children (Lembech, 1981). Although the study has been criticized for its weakness in research design and narrow focus, it was accepted by President Dwight D. Eisenhower. In the 1950's President Eisenhower focused the nation's attention on the low level of fitness in children. He created the President's Council on Physical Fitness, which led to the development of the American Alliance for Health, Physical Education and Recreation (AAHPER) Youth Fitness Test.

Throughout the 1960's the trend for motor fitness and athletic ability continued. The expansion of athletic programs, especially for females, served to further reinforce the motor fitness concept. The specific components of motor fitness are agility, power, cardiovascular endurance, muscular strength and endurance, flexibility and speed. By the 1970's, physical educators began to challenge the motor fitness message given to children: "If you want to be physically fit you must be fast, agile, and powerful as well as strong and enduring" (Pate, 1983, p. 80).

The most recent trend has been health-related fitness programs. The specific components of health-related fitness include cardiorespiratory endurance, muscular strength and endurance, body composition, and flexibility (Koslow, 1988). Compared to motor fitness, health-related fitness is a more narrow concept that includes the fitness components that can prevent disease or promote health. Health-related physical fitness, according to Pate (1983) is:

> ...(1) the ability to perform strenuous physical activity with vigor and without excessive fatigue, and (2) demonstration of physical activity traits and capacities that are consistent with minimal risk of developing hypokenetic disease (p.82).

Cardiorespiratory fitness has been identified as a significant factor in work load capacity. Aerobic activity has been linked to reduced risk in coronary heart disease (Kraus, 1988). Evidence also indicates that regular physical activity is a key determinant in body composition. Flexibility has been accepted as an important health-related fitness component. The relative effectiveness of a structured health-related fitness program was compared with the customary organized activities for fifth grade students (Duncan, Boyce, Itami, Puffenbarger, 1983). The experimental group who participated in the nine month health-related fitness program showed a significant increase in the level of fitness, including flexibility, strength, and endurance. National studies and published documents after the Kraus and Hirschland study have been an impelling force behind the health related fitness movement. The document, "Promoting Health/Preventing Disease: Objectives for the Nation" (1980) stated that 90 percent of the 10 to 17 year old students will participate in vigorous activity, 60 percent will be enrolled in daily physical education and 70 percent will participate in periodic fitness testing by 1990. Two other objectives called for data to monitor participation in physical activity and for evaluating the short and long term health benefits of exercise. This document initiated the first National Children and Youth Fitness Study (NCYFS I, 1984). The NCYFS I was designed to gather baseline data related to national objectives in physical fitness and exercise for 10 to 18 year olds. Compared to national data in the 1960's, NCYFS I showed an increase in body fat composition. Two years later the study was expanded to include elementary school children. The second National Children and Youth Fitness Study (NCYFS II, 1984) was initiated to study the physical fitness level and habits of children age six to nine. The study was the first to specifically assess the fitness of this age group, describe their pattern of physical activity and determine the factors affecting their level of fitness. A total of 4,478 children participated in six fitness tests, including the Sit and Reach Test to measure lower back and hamstring flexibility. The NCYFS II developed new health-related fitness norms by age and gender and by grade and gender.

The reoriented definition of youth fitness carries highly significant implications for physical educators and health professionals. Fox and Biddle (1988) have summarized the philosophy of fitness education as the following:

1. Health and well-being is a welfare issue, therefore the fitness of all children is of concern.
2. Because health related-fitness cannot be stored, educational goals must be oriented toward the maintenance of lifetime exercise.
3. A focus of lifetime fitness places greater emphasis on the psysiological orientation of students toward physical activity. Exercise becomes a choice behavior, and the child who has the desire, confidence and expertise to maintain

regular exercise will be better equipped to make healthy lifestyle choices.

Fitness of the nation's youth must be approached with perseverance. The basis of a sound physical education and fitness program should be scientific research. According to Koslow (1985):

> Since the concept of physical fitness has attracted a great deal of scientific interest and has been endorsed by numerous scholars as an essential part of the physical education curriculum, a primary objective relating to the development of specific elements of physical fitness lends itself to such an analysis (p.75).

Flexibility and Lower Back Pain

Evidence indicates that lower back pain is associated with the lack of flexibility in the lower back (lumbar region) and hamstring muscles (Blair, Falls, Pate, 1983). Weak abdominal muscles and lack of hamstring flexibility have been identified as precursors of low back pain. It has been estimated that this malady affects up to 80 percent of all persons during their lifetime. Lower back pain is the second most common medical complaint and reason for missing work. It is the most frequent cause of activity limitation of individuals under 45 years of age (Liemohn, 1988). The National School Population Fitness Survey (1985) stated that the low trunk flexibility in boys indicated a good possibility of lower back problems later in life. Therefore, increasing flexibility in the lower back and hamstring muscles may deter the onset of lower back pain.

Lower back pain is not a condition typically thought of as being a problem in youth. A study of 446 students (227 males and 219 females) showed that 26 percent had experienced back pain (Fairbank, 1984). The study further deduced that the onset of symptoms peaked at 13 years of age in boys and 14 years in girls. Fairbank also found back pain to be more common for those who did not participate in athletics. This is not surprising since it is known that exercise can be a factor in reducing the incidence and severity of lower back pain in adults. It strongly supports the contention that development of exercises and maintenance of flexibility are desirable.

Tightness in the pelvic and/or hip musculature may be a factor that can increase an individual's susceptibility to lower back pain (Liemohn, 1988). The Sit and Reach Test is a reliable test for measuring both hamstring and lower back flexibility (Jackson, 1986). Evaluating a student's performance on the Sit and Reach and the quality of movement is an important factor to consider. Poor performance, accompanied by a rounding of the upper back with a fairly straight lower back could suggest tightness in the lower back musculature. It is also possible that some individuals with less flexible hamstring muscles and greater mobility in the lumbar region can compensate for performance on the Sit and Reach Test. Since 75 percent of the trunk's total flexion occurs at the lumbosacral joint (the lowest part of the lumbar region), this compensatory ability might subject the lower back to potential stress in acute flexion. Adequate warm-up should preceed stretching activities involving the lower back to decrease the possibility of soft tissue injury.

Fitness Testing and Flexibility

The widespread use of fitness testing in schools has proceeded on the assumption that it motivates children to be more physically fit. However, the premise that fitness testing motivates children to increase their activity level and improve their fitness level has yet to be substantiated (Koslow, 1988). Fitness testing can result in positive or negative experiences for children. Elementary students in Texas who scored in the highest 25 percent and the lowest 25 percent on the Texas Physical Fitness Test were compared for attitude toward physical education and self-concept (Sherrill, Holguin and Caywood, 1989). The results indicated that more physically fit boys and girls had a higher self-concept and a more positive attitude toward physical education than the boys and girls scoring low in fitness. A great amount of time has been spent on identifying the most valid and reliable tests to use in schools. However, after many years, it is still unclear which testing methods are the best to use in school physical education programs or if fitness testing promotes exercise and fitness (Fox, Biddle, 1988). Early fitness testing determined fitness levels in children, but did not determine how children were motivated to perform on the tests.

The first national effort to test the fitness level of young children was with the Kraus-Webber Minimum Muscular Fitness Test (Lemlech, 1981). The Kraus-Webber Test was administered to 5000 American children and 3000 children in Austria, Italy, and Switzerland. It included five tests for muscular strength to measure hip-flexing muscles, abdominal muscles, upper and lower back muscles. There was one "toe touch" test to measure lower back and hamstring flexibility. The unfitness of American children was alarming (Kraus, 1988). Figure 1 shows the percent of deficiency in American children. There were no percentile ranking of scores. If the child could complete the particular test, then he/she would pass. If he/she was not able to perform the test, then it was considered a fail.

Figure 1 clearly indicates the high percentage of failure in the flexibility test, muscular strength and the percentage of children that failed at least one test. Although the Kraus-Webber test was criticized, it prompted President Eisenhower to form the President's Council on Youth Fitness, now renamed President's Council on Physical Fitness and Sports (PCPFS).

There are fitness tests from AAHPERD, PCPFS, the Institute for Aerobic Research (IAR), as well as individual states, nonprofit agencies and private individuals and groups. "The selection of test items has too often been the result of political compromise rather than measurement

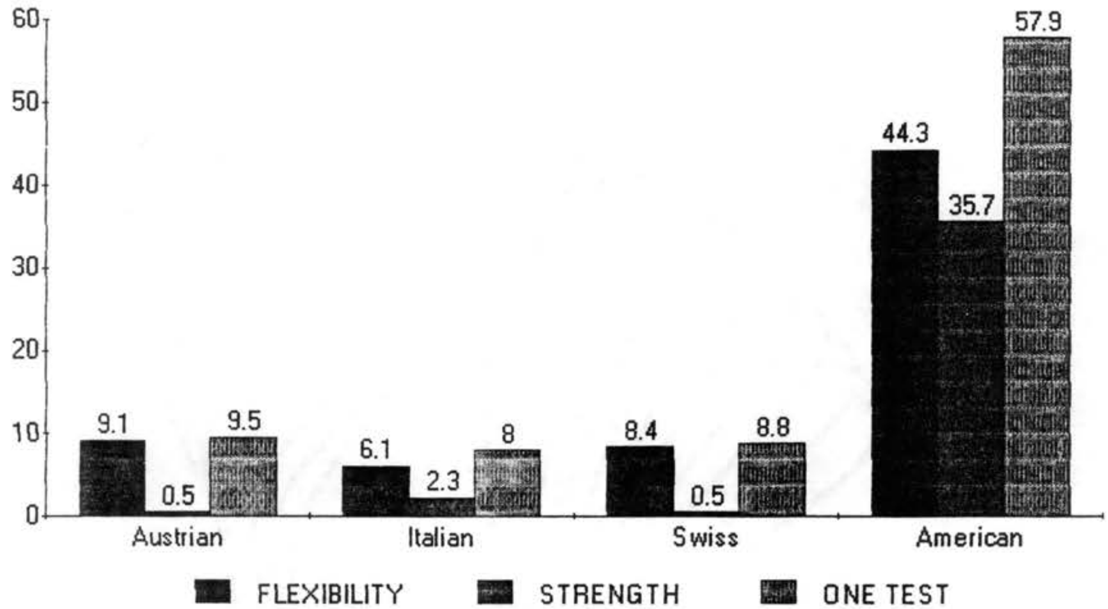

Figure 1 Kraus-Webber 1956 Fitness Test
Percentage of Failures

processes" (Franks, Morrow, Plowman, 1988, p. 187). The original Youth Fitness Test in 1957 was developed by AAHPER (The D was added in 1979) and gained national visibility for fitness testing. There is very little relationship between the AAHPER Youth Fitness Test and the Kraus-Webber Test. Ironically, the most frequently failed component of the Kraus-Webber Test was the toe-touch test. However, AAHPER failed to include a measurement of flexibility in the Youth Fitness Test (Kraus, 1988).

In 1965, the President's Fitness Award was introduced based on the Youth Fitness Test. The Youth Fitness Test did not include a formal definition of youth fitness and was not developed through sufficient measurement procedures.

developed through sufficient measurement procedures. AAHPERD began revising the Youth Fitness Test in 1975. This led to the Health-Related Fitness Test in 1980, which added body composition and flexibility testing. Hamstring and lower back flexibility is measured by the Sit and Reach component of the AAHPERD Health-Related Fitness Test. The AAHPERD Health Related-Fitness Test consists of the following:

TEST ITEM	FITNESS COMPONENT
Mile run or 9 minute run	Cardiorespiratory Fitness
Skin fold testing	Body composition
Sit ups	Muscular strength and endurance
Sit and Reach	Flexibility

The AAHPERD Health-Related Fitness Test has shown to be highly reliable in measuring physical fitness in 11 to 14 year olds (Safrit, Wood, 1987). AAHPERD continued to endorse both the Youth Fitness Test and the new Health-Related Fitness Test for several years. PCPFS used the Youth Fitness Test and the President's Fitness Award system. In 1979, the IAR developed the first computerized national fitness testing. The "Fitnessgram" was used in cooperation with AAHPERD and PCPFS. By 1985, however, AAHPERD published only one test booklet, the Health-Related Fitness Test. AAHPERD states:

> ... skill related aspects of fitness, such as agility, balance, and coordination may be the As, Bs, and Cs necessary for high quality sports performance, but they do not directly function to promote health.

> Certain components of fitness, however, which include cardiovascular fitness, muscular strength and endurance, flexibility and body composition are closely allied to aspects of health (1980).

Ash Hays, executive director of the PCPFS contends that physical fitness development and assessment should meet all purposes whether they are health-related or performance related (Murphy, 1986). The PCPFS eventually announced its own test items. All three organizations were sponsoring a different fitness test by 1988. This indicates that professional, governmental and industrial cooperative program may not be greatly successful (Franks, Morrow and Plowman, 1988).

Fitness tests measure how much a body is capable of performing at a particular time. Variables such as muscle fiber type, body type and size, and body mechanics contribute to differences in fitness test scores (Fox, Biddle, 1988). The way a fitness test is presented can have an impact on how children interpret their own level of fitness and competence. Fitness tests should be used to monitor and encourage change over time and be accompanied by realistic exercise. The focus should be on the follow-up exercise program after the fitness testing. "There is little point is exposing students to their fitness weaknesses if a back-up service is not available for help" (Fox, Biddle, 1988, p. 52).

CHAPTER III

METHODS AND PROCEDURES

The purpose of this study was to determine the effect of static stretch exercise on hamstring and lower back flexibility in boys and girls six through eleven years of age. The procedures have been presented in the following order: Selection of Subjects, Assignment of Subjects to Sub-Groups, Selection and Administration of Instrument, Procedures and Analysis of Data.

Selection of Subjects

The subjects for this study were 317 students from Mildred Dean Elementary School in the Newport Independent School District in Newport, Kentucky. 156 boys and 161 girls participated in the study. Participants were six through eleven years of age, in first through fifth grade, and represented the total population of the school. Passive written parental consent was obtained for each student, acknowledging that the child was in normal health and that there was no known physical reason limiting the child from the study. A copy of the consent form can be found in Appendix B. Consent was also given by Mr. Frank Burns, Assistant Superintendent of Newport Independent Schools and

Mr. Robert Eaton, principal of Mildred Dean Elementary. All subjects participated in 90 minutes of physical education each week and had not performed exercises designed to increase hamstring and lower back flexibility for at least three months prior to the study.

Assignment of Subjects to Sub-groups

The subjects, (156 males and 161 females) were randomly assigned to a treatment group or control group based on age and gender. (Table I.) The representative participant proportions by age and gender are presented in Table II. Criteria for age were established. A student having a birthday before April 1, 1991 was placed in the appropriate sub-group. A student having a birthday during the eight-week study had no effect on his/her placement within a sub-group.

Selection and Administration of Instrument

For this study, static stretch was characterized by a sustained position over a selected length of time. This served to reduce the danger of damage due to over extending the tissue involved (Cooper, 1978).

Procedures

All students in the study participated during their regular physical education class. All students attended two physical education classes each week for a duration of 45

TABLE I

SUBJECTS IN SUB-GROUPS

	Treatment	Control
Boys, 6 years	4	3
Girls, 6 years	7	7
Boys, 7 years	16	15
Girls, 7 years	13	13
Boys, 8 years	13	11
Girls, 8 years	15	17
Boys, 9 years	17	20
Girls, 9 years	15	12
Boys, 10 years	14	13
Girls, 10 years	18	17
Boys, 11 years	15	15
Girls, 11 years	14	13
Total	161	156

minutes each for eight weeks. The researcher conducted all testing procedures and exercise sessions. Due to time constraints, no warm-up activity was done prior to the static stretch exercise. The students in the treatment group were instructed to sit on the floor with legs extended and feet together in front of them. Although the students were tested with their feet shoulder width apart, they

TABLE II

REPRESENTATIVE PARTICIPANT PROPORTIONS

Gender/ Age		Total No. of subjects	% of Total Population
Boys, 6 years		7	2.2%
Girls, 6 years		14	4.4%
Boys, 7 years		31	9.8%
Girls, 7 years		26	8.2%
Boys, 8 years		24	7.6%
Girls, 8 years		32	10.1%
Boys, 9 years		37	11.6%
Girls, 9 years		27	8.5%
Boys, 10 years		27	8.5%
Girls, 10 years		35	11.1%
Boys 11 years		30	9.5%
Girls, 11 years		27	8.5%
	Total	317	100.0

performed static stretch exercise with feet together. The researcher felt that this would provide more consistency in the exercise procedures and would not allow students to vary the width between the feet, thus possibly altering the effect of the stretching exercise. On verbal command, students reached toward the feet with both hands. They were instructed to stretch slowly and gently, stretch to the point of tension not pain, and to relax remainder of body while stretching. Students were also instructed to keep legs flat on the floor to avoid knee felxion and keep toes pointing upward. Each static stretch was held for 10 seconds with a 10 second rest between each static stretch. Students completed five static stretches during each exercise session. Due to time constraints, the researcher could only designate a few minutes of time each class period to static stretching. The students performed a total of 100 seconds of static stretching each week (5 stretches for 10 seconds each, two days per week). The control group in each class was allowed to choose an activity related to ball throwing. Ball throwing was chosen for the control group because it requires upper body motor skills and strength and is not related to static stretching. Both groups participated in an equal amount of activity time. A total of six to seven minutes was used at the beginning of each physical education class to take attendance, divide the treatment and control groups, and complete the static stretch exercise.

During the class, after each stretching session, all students participated in regular physical education activity. The students participated in square dance for two weeks, floor hockey skills for three weeks and passing skills for two weeks. These activities were chosen because they would have minimal effect of lower back and hamstring flexibility, thus altering flexibility test scores.

The Sit and Reach Test was administered using a wooden cube with 30 centimeter sides. The top side has a 23 centimeter wooden extension and is marked in centimeters. The Sit and Reach procedures used in the AAHPERD Health-Related Fitness Test (1980) were strictly followed. The student sat on the floor with the legs extended shoulder width apart with the bottom of feet, without shoes against the box. The "23-cm" marked the edge of the box where the soles of the feet were placed. The 23-cm top section of the cube extended toward the student. An illustration of the Sit and Reach Box is shown in Figure 2. The test position for the Sit and Reach Test is shown in Figure 3. The student was instructed to place his/her hands on top of each other, reach forward as far as possible, with palms down and hold his/her fingers on the extension board for a minimum of one second. The legs were to be kept extended and flat on the floor. The score was measured at the end of the fingertips in centimeters. The best of three scores was recorded. A copy of the data collection sheet can be found in Appendix C. A separate data collection sheet was used for each class. If a student failed to perform the Sit and Reach properly, (ie., failed to keep legs flat, reached unevenly with hands) this counted as one of the three tests. This was followed since one additional trial could increase a student's high score on the test. Table III shows the AAHPERD Health-Related Fitness Test Norms for the Sit and

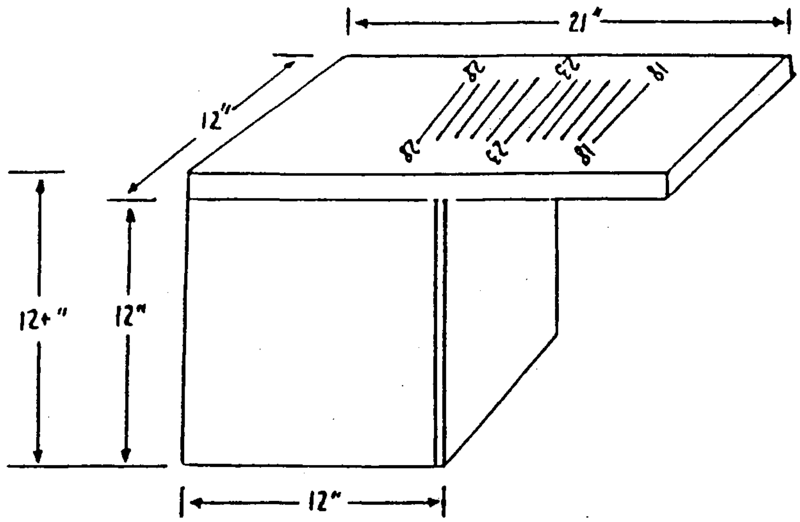

Figure 2 Sit and Reach Box

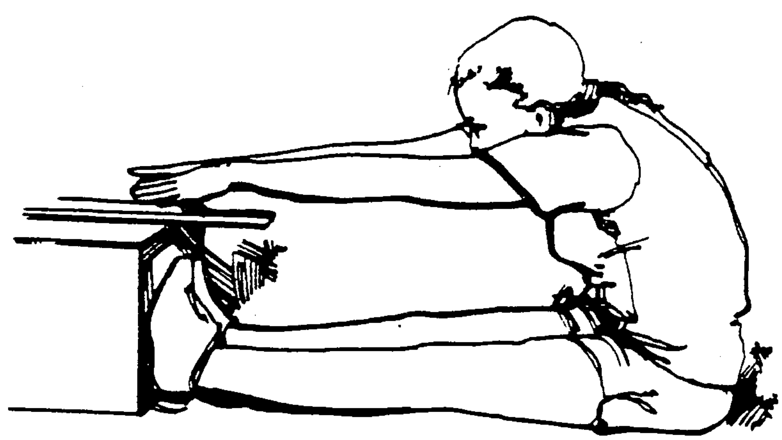

Figure 3 Test Position for the Sit and Reach

TABLE III

AAHPERD PERCENTILE NORMS FOR
THE SIT AND REACH
IN CENTIMETERS

	Percentile	Age 6	7	8	9	10	11
	95	34	34	36	35	35	37
	75	30	31	31	31	31	32
GIRLS	50	27	27	28	28	28	29
	25	23	24	23	23	24	24
	5	18	16	17	17	16	16
	95	34	33	34	34	33	34
	75	29	28	29	29	28	29
BOYS	50	26	25	25	25	25	25
	25	16	16	16	16	12	12
	5	17	16	16	16	12	12

Reach.

The three tests were taken with 20 seconds between each test. One student was designated to gently place pressure on top of the subject's knees while being tested to aid in keeping the legs flat on the floor. This procedure was followed for all students.

After students were tested, they were isolated from the students who had not tested to avoid sharing information about scores. Thus, this would not allow competetion during the time of testing.

Reliability of the Sit and Reach was measured by completing two pretests and two posttests. The pretest was administered once each day, two consecutive days before the static stretch sessions began. The posttest was administered two consecutive days after the last static stretch exercise session. The pretest and posttest were administered to all students.

Analysis of Data

A two factor analysis of covariance design (ANCOVA) was computed to determine if significant differences existed between male and female subjects and/or between treatment and control groups. The collected data were coded and computed at the Department of Health, Physical Education and Recreation at Chicago State University. The adjusted posttest means of each of the variables for the two groups were compared to determine if any significant differences occurred due to the treatment. Tukey W Procedure HSD (honestly significant difference) was applied post hoc to locate significance indicated by the F ratio for interaction. Significance was accepted at the .05 level for all comparisons.

CHAPTER IV

RESULTS

A total of 317 students from Mildred Dean Elementary in Newport, Kentucky participated in the pretest and posttest of the study to determine the effect of an eight-week, two days a week static stretch program on lower back and hamstring flexibility. One hundred and sixty one females and 156 males participated in the study. The subjects were randomly assigned to a control group or treatment group: 79 males in the treatment group, 77 males in the control group, 82 females in the treatment group, 79 females in the control group. Subjects were eliminated from the study for missing more than three exercise sessions. No subjects were eliminated based on this criteria.

To aid in interpretation, the analysis of data will be presented according to the following areas: methods used in statistical analysis, analysis of data, results, discussion and summary.

Methods Used in Statistical Analysis

To quantitatively describe the data, means and standard deviations of the gain in centimeters were computed as measures of central tendency and dispersion, respectively. (Table IV.)

TABLE IV

DESCRIPTIVE STATISTICS FOR THE SIT AND REACH

Source	Mean	Standard Deviation
Male Treatment Group	4.02	2.09
Male Control Group	0.02	1.13
Female Treatment Group	4.93	1.88
Female Control Group	0.27	1.11

Gender and group (treatment and control) were variables in the study. Therefore, the means of the pretest, posttest and gains between males and females and between treatment and control groups were computed and are shown in Figures 4-9.

A two factor analysis of covariance (ANCOVA) was computed to determine if significant differences existed in gender, between male and female subjects and/or in group, between treatment and control groups. The posttest Sit and Reach means for males and females and for the treatment and control groups were compared, controlling and adjusting for the pretest Sit and Reach means. The level of probability was set at $p < .05$ for all comparisons. Tukey W Procedure

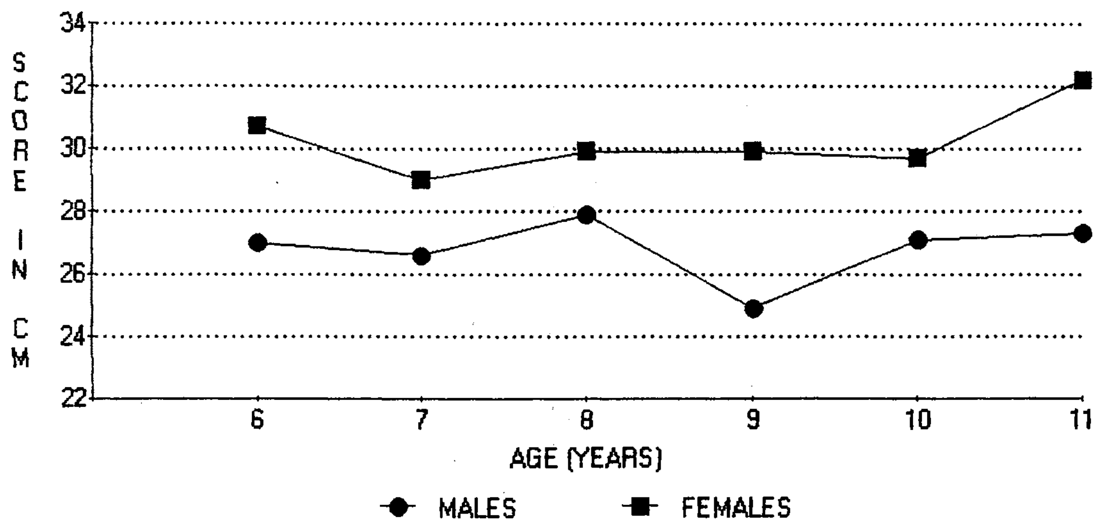

Figure 4 Sit and Reach: Pretest Means Males vs Females

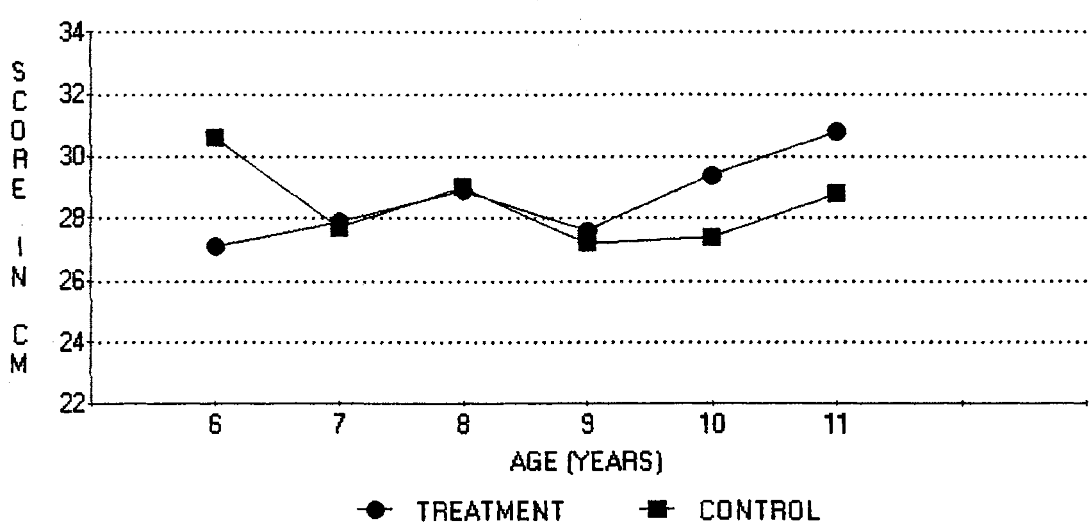

Figure 5 Sit and Reach Pretest Means
Treatment vs Control

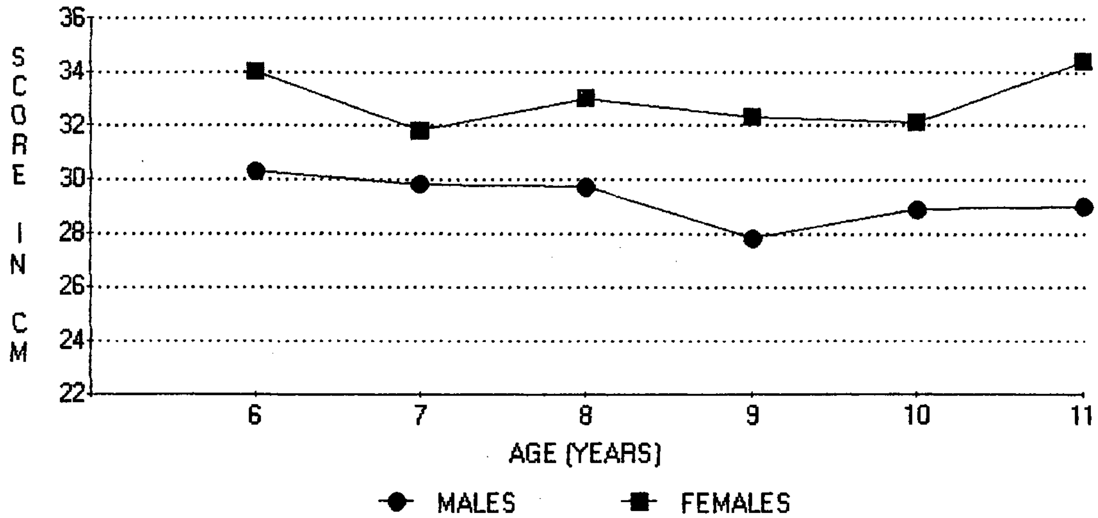

Figure 6 Sit and Reach: Posttest Means Males vs Females

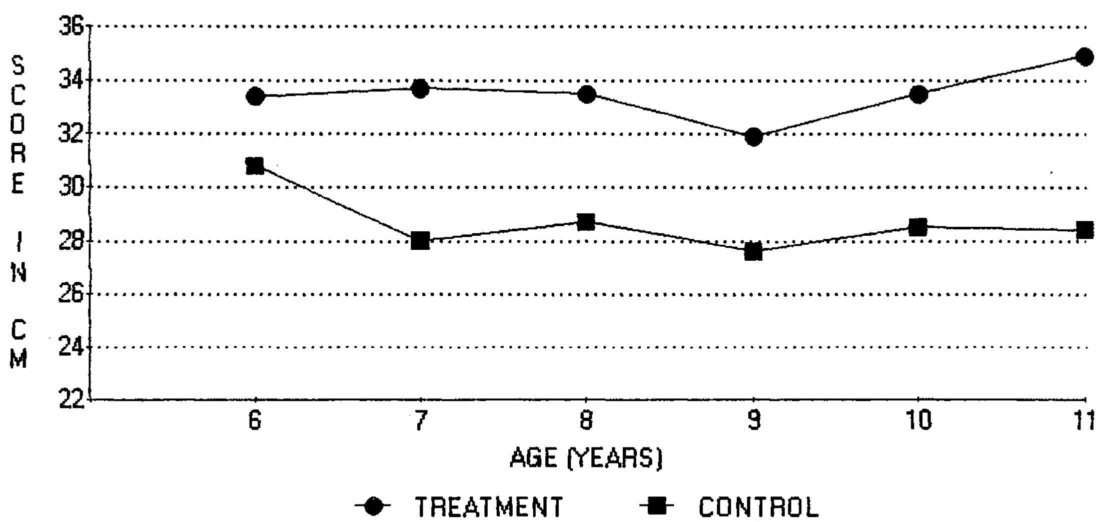

Figure 7 Sit and Reach: Posttest Means
Treatment vs Control

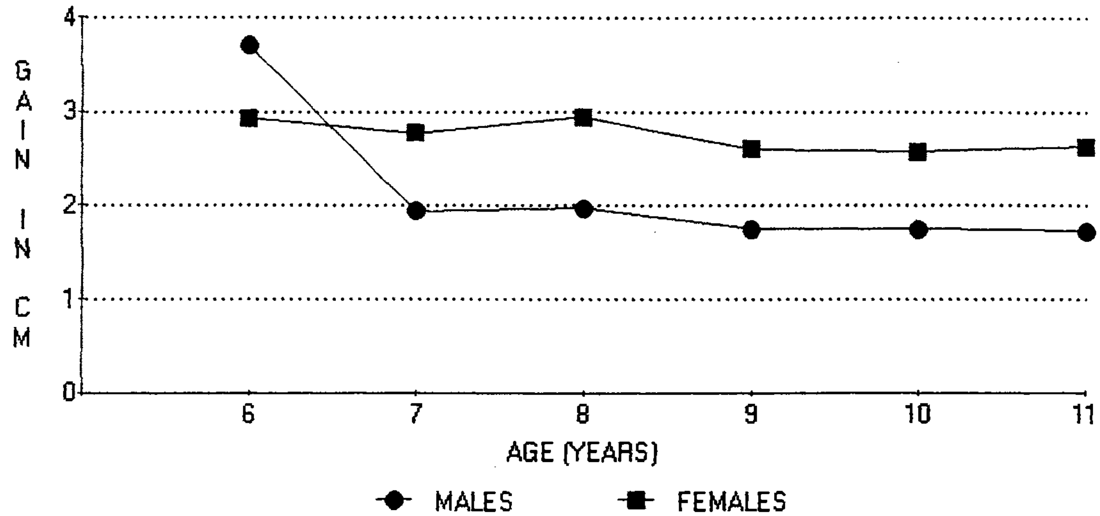

Figure 8 Sit and Reach: Gain Means Males vs Females

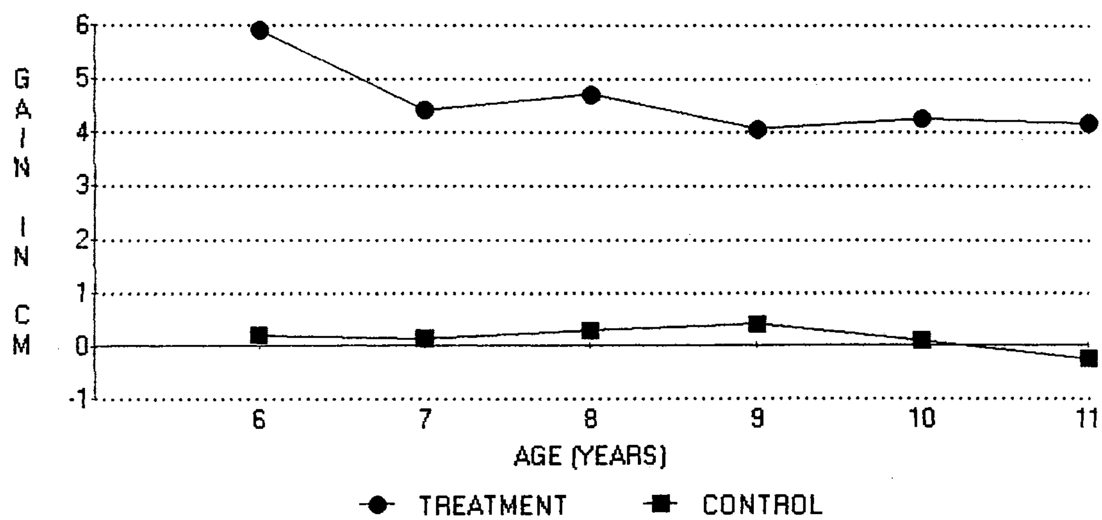

Figure 9 Sit and Reach: Gain Means
Treatment vs Control

HSD (honestly significant difference) was applied post hoc to locate significance indicated by the F ratio for interaction (AxB).

Analysis of Data

The ANCOVA resulted in an F ratio of 11.12 for differences in sit and reach measurements with respect to gender. The ANCOVA resulted in an F ratio of 516.64 for differences in sit and reach measurements with respect to treatment and control groups. Results are shown in Table V.

TABLE V

ANALYSIS OF COVARIANCE FOR SIT AND REACH MEASUREMENT: COMPARISON OF GENDER AND GROUP

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F	Prob.
Gender	33.33	1	33.33	11.12	0.001
Group	1548.58	1	1548.58	516.64	0.000
Interaction	13.49	1	13.49	4.50	0.032
Error	938.18	313	3.00		
Total		316			

Results

Using the pretest sit and reach measurement as the covariate, the F ratio for gender was 11.12. This value was significant at the .05 level of probability. Therefore, the hypothesis of no significant difference of the pretest and posttest of the sit and reach between males and females was rejected. Using the pretest and posttest measurement as the covariate for treatment and control group, the F ratio was 516.64. This value was significant at the .05 level of probability. Therefore, the hypothesis of no significant difference of the pretest and posttest of the sit and reach between the treatment and control group was rejected.

Discussion

The statistical analysis revealed significant differences in the pre and posttest measurements of both variables, gender and group.

A significant difference was found in the pretest and posttest measurement of boys and girls. The adjusted posttest mean of the Sit and Reach score was 30.67 for boys and 31.36 for girls, with girls scoring .69 cm higher than boys. This change implies that the girls had a larger increase in flexibility due to participation in the static stretch exercise program. These results contradict previous studies. Kosh and associates (1988) found that both boys and girls significantly increased in flexibility after completing a 12 week strength and flexibility program.

There was no difference in the comparison of boys and girls. The children, however participated in 30 minutes of flexibility two days a week as compared to only 100 seconds a week in this study.

The ANCOVA resulted in a significant difference among the treatment and control groups. The adjusted posttest mean for the Sit and Reach score was 33.22 for the treatment group and 28.81 for the control group. The difference is 4.41 cm. This clearly indicates a change due to participation in the static stretch exercise program. The magnitude and direction of the change in this study is greater than changes found in similar studies. One explanation for this could be that unlike other studies sited earlier, this study included six year old subjects. These subjects had the largest gain of all age groups, thus contributing to the greater change in adjusted posttest means.

Summary

The purpose of this study was to determine the effect of an eight-week static stretch program on hamstring and lower back flexibility on boys and girls six through eleven years of age. Pre and posttest measurements were taken on two groups of subjects, including a treatment group and control group. An analysis of covariance was performed on the data to determine if significant differences existed between males and females and between the two groups.

The results of the study, based on the stated null hypotheses included:

1. There will be no significant difference in hamstring and lower back flexibility in males. The F ratio of 11.12 was significant at .05 level of probability; therefore the null hypothesis is rejected.

2. There will be no significant difference in hamstring and lower back flexibility in females. The F ratio of 11.12 was significant at .05 level of probability; therefore the null hypothesis is rejected.

3. There will be no significant difference in hamstring and lower back flexibility in the comparison of treatment and control groups in males and females. The F ratio of 516.64 was significant at .05 level probability; therefore the null hypothesis is rejected.

Based on the analysis of data, the results include:

1. The adjusted posttest mean of males in the treatment group was significantly higher than the adjusted posttest mean of males in the control group.

2. The adjusted posttest mean of the females in the treatment group was significantly higher than the adjusted posttest means of females in the control group.

3. The adjusted posttest mean of females was significantly higher than the adjusted posttest means of males.

4. The adjusted posttest mean of the treatment group was significantly higher than the adjusted posttest mean of

the control group.

CHAPTER V

CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

Despite the national interest in fitness by adults, children are becoming less fit. A cooperative effort by parents, teachers, pediatricians and politicians is needed to reverse this trend. A significant component of health-related fitness is flexibility. A reasonable degree of flexibility is needed for effective movement. Clinical evidence implicates lack of flexibility in the lower back and hamstring muscle group as a leading cause of lower back pain later in life. Evidence also suggests that regular exercise and appropriate stretching can correct this problem. It is unknown when this flexibility exercise should begin in life to produce the most beneficial results. A diminution in flexibility appears to be concomitant with age (Hardy, 1985). However, aging decrements can be very minimal provided that there is an absence of disease and injury, and one endeavors to maintain flexibility by stretching exercise. Limited research exists on the effect of a structured flexibility exercise program on elementary school children.

It was the purpose of this study to determine the effect of participation in an eight-week, two days a week static stretch exercise program on hamstring and lower back flexibility of boys and girls six through eleven years of age.

Conclusions

The results of this study showed a significant difference in the comparison of the adjusted posttest means of males and females and between the adjusted posttest means of the treatment group and control group. Several conclusions can be drawn based upon the stated results.

In the comparison of boys and girls, it can be concluded that girls had a greater increase from pretest to posttest than boys. It can be assumed that the static exercise program was more effective for girls than for boys. The existing studies (Hartley-O'Brien, 1980, Devries, 1962, Koch, et al, 1988) show similar conclusions with static stretch exercise, but all were based on an older population. Six year old boys in this study had a larger increase than six year old girls from pretest to posttest. One study,(NCYFS II, 1984) tested flexibility of six to nine year olds. The study established fitness norms, but did not use any exercise program to determine change in flexibility. There are no additional studies that support this difference in six year olds. The lack of supporting research on the effect of flexibility exercise on six year old children does not allow the conclusion that six year old boys score significantly higher than six year old girls.

Another conclusion that can be drawn is that the treatment groups had a greater increase from pretest to posttest than the control groups. The significant change was not surprising given the existing studies showing similar results.

It can be concluded that regular participation in a static stretch program of a minimum of eight weeks can improve hamstring and lower back flexibility. It can also be concluded that during the eight-week exercise program, performing static stretching for a minimum of six to seven minutes each day, two days a week can improve the hamstring and lower back flexibility of six through eleven year old children. Therefore, the static stretch exercise program in this study was of sufficient intensity, duration and frequency to have a significant effect on hamstring and lower back flexibility of six through eleven year old children.

Discussion

The decline of the fitness level of American children should prompt action by various levels in the educational system. The federal government continues to financially support schools. National organizations, such as AAHPERD continue to offer support to physical education teachers by sponsoring physical education conventions, publishing resource journals and sponsoring fitness testing for school age children. Each state financially supports its public schools, including money for teacher salaries and supplies and equipment. Each school district within each state must decide on how this money is spent and what portion will go to physical education programs. If money is scarce, individual schools must try to provide quality physical education programs with as little financial resources as possible.

The focus of physical education must be redirected toward health promotion. A fitness program can be one of the least expensive, yet most valuable parts of a physical education program. The physical education teacher should be responsible for implementing a sound fitness program. However, there is a need to increase the number of children exposed to physical education on a daily basis. The biggest reason why elementary physical education teachers do not have a regular fitness program is because of the lack of class time (Pate, Corbin, Simmons-Morton, Ross, 1987). Teachers must try to find ways to incorporate fitness concepts and activities in a minimum amount of time.

Flexibility has been established as a health-related fitness component. It was the primary purpose of this study to determine if there was a change in flexibility in elementary school children due to static stretch exercise. The study was designed within the constraints of only meeting two days a week for physical education. The researcher was limited to allowing only a few minutes for flexibility exercises in each class session due to the responsibility of teaching other physical education activities. Therefore, a secondary purpose of this study was to determine if a minimum amount of time designated to static stretch exercise, two days a week would make a significant difference in lower back and hamstring flexibility. The results concluded that a minimum of six to seven minutes each day, two days a week can improve hamstring and lower back flexibility.

It is important to note that the total amount of static stretch exercise time in this study was 100 seconds each week (5 stretches for 10 seconds, two days a week). Koch, et al, (1988) used 30 minutes of stretching, Hubley, Kozey and Stanish (1984) used 15 minutes and Devries (1962) used 30 minutes. All of these studies showed significant differences in flexibility from pretest to posttest using longer stretching time. However, none showed any significant difference between males and females. A reason for the difference between boys and girls in this study could be that girls of a younger age (6-11 years) respond more effectively to static stretching than older females. Another reason may be that girls respond better to such a minimal amount of time !100 seconds per week) than do boys, with boys scoring equally as well when a longer stretching time is used. A static stretch program of this minimal intensity could be valuable to an elementary physical education teacher who is limited to only two days of physical education a week for his/her students. However, boys may need to spend more time stretching than girls to compensate.

The results of this study contribute to the education of the public for the need of a flexibility program in elementary schools. This study can also help to justify the need for increasing the amount of weekly physical education for elementary school children. Children who regularly participate in a static stretch exercise program will make fundamental strides toward the development of sound physical fitness.

It is my hope that this study will help develop interest in the area of flexibility exercise for children, serve as a guidepost for elementary physical education teachers, and be a practical example to use when teaching fitness concepts.

Recommendations

The following are recommendations for future study related to a static stretch exercise program:

1. A static stretch study with an expanded school age population (K-12 grades).
2. A static stretch study of an extended duration (16 weeks) examining hamstring and lower back flexibility.
3. A static stretch study to determine the affect on additional areas of the body (shoulder, neck, ankle).
4. A study comparing more than one type of stretching exercise.

5. A study using subjects scoring in the bottom 10th percentile on the Sit and Reach Test of the AAHPERD Health-Related Fitness Test.

6. A longitudinal study of a minimum of five years to determine the longer range effect of static stretching.

7. A longitudinal study comparing flexibility and sport injury in adults.

8. A longitudinal study comparing chronic lower back pain and sport injury in adults.

9. A study examining the effect of flexibility exercise on hamstring and lower back flexibility of adolescents through puberty, particularly through the growth spurt.

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APENDIXES

APPENDIX A

INSTITUTIONAL REVIEW BOARD FOR HUMAN SUBJECTS APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Proposal Title: Effects of Static Stretching on Hamstring and Lower Back Flexibility in the Performance of the Sit and Reach Component of the AAHPERD Health Related Fitness Test in Boys and Girls Six Through Eleven Years of Age

Principal Investigator: Milton Rhoads/Jean Heise

Date: March 11, 1991 IRB # ED-91-025

This application has been reviewed by the IRB and

Processed as: Exempt [X] Expedite [ ] Full Board Review [ ]

Renewal or Continuation [ ]

Approval Status Recommended by Reviewer(s):

Approved [X] Deferred for Revision [ ]

Approved with Provision [ ] Disapproved [ ]

Approval status subject to review by full Institutional Review Board at next meeting, 2nd and 4th Thursday of each month.

Comments, Modifications/Conditions for Approval or Reason for Deferral or Disapproval:

The Institutional Review Board does not normally approve "passive" consent, i.e., parents returning the consent form if they do not want their child to participate in the study. However, this research falls under the Exempt category in that it is "research conducted in established or commonly accepted educational settings, involving normal educational practices." As the activities conducted in this research study could be conducted in the class as a part of normal class activity, there is no problem with the passive consent form.

Signature: ______________________ Date: March 15, 1991
Chair of Institutional Review Board

APPENDIX B

PASSIVE CONSENT FORM

CONSENT FORM

I have always had a keen interest in children's fitness during my career as a physical education teacher. I will be conducting a study with all students at Mildred Dean Elementary on flexibility in lower back and hamstring muscles (the muscles in the back of the legs). The study will last eight weeks, beginning on April 8, 1991. Each student's flexibility will be measured by using the Sit and Reach Test before the study begins. Students will be randomly assigned to either an exercise group or control group. The exercise group will perform five static stretch exercises during the first few minutes of their normal physical education class two days a week. The students in the control group will practice ball throwing skills and perform no stretching exercises. At the end of eight weeks, each student's flexibility will be measured to determine if there are any significant differences in either group. At the end of the study, students in the control group will be taught the stretching exercises.

Please read the following important information about the study:

1. Participation in this study is completely voluntary. Refusal to participate will not effect the physical education grade.

2. There are no known or potential risks associated with participation in the study.

3. All measurements will be kept confidential and not be available to any other school official except myself.

4. Any student is free to withdraw from the study at any time.
5. Results from the study may be obtained by contacting Jean Hiese at Mildred Dean Elementary (292-3009). You may also contact Terry Maciula, University Research Services, 001 Life Sciences East, Oklahoma State University, Stillwater, Ok 74078 (405)744-5700.

By participating in the study, your child will learn exercises designed to increase flexibility of the lower back and hamstring muscles. Information obtained from this study will improve the knowledge of human exercise and flexibility. Better physical education programs may result.

Please return the attached sheet if you DO NOT give permission for your child to participate in the study.

____
Jean Heise, physical education teacher

Mildred Dean Elementary

"I DO NOT give consent for my child ________________________, age ______to participate in the study conducted by Jean Heise, physical education teacher at Mildred Dean Elementary. I understand that refusal to participate will not effect my child's grade in physical education.

Signed,__________________________________

parent or guardian

* Please keep this copy of the consent information.

APPENDIX C

DATA COLLECTION SHEET

DATA COLLECTION SHEET

SIT AND REACH TEST

NAME	PRETEST	POSTTEST	DIFFERENCE
1.			
2.			
3.			
4.			
5.			
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23.			

APPENDIX D

RAW DATA

RAW DATA

Subject	Age	Sex	Group	Pretest	Posttest	Difference
1	6	M	T	26	33	7
2	6	M	T	22	26	4
3	6	M	T	27	34	7
4	6	M	T	25	32	7
5	6	M	C	36	36	0
6	6	M	C	27	28	1
7	6	M	C	24	24	0
8	6	F	T	31	37	6
9	6	F	T	26	32	6
10	6	F	T	31	36	5
11	6	F	T	34	39	5
12	6	F	T	34	41	7
13	6	F	T	23	30	7
14	6	F	T	30	34	4
15	6	F	C	33	33	0
16	6	F	C	33	33	0
17	6	F	C	30	31	1
18	6	F	C	29	28	-1
19	6	F	C	34	33	-1
20	6	F	C	30	32	2
21	6	F	C	36	36	0
22	7	M	T	25	29	4
22	7	M	T	33	39	6
23	7	M	T	31	35	4
24	7	M	T	31	34	3
25	7	M	T	24	29	5
26	7	M	T	23	30	7
27	7	M	T	21	29	7
28	7	M	T	27	31	4
29	7	M	T	23	26	5
30	7	M	T	25	28	3
31	7	M	T	27	34	7
32	7	M	T	27	32	5
33	7	M	T	32	36	4
34	7	M	T	34	40	6
35	7	M	T	19	22	3
36	7	M	T	25	30	5
37	7	M	C	29	29	0
38	7	M	C	28	29	1
39	7	M	C	34	33	-1
40	7	M	C	29	28	-1
41	7	M	C	23	25	2
42	7	M	C	23	24	-1
43	7	M	C	29	28	-1

Subject	Age	Sex	Group	Pretest	Posttest	Difference
44	7	M	C	22	22	0
45	7	M	C	29	30	1
46	7	M	C	28	29	1
47	7	M	C	33	32	-1
48	7	M	C	28	27	-1
49	7	M	C	30	30	0
50	7	M	C	32	32	0
51	7	M	C	23	22	-1
52	7	F	T	31	34	3
53	7	F	T	34	40	6
54	7	F	T	27	36	9
55	7	F	T	30	37	7
56	7	F	T	31	32	1
57	7	F	T	27	34	7
58	7	F	T	31	36	5
59	7	F	T	27	29	2
60	7	F	T	35	39	4
61	7	F	T	33	39	6
62	7	F	T	37	41	4
63	7	F	T	20	26	6
64	7	F	T	36	42	6
65	7	F	C	29	30	1
66	7	F	C	30	30	0
67	7	F	C	32	33	1
68	7	F	C	28	28	0
69	7	F	C	27	29	2
70	7	F	C	27	26	-1
71	7	F	C	23	24	1
72	7	F	C	32	31	-1
73	7	F	C	28	29	1
74	7	F	C	27	26	-1
75	7	F	C	20	20	0
76	7	F	C	29	29	0
77	7	F	C	24	25	1
78	7	F	C	27	27	0
79	8	M	T	41	49	8
80	8	M	T	28	28	0
81	8	M	T	28	32	4
82	8	M	T	20	24	4
83	8	M	T	23	27	4
84	8	M	T	28	33	5
85	8	M	T	27	31	4
86	8	M	T	30	34	4
87	8	M	T	22	24	2
88	8	M	T	30	30	0
89	8	M	T	23	29	6
90	8	M	T	33	35	2
91	8	M	T	27	31	4

Subject	Age	Sex	Group	Pretest	Posttest	Difference
92	8	M	C	22	20	-2
93	8	M	C	29	29	0
94	8	M	C	30	30	0
95	8	M	C	29	29	0
96	8	M	C	21	20	-1
97	8	M	C	23	24	1
98	8	M	C	29	29	0
99	8	M	C	24	24	0
100	8	M	C	30	31	1
101	8	M	C	34	36	2
102	8	M	C	38	36	-2
103	8	F	T	22	30	8
104	8	F	T	29	34	5
105	8	F	T	30	33	3
106	8	F	T	31	36	5
107	8	F	T	35	43	8
108	8	F	T	29	33	4
109	8	F	T	33	35	3
110	8	F	T	29	35	6
111	8	F	T	37	44	7
112	8	F	T	24	32	8
113	8	F	T	31	37	6
114	8	F	T	32	39	7
115	8	F	T	24	29	5
116	8	F	T	31	36	5
117	8	F	T	33	39	6
118	8	F	C	31	32	1
119	8	F	C	20	22	2
120	8	F	C	30	31	1
121	8	F	C	23	22	-1
122	8	F	C	25	25	0
123	8	F	C	35	34	-1
124	8	F	C	33	34	1
125	8	F	C	28	28	0
126	8	F	C	38	38	0
127	8	F	C	28	29	1
128	8	F	C	32	32	0
129	8	F	C	30	31	1
130	8	F	C	31	30	-1
131	8	F	C	30	32	2
132	8	F	C	36	36	0
133	8	F	C	26	26	0
134	8	F	C	30	31	1
135	9	M	T	31	36	6
136	9	M	T	25	27	2
137	9	M	T	20	23	3
138	9	M	T	20	21	1
139	9	M	T	26	30	4

Subject	Age	Sex	Group	Pretest	Posttest	Difference
140	9	M	T	23	30	7
141	9	M	T	26	31	5
142	9	M	T	30	33	3
143	9	M	T	25	31	6
144	9	M	T	29	30	1
145	9	M	T	22	27	5
146	9	M	T	26	34	8
147	9	M	T	27	31	4
148	9	M	T	33	35	2
149	9	M	T	30	34	4
150	9	M	T	15	18	3
151	9	M	T	20	24	4
152	9	M	C	23	24	1
153	9	M	C	27	27	0
154	9	M	C	35	34	−1
155	9	M	C	27	28	1
156	9	M	C	32	31	−1
157	9	M	C	29	29	0
158	9	M	C	29	28	−1
159	9	M	C	30	30	0
160	9	M	C	20	21	1
161	9	M	C	23	22	−1
162	9	M	C	21	20	−1
163	9	M	C	27	29	2
164	9	M	C	28	27	−1
165	9	M	C	23	24	1
166	9	M	C	26	27	1
167	9	M	C	22	24	2
168	9	M	C	20	20	0
169	9	M	C	30	29	−1
170	9	M	C	18	18	−1
171	9	M	C	26	27	1
172	9	F	T	37	44	7
173	9	F	T	29	35	6
175	9	F	T	29	31	2
176	9	F	T	28	34	6
177	9	F	T	33	36	3
178	9	F	T	35	41	6
179	9	F	T	27	29	2
180	9	F	T	20	26	6
181	9	F	T	29	33	4
182	9	F	T	33	37	4
183	9	F	T	33	37	4
184	9	F	T	34	39	5
185	9	F	T	26	29	3
185	9	F	T	25	27	2
186	9	F	T	30	34	4
187	9	F	C	28	28	0

Subject	Age	Sex	Group	Pretest	Posttest	Difference
188	9	F	C	30	30	0
189	9	F	C	23	24	1
190	9	F	C	28	28	0
191	9	F	C	30	31	1
192	9	F	C	33	32	-1
193	9	F	C	39	41	2
194	9	F	C	29	31	2
195	9	F	C	27	29	2
196	9	F	C	24	24	0
197	9	F	C	35	36	1
198	9	F	C	31	31	0
199	10	M	T	26	32	6
200	10	M	T	22	24	2
201	10	M	T	25	29	4
202	10	M	T	29	31	2
203	10	M	T	25	30	5
204	10	M	T	36	41	5
205	10	M	T	30	36	6
206	10	M	T	32	34	2
207	10	M	T	24	24	0
208	10	M	T	32	33	1
209	10	M	T	25	31	6
210	10	M	Y	20	24	4
211	10	M	T	35	38	3
212	10	M	T	32	35	3
213	10	M	C	26	26	0
214	10	M	C	20	18	-2
215	10	M	C	19	18	-1
216	10	M	C	31	30	-1
217	10	M	C	28	29	1
218	10	M	C	34	34	0
219	10	M	C	32	33	1
220	10	M	C	22	22	0
221	10	M	C	30	31	1
222	10	M	C	30	29	-1
223	10	M	C	27	28	1
224	10	M	C	25	25	0
225	10	M	C	16	17	1
226	10	F	T	34	39	5
227	10	F	T	30	34	4
228	10	F	T	25	32	7
229	10	F	T	32	37	5
230	10	F	T	29	33	4
231	10	F	T	30	38	8
232	10	F	T	25	28	3
233	10	F	T	25	31	6
234	10	F	T	28	30	2
235	10	F	T	28	33	5

Subject	Age	Sex	Group	Pretest	Posttest	Difference
236	10	F	T	22	25	3
237	10	F	T	35	38	3
238	10	F	T	32	35	3
239	10	F	T	36	38	2
240	10	F	T	33	37	4
241	10	F	T	38	46	8
242	10	F	T	38	45	7
243	10	F	T	30	36	6
244	10	F	C	26	26	0
245	10	F	C	28	28	0
246	10	F	C	35	36	1
247	10	F	C	38	38	0
248	10	F	C	31	30	-1
249	10	F	C	30	31	1
250	10	F	C	29	30	1
251	10	F	C	29	29	0
252	10	F	C	42	42	0
253	10	F	C	33	30	-3
254	10	F	C	29	31	2
255	10	F	C	28	29	1
256	10	F	C	27	27	0
257	10	F	C	23	22	-1
258	10	F	C	37	38	1
259	10	F	C	23	24	1
260	10	f	c	26	26	0
261	11	M	T	18	24	6
262	11	M	T	23	25	2
263	11	M	T	25	27	2
264	11	M	T	33	36	3
265	11	M	T	20	27	7
266	11	M	T	23	25	2
267	11	M	T	23	23	0
268	11	M	T	27	26	-1
269	11	M	T	28	31	3
270	11	M	T	36	44	8
271	11	M	T	34	35	1
272	11	M	T	28	34	6
273	11	M	T	26	30	4
274	11	M	T	36	41	5
275	11	M	T	31	36	5
272	11	M	C	27	26	-1
277	11	M	C	20	22	2
278	11	M	C	36	34	-2
279	11	M	C	23	25	2
280	11	M	C	35	36	1
281	11	M	C	29	28	-1
282	11	M	C	16	19	3
283	11	M	C	26	27	1

Subject	Age	Sex	Group	Pretest	Posttest	Difference
284	11	M	C	32	30	-2
285	11	M	C	30	30	0
286	11	M	C	23	21	-2
287	11	M	C	26	26	0
288	11	M	C	30	29	-1
289	11	M	C	29	29	0
290	11	M	C	26	24	-2
291	11	F	T	26	29	3
292	11	F	T	27	33	4
293	11	F	T	34	39	5
294	11	F	T	42	46	2
295	11	F	T	30	36	6
296	11	F	T	41	44	3
297	11	F	T	35	39	4
298	11	F	T	32	36	4
299	11	F	T	39	41	2
300	11	F	T	40	47	7
301	11	F	T	37	44	7
302	11	F	T	28	33	5
303	11	F	T	37	39	2
304	11	F	T	30	39	9
305	11	F	C	20	22	2
306	11	F	C	36	37	1
307	11	F	C	18	20	2
308	11	F	C	30	29	-1
309	11	F	C	24	23	-1
310	11	F	C	24	22	-2
311	11	F	C	32	32	0
312	11	F	C	39	39	0
313	11	F	C	31	30	-1
314	11	F	T	41	40	-1
315	11	F	C	39	37	-2
316	11	F	C	34	33	-1
317	11	F	C	26	24	-2

M=Male F=Female T=Treatment C=Control

VITA 2

Barbara Jean Heise

Candidate for the Degree of

Doctor of Education

Thesis: THE EFFECT OF STATIC STRETCHING ON HAMSTRING AND LOWER BACK FLEXIBILITY IN ELEMENTARY SCHOOL CHILDREN

Major Field: Higher Education

Minor Field: Health, Physical Education and Leisure

Biographical:

Personal Data: Born in Lafayette, Indiana, June 1, 1958, the daughter of Mary and Mark Pickel.

Education: Graduated from North Montgomery High School, Crawfordsville, Indiana, May, 1976; received Bachelor of Arts in Education degree from Ball State University, Muncie, Indiana, May 1981; received Master of Education degree from Central State University, Edmond, Oklahoma, May 1986; completed degree requirements for the Doctor of Education degree at Oklahoma State University, July, 1993.

Professional Experience: Physical Education Teacher, Oklahoma City Public Schools, August, 1982-May 1990; Physical Education Teacher, Newport Independent Schools, August 1990-May 1991; Physical Education Teacher, Suffolk County Schools, Suffolk County, England; Instructor in Health, Physical Education and Recreation Department, Chicago State University, August 1992-present.

Professional Organizations: American Alliance for Health, Physical Education, Recreation and Dance; Midwest District of the American Alliance of Health, Physical Education, Recreation and Dance; Illinois Alliance for Health, Physical Education, Recreation and Dance; Association for Supervision and Curriculum Development; National Association for Physical Education in Higher Education; Awarded Fulbright Scholarship in Teacher Exchange Program.