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The Effect of Exer-Genie Exercises upon Trunk Flexibility

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THE EFFECT OF EXER-GENIE EXERCISES UPON TRUNK FLEXIBILITY

by

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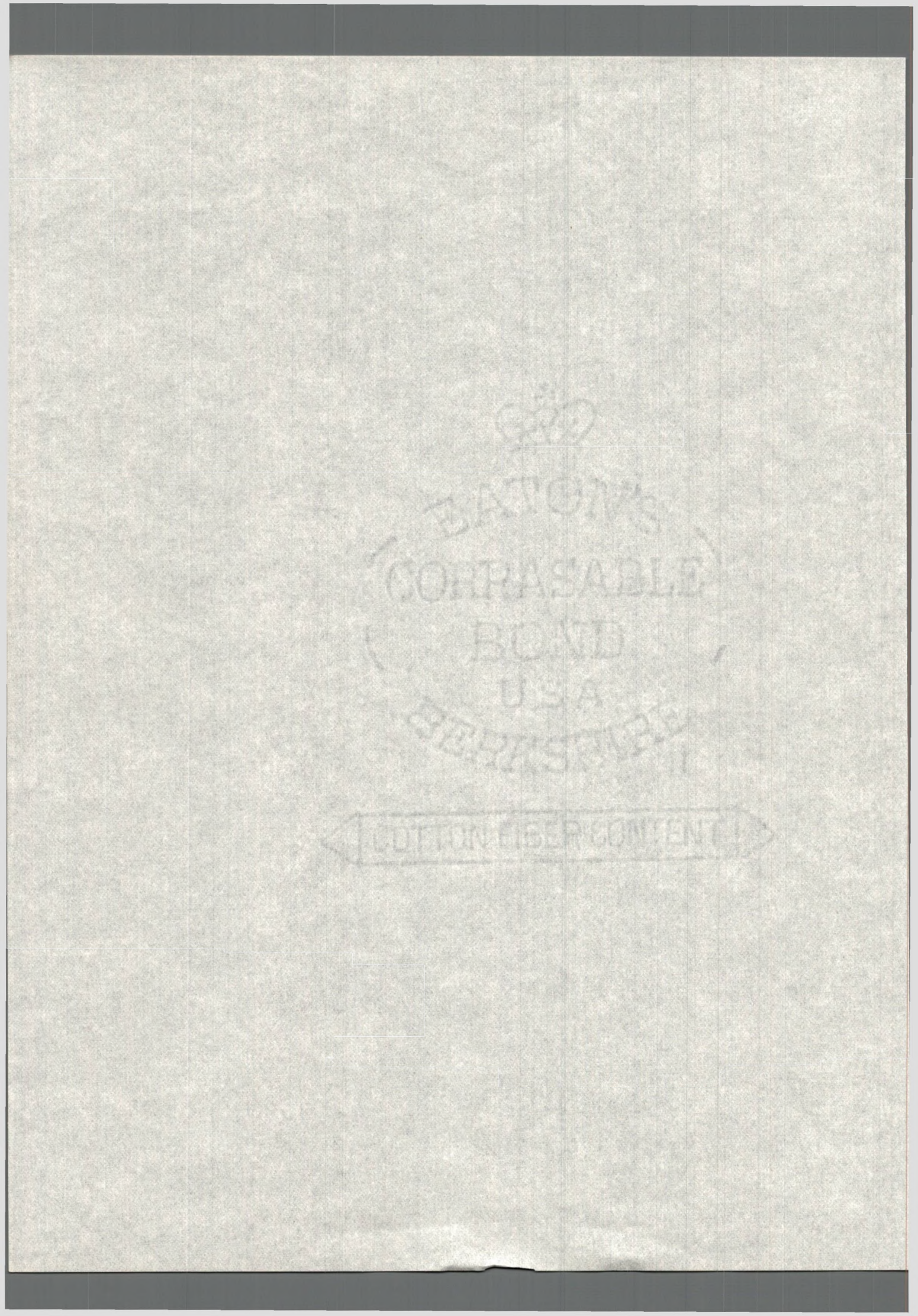
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This thesis submitted by John A. Gray in partial fulfillment of the requirements for the Degree of Master of Science in the University of North Dakota is hereby approved by the Committee under whom the work has been done.

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ABSTRACT

The participants in this study consisted of fifty-seven sophomore boys attending Fargo North High School in Fargo, North Dakota. Three groups of nineteen members each were equated on the basis of age, weight and height. The control group participated in regular physical education two periods a week. Experimental group A participated in a systematic Exer-Genie exercise program two periods a week. Experimental group B participated in the same systematic Exer-Genie activity five periods a week.

All participants in this study were given four tests of trunk flexibility before and after the four week experimental period. The Leighton Flexometer was the instrument used to measure in degrees the range of movement in the trunk and hip segments of the body.

Comparisons were made between the mean difference within groups as indicated by the initial and final test results. Comparisons were also made between the retest results of group A and the control group; group B and the control group; and between group A and group B. For all comparisons the null hypothesis was retained below the .05 level of significance and the "t" technique was used to test this significance.

Based on the results of this study, the investigator concluded that a systematic Exer-Genie program carried on two periods a week (group A) or five periods per week (group B) for four weeks will produce significant increases in selected measures of trunk flexibility.

CHAPTER I

THE PROBLEM AND ITS SCOPE

The Problem

The problem of this study was to determine whether or not participation in a systematic EXER-GENIE exercise program two periods a week could increase trunk flexibility.

Another phase of the problem was to determine whether this program, when carried on five periods a week, showed more significant results.

Delimitations

The participants in this study consisted of sophomore boys attending Fargo North High School, Fargo, North Dakota.

The age of subjects ranged from 14 to 16 years.

The subjects were tested before and after the four-week experimental program, which was conducted during the month of May, 1966.

One of the experimental groups participated in the program two periods a week while the other group participated in the program five periods a week.

Limitations

The fact that the physical education class periods were forty minutes in duration should be kept in mind, since this allowed a maximum of thirty minutes for participants to complete the exercise program.

Physical education facilities during the month of May, 1966 were extremely limited due to the collapse of the gymnasium roof.

The number of EXER-GENIE'S used was limited to ten because of the personal expense involved.

The experimental groups consisted of volunteer students from the boys' physical education classes.

Definition of Terms

EXER-GENIE: A Commercial isometric and isotonic exercising device used by both experimental groups. The resistance created by this device was from the friction of the movement of a nylon line winding around a shaft.

Flexometer: Refers to the Leighton Flexometer which was the instrument used in establishing degrees of flexibility for the movements tested.

Flexibility: The potential and existing ranges of movement of one body segment with respect to another segment.

Isometric: Involves the contraction of motionless muscles for brief periods of time by pushing or pulling against immovable resistance.

Isotonic: Any exercise that involves movement.

Range of Motion: The distance in degrees that a body segment moves in respect to the joint through or about which it moves.

Need for the Study

Recent physiological studies have indicated that full flexibility of all joints is so very important that any reduction in flexibility would reduce one's efficiency in any sport. This lessening of flexibility would make it difficult to effectively throw a ball, toss a shot put, pass a football, shoot a basketball, or slap a puck.

> The study of flexibility--or range of joint movement as an element of physical fitness has been given new impetus with the advent of the President's Conference on the Fitness of American Youth. This conference came into being partially as a result of the published findings of the Kraus-Hirshland study on the fitness of American Youth as compared with European Youth. American Youth were found to lack flexibility.[1]

Dr. Martin[2] claimed that flexing the body completely is something most of us fail to practice and can not do. Complete "flexion" is one of the best methods of pushing the "pot" up under the ribs and helping to eliminate it. The flexed posture is also advantageous in seeing better, hearing

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[1]Jack R. Leighton, "Flexibility Characteristics of Four Specialized Skill Groups of College Athletes," Archives of Physical Medicine and Rehabilitation, (Vol. XXXIII, No. 1, January, 1957), p. 24.

[2]Robert M. Martin, M.D., "Flexion--Its Postural Importance in Theory and Practice," Physical Power, (Vol. IV, No. 4, July-August 1963), p. 9.

better, reaching, feeling and eating. However, adapting the body to get closer to hear, smell, feel, and touch can result in misuse of the flexed posture.

> Flexion exercises, when used correctively and always succeeding or preceding its counterpart, will then be a necessity to the needs of the body. All authorities accept the text that all joints should be placed through a full range of motion. However, there are some that oppose the teaching of extension exercises, before realizing that complete motion can not be practiced without utilizing extension exercises. In no way can a slumped, overdeveloped flexed posture be corrected without placing emphasis on extension exercises.[3]

Dr. Newel C. Kephart[4] discussed the posture and balance of the child with a perceptual motor handicap. He claimed that important here is:

> Flexibility in postural adjustment so that the child can maintain his relationship to gravity even though he moves in a large number of different ways in relation to the center of gravity.

The successful teaching of motor skills is an extremely important fundamental requisite of physical education teachers.

McCloy[5] listed flexibility as one of ten factors necessary to effective learning of motor skills.

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[3] Ibid., p. 23.

[4] Newell C. Kephart, Ph.D., "Teaching the Child with a Perceptual-Motor Handicap," p. 2. (Paper presented at CDAHPER Convention, Topeka, Kansas, April 1,2,3, 1966)

[5] C.H. McCloy, "A Preliminary Study of Factors in Motor Educability," Research Quarterly, (Vol. XI, No. 2, May 1940), p. 28.

Tyrance[6] also concluded in his study of flexibility that, "motor ability performance depends upon many interrelated factors, among which is joint mobility or flexibility."

Taylor[7] discovered that prescribed exercises to increase flexibility, not only can be administered without decreasing strength, but also that increases in strength can accompany increased flexibility.

Cureton[8] found that flexibility exercises, if built to sufficient dosage may condition muscles, tendons, ligaments and bones to greater tensite strength and elasticity, a factor which is basic to preventing injuries in many sports. He also noted that flexibility exercises are more conducive to building endurance in movements like swimming, running, acrobatic dancing and tumbling than short static, or weight lifting type activities.

Finally, there has been much controversy in the last few years concerning "isometric" training as opposed to regular "isotonic" training. The EXER-GENIE EXERCISER, used in this study, purports to be a "breakthrough" in this field of physical fitness since it combines the two theories in every exercise.

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[6]Herman J. Tyrance, "Relationships of Extreme Body Types to Ranges of Flexibility," Research Quarterly, (Vol. XXIX, No. 3, October, 1958), p. 17.

[7]L. Taylor, "Studies in Flexibility" (unpublished Master's Thesis, Springfield College, 1938), p. 74.

[8]Thomas K. Cureton, "Flexibility as an Aspect of Physical Fitness," Research Quarterly, (Vol. XII, May, 1941) p. 381.

Review of Related Literature

Current widespread interest in physical fitness has focused attention on the problem of defining, developing and measuring the fundamental components of fitness. One of the components, about which there has been considerable discussion and speculation of late, is flexibility. The following section consists of references that relate, as nearly as possible, to the problem of defining, developing and measuring flexibility.

Most authorities accept the belief that flexibility is a significant element of physical fitness and, therefore, deserves due consideration by coaches and physical educators. Flexibility has long been a matter of vital interest to the medical profession. Advocates of isotonic and isometric resistive exercises have had much to say about their methods, as far as increased strength and improved performance, but what happens to flexibility during training is still shrouded in mystery.

A greater area of study desired, however, is that concerned with the relationship of flexibility to performance.

The fact that flexibility is not a general factor but a specific factor with each joint accounts in part for the many specialized flexibility characteristics that appear in the following review.

Leighton,[9] found a definite decreasing trend for most of the flexibility characteristics from age 10 to age 16 with a low at age sixteen.

Hupperich and Sigerseth[10] conducted a similar study in 1950 in which they reported on the flexibility characteristics of girls 6-18 years of age. When Leighton compared his findings with this study he found that no significant change appeared for girls ages 9-15 on the six movements studied.

Leighton[11] then conducted a study in which he investigated the flexibility performance of men skilled in four different activities, namely swimming, baseball, basketball, and track and field throwing events. Highly specialized performance was noted in hip flexion and extension while superior flexibility performance existed in neck movements that aid in extending peripheral vision. Acceptable evidence was presented that showed that flexibility performance was specific for the four specialized skill groups of college athletics.

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[9]Jack R. Leighton, "Flexibility Characteristics of Males Ten to Eighteen Years of Age," Archives of Physical Medicine and Rehabilitation, (Vol. XXXVII, No. 8, August 1957), p. 494.

[10]Florence L. Hupperich, Peter O. Sigerseth, "The Specificity of Flexibility in Girls," Research Quarterly, (Vol. XXI, March 1950), p. 25.

[11]Jack R. Leighton, "Flexibility Characteristics of Four Specialized Skill Groups of College Athletes," ibid., p. 24.

Leighton[12] followed this study with another using three specialized skill groups. This time he studied the flexibility performance of champion weight lifters, gymnasts, and wrestlers. He found that weight lifters and gymnasts showed the highest flexibility performance. Once again, Leighton found that significant differences existed in the flexibility performance ability among skilled performers specializing in different activities.

Sigerseth and Haliski,[13] in their study, used the Leighton Flexometer to test 100 football players and 100 regular college students at the University of Oregon. In a comparison of flexibility of twenty-one joint areas of the body, the regular college students were significantly more flexible than football players in a greater number of body joints.

Wilson[14] used sixteen male college students who exercised with weights three times per week for four months. Using the Cureton Flexibility Tests for trunk flexion, trunk extension and shoulder lift, the mean flexibility of the

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[12]Jack R. Leighton, "Flexibility Characteristics of Three Specialized Skill Groups of Champion Athletes," Archives of Physical Medicine and Rehabilitation, (Vol. XXXVIII, September, 1957), p. 580.

[13]Peter O. Sigerseth and Chester C. Haliski, "The Flexibility of Football Players," Research Quarterly, (Vol. XXI, No. 4, December, 1950), p. 394.

[14]A. L. Wilson, "The Effect of Weight Training on the Physical Fitness of Young Men," (unpublished Master's Thesis, University of Illinois, 1947).

group showed a slight increase in all three areas at the close of the four month period.

A more significant study was reported by Massey and Chaudet.[15] In this study thirteen college men participated in a six month weight training program which included a routine of ten exercises involving all major areas of the body. A flexometer was used to measure flexibility. A significant decrease was found in elbow flexion, hip extension, shoulder flexion, and shoulder extension. No significant change occurred in hip flexion or knee flexion.

Funk[16] studied a group of twenty-five male college students who participated in a weight training program twice a week for two months and employed the one set, ten repetitions--maximum system. His program included specific exercises designed to strengthen all major areas of the body. Using the Cureton Flexibility Tests, he found a statistically significant decrease both in trunk flexion and trunk extension.

A follow up on Funk's study was done by Wickstrom,[17]

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[15]Benjamin H. Massey and Norman L. Chaudet, "Effects of Systematic Heavy Resistive Exercises on Range of Joint Movement in Young Adult Males," Research Quarterly, (Vol. II, 1956), p. 44-51.

[16]Dean C. Funk, "A Study of the Effect of Systematic Weight Training Program on Trunk Flexibility of Male College Students," unpublished study, 1960.

[17]Ralph L. Wickstrom, "The Effect of Heavy Resistance Weight Training on Selected Measures of Flexibility in College Men," unpublished study in 1960.

who used twenty-five different students, pursuing the same type of exercise program for a period of twelve rather than eight weeks. However, in this study, the Leighton Flexometer was used to measure flexibility. There was a slight decrease in arm flexibility (flexion-extension range) and slight increase in trunk flexibility (flexion-extension range) but neither change was statistically significant.

Wickstrom,[18] found in reviewing literature relating to weight training and flexibility that either there was no statistically significant difference or there was a significant decrease in the selected measure of flexibility. He also noted, "that no study reported a statistically significant increase in a measure of flexibility."

In a 1960 study,[19] the low resistance high repetition system of exercise was used by sixty-four male college students. The program in this study was conducted every Tuesday and Thursday for twelve weeks. Each participant did one set of each exercise with a maximum of 15-20 repetitions. Their program consisted of exercises for all important areas of the body with no undue emphasis upon any. There was a significant increase in trunk flexibility but no significant

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[18]Ralph L. Wickstrom, "Weight Training and Flexibility," Journal of Health, Physical Education and Recreation," (February, 1963), p. 61.

[19]Ralph L. Wickstrom, "The Effect of Low-Resistance, High Repetition Progressive Resistance Exercises upon Selected Measures of Strength and Flexibility," Journal of the Association of Physical and Mental Rehabilitation, (Vol. XIV, 1960) p. 161-163.

change in arm flexibility. The findings of this study indicated that with a relatively large group of subjects no significant decrease in range of motion was noted as a result of using a low-resistance exercise system.

McQue[20] used the Leighton Flexometer to compare a more active group of girls with a less active group and found that the former tended to be more flexible.

Cureton,[21] in his study of flexibility, concluded that flexibility exercises are more conducive to building endurance in movements like swimming, running, acrobatic dancing and tumbling than short static, or weight lifting type activities.

Clark,[22] has stated that trunk flexibility has been an indication of general body flexibility.

Miller,[23] president of Physical Fitness Inc., conducted a study in which the EXER-GENIE was released to 2,000 local residents from ages three to eighty-four. They were carefully trained in the use of the machine and were asked to carry on a home program based on a six-minute per

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[20]Betty F. McQue, "Flexibility Measurements of College Women," Research Quarterly, (Vol. XXIV, Oct., 1953), p. 316.

[21]Cureton, op.cit., p. 381.

[22]H. Harrison Clark, Application of Measurement to Health and Physical Education, (New Jersey; Prentice-Hall, Inc., 1961), p. 175.

[23]Dean D. Miller, "Exer-Genie Background", (unpublished study), p. 3.

day workout. Body measurements were taken and tests were given for endurance, strength and body flexibility. Miller hypothesized that 1641 of the subjects should reduce around the waist. Doing only three sit-ups per day with a complete ten-second isometric contraction before each one, all of the predicted 1641 participants lost at least one inch around the waist, thirty-three of them lost four inches, and seven of them lost over five inches.

In another study of flexibility, Miller[24] used 3,000 local high school boys, none of whom were in competitive sports, and gave them three tests of flexibility before and after the nine week experimental program of Exer-Genie exercises.

In the first test, participants were asked to bend down and touch their fingers to the ground. When the program started, 66 per cent of the participants could do this task. At the end of the nine-weeks program, 96 per cent of the subjects could touch the ground.

In the second test the subjects had to touch their palms to the ground. The number of successful subjects on this test increased from 54 per cent to 88 per cent.

The third test required that the participants bend down to touch their head to the ground by spreading their legs outward. On this test the percentage increased from 3.7 per cent to 51 per cent.

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[24] Ibid., p. 5.

Summary

From the foregoing statements, it would seem that there is a definite need for further study of flexibility, particularly in the area of developing exercises that will meet a twofold purpose of increasing strength and flexibility. Following are a review of the significant points discussed in Chapter I.

1. Flexibility is important to efficient performance of any sport.
2. Flexibility is a necessary component of physical fitness.
3. Flexion and its counterpart extension are extremely important to physical appearance.
4. Flexibility contributes to good posture.
5. Flexibility is extremely important in maintaining body balance and body equilibrium.
6. Flexibility is necessary for efficient performance of motor skills.
7. Suppleness or good body flexibility, is instrumental in the prevention of athletic injuries.

CHAPTER II

METHODOLOGY

Selection and Equation of the Three Groups

Three groups of nineteen subjects each were selected from the sophomore class of boys at Fargo North High School. Members of this class were asked to volunteer to participate in one of the following three groups.

Experimental Group "A": Members of this group participated in a systematic EXER-GENIE exercise program during their regular physical education period two days a week for four weeks.

Experimental Group "B": Members of this group participated in a systematic EXER-GENIE exercise program five days a week for four weeks. Each subject performed the required exercises during two regular physical education periods and during three study hall periods on the alternate days.

Control Group: Members of this group participated only in their regular physical education periods twice weekly which involved such activities as boomerang, water-polo, swimming, golf, calisthenics and softball.

The three groups were equated by using a formula of age, weight, and height factors. This method of classi-

fication was adopted from the Winnipeg Public School Division No. 1, Winnipeg, Manitoba, Canada. The system was based on the following formula:

$$\frac{\text{Age in Months}}{3} + \frac{\text{Weight in Pounds}}{2} + \text{Height in Inches} =$$

Available scores from the control group and experimental group A were matched with the scores of the nineteen members of group B until three groups of nineteen subjects had been equated. Therefore, the subjects had been paired on the basis of their results on the above age-weight-height system of somatotyping.

Further statistical data concerning the high positive correlation coefficient between the three groups can be found in (CHAPTER III - ANALYSIS OF DATA) and (APPENDIX A). More information about this method of equating groups is presented in a review of the following literature.

Miller,[25] using height and weight as a system of classification, found that such a system might have a place as an equalizing technique in the physical education program.

Miller claimed that Cozen's classification scheme--a plan based on height and weight factors - provides a satisfactory equating device for grouping college men according to body size.

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[25]Kenneth D. Miller, "A Critique on the Use of Height-Weight Factors in the Performance Classification of College Men," Research Quarterly, (Vol. XXIII, December, 1952), p. 402-416.

Cureton,[26] from his studies of somatotyping concluded, "that combinations of age, height and weight make a reasonably good basis for norming athletic performance up to the age of seventeen."

Tests Selected For This Study

A total of 117 volunteer subjects were given four initial tests of trunk flexibility prior to the experimental period and 95 boys were retested at the end of the four week experimental period. The remaining twenty-two had to be eliminated because they failed to complete either the necessary twenty periods of exercise required for group B or the necessary eight periods required for group A.

The instrument used in measuring trunk flexibility was the Leighton Flexometer, a type of goniometer devised by Jack R. Leighton.[27] This instrument (see figure 1. p. 17) which Leighton discussed in detail in his study, "A Simple Objective and Reliable Measure of Flexibility," was found to be "sufficiently reliable to warrant its use for measuring individuals or groups." Statistical evidence was given to support the application of this highly reliable system of measurement of thirteen different movements as one means of measuring flexibility.

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[26]Thomas Kirk Cureton, "Body Build as a Framework of Reference for Interpreting Physical Fitness and Athletic Performance," supplement to Research Quarterly, (Vol. XII,

[27]Jack R. Leighton, "A Simple and Reliable Measure of Flexibility," Research Quarterly, (Vol. XIII, May, 1942), p. 205-216.

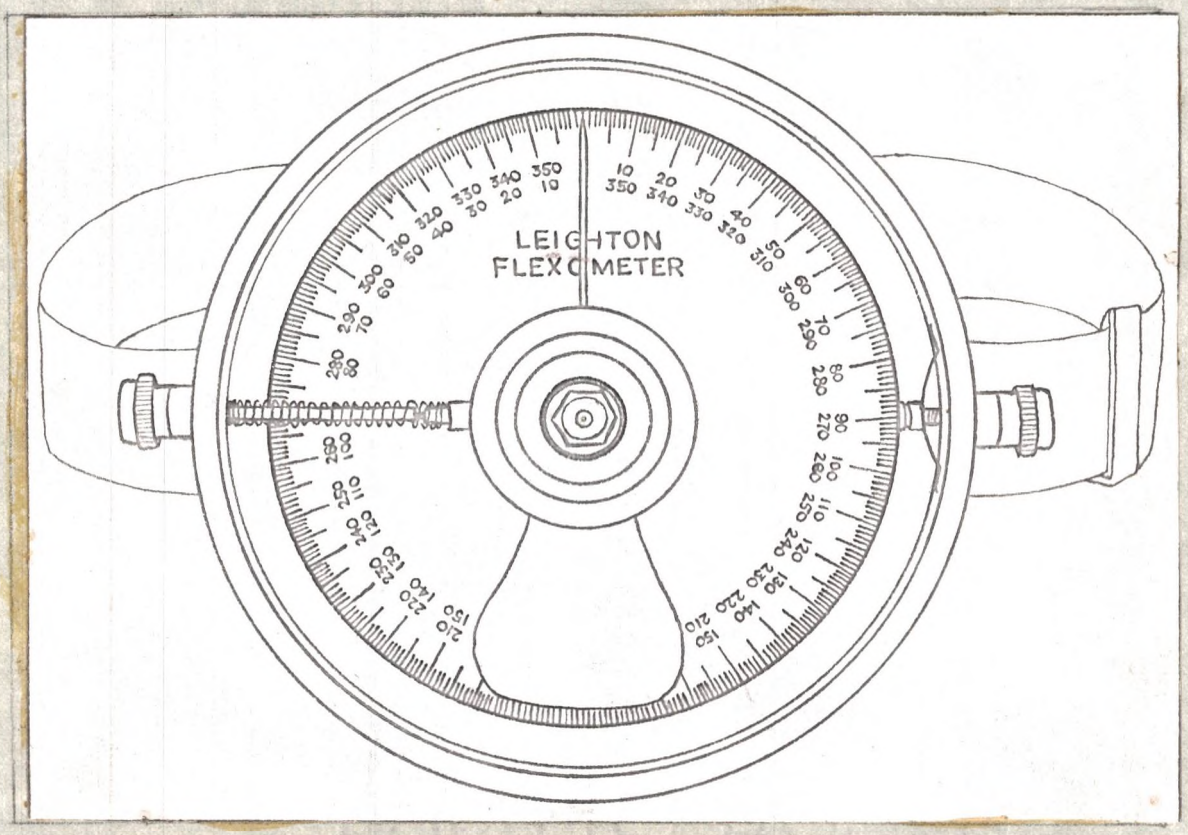

Figure 1
The Leighton Flexometer

The drawing in Figure 1 presents the instrument in the starting position for the movement to be measured. The weighted dial comes to rest with the zero degree mark uppermost on the instrument. The weighted needle comes to rest with the point resting on zero. The posts on the instrument contain locking devices. Once the instrument is in the starting position the dial is locked and the movement performed. When the movement is completed to its extreme limit, the needle is locked. The direct reading of the needle on the dial is the arc through which the movement took place.

> The mechanics of the apparatus is (sic) based upon the fact that gravity always pulls the weighted end of the needle downward during the execution of the movement. Its validity as a device to measure flexibility of ranges of motion is based upon the condition that most of the bending done by an individual during a particular movement is assumed to take place around the joint or joints of the segments; this movement is the one measured. In all measurements taken as the segment rotates about a fixed point or axis, the dial moves but the needle remains in the same vertical position or returns to it.[28]

Sigerseth and Haliski[29] obtained a reliability coefficient of .975 when they used the Leighton Flexometer for measuring 100 football players for trunk and hip flexion.

For this study all subjects were measured at room temperature, 72°F, and in no instance was a subject allowed to perform any exercise or activity before measurements were taken. The instrument and purpose of the experiments were explained to all subjects before starting.

Two of the thirteen flexibility movements tested by Leighton were adopted for this study. Following are the movements measured in this study:

1. Trunk and Hip Extension and Flexion
2. Sideward Trunk and Hip Flexion and Extension

Leighton,[30] achieved a reliability coefficient "r" of .997 for the first movement and an "r" of .977 for the second movement.

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[28] Ibid., p. 209.

[29] Sigerseth and Haliski, p. 394.

[30] Leighton, XIII, p. 212.

1. Trunk and Hip Extension and Flexion

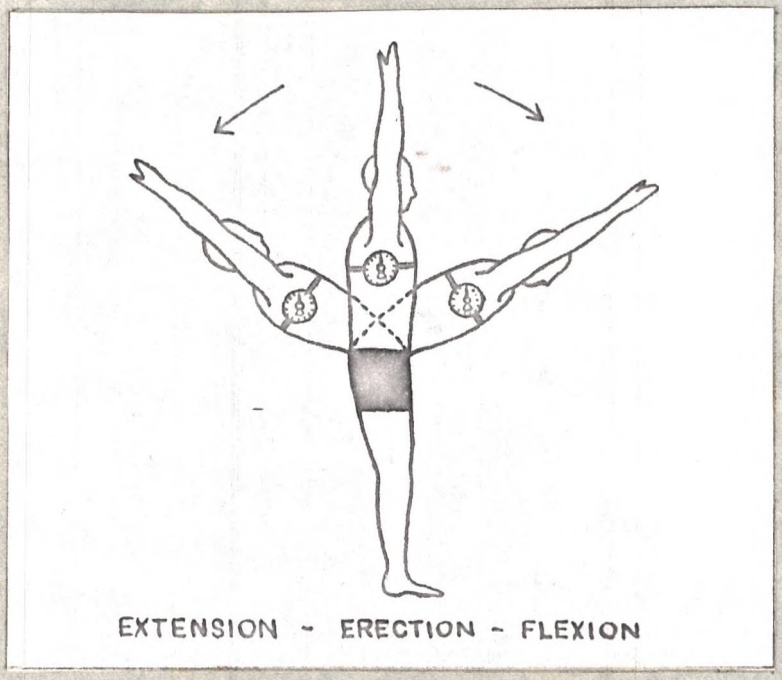

Figure 2.

The Leighton Flexometer was strapped around the subject's chest so that the instrument was directly under the right arm pit. The subject then stood erect (see Figure 2.) with his feet together, arms stretched over head. At this point the instrument read zero degrees. Keeping his legs straight, knees locked, feet together and flat on the floor, the subject extended backward as far as possible where a reading for Test 1. - Trunk and Hip Extension was taken. (see Figure 2.). The subject then stood erect and the instrument was reset at zero. For Test 2. - Trunk and Hip Flexion, the subject followed the same procedure, only this time he bent forward as far as possible. A reading in degrees was taken at the subject's maximum flexed position. (see Figure 2.).

2. Sideward Trunk and Hip Flexion and Extension

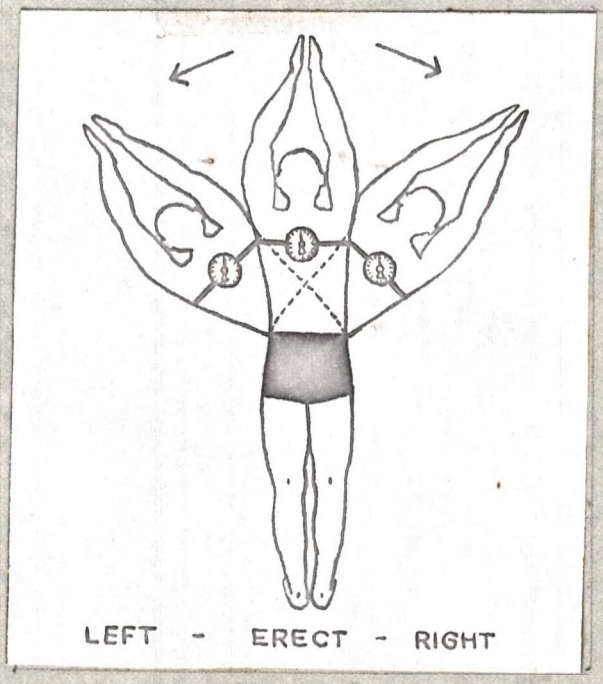

Figure 3.

The Leighton Flexometer was strapped around the subject's chest so that the instrument was on the middle of the back, with the belt passing around the chest at nipple height. The subject stood erect (see Figure 3.) with his feet together and arms stretched overhead. At this point the instrument read zero degrees. The subject was then instructed to keep his knees locked, feet together and flat on the floor, and to bend to his left side as far as possible (see Figure 3.) At this point a reading for Test 3. - Left Side Trunk and Hip Flexion was taken. Returning to the starting position, the subject stood erect and the instrument was reset at zero. The subject then flexed as far as possible to his right side (see Figure 3.) where a reading for Test 4. - Right Side Trunk and Hip Flexion was taken.

EXER-GENIE Exercises Selected for this Study

The EXER-GENIE (see figure 4., p. 22) is a commercial exercising device developed by Physical Fitness Inc.[31] The principle of this machine involves starting each exercise isometrically for ten seconds and then following through isotonically.

The resistance principle of the EXER-GENIE exerciser is friction from the movement of a nylon line around a shaft. (see drawing II, figure 4., p. 22. The amount of line passing over the shaft determines the approximate resistance in pounds of pull indicated on the calibration chart on the Exer-Genie cylinder (see Drawing I, figure 4., p. 22). The calibration chart reflects an average resistance in sample testing and is intended for quick reference only. Resistance can be varied from free movement up through maximum effort exercises.

To fasten the EXER-GENIE between door and door-frame, a paper dowel is inserted into the open end of the nylon holding strap (see drawing I, figure 4, p. 22). The strap is then placed on the top or hinged side of the door and the door is closed.

Not shown in figure 4 are the handles which are fastened to the ends of the trail line and the special exercise board. The trail line is a single piece of nylon rope approximately 8 feet long.

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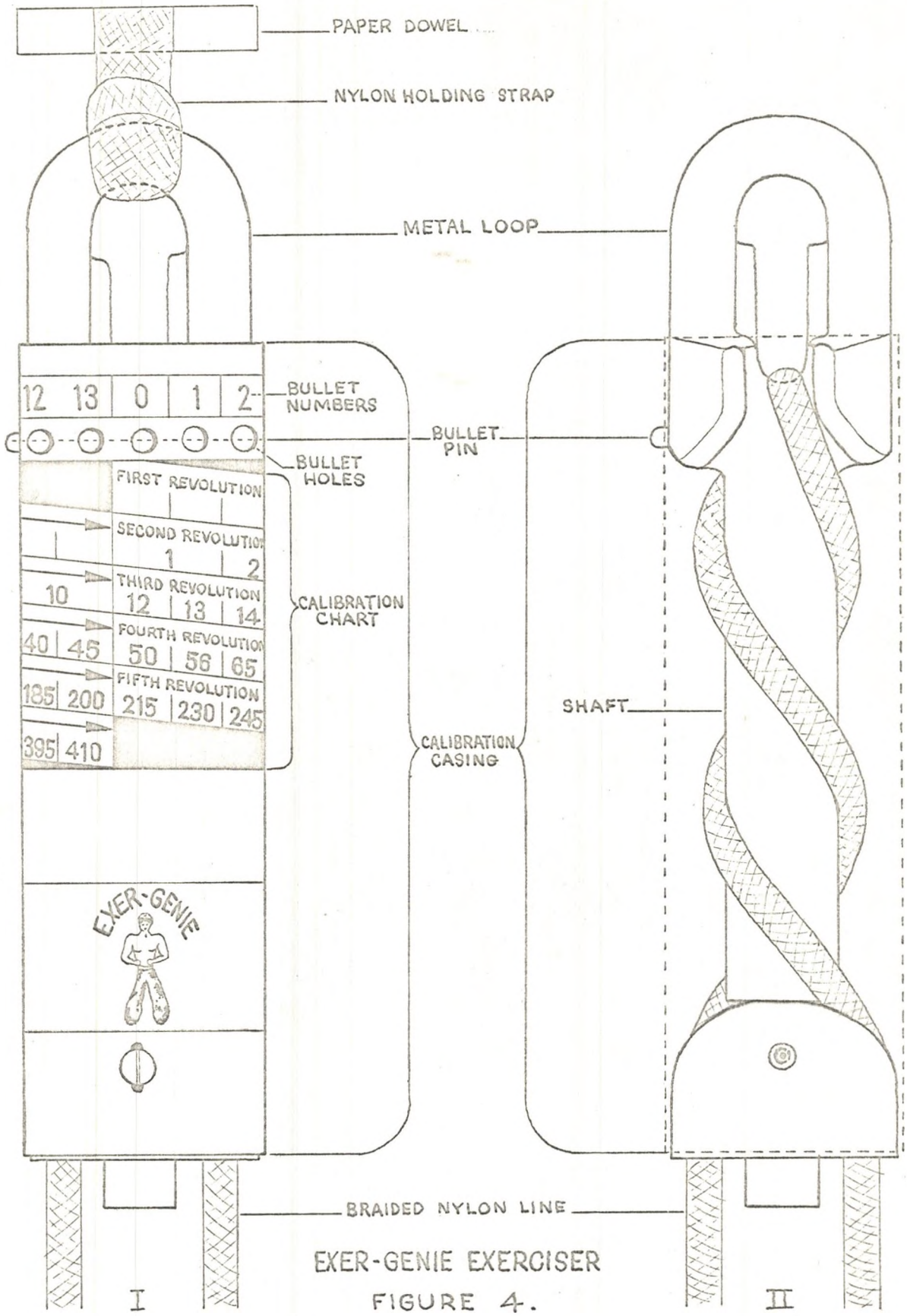
[31]Dean D. Miller, Exer-Genie Exerciser, Fullerton, California; Exer-Genie, Inc., 1964), p. 2.



EXER-GENIE EXERCISER

FIGURE 4.

Exercise 1. - Two-Man Sit-up:

The subject assumed a regular bent-leg sit up position with feet held down by a partner. Grasping the handle of the Exer-Genie behind his head, the subject raised the head and shoulders to set the muscles of the stomach isometrically for ten seconds. After the ten second hold, the subject released the trail line and followed through with a complete sit-up against pre-set resistance.

Purpose was to strengthen and reduce the abdominal area. Each subject completed three repetitions.

Subjects were cautioned that breathing throughout the entire exercise should be as normal as possible.

At the beginning of the experimental period, some subjects could not complete one sit-up, let alone three repetitions of this exercise. Therefore, the standing sit-up was substituted by fixing the Exer-Genie through the top of the door and the same principle followed, except that the handle was held behind the head while in the erect position. The Standing Sit-up was complete when the subject had taken a maximum flexed position with the feet together and knees locked.

All except one of the subjects were performing three repetitions of the regular sit-up by the end of the first two weeks of the experimental period.

Exercise 2. - Two-Man Rowing:

The Exer-Genie was fixed through the inside edge of the door approximately one foot from the floor. The subject in a sitting position on the floor, braced his feet against the wall or door. The first subject with knees slightly flexed started the rowing motion by bending forward, grasping the handle and pulling isometrically for ten full seconds to tire the muscles involved. The second subject regulated resistance by adjusting pressure on the trail rope as it slid through his hand. The rowing was continued until the subject reached the supine position, had pulled the handle to his chin and pressed it to a supine-erect position with arms fully stretched overhead.

This was intended as an over all body exercise involving the back, abdominal area, leg and shoulder girdle muscles. Each subject completed three repetitions.

Exercise 3. - The Bicycle:

For exercise three, the Exer-Genie was placed in the inside edge of the door, about three feet up from the floor. The subject assumed a supine position with his head toward the door. His legs were then raised and the ends of the nylon rope looped over each foot. The right leg was raised over the body and as close toward the door as possible. The knee was locked, stretching the hamstring muscle and the leg held in this position for a ten second isometric

Exercise 5. - The Big Four:

The Exer-Genie was again hooked to the special exercise board. As the name implies, there were four phases of this exercise. For the first phase, the subject stood on the ends of the board, squatted down and grasped the handle of the short rope and pulled isometrically for ten seconds. The trail line was looped around the index finger of one hand and the resistance was regulated throughout the first phase. The second phase duplicated the dead lift by straightening the back, keeping arms down and legs flexed. In the third phase the subject duplicated the squat lift by straightening the legs and bringing the hands up with the elbows in, completing the forearm curl. In the final phase, the trail line was dropped, the hand grip reversed and a military press completed against the pre-set resistance.

The purpose of this exercise was to substitute for four of the most important weight training exercises to develop and condition the entire body, especially lower back and hips. Three repetitions of this exercise were required.

In summary, each of the five exercises began with a ten second isometric hold and then the subject followed through a complete range of motion isotonically. Approximately 15 to 20 minutes was necessary for two subjects, working diligently to complete all five exercises.

pull downward. The knee was locked throughout the entire exercise which was completed when the leg reached the floor. The left leg regulated the resistance by regulating the trail line while that leg was being pulled overhead. The same procedure was then carried out with the left leg.

This exercise was designed to strengthen and reduce the calves, thighs, and hip areas. Three repetitions with each leg were completed.

Exercise 4. - Side Bends:

For the exercise of Side Bends, the ropes were shortened and the Exer-Genie hooked on to a special Exer-Genie board. The subject stood on the ends of the board and grasped the handles at the ends of the ropes with each hand. The subject then bent directly to the left side as far as possible with the legs kept straight. From this position the subject pulled isometrically for ten seconds. The right hand regulated the trail line and resistance. The exercise was completed when the subject reached the anatomically opposite position by bending to his right as far as possible.

The purpose of this routine was to exercise the diagonal muscles of the abdominal area and the lower back. It was believed beneficial for reducing that "spare tire". For this exercise five repetitions were required.

CHAPTER III

ANALYSIS OF THE DATA

The purpose of this study was to determine whether or not participation in a systematic EXER-GENIE exercise program two periods a week increased trunk flexibility. In addition, there was interest in whether or not more significant results could be obtained when the same program was carried on five periods a week. The control group did not perform any of the EXER-GENIE exercises but they did participate in regular physical education class activities. All three groups were given four tests of trunk flexibility before and after the experimental period.

STATISTICAL PROCEDURE FOR EQUATING GROUPS

This investigator selected the Pearson Product Moment Method[32] to define the intergroup relationship between the scores achieved by each subject of each group on the age, weight, height system of somatotyping used to equate the groups. This relationship which is called correlation, has been indicated by the Pearson coefficient "r". This correlation varies from a perfect positive correlation of + 1.0 to a perfect negative correlation of -1.0.

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[32]Albert E. Bartz, Educational Measurement, Burgess Publishing Company, Minneapolis, Minnesota, p. 45.

The correlation coefficient were as follows: 1. Between the control group and experimental group A which performed the EXER-GENIE exercises two periods a week, "r" equalled +.98. 2. Between the control group and experimental group B which performed the EXER-GENIE exercises five periods per week, "r" equalled +.99. 3. Between group A and group B "r" equalled +.99. (see APPENDIX A on p. 50).

The Pearson Product Moment Method utilized the actual size of the scores, and therefore, was preferred for greater accuracy.

STATISTICAL PROCEDURE FOR WITHIN GROUP COMPARISON

This investigator assumed the null hypothesis[33] in analyzing the difference between the means of the initial and final tests within each group. This hypothesis asserts that there is no true difference between the mean scores, and that the difference found between sample means is a chance difference and is accidental and unimportant. The "t" technique for testing the significance of the difference between means derived from correlated scores from small samples was found to be suitable for this study. This technique or test determines the ratio between the mean difference and the estimate of the sampling error of the mean difference. The ratio, expressed as "t" was obtained by dividing

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[33]Allen L. Edwards, Statistical Methods for the Behavioral Sciences, Rinehart & Company, Inc., New York, 1954), p. 255.

the actual mean difference by the estimate of the sampling error of the mean difference. The "t" table was used to check the significance of this result.

For this study the null hypothesis was retained at the .05 level of significance. The "t" value required for 18 degrees of freedom on the "t" table was 2.10.

Complete data including raw scores, mean differences, and ranges for each group, together with the details for the mathematical process employed in analysis are presented in APPENDIX B, p. 58.

The following results were obtained by an analysis of the data collected in this study. A summary of the following material is presented in Table 5., p. 34.

Trunk and Hip Extension:

As shown in Table 1, p. 30, the control group had a mean score of 46.3 degrees on the initial test and a mean score of 47.1 degrees on the retest. The mean difference was .8 degrees and the estimate of the sampling error was 1.315. The "t" value of .13 indicated no significance difference at the .05 level.

Experimental group A (two periods per week) had a mean score of 43.4 degrees in the initial test and a mean score of 50.0 degrees in the retest. The mean difference was 6.6 degrees and the estimate of the sampling error was 1.747. The "t" value of 3.79 indicated a significant in-

crease at the .05 level.

TABLE 1.--"t" and the significance of difference in intra-group comparison for Test 1.--Trunk and Hip Extension

Group	Mean Diff.	"t"	Significance
CONTROL GROUP (regular physical education)	.8	.13	not significant
GROUP A (Exer-Genie--two periods per week)	6.6	3.79	significant
GROUP B (Exer-Genie--five periods per week)	5.0	2.96	significant

Experimental group B (five periods per week) had a mean score of 47.3 degrees in the initial test and a mean score of 52.3 degrees in the retest. The mean difference was 5.0 degrees and the estimate of sampling error was 1.708. The "t" value of 2.96 indicated a significant increase at the .05 level.

Trunk and Hip Flexion:

As shown in Table 2, p. 31, the control group had a mean score of 127.8 on the initial test and a mean score of 127.0 on the retest. The mean difference was -.8 degrees and the estimate of sampling error was 2.383. The "t" value of -.33 indicated no significant decrease at the .05 level.

TABLE 2.--"t" and the significance of difference in intra-group comparison for Test 2.--Trunk and Hip Flexion

Group	Mean Diff.	"t"	Significance
CONTROL GROUP (regular physical education)	- .8	- .33	not a significant decrease
GROUP A (Exer-Genie--two periods per week)	10.5	3.15	significant
GROUP B (Exer-Genie--five periods per week)	9.5	3.77	significant

Experimental group A (two periods per week) had a mean score of 128.5 degrees on the initial test and a mean score of 139.0 degrees on the retest. The mean difference was 10.5 degrees and the estimate of sampling error was 3.630. The "t" value of 3.15 indicated a significant increase at the .05 level.

Experimental group B (five periods per week) had a mean score of 128.3 degrees on the initial test and a mean score of 137.8 degrees on the retest. The mean difference was 9.5 degrees and the estimate of sampling error was 2.513. The "t" value of 3.77 indicated a significant increase at the .05 level.

Left Side Trunk and Hip Flexion:

As shown in Table 3, p. 32, the control group had a

mean score of 53.1 degrees on the initial test and a mean score of 57.3 degrees on the retest. The mean difference was 4.2 degrees and the estimate of sampling error was 1.251. The "t" value of 3.28 indicated a significant increase at the .05 level.

Experimental group A (two periods per week) had a mean score of 51.2 degrees on the initial test and a mean score of 62.1 on the retest. The mean difference was 10.9 degrees and the estimate of the sampling error was 2.344. The "t" value of 4.65 indicated a significant increase at the .05 level.

TABLE 3.--"t" and the significance of difference in intra-group comparison for Test 3.--Left Side Trunk and Hip Flexion

Group	Mean Diff.	"t"	Significance
CONTROL GROUP (regular physical education	4.2	3.28	significant
GROUP A (Exer-Genie--two periods per week)	10.9	4.65	significant
GROUP B (Exer-Genie--five periods per week)	9.2	6.10	significant

Experimental group B (five periods per week) had a mean score of 49.8 degrees on the initial test and a mean score of 59.0 degrees on the retest. The mean difference

was 9.2 degrees and the estimate of sampling error was 1.510. The "t" value of 6.10 indicated a significant increase at the .05 level.

Right Side Trunk and Hip Flexion:

As shown in Table 4, the control group had a mean score of 58.1 degrees on the initial test and a mean score of 61.2 degrees on the retest. The mean difference was 3.1 degrees and the estimate of sampling error was 1.294. The "t" value of 2.40 indicated a significant increase at the .05 level.

TABLE 4.--"t" and the significance of difference in intra-group comparison for Test 4.--Right Side Trunk and Hip Flexion

Group	Mean Diff.	"t"	Significance
CONTROL GROUP (regular physical education)	3.1	2.40	significant
GROUP A (Exer-Genie--two periods per week)	8.8	3.76	significant
GROUP B (Exer-Genie--five periods per week)	7.5	8.22	significant

Experimental group A (two periods per week) had a mean score of 56.5 degrees on the initial test and a mean score of 65.3 degrees on the retest. The mean difference was 8.8 degrees and the estimate of sampling error was 2.340.

The "t" value of 3.76 indicated a significant increase at the .05 level.

Experimental group B (five periods per week) had a mean score of 57.7 degrees on the initial test and a mean score of 65.2 on the retest. The mean difference was 7.5 degrees and the estimate of sampling error was 1.622. The "t" value of 8.22 indicated a significant increase at the .05 level.

TABLE 5.--summary table of the significance of the difference between means derived from correlated scores from small samples

TEST	CONTROL GROUP	GROUP "A"	GROUP "B"
Trunk and Hip Extension	not significant	significant increase	significant increase
Trunk and Hip Flexion	not significant	significant increase	significant increase
Left Side Trunk and Hip Flexion	significant increase	significant increase	significant increase
Right Side Trunk and Hip Flexion	significant increase	significant increase	significant increase

STATISTICAL PROCEDURE FOR BETWEEN GROUP COMPARISON

This investigator, through the guidance of his committee took advantage of the extremely high correlation obtained when the subjects of the three groups were paired on the basis of their age, weight and height. (see APPENDIX A, p. 50).

The purpose here was to determine whether the means of the retest results of the three groups differed significantly. This was calculated by the use of the formula for establishing the standard error of the difference between means for paired observations.[34] For this analysis, the null hypothesis was retained at the .05 level of significance. The "t" value required for (N-1) or 18 degrees of freedom was 2.10.

Complete data including raw scores, mean differences and between group ranges, together with the details for the mathematical process employed in the analysis for each test are presented in APPENDIX C, p. 84.

The following results were obtained by an analysis of the data in APPENDIX C of this study. A summary of the following material is presented in Table 10 on p. 41.

Trunk and Hip Extension:

a) As shown in Table 6, p. 36, experimental group A (two periods per week) had a mean score of 50.0 degrees and the standard error of the mean was 2.023, while the control group had a mean score of 47.1 degrees and the standard error of the mean was 2.042. The difference between means was 2.9 degrees. The "t" value of 7.23 indicated that group A was significantly more flexible in this area than the control group at the .05 level.

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[34] Ibid., pp. 278-282.

b) Experimental group B (five periods per week) had a mean score of 52.3 degrees and the standard error of the mean was 2.531, while the control group had a mean score of 47.1 degrees and the standard error of the mean was 2.042. The difference between means was 5.2 degrees. The "t" value of 8.88 indicated that group B was also significantly more flexible in this area than the control group at the .05 level with respect to trunk and hip extension.

TABLE 6.--"t" and the significance of difference in inter group comparison for Test 1.--Trunk and Hip Extension

Groups Compared	Diff. Between Means	"t"	Results
a) CONTROL GROUP with GROUP A	2.9	7.23	GROUP A significantly more flexible
b) CONTROL GROUP with GROUP B	5.2	8.88	GROUP B significantly more flexible
c) GROUP A with GROUP B	2.25	3.70	GROUP B significantly more flexible

When experimental group A (two periods per week) was compared with experimental group B (five periods per week) regarding trunk and hip extension, the difference between means on the final test was 2.25 in favor of group B. The resulting "t" value of 3.70 indicated that group B was significantly more flexible than was group A with respect to

trunk and hip extension when the experimental period ended.

Trunk and Hip Flexion:

a) As shown in Table 7, experimental group A (two periods per week) had a mean score of 139.0 degrees and the standard error of the mean was 2.607, while the control group had a mean score of 127.0 degrees and the standard error of the mean 2.712. The difference between means was 12.9 degrees. The "t" value of 23.80 indicated that group A was significantly more flexible in this area than the control group concerning trunk and hip flexion.

TABLE 7.--"t" and the significance of difference in inter-group comparison for Test 2.--Trunk and Hip Flexion

Groups Compared	Diff. Between Means	"t"	Results
a) CONTROL GROUP with GROUP A	12.9	23.80	GROUP A significantly more flexible
b) CONTROL GROUP with GROUP B	10.8	11.38	GROUP B significantly more flexible
c) GROUP A with GROUP B	2.1	2.17	GROUP A significantly more flexible

b) Experimental group B (five periods per week) had a mean score of 137.8 degrees and the standard error of the mean was 3.476, while the control group had a mean score of 127.0 degrees and the standard error of the mean was 2.712. The difference between means was 10.8 degrees. The "t"

value of 11.38 indicated that group B was also significantly more flexible than was the control group in trunk and hip flexion.

c) When experimental group A (two periods per week) was compared with experimental group B (five periods per week) regarding trunk and hip flexion, the difference between means on the final test was 2.1 degrees in favor of group A. The resulting "t" value of 2.17 indicated that group A was significantly more flexible than was group B with respect to trunk and hip flexion when the experimental period ended.

Left Side Trunk and Hip Flexion:

a) As shown in Table 8 on p. 39, experimental group A (two periods per week) had a mean score of 62.1 degrees and the standard error of the mean was 1.552, while the control group had a mean score of 57.3 degrees and the standard error of the mean was 1.353. The difference between means was 4.8 degrees. The "t" value of 13.71 indicated that group A was significantly more flexible in this area than the control group concerning left side trunk and hip flexion.

b) Experimental group B (five periods per week) had a mean score of 59.0 degrees and the standard error of the mean was 1.983, while the control group had a mean score of 57.3 degrees and the standard error of the mean was 1.353. The difference between means was 1.7 degrees. The "t"

value of 2.53 indicated that group B was also significantly more flexible than was the control group in left side trunk and hip flexion.

TABLE 8.--"t" and the significance of difference in inter-group comparison for Test 3.--Left Side Trunk and Hip Flexion

Groups Compared	Diff. Between Means	"t"	Results
a) CONTROL GROUP with GROUP A	4.8	13.71	GROUP A significantly more flexible
b) CONTROL GROUP with GROUP B	1.7	2.53	GROUP B significantly more flexible
c) GROUP A with GROUP B	3.1	5.65	GROUP A significantly more flexible

c) When experimental group A (two periods per week) was compared with experimental group B (five periods per week) regarding left side trunk and hip flexion, the difference between means on the final test was 3.1 degrees in favor of group A. The resulting "t" value of 5.65 indicated that group A was significantly more flexible than was group B with respect to left side trunk and hip flexion when the experimental period ended.

Right Side Trunk and Hip Flexion:

a) As shown in Table 9 on p. 40, experimental group A (two periods per week) had a mean score of 65.3

degrees and the standard error of the mean was 1.503, while the control group had a mean score of 61.2 degrees and the standard error of the mean was 1.707. The difference between means was 4.1 degrees. The "t" value of 10.78 indicated that group A was significantly more flexible in this area than the control group concerning right side trunk and hip flexion.

TABLE 9.--"t" and the significance of difference in intergroup comparison for Test 4.--Right Side Trunk and Hip Flexion

Groups Compared	Diff. Between Mean	"t"	Results
a) CONTROL GROUP with GROUP A	4.1	10.78	GROUP A significantly more flexible
b) CONTROL GROUP with GROUP B	4.0	6.68	GROUP B significantly more flexible
c) GROUP A with GROUP B	.1	.12	no significant difference

b) Experimental group B (five periods per week) had a mean score of 65.2 degrees and the standard error of the mean was 2.238, while the control group had a mean score of 61.2 degrees and the standard error of the mean was 1.707. The difference between means was 4.0 degrees. The "t" value of 6.68 indicated that group B was also significantly more flexible than was the control group in right side trunk and hip flexion.

c) When experimental group A (two periods per week) was compared with experimental group B (five periods per week) regarding right side trunk and hip flexion, the difference between the means on the final test was .1 degrees in favore of group A . The resulting "t" value of .12 indicated no significant difference at the .05 level between groups A and B with respect to right side trunk and hip flexion.

TABLE 10.--summary table of the significance of difference between means derived from intergroup comparison of paired observations

TEST	GROUP A with CONTROL	GROUP B with CONTROL	GROUP B with GROUP A
Trunk and Hip Extension	GROUP A significantly more flexible	GROUP B significantly more flexible	GROUP B significantly more flexible
Trunk and Hip Flexion	GROUP A significantly more flexible	GROUP B significantly more flexible	GROUP A significantly more flexible
Left Side Trunk and Hip Flexion	GROUP A significantly more flexible	GROUP B significantly more flexible	GROUP A significantly more flexible
Right Side Trunk and Hip Flexion	GROUP A significantly more flexible	GROUP B significantly more flexible	no significant difference

CHAPTER IV

DISCUSSION

A major concern of coaches in modern day sports is the improvement of performance capacity of their athletes. There is no doubt that endurance, strength, speed, power, agility and coordination, the most talked about components of fitness, are important ingredients of physical fitness and that each of these physical qualities is important to successfull performance. However, flexibility should not be disregarded.

Physical educators are vitally concerned not only with the present physical fitness of their students, but also with teaching students how to keep fit throughout life. Flexibility plays a major role in both of the above areas.

Most events in athletics, and many physical education activities require, above all else, strength and speed. When one individual competes with another, the strength of the individual may be the important factor which determines the outcome of the contest.

Coaches and physical educators alike have employed various resistance types of exercises in order to develop and maintain the fitness level necessary for competition in

vigorous activities.

"Isometrics" have been found to be very effective in building of strength. These exercises do not seem to improve cardio-vascular efficiency, endurance or flexibility significantly. In fact, isometrics may reduce efficiency in these areas.

"Isotonics", if rigidly regulated by weight and repetition, a time consuming process, can be effective in the development of most of the attributes of physical fitness mentioned above.

The whole key to "Exer-Genie" is that it starts each exercise isometrically, to get the strength benefits of the contraction, and then completes the isotonic movement to develop endurance and flexibility. Such a system of exercise should result in greater increases in endurance and flexibility along with similar gains in strength.

Although no specific tests of strength were administered to the experimental groups in this study, the participants and this writer recognized obvious increases in this area. Exploratory tests were given to several individuals. An increase in arm and shoulder strength as measured by "pull-ups" was one such test.

Of more importance was the notable increase in abdominal strength along with the increases in trunk flexibility. This increase of abdominal strength was noted when students were asked to hang from an uneven parallel bar and

flex their legs at the hip so that a 90° angle was formed between trunk and hip segments of the body. Holding such a position as long as possible definitely involves strength and muscular endurance.

Since five EXER-GENIE exercises were used in this experiment, there is no way of knowing which exercise contributed the most to improving trunk flexibility. However, because the bicycle exercise necessitated the stretching of the hamstring muscles and the bent-leg sit-up was done against resistance, it is believed that these two exercises contributed greatly to increasing trunk flexibility.

Of great importance is the fact that participants of experimental group A showed significant increases over the control group in trunk flexibility after only eight fifteen minute periods of exercise in four weeks.

Although participants of experimental group B showed a similar significant increase over the control group in trunk flexibility, group B's results were not significantly greater than the results of group A. This investigator feels that this was due to the fact that the subjects, as they improved in performance, increased the resistance (pounds pull) rather than the number of repetitions.

Although group B was not significantly greater than group A in trunk flexibility, any exercise that can show significant increases in both strength and flexibility will be

in great demand in physical education. This investigator feels that the use of the EXER-GENIE could develop strength, endurance and flexibility simultaneously.

The exercise program used in this study seemed to have more effect upon those subjects who were less flexible at the beginning than on those who were more flexible.

Also, this investigator observed that some subjects increased their range of motion at joints other than the areas measured in this study. These results could be due to the fact that each EXER-GENIE exercise, to a great extent develops and conditions the entire body.

In comparing the "isometric", "isotonic" and "Exer-Genie" styles of resistive exercise, the writer feels that the "Exer-Genie" and the high resistance, low repetition "isotonic" types have the most appeal to high school students. The low resistance, high repetition system of "isotonic" exercise does not particularly appeal to healthy young boys and "isometrics" not only have the least appeal, but also give little indication to the coach or instructor regarding the amount of energy and effort required by the participants to perform such exercises.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary:

The participants in this study consisted of fifty-seven sophomore boys attending Fargo North High School in Fargo, North Dakota. The subjects were paired by age, weight and height into three correlated groups of nineteen members each. A Leighton Flexometer was used to test all participants on four aspects of trunk flexibility before and after the four week experimental period.

The experimental period included a systematic Exer-Genie exercise program. One group (Group "A") participated in the program two periods a week, while the second group (Group "B") participated in the program five periods a week. The third group acted as a control group and participated only in regular physical education classes not involving work with the Exer-Genie.

Comparisons were made between the mean differences within each group as indicated by the initial and retest scores. The Null hypothesis was retained at the .05 level of significance.

Between group comparisons were made between the mean differences of the retest results for each group. The testing tool used was the "t" technique for paired observations.

Findings:

1. In the areas of Sideward Trunk and Hip Flexion and Extension the control group produced "t" values that indicated significant increases at the .05 level.
2. In all tests groups A and B produced "t" values that indicated significant increases at the .05 level.
3. In all tests groups A and B produced results that were significantly better than the control group at the .05 level.
4. In the area of trunk and hip extension, group B produced results that indicated significantly more flexibility than did group A at the conclusion of the experimental period.
5. In the tests of Trunk and Hip Flexion and Left Side Trunk and Hip Flexion group A's results indicated significantly more flexibility than that achieved by group B in this area.
6. In the test for Right Side Trunk and Hip Flexion there was no significant difference between the results of groups A and B at the .05 level.

Conclusions:

1. The control group which participated in regular physical education activities showed significant increases in flexibility for Sideward Trunk and Hip Extension and Flexion. The changes in this group were not significant in Trunk and Hip Extension and Flexion.
2. A systematic Exer-Genie program carried on two periods a week for four weeks produced significant increases in selected measures of trunk flexibility among sophomore boys.
3. The same program carried on five periods a week for four weeks produced significant increases in selected measures of trunk flexibility among sophomore boys.
4. Participation in a five period Exer-Genie exercise program produced significantly more flexibility than did the two period program in the area of trunk and hip extension.
5. It would seem possible to conclude that participation in a systematic Exer-Genie program can improve the flexibility of high school sophomore boys, at least in the areas tested in this study.

Recommendations:

Since this study was limited to trunk flexibility, this investigator recommends a similar study to include several selected measures of body flexibility involving additional body segments.

Participants in this study noted an obvious increase in certain areas of strength. Therefore, it is recommended that a study to determine the correlation between flexibility and strength while using the Exer-Genie be undertaken.

A similar study that will compare the Exer-Genie with a systematic exercise program of isometric and isotonic exercises in such components of physical fitness as strength, speed, endurance, and flexibility seems desirable.

This investigator also feels that another study is needed to observe the effects of the types of resistive exercise used in this study upon performance of skills.

PAIRED GROUPS BASED UPON INDIVIDUAL'S AGE, WEIGHT AND HEIGHT

INDIVIDUAL	GROUP "B"	GROUP "A"	CONTROL
1.	221	217	224
2.	215	214	217
3.	209	208	209
4.	207	206	204
5.	210	210	210
6.	191	192	190
7.	186	188	188
8.	231	233	230
9.	213	214	211
10.	230	229	234
11.	227	227	225
12.	210	209	210
13.	190	189	189
14.	206	206	208
15.	216	216	216
16.	191	191	191
17.	220	219	219
18.	192	196	193
19.	205	208	205
TOTAL	3970	3972	3973

Mean Score of Group "B" = 208.94

Mean Score of Group "A" = 209.05

Mean Score of Control Group = 209.10

CALCULATION OF THE PEARSON PRODUCT-MOMENT "r"

The formula for the correlation coefficient for this method is:

$$r = \frac{xy}{\sqrt{(x^2)\ (y^2)}}$$

"r" is the correlation coefficient

x = Deviation of each score in Group X, from the Mean of Group X.

y = Deviation of each score in Group Y, from the Mean of Group Y.

xy = Is the product of each "x" and each "y" for every individual.

x^2 = Is the sum of the squared deviations from the Mean in Group X.

y^2 = Is the sum of the squared deviations from the Mean in Group Y.

This correlation coefficient is interpreted as the measure of relationship between the groups. A coefficient of +1.0 denotes a perfect relationship in a positive direction, while a coefficient of -1.0 denotes a perfect relationship in a negative direction. The greater the coefficient, the greater the relationship that exists.

CORRELATION TABLE FOR CONTROL GROUP (X) AND GROUP "A" (Y)

INDIV.	X	Y	x	y	x^2	y^2	xy
1.	224	217	14.90	7.95	222.01	63.20	118.45
2.	217	214	7.90	5.95	62.41	35.40	47.00
3.	209	208	- .10	- 1.05	.10	1.10	.10
4.	204	206	- 5.10	- 3.05	26.01	9.30	15.55
5.	210	210	.90	.95	.81	.90	.85
6.	190	192	-19.10	-17.05	364.81	290.70	325.65
7.	188	188	-21.10	-21.05	445.21	443.10	444.15
8.	230	233	20.90	23.95	436.81	576.60	500.55
9.	211	214	1.90	4.95	3.61	24.50	9.40
10.	234	229	24.90	19.95	620.01	398.00	496.75
11.	225	227	15.90	17.95	252.81	322.20	285.40
12.	210	209	.90	- .05	.81	.25	- .04
13.	189	189	-20.10	-20.05	404.01	402.00	403.00
14.	208	206	- 1.10	- 3.05	1.21	9.30	3.35
15.	216	216	6.90	6.95	47.61	48.30	47.95
16.	191	191	-18.10	-18.05	327.61	325.80	326.70
17.	219	219	9.90	9.95	98.01	99.00	98.50
18.	193	196	-16.10	-13.05	259.21	170.30	210.10
19.	205	208	- 1.10	- 1.05	1.21	1.10	1.15
TOTAL	3973	3972	3.11	1.05	3574.28	3221.13	3334.56

Mean Score of Control Group = 209.10

Mean Score of Group "A" = 209.05

CALCULATION OF THE CORRELATION COEFFICIENT FOR CONTROL GROUP AND GROUP "A"

Pearson "r" = Correlation Coefficient

$xy = 3334.56$

$x^2 = 3574.28$

$y^2 = 3221.13$

$$r = \frac{xy}{\sqrt{(x^2)(y^2)}}$$

$$= \frac{3334.56}{\sqrt{3574.28 \cdot 3221.13}}$$

$$= \frac{3334.56}{\sqrt{11,513,220.53}}$$

$$= \frac{3334.56}{3393.11}$$

$$= +.98$$

Correlation Between Control Group and Experimental Group "A" = + .98

CORRELATION TABLE FOR CONTROL GROUP (X) AND GROUP "B" (Y)

INDIV.	X	Y	x	y	x^2	y^2	xy
1.	224	221	14.90	12.06	222.01	145.44	179.69
2.	217	215	7.90	6.06	62.41	36.72	47.87
3.	209	209	- .10	.06	.10	.36	- .60
4.	204	207	- 5.10	- 1.94	26.01	3.76	9.89
5.	210	210	.90	1.06	.81	1.12	.95
6.	190	191	-19.10	-17.94	364.81	321.84	342.65
7.	188	186	-21.10	-22.94	445.21	526.24	484.03
8.	230	231	20.90	22.06	436.81	486.64	461.05
9.	211	213	1.90	4.06	3.61	16.48	7.71
10.	234	230	24.90	21.06	620.01	443.52	524.39
11.	225	227	15.90	18.06	252.81	326.16	287.15
12.	210	210	.90	1.06	.81	1.12	.95
13.	189	190	-20.10	-18.94	404.01	358.72	380.69
14.	208	206	- 1.10	- 2.94	1.21	8.64	3.23
15.	216	216	6.90	7.06	47.61	49.84	48.71
16.	191	191	-18.10	-17.94	327.61	321.84	324.71
17.	219	220	9.90	11.06	98.01	122.32	109.49
18.	193	192	-16.10	-16.94	259.21	286.96	272.73
19.	205	205	- 1.10	- 3.94	1.21	15.52	4.33
TOTAL	3973	3970	3.11	.14	3573.28	3473.24	3489.62

Mean Score of Control Group = 209.10

Mean Score of Group "A" = 208.94

CALCULATION OF THE CORRELATION COEFFICIENT FOR CONTROL GROUP AND GROUP "B"

Pearson "r" = Correlation Coefficient

$xy = 3489.62$

$x^2 = 3573.28$

$y^2 = 3473.24$

$$r = \frac{xy}{\sqrt{(x^2)(y^2)}}$$

$$= \frac{3489.62}{\sqrt{3573.28 \cdot 3473.24}}$$

$$= \frac{3489.62}{\sqrt{12,410,859.03}}$$

$$= \frac{3489.62}{3522.94}$$

$$= +.99$$

Correlation Between Control Group and Group "B" = + .99

CORRELATION TABLE FOR EXPERIMENTAL GROUPS "A" (X) AND "B" (Y)

INDIV.	X	Y	x	y	x^2	y^2	xy
1.	217	221	7.95	12.06	63.20	145.44	95.87
2.	214	215	5.95	6.06	35.40	36.72	36.05
3.	208	209	- 1.05	.06	1.10	.36	- .06
4.	206	207	- 3.05	- 1.94	9.30	3.76	5.91
5.	210	210	.95	1.06	.90	1.12	1.00
6.	192	191	-17.05	-17.94	290.70	321.84	305.87
7.	188	186	-21.05	-22.94	443.10	526.24	482.88
8.	233	231	23.95	22.06	576.60	486.64	528.33
9.	214	213	4.95	4.06	24.50	16.48	20.09
10.	229	230	19.95	21.06	398.00	443.52	420.14
11.	227	227	17.95	18.06	322.20	326.16	324.17
12.	209	210	- .05	1.06	.25	1.12	- .05
13.	189	190	-20.05	-18.94	402.00	358.72	379.74
14.	206	206	- 3.05	- 2.94	9.30	8.64	8.96
15.	216	216	6.95	7.06	48.30	49.84	49.06
16.	191	191	-18.05	-17.94	325.80	321.84	323.81
17.	219	220	9.95	11.06	99.00	122.32	110.04
18.	196	192	-13.05	-16.94	170.30	286.96	221.06
19.	208	205	- 1.05	- 3.94	1.10	15.52	4.13
TOTAL	3972	3970	1.05	.14	3221.13	3473.24	3317.00

Mean Score of Group "A" = 209.05

Mean Score of Group "B" = 208.94

CALCULATION OF THE CORRELATION COEFFICIENT FOR EXPERIMENTAL GROUPS "A" AND "B"

Pearson "r" = Correlation Coefficient

$xy = 3317.00$

$x^2 = 3221.13$

$y^2 = 3473.24$

$$r = \frac{xy}{\sqrt{(x^2)(y^2)}}$$

$$= \frac{3317.00}{\sqrt{3221.13 \cdot 3473.24}}$$

$$= \frac{3317.00}{\sqrt{11,187,757.56}}$$

$$= \frac{3317.00}{3332.83}$$

$$= +.99$$

Correlation Between Experimental Groups "A" and "B" = + .99

INITIAL TEST AND RETEST OF CONTROL GROUP
IN TRUNK AND HIP EXTENSION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	43	45	2	4
2.	35	42	7	49
3.	42	42	0	0
4.	48	46	- 2	4
5.	45	48	3	9
6.	55	60	5	25
7.	68	70	2	4
8.	42	42	0	0
9.	49	42	- 7	49
10.	60	58	- 2	4
11.	35	42	7	49
12.	36	39	3	9
13.	42	35	- 7	49
14.	52	58	6	36
15.	44	52	+ 8	64
16.	46	53	7	49
17.	54	41	- 13	169
18.	44	36	- 8	64
19.	40	44	4	16
	880	895	+ 15	604

Mean Score of Initial Test	46.3
Mean Score of Retest	47.1
Sum of Differences	15
Sum of Differences Squared	604

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN
MEANS DERIVED FROM CORRELATED SCORES
FROM SMALL SAMPLES

TEST TRUNK AND HIP EXTENSION GROUP CONTROL

$N = 19$

$\varepsilon D = 15$

$\varepsilon D^2 = 604$

$S_{\bar{D}}$ (estimate of the sampling error of $\bar{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\varepsilon D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{604 - \frac{(15)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\bar{D}} = 1.315$

$\bar{D} = \frac{\varepsilon D}{N} = \frac{15}{19} = .789$

"t" $= \frac{\bar{D}}{S_{\bar{D}}} = \frac{.789}{1.315} = .131$

df $= N-1 = 18$

"t" at .05 level = 2.10

Not significant at .05 level

INITIAL TEST AND RETEST OF GROUP "A"
IN TRUNK AND HIP EXTENSION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	45	48	3	9
2.	41	45	4	16
3.	40	45	5	25
4.	34	31	- 3	9
5.	48	60	12	144
6.	20	34	14	196
7.	53	50	- 3	9
8.	46	48	2	4
9.	45	48	3	9
10.	37	48	11	121
11.	56	64	8	64
12.	39	62	23	529
13.	55	55	0	0
14.	56	54	- 2	4
15.	38	54	16	256
16.	50	62	12	144
17.	47	57	10	100
18.	45	41	- 4	16
19.	30	45	15	225
	825	951	126	1880

Mean Score of Initial Test	43.4
Mean Score of Retest	50.0
Sum of Differences	126
Sum of Differences Squared	1880

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST TRUNK AND HIP EXTENSION GROUP "A"

$N = 19$

$\varepsilon D = 126$

$\varepsilon D^2 = 1880$

$S_{\overline{D}}$ (estimate of the sampling error of $\overline{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\varepsilon D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{1880 - \frac{(126)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\overline{D}} = 1.747$

$\overline{D} = \frac{\varepsilon D}{N} = \frac{126}{19} = 6.631$

"t" $= \frac{\overline{D}}{S_{\overline{D}}} = \frac{6.631}{1.747} = 3.79$

df $= N-1 = 18$

"t" at .05 level = 2.10

Significant increase at .05 level

INITIAL TEST AND RETEST OF GROUP "B"
IN TRUNK AND HIP EXTENSION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	58	59	1	1
2.	44	45	1	1
3.	55	59	4	16
4.	45	55	10	100
5.	39	47	8	64
6.	45	45	0	0
7.	44	55	11	121
8.	58	78	20	400
9.	65	61	- 4	16
10.	42	39	- 3	9
11.	28	32	4	16
12.	55	67	12	144
13.	45	65	20	400
14.	45	52	7	49
15.	40	43	3	9
16.	34	36	2	4
17.	60	56	- 4	16
18.	55	50	- 5	25
19.	41	50	9	81
	898	994	96	1472

Mean Score of Initial Test	47.3
Mean Score of Retest	52.3
Sum of Differences	96
Sum of Differences Squared	1472

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST TRUNK AND HIP EXTENSION GROUP "B"

$N = 19$

$\Sigma D = 96$

$\Sigma D^2 = 1472$

$S_{\bar{D}}$ (estimate of the sampling error of $\bar{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\Sigma D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{1472 - \frac{(96)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\bar{D}} = 1.708$

$\bar{D} = \frac{\Sigma D}{N} = \frac{96}{19} = 5.052$

"t" $= \frac{\bar{D}}{S_{\bar{D}}} = \frac{5.052}{1.708} = 2.96$

df $= N-1 = 18$

"t" at .05 level $= 2.10$

Significant increase at .05 level

INITIAL TEST AND RETEST OF CONTROL GROUP
IN TRUNK AND HIP FLEXION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	134	150	16	256
2.	110	126	16	256
3.	118	126	8	64
4.	140	132	- 8	64
5.	145	133	- 12	144
6.	114	125	11	121
7.	148	135	- 13	169
8.	146	131	- 15	225
9.	118	123	5	25
10.	122	118	- 4	16
11.	106	95	- 11	121
12.	125	129	4	16
13.	128	117	- 11	121
14.	134	136	2	4
15.	126	137	11	121
16.	134	132	- 2	4
17.	98	105	7	49
18.	138	128	- 10	100
19.	144	135	- 9	81
	2428	2413	- 15	1957

Mean Score of Initial Test	127.8
Mean Score of Retest	127.0
Sum of Differences	- 15
Sum of Differences Squared	1957

THE SIGNIFICANCE OF THE DIFFERENCES BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST TRUNK AND HIP FLEXION GROUP CONTROL

$N = 19$

$\varepsilon D = -15$

$\varepsilon D^2 = 1957$

$S_{\bar{D}}$ (estimate of the sampling error of $\bar{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\varepsilon D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{1957 - \frac{(-15)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\bar{D}} = 2.383$

$\bar{D} = \frac{\varepsilon D}{N} = \frac{15}{19} = -.789$

"t" $= \frac{\bar{D}}{S_{\bar{D}}} = \frac{-.789}{2.383} = -.33$

df $= N-1 = 18$

"t" at .05 level = 2.10

Not a significant decrease at .05 level

INITIAL TEST AND RETEST OF GROUP "A"
IN TRUNK AND HIP FLEXION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	131	155	24	576
2.	130	141	11	121
3.	125	130	5	25
4.	115	120	5	25
5.	142	135	- 7	49
6.	90	146	56	3136
7.	153	150	- 3	9
8.	118	130	12	144
9.	141	138	- 3	9
10.	105	143	38	1444
11.	125	118	- 7	49
12.	115	135	20	400
13.	138	153	15	225
14.	156	158	2	4
15.	138	154	16	256
16.	102	124	22	484
17.	130	134	4	16
18.	140	143	3	9
19.	148	152	4	16
	2442	2659	217	6997

Mean Score of Initial Test	128.5
Mean Score of Retest	139.0
Sum of Differences	217
Sum of Differences Squared	6997

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST TRUNK AND HIP FLEXION GROUP "A"

$N = 19$

$\varepsilon D = 217$

$\varepsilon D^2 = 6997$

$S_{\overline{D}}$ (estimate of the sampling error of $\overline{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\varepsilon D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{6997 - \frac{(217)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\overline{D}} = 3.63$

$\overline{D} = \frac{\varepsilon D}{N} = \frac{217}{19} = 11.421$

"t" $= \frac{\overline{D}}{S_{\overline{D}}} = \frac{11.421}{3.63} = 3.15$

df $= N-1 = 18$

"t" at .05 level $= 2.10$

Significant increase at .05 level

INITIAL TEST AND RETEST OF GROUP "B"
IN TRUNK AND HIP FLEXION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	138	137	- 1	1
2.	123	132	9	81
3.	138	138	0	0
4.	155	154	- 1	1
5.	107	120	13	169
6.	125	142	17	289
7.	130	165	35	1225
8.	148	145	- 3	9
9.	110	120	10	100
10.	112	122	10	100
11.	122	125	3	9
12.	145	162	17	289
13.	143	154	11	121
14.	150	148	- 2	4
15.	128	130	2	4
16.	106	130	24	576
17.	120	116	- 4	16
18.	104	130	26	676
19.	135	149	14	196
	2439	2619	180	3866

Mean Score of Initial Test	128.3
Mean Score of Retest	137.8
Sum of Differences	180
Sum of Differences Squared	3866

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST TRUNK AND HIP FLEXION GROUP "B"

$N = 19$

$\mathcal{E}D = 180$

$\mathcal{E}D^2 = 3866$

$S_{\bar{D}}$ (estimate of the sampling error of $\bar{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\mathcal{E}D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{3866 - \frac{(180)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\bar{D}} = 2.513$

$\bar{D} = \frac{\mathcal{E}D}{N} = \frac{180}{19} = 9.473$

"t" $= \frac{\bar{D}}{S_{\bar{D}}} = \frac{9.473}{2.513} = 3.77$

df $= N-1 = 18$

"t" at .05 level $= 2.10$

Significant increase at .05 level

INITIAL TEST AND RETEST OF CONTROL GROUP
IN LEFT SIDE TRUNK AND HIP FLEXION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	58	70	12	144
2.	40	56	16	256
3.	58	59	1	1
4.	50	59	9	81
5.	56	57	1	1
6.	55	60	5	25
7.	59	70	11	121
8.	49	48	- 1	1
9.	46	45	- 1	1
10.	60	62	2	4
11.	44	53	9	81
12.	54	55	1	1
13.	50	58	8	64
14.	55	59	4	16
15.	50	55	5	25
16.	56	59	3	9
17.	57	53	- 4	16
18.	55	55	0	0
19.	58	55	- 3	9
	1010	1088	78	856

Mean Score of Initial Test	53.1
Mean Score of Retest	57.3
Sum of Differences	78
Sum of Differences Squared	856

THE SIGNIFICANCE OF THE DIFFERENCES BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST LEFT SIDE TRUNK AND HIP FLEXION GROUP CONTROL

$N = 19$

$\Sigma D = 78$

$\Sigma D^2 = 856$

$S_{\bar{D}}$ (estimate of the sampling error of $\bar{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\Sigma D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{856 - \frac{(78)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\bar{D}} = 1.251$

$\bar{D} = \frac{\Sigma D}{N} = \frac{78}{19} = 4.105$

"t" $= \frac{\bar{D}}{S_{\bar{D}}} = \frac{4.105}{1.251} = 3.28$

df $= N-1 = 18$

"t" at .05 level $= 2.10$

Significant increase at .05 level

INITIAL TEST AND RETEST OF GROUP "A"
IN LEFT SIDE TRUNK AND HIP FLEXION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	51	48	- 3	9
2.	68	68	0	0
3.	43	55	12	144
4.	45	64	19	361
5.	63	60	- 3	9
6.	40	62	22	484
7.	64	61	- 3	9
8.	49	65	16	256
9.	45	68	23	529
10.	35	66	31	961
11.	52	70	18	324
12.	48	68	20	400
13.	62	65	3	9
14.	67	68	1	1
15.	50	65	15	225
16.	35	44	9	81
17.	53	63	10	100
18.	63	64	1	1
19.	40	56	16	256
	973	1180	207	4156

Mean Score of Initial Test	51.2
Mean Score of Retest	62.1
Sum of Differences	207
Sum of Differences Squared	4156

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST LEFT SIDE TRUNK AND HIP FLEXION GROUP "A"

$N = 19$

$\varepsilon D = 207$

$\varepsilon D^2 = 4156$

$S_{\bar{D}}$ (estimate of the sampling error of $\bar{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\varepsilon D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{4156 - \frac{(207)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\bar{D}} = 2.344$

$\bar{D} = \frac{\varepsilon D}{N} = \frac{207}{19} = 10.894$

"t" $= \frac{\bar{D}}{S_{\bar{D}}} = \frac{10.894}{2.344} = 4.65$

df $= N-1 = 18$

"t" at .05 level $= 2.10$

Significant increase at .05 level

INITIAL TEST AND RETEST OF GROUP "B"
IN LEFT SIDE TRUNK AND HIP FLEXION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	54	58	4	16
2.	43	61	18	324
3.	48	45	- 3	9
4.	62	65	3	9
5.	45	56	11	121
6.	40	55	15	225
7.	63	75	12	144
8.	63	72	9	81
9.	53	67	14	196
10.	40	50	10	100
11.	42	41	- 1	1
12.	48	57	9	81
13.	58	61	3	9
14.	38	50	12	144
15.	46	64	18	324
16.	34	55	21	441
17.	54	62	8	64
18.	55	57	2	4
19.	60	70	10	100
	946	1121	175	2393

Mean Score of Initial Test	49.8
Mean Score of Retest	59.0
Sum of Differences	175
Sum of Differences Squared	2393

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN
MEANS DERIVED FROM CORRELATED SCORES
FROM SMALL SAMPLES

TEST LEFT SIDE TRUNK AND HIP FLEXION GROUP "B"

$N = 19$

$\varepsilon D = 175$

$\varepsilon D^2 = 2393$

$S_{\bar{D}}$ (estimate of the sampling error of $\bar{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\varepsilon D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{2393 - \frac{(175)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\bar{D}} = 1.510$

$\bar{D} = \frac{\varepsilon D}{N} = \frac{175}{19} = 9.210$

"t" $= \frac{\bar{D}}{S_{\bar{D}}} = \frac{9.210}{1.510} = 6.10$

df $= N-1 = 18$

"t" at .05 level $= 2.10$

Significant increase at .05 level

INITIAL TEST AND RETEST OF CONTROL GROUP
IN RIGHT SIDE TRUNK AND HIP FLEXION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	50	60	10	100
2.	55	63	8	64
3.	62	70	8	64
4.	55	61	6	36
5.	56	59	3	9
6.	60	65	5	25
7.	71	80	9	81
8.	55	60	5	25
9.	46	45	- 1	1
10.	61	61	0	0
11.	57	60	3	9
12.	61	64	3	9
13.	76	70	- 6	36
14.	64	58	- 6	36
15.	58	65	7	49
16.	54	61	7	49
17.	50	58	8	64
18.	58	48	- 10	100
19.	55	55	0	0
	1104	1163	59	757

Mean Score of Initial Test	58.1
Mean Score of Retest	61.2
Sum of Differences	59
Sum of Differences Squared	757

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST RIGHT SIDE TRUNK AND HIP FLEXION GROUP CONTROL

$N = 19$

$\varepsilon D = 59$

$\varepsilon D^2 = 757$

$S_{\bar{D}}$ (estimate of the sampling error of $\bar{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\varepsilon D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{757 - \frac{(59)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\bar{D}} = 1.294$

$\bar{D} = \frac{\varepsilon D}{N} = \frac{59}{19} = 3.105$

"t" $= \frac{\bar{D}}{S_{\bar{D}}} = \frac{3.105}{1.294} = 2.40$

df $= N-1 = 18$

"t" at .05 level $= 2.10$

Significant increase at .05 level

INITIAL TEST AND RETEST OF GROUP "A"
IN RIGHT SIDE TRUNK AND HIP FLEXION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	56	56	0	0
2.	76	76	0	0
3.	55	60	5	25
4.	50	60	10	100
5.	48	58	10	100
6.	55	60	5	25
7.	65	65	0	0
8.	61	67	6	36
9.	73	70	- 3	9
10.	50	66	16	256
11.	56	64	8	64
12.	54	78	24	576
13.	55	78	23	529
14.	56	69	13	169
15.	58	67	9	81
16.	61	67	6	36
17.	47	57	10	100
18.	55	63	8	64
19.	42	61	19	361
	1073	1242	169	2531

Mean Score of Initial Test	56.5
Mean Score of Retest	65.3
Sum of Differences	169
Sum of Differences Squared	2531

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST RIGHT SIDE TRUNK AND HIP FLEXION GROUP "A"

$N = 19$

$\varepsilon D = 169$

$\varepsilon D^2 = 2531$

$S_{\overline{D}}$ (estimate of the sampling error of $\overline{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\frac{\varepsilon D^2 - \frac{(D)^2}{N}}{N-1}}}{\sqrt{N}} = \frac{\sqrt{\frac{2531 - \frac{(169)^2}{19}}{18}}}{\sqrt{19}}$$

$S_{\overline{D}} = 2.360$

$\overline{D} = \frac{\varepsilon D}{N} = \frac{169}{19} = 8.894$

"t" $= \frac{\overline{D}}{S_{\overline{D}}} = \frac{8.894}{2.360} = 3.76$

df $= N-1 = 18$

"t" at .05 level $= 2.10$

Significant increase at .05 level

INITIAL TEST AND RETEST OF GROUP "B"
IN RIGHT SIDE TRUNK AND HIP FLEXION

	Initial Test	Retest	Sum of Differences	Differences Squared
1.	52	72	20	400
2.	63	67	4	16
3.	68	71	3	9
4.	68	75	7	49
5.	55	62	7	49
6.	50	56	6	36
7.	52	78	26	676
8.	65	74	9	81
9.	70	70	0	0
10.	53	51	- 2	4
11.	40	40	0	0
12.	57	63	6	36
13.	72	78	6	36
14.	55	70	15	225
15.	56	60	4	16
16.	46	56	10	100
17.	56	56	0	0
18.	60	70	10	100
19.	58	70	12	144
	1096	1239	143	1977

Mean Score of Initial Test	57.7
Mean Score of Retest	65.2
Sum of Differences	143
Sum of Differences Squared	1977

THE SIGNIFICANCE OF THE DIFFERENCES BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

TEST RIGHT TRUNK AND HIP FLEXION GROUP "B"

$N = 19$

$\varepsilon D = 143$

$\varepsilon D^2 = 1977$

$S_{\overline{D}}$ (estimate of the sampling error of $\overline{D}$) $= \frac{SD}{\sqrt{N}} =$

$$\frac{\sqrt{\varepsilon D^2 - \frac{(D)^2}{N}}}{\sqrt{N}} = \frac{\sqrt{1977 - \frac{(143)^2}{19}}}{\sqrt{19}}$$

$S_{\overline{D}} = 1.622$

$\overline{D} = \frac{\varepsilon D}{N} = \frac{143}{19} = 7.526$

"t" $= \frac{\overline{D}}{S_{\overline{D}}} = \frac{7.526}{1.622} = 8.22$

df $= N-1 = 18$

"t" at .05 level $= 2.10$

Significant increase at .05 level

RETEST RESULTS OF CONTROL GROUP AND GROUP "A"
IN TRUNK AND HIP EXTENSION

INDIV.	CONTROL GROUP	d	d^2	GROUP "A"	d	d^2
1.	45	- 2.1	4.41	48	- 2.05	4.20
2.	42	- 5.1	26.01	45	- 5.05	25.50
3.	42	- 5.1	26.01	45	- 5.05	25.50
4.	46	- 1.1	1.21	31	-19.05	362.90
5.	48	.9	.81	60	9.95	99.00
6.	60	12.9	166.41	34	-16.05	257.00
7.	70	22.9	524.41	50	- .05	.25
8.	42	- 5.1	26.01	48	- 2.05	4.20
9.	42	- 5.1	26.01	48	- 2.05	4.20
10.	58	10.9	118.81	48	- 2.05	4.20
11.	42	- 5.1	26.01	64	13.95	194.60
12.	39	- 8.1	65.61	62	11.95	142.80
13.	35	-12.1	146.41	55	4.95	24.50
14.	58	10.9	118.81	54	3.95	15.60
15.	52	4.9	24.01	54	3.95	15.60
16.	53	5.9	34.81	62	11.95	142.80
17.	41	- 6.1	37.21	57	6.95	48.30
18.	36	-11.1	123.21	41	9.05	81.90
19.	44	- 3.1	9.61	45	5.05	25.50
TOTAL	895		1505.79	951		1478.55

Mean Score of Control Group = 47.1

Mean Score of Group "A" = 50.05

RETEST RESULTS OF CONTROL GROUP AND GROUP "B"
IN TRUNK AND HIP EXTENSION

INDIV.	CONTROL GROUP	d	d^2	GROUP "B"	d	d^2
1.	45	- 2.1	4.41	59	6.7	44.89
2.	42	- 5.1	26.01	45	- 7.3	53.29
3.	42	- 5.1	26.01	59	6.7	44.89
4.	46	- 1.1	1.21	55	2.7	7.29
5.	48	.9	.81	47	- 5.3	28.09
6.	60	12.9	166.41	45	- 7.3	53.29
7.	70	22.9	524.41	55	2.7	7.29
8.	42	5.1	26.01	78	25.7	660.49
9.	42	5.1	26.01	61	8.7	75.69
10.	58	10.9	118.81	39	-13.3	176.89
11.	42	5.1	26.01	32	-20.3	412.09
12.	39	8.1	65.61	67	14.7	216.09
13.	35	12.1	146.41	65	12.7	161.29
14.	58	10.9	118.81	52	- .3	.09
15.	52	4.9	24.01	43	- 9.3	86.49
16.	53	5.9	34.81	36	-16.3	265.69
17.	41	6.1	37.21	56	3.7	13.69
18.	36	11.1	123.21	50	- 2.3	5.29
19.	44	3.1	9.61	50	- 2.3	5.29
TOTAL	895		1505.79	994		2318.11

Mean Score of Control Group = 47.1

Mean Score of Group "B" = 52.3

RETEST RESULTS OF GROUPS "A" AND "B"
IN TRUNK AND HIP EXTENSION

INDIV.	GROUP "A"	d	d^2	GROUP "B"	d	d^2
1.	48	- 2.05	4.20	59	6.7	44.89
2.	45	- 5.05	25.50	45	- 7.3	53.29
3.	45	- 5.05	25.50	59	6.7	44.89
4.	31	-19.05	362.90	55	2.7	7.29
5.	60	9.95	99.00	47	- 5.3	28.09
6.	34	-16.05	257.60	45	- 7.3	53.29
7.	50	- .05	.25	55	2.7	7.29
8.	48	- 2.05	4.20	78	25.7	660.49
9.	48	- 2.05	4.20	61	8.7	75.69
10.	48	2.05	4.20	39	-13.3	176.89
11.	64	13.95	194.60	32	-20.3	412.09
12.	62	11.95	142.80	67	14.7	216.09
13.	55	4.95	24.50	65	12.7	161.29
14.	54	3.95	15.60	52	- .3	.09
15.	54	3.95	15.60	43	- 9.3	86.49
16.	62	11.95	142.80	36	-16.3	265.69
17.	57	- 6.95	48.30	56	3.7	13.69
18.	41	- 9.05	81.90	50	- 2.3	5.29
19.	45	5.05	25.50	50	- 2.3	5.29
TOTAL	951		1478.55	994		2318.11

Mean Score of Group "A" = 50.05

Mean Score of Group "B" = 52.3

STANDARD ERROR OF THE MEANS OF PAIRED OBSERVATIONS IN TRUNK AND HIP EXTENSION

Formulae Applied:

$$SD = \sqrt{\frac{d^2}{N}} \qquad SE = \frac{SD}{\sqrt{N}}$$

Control Group:

$$SD = \sqrt{\frac{1505.79}{19}} \qquad SE = \frac{8.902}{4.3589}$$

$$= 8.902 \qquad = 2.042$$

Experimental Group A:

$$SD = \sqrt{\frac{1478.55}{19}} \qquad SE = \frac{8.821}{4.3589}$$

$$= 8.821 \qquad = 2.023$$

Experimental Group B:

$$SD = \sqrt{\frac{2318.11}{19}} \qquad SE = \frac{11.036}{4.3589}$$

$$= 11.036 \qquad = 2.531$$

Standard Error of the Mean of Control Group = 2.042

Standard Error of the Mean of Group A = 2.023

Standard Error of the Mean of Group B = 2.531

SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MEANS OF PAIRED OBSERVATIONS

TEST: Trunk and Hip Extension

GROUPS: Experimental Group A $S_{\overline{D}_1} = 2.023$

Control Group $S_{\overline{D}_2} = 2.042$

$S_{\overline{D}_1} - S_{\overline{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2 - 2rS_{\overline{D}_1} \times S_{\overline{D}_2}}$$

$$= \sqrt{(2.023)^2 + (2.042)^2 - (2)(.98)(2.023)(2.042)}$$

$$= \sqrt{.167}$$

$$= .408$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\overline{D}_1} - S_{\overline{D}_2}} = \frac{50.05 - 47.1}{.408} = 7.23$$

"t" at the .05 level = 2.10

Group A significantly more flexible than Control group at .05 level.

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
THE MEANS OF PAIRED OBSERVATIONS

TEST: Trunk and Hip Extension

GROUPS: Experimental Group B $S_{\overline{D}_1} = 2.531$

Control Group $S_{\overline{D}_2} = 2.042$

$S_{\overline{D}_1} - S_{\overline{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2 - 2rS_{\overline{D}_1} \times S_{\overline{D}_2}}$$

$$= \sqrt{(2.531)^2 + (2.042)^2 - (2)(.99)(2.531)(2.042)}$$

$$= \sqrt{.343}$$

$$= .585$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\overline{D}_1} - S_{\overline{D}_2}} = \frac{52.3 - 47.1}{.585} = 8.88$$

"t" at the .05 level = 2.10

Group B significantly more flexible than Control Group at .05 level.

SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MEANS OF PAIRED OBSERVATIONS

TEST: Trunk and Hip Extension

GROUPS: Experimental Group B $S_{\overline{D}_1} = 2.531$

Experimental Group A $S_{\overline{D}_2} = 2.023$

$S_{\overline{D}_1} - S_{\overline{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\overline{D}_1}^2 + S_{\overline{D}_2}^2 - 2rS_{\overline{D}_1} \times S_{\overline{D}_2}}$$

$$= \sqrt{(2.531)^2 + (2.023)^2 - (2)(.99)(2.531)(2.023)}$$

$$= \sqrt{.361}$$

$$= .608$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\overline{D}_1} - S_{\overline{D}_2}} = \frac{52.30 - 50.05}{.608} = 3.70$$

"t" at the .05 level = 2.10

Group B significantly more flexible than Group A at the .05 level.

RETEST RESULTS OF CONTROL GROUP AND GROUP "A"
IN TRUNK AND HIP FLEXION

INDIV.	CONTROL GROUP	d	d^2	GROUP "A"	d	d^2
1.	150	23.0	529	155	15.1	228.01
2.	126	- 1.0	1	141	1.1	1.21
3.	126	- 1.0	1	130	- 9.9	98.01
4.	132	5.0	25	120	-19.9	396.01
5.	133	6.0	36	135	- 4.9	24.01
6.	125	- 2.0	4	146	6.1	37.21
7.	135	8.0	64	150	10.1	102.01
8.	131	4.0	16	130	- 9.9	98.01
9.	123	- 4.0	16	138	- 1.9	3.61
10.	118	- 9.0	81	143	3.1	9.61
11.	95	-32.0	1024	118	-21.9	479.61
12.	129	2.0	4	135	- 4.9	24.01
13.	117	-10.0	100	153	13.1	171.61
14.	136	9.0	81	158	18.1	327.61
15.	137	10.0	100	154	14.1	198.81
16.	132	5.0	25	124	-15.9	252.01
17.	105	-22.0	484	134	- 5.9	34.81
18.	128	1.0	1	143	3.1	9.61
19.	135	8.0	64	152	12.1	146.41
TOTAL	2413		2656	2659		2642.19

Mean Score of Control Group = 127.0

Mean Score of Group "A" = 139.9

RETEST RESULTS OF CONTROL GROUP AND GROUP "B"
IN TRUNK AND HIP FLEXION

INDIV.	CONTROL GROUP	d	d^2	GROUP "B"	d	d^2
1.	150	23.0	529	137	- .8	.64
2.	126	- 1.0	1	132	- 5.8	33.64
3.	126	- 1.0	1	138	.2	.40
4.	132	5.0	25	154	16.2	262.44
5.	133	6.0	36	120	-17.8	316.84
6.	125	- 2.0	4	142	4.2	17.64
7.	135	8.0	64	165	27.2	739.84
8.	131	4.0	16	145	7.2	51.84
9.	123	- 4.0	16	120	-17.8	316.84
10.	118	- 9.0	81	122	-15.8	249.64
11.	95	-32.0	1024	125	-12.8	163.84
12.	129	2.0	4	162	24.2	585.64
13.	117	-10.0	100	154	16.2	262.44
14.	136	9.0	81	148	10.2	104.04
15.	137	10.0	100	130	- 7.8	60.84
16.	132	5.0	25	130	- 7.8	60.84
17.	105	-22.0	484	116	-21.8	475.24
18.	128	1.0	1	130	- 7.8	60.84
19.	135	8.0	64	149	11.2	125.44
TOTAL	2413		2656	2619		3888.92

Mean Score of Control Group = 127.0

Mean Score of Group "B" = 137.8

RETEST RESULTS OF GROUPS "A" AND "B"
IN TRUNK AND HIP FLEXION

INDIV.	GROUP "A"	d	d^2	GROUP "B"	d	d^2
1.	155	15.1	228.01	137	- .8	.64
2.	141	1.1	1.21	132	- 5.8	33.64
3.	130	- 9.9	98.01	138	.2	.40
4.	120	-19.9	396.01	154	16.2	262.44
5.	135	- 4.9	24.01	120	-17.8	316.84
6.	146	6.1	37.21	142	4.2	17.64
7.	150	10.1	102.01	165	27.2	739.84
8.	130	- 9.9	98.01	145	7.2	51.84
9.	138	- 1.9	3.61	120	-17.8	316.84
10.	143	3.1	9.61	122	-15.8	249.64
11.	118	-21.9	479.61	125	12.8	163.84
12.	135	- 4.9	24.01	162	24.2	585.64
13.	153	13.1	171.61	154	16.2	262.44
14.	158	18.1	327.61	148	10.2	104.04
15.	154	14.1	198.81	130	- 7.8	60.84
16.	124	-15.9	252.01	130	- 7.8	60.84
17.	134	- 5.9	34.81	116	-21.8	475.24
18.	143	3.1	9.61	130	- 7.8	60.84
19.	152	12.1	146.41	149	11.2	125.44
TOTAL	2659		2642.19	2619		3888.92

Mean Score of Group "A" = 139.9

Mean Score of Group "B" = 137.8

STANDARD ERROR OF THE MEANS OF PAIRED OBSERVATIONS IN TRUNK AND HIP FLEXION

Formulae Applied:

$$SD = \sqrt{\frac{d^2}{N}} \qquad SE = \frac{SD}{\sqrt{N}}$$

Control Group:

$$SD = \sqrt{\frac{2656}{19}} \qquad SE = \frac{11.823}{4.3589}$$

$$= 11.823 \qquad = 2.712$$

Experimental Group A

$$SD = \sqrt{\frac{2642.19}{19}} \qquad SE = \frac{11.365}{4.3589}$$

$$= 11.365 \qquad = 2.607$$

Experimental Group B

$$SD = \sqrt{\frac{3888.92}{19}} \qquad SE = \frac{15.155}{4.3589}$$

$$= 15.155 \qquad = 3.476$$

Standard Error of the Mean of Control Group = 2.712

Standard Error of the Mean of Group A = 2.607

Standard Error of the Mean of Group B = 3.476

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
THE MEANS OF PAIRED OBSERVATIONS

TEST: Trunk and Hip Flexion

GROUPS: Experimental Group A $S_{\bar{D}_1} = 2.607$

Control Group $S_{\bar{D}_2} = 2.712$

$S_{\bar{D}_1} - S_{\bar{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2 - 2rS_{\bar{D}_1} \times S_{\bar{D}_2}}$$

$$= \sqrt{(2.607)^2 + (2.712)^2 - (2)(.98)(2.607)(2.712)}$$

$$= \sqrt{.294}$$

$$= .542$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\bar{D}_1} - S_{\bar{D}_2}} = \frac{139.9 - 127.0}{.542} = 23.80$$

"t" at the .05 level = 2.10

Group A significantly more flexible than Control Group at the .05 level

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
THE MEANS OF PAIRED OBSERVATIONS

TEST: Trunk and Hip Flexion

GROUPS: Experimental Group B $S_{\bar{D}_1} = 3.476$

Control Group $S_{\bar{D}_2} = 2.712$

$S_{\bar{D}_1} - S_{\bar{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2 - 2rS_{\bar{D}_1} \times S_{\bar{D}_2}}$$

$$= \sqrt{(3.476)^2 + (2.712)^2 - (2)(.99)(3.476)(2.712)}$$

$$= \sqrt{.772}$$

$$= .878$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\bar{D}_1} - S_{\bar{D}_2}} = \frac{137.8 - 127.0}{.878} = 11.38$$

"t" at the .05 level = 2.10

Group B significantly more flexible

than Control Group at the .05 level

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
THE MEANS OF PAIRED OBSERVATIONS

TEST: Trunk and Hip Flexion

GROUPS: Experimental Group A $S_{\bar{D}_1} = 2.607$

Experimental Group B $S_{\bar{D}_2} = 3.476$

$S_{\bar{D}_1} - S_{\bar{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2 - 2rS_{\bar{D}_1} \times S_{\bar{D}_2}}$$

$$= \sqrt{(2.607)^2 + (3.476)^2 - (2)(.99)(2.607)(3.476)}$$

$$= \sqrt{.937}$$

$$= .967$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\bar{D}_1} - S_{\bar{D}_2}} = \frac{139.9 - 137.8}{.967} = 2.17$$

"t" at the .05 level = 2.10

Group A significantly more flexible

than Group B at the .05 level.

RETEST RESULTS OF CONTROL GROUP AND GROUP "A"
IN LEFT SIDE TRUNK AND HIP FLEXION

INDIV.	CONTROL GROUP	d	d^2	GROUP "A"	d	d^2
1.	70	12.7	161.29	48	14.1	198.81
2.	56	- 1.3	1.69	68	5.9	34.81
3.	59	1.7	2.89	55	- 7.1	50.41
4.	59	1.7	2.89	64	1.9	3.61
5.	57	- .3	.09	60	- 2.1	4.41
6.	60	2.7	7.29	62	.1	.01
7.	70	12.7	161.29	61	- 1.1	1.21
8.	48	- 9.3	86.49	65	2.9	8.41
9.	45	-12.3	151.29	68	5.9	34.81
10.	62	4.7	22.09	66	3.9	15.21
11.	53	- 4.3	18.49	70	7.9	62.41
12.	55	- 2.3	5.29	68	5.9	34.81
13.	58	.7	.49	65	2.9	8.41
14.	59	1.7	2.89	68	5.9	34.81
15.	55	- 2.3	5.29	65	2.9	8.41
16.	59	1.7	2.89	44	-18.1	327.61
17.	53	- 4.3	18.49	63	.9	.81
18.	55	- 2.3	5.29	64	1.9	3.61
19.	55	- 2.3	5.29	56	- 6.1	37.21
TOTAL	1088		661.71	1180		869.79

Mean Score of Control Group = 57.3

Mean Score of Group "A" = 62.1

RETEST RESULTS OF CONTROL GROUP AND GROUP "B"
IN LEFT SIDE TRUNK AND HIP FLEXION

INDIV.	CONTROL GROUP	d	d^2	GROUP "B"	d	d^2
1.	70	12.7	161.29	58	- 1.0	1.00
2.	56	- 1.3	1.69	61	2.0	4.00
3.	59	1.7	2.89	45	-14.0	196.00
4.	59	1.7	2.89	65	6.0	36.00
5.	57	- .3	.09	56	- 3.0	9.00
6.	60	2.7	7.29	55	- 4.0	16.00
7.	70	12.7	161.29	75	16.0	256.00
8.	48	- 9.3	86.49	72	13.0	169.00
9.	45	-12.3	151.29	67	8.0	64.00
10.	62	4.7	22.09	50	- 9.0	81.00
11.	53	- 4.3	18.49	41	-18.0	324.00
12.	55	- 2.3	5.29	57	- 2.0	4.00
13.	58	.7	.49	61	2.0	4.00
14.	59	1.7	2.89	50	- 9.0	81.00
15.	55	- 2.3	5.29	64	5.0	25.00
16.	59	1.7	2.89	55	- 4.0	16.00
17.	53	- 4.3	18.49	62	3.0	9.00
18.	55	- 2.3	5.29	57	- 2.0	4.00
19.	55	- 2.3	5.29	70	11.0	121.00
TOTAL	1088		661.71	1121		1420.00

Mean Score of Control Group = 57.3

Mean Score of Group "B" = 59.0

RETEST RESULTS OF GROUPS "A" AND "B"
IN LEFT SIDE TRUNK AND HIP FLEXION

INDIV.	GROUP "A"	d	d^2	GROUP "B"	d	d^2
1.	48	-14.1	198.81	58	- 1.0	1.00
2.	68	5.9	34.81	61	2.0	4.00
3.	55	- 7.1	50.41	45	-14.0	196.00
4.	64	1.9	3.61	65	6.0	36.00
5.	60	- 2.1	4.41	56	- 3.0	9.00
6.	62	.1	.01	55	- 4.0	16.00
7.	61	- 1.1	1.21	75	16.0	256.00
8.	65	2.9	8.41	72	13.0	169.00
9.	68	5.9	34.81	67	8.0	64.00
10.	66	3.9	15.21	50	- 9.0	81.00
11.	70	7.9	62.41	41	-18.0	324.00
12.	68	5.9	34.81	57	- 2.0	4.00
13.	65	2.9	8.41	61	2.0	4.00
14.	68	5.9	34.81	50	- 9.0	81.00
15.	65	2.9	8.41	64	5.0	25.00
16.	44	-18.1	327.61	55	- 4.0	16.00
17.	63	.9	.81	62	3.0	9.00
18.	64	1.9	3.61	57	- 2.0	4.00
19.	56	- 6.1	37.21	70	11.0	121.00
TOTAL	1180		869.79	1121		1420.00

Mean Score of Group "A" = 62.1

Mean Score of Group "B" = 59.0

STANDARD ERROR OF THE MEANS OF PAIRED
OBSERVATIONS IN LEFT SIDE
TRUNK AND HIP FLEXION

Formulae Applied:

$$SD = \sqrt{\frac{d^2}{N}} \qquad SE = \frac{SD}{\sqrt{N}}$$

Control Group:

$$SD = \sqrt{\frac{661.71}{19}} \qquad SE = \frac{5.901}{4.3589}$$

$$= 5.901 \qquad = 1.353$$

Experimental Group A

$$SD = \sqrt{\frac{869.79}{19}} \qquad SE = \frac{6.766}{4.3589}$$

$$= 6.766 \qquad = 1.552$$

Experimental Group B

$$SD = \sqrt{\frac{1420.0}{19}} \qquad SE = \frac{8.644}{4.3589}$$

$$= 8.644 \qquad 1.983$$

Standard Error of the Mean of Control Group = 1.353

Standard Error of the Mean of Group A = 1.552

Standard Error of the Mean of Group B = 1.983

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
THE MEANS OF PAIRED OBSERVATIONS

TEST: Left Side Trunk and Hip Flexion

GROUPS: Experimental Group A $S_{\bar{D}_1} = 1.552$

Control Group $S_{\bar{D}_2} = 1.353$

$S_{\bar{D}_1} - S_{\bar{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2 - 2rS_{\bar{D}_1} \times S_{\bar{D}_2}}$$

$$= \sqrt{(1.552)^2 + (1.353)^2 - (2)(.98)(1.552)(1.353)}$$

$$= \sqrt{.1236}$$

$$= .35$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\bar{D}_1} - S_{\bar{D}_2}} = \frac{62.1 - 57.3}{.35} = 13.71$$

"t" at the .05 level = 2.10

Group A significantly more flexible

than Control Group at the .05 level

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
THE MEANS OF PAIRED OBSERVATIONS

TEST: Left Side Trunk and Hip Flexion

GROUPS: Experimental Group B $S_{\bar{D}_1} = 1.983$

Control Group $S_{\bar{D}_2} = 1.353$

$S_{\bar{D}_1} - S_{\bar{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2 - 2rS_{\bar{D}_1} \times S_{\bar{D}_2}}$$

$$= \sqrt{(1.983)^2 + (1.353)^2 - (2)(.99)(1.983)(1.353)}$$

$$= \sqrt{.451}$$

$$= .671$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\bar{D}_1} - S_{\bar{D}_2}} = \frac{59.0 - 57.3}{.671} = 2.53$$

"t" at the .05 level = 2.10

Group B significantly more flexible than Control Group at the .05 level.

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
THE MEANS OF PAIRED OBSERVATIONS

TEST: Left Side Trunk and Hip Flexion

GROUPS: Experimental Group A $S_{\bar{D}_1} = 1.552$

Experimental Group B $S_{\bar{D}_2} = 1.983$

$S_{\bar{D}_1} - S_{\bar{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2 - 2rS_{\bar{D}_1} \times S_{\bar{D}_2}}$$

$$= \sqrt{(1.552)^2 + (1.983)^2 - (2)(.99)(1.552)(1.983)}$$

$$= \sqrt{.3013}$$

$$= .548$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\bar{D}_1} - S_{\bar{D}_2}} = \frac{62.1 - 59.0}{.548} = 5.65$$

"t" at the .05 level = 2.10

Group A significantly more flexible

than Group B at the .05 level.

RETEST RESULTS OF CONTROL GROUP AND GROUP "A"
IN RIGHT SIDE TRUNK AND HIP FLEXION

INDIV.	CONTROL GROUP	d	d^2	GROUP "A"	d	d^2
1.	60	- 1.2	1.44	56	- 9.36	87.61
2.	63	1.8	3.24	76	10.64	115.35
3.	70	8.8	77.44	60	- 5.36	28.73
4.	61	- .2	.04	60	- 5.36	28.73
5.	59	- 2.2	4.84	58	- 7.36	54.17
6.	65	3.8	14.44	60	- 5.36	28.73
7.	80	18.8	353.44	65	- .36	.13
8.	60	- 1.2	1.44	67	1.64	2.69
9.	45	-16.2	262.44	70	4.64	21.53
10.	61	- .2	.04	66	.64	.41
11.	60	- 1.2	1.44	64	- 1.36	1.85
12.	64	2.8	7.84	78	12.64	159.77
13.	70	8.8	77.44	78	12.64	159.77
14.	58	- 3.2	10.24	69	3.64	13.25
15.	65	3.8	14.44	67	1.64	2.69
16.	61	- .2	.04	67	1.64	2.69
17.	58	- 3.2	10.24	57	- 8.36	69.89
18.	48	-13.2	174.24	63	- 2.36	5.57
19.	55	- 6.2	38.44	61	- 4.36	19.01
TOTAL	1163		1053.16	1242		815.79

Mean Score of Control Group = 61.2

Mean Score of Group "A" = 65.3

RETEST RESULTS OF CONTROL GROUP AND GROUP "B"
IN RIGHT SIDE TRUNK AND HIP FLEXION

INDIV.	CONTROL GROUP	d	d^2	GROUP "B"	d	d^2
1.	60	- 1.2	1.44	72	6.8	46.24
2.	63	1.8	3.24	67	1.8	3.24
3.	70	8.8	77.44	71	5.8	33.64
4.	61	- .2	.04	75	9.8	96.04
5.	59	- 2.2	4.84	62	- 3.2	10.24
6.	65	3.8	14.44	56	- 9.2	84.64
7.	80	18.8	353.44	78	12.8	163.84
8.	60	- 1.2	1.44	74	8.8	77.44
9.	45	-16.2	262.44	70	4.8	23.04
10.	61	- .2	.04	51	-14.2	201.64
11.	60	- 1.2	1.44	40	-25.2	635.04
12.	64	2.8	7.84	63	- 2.2	4.84
13.	70	8.8	77.44	78	12.8	163.84
14.	58	- 3.2	10.24	70	4.8	23.04
15.	65	3.8	14.44	60	- 5.2	27.04
16.	61	- .2	.04	56	- 9.2	84.64
17.	58	- 3.2	10.24	56	- 9.2	84.64
18.	48	-13.2	174.24	70	4.8	23.04
19.	55	- 6.2	38.44	70	4.8	23.04
TOTAL	1163		1053.16	1239		1809.16

Mean Score of Control Group = 61.2

Mean Score of Group "B" = 65.2

RETEST RESULTS OF GROUPS "A" AND "B"
IN RIGHT SIDE TRUNK AND HIP FLEXION

INDIV.	GROUP "A"	d	d^2	GROUP "B"	d	d^2
1.	56	- 9.36	87.61	72	6.8	46.24
2.	76	10.64	115.35	67	1.8	3.24
3.	60	- 5.36	28.73	71	5.8	33.64
4.	60	- 5.36	28.73	75	9.8	96.04
5.	58	- 7.36	54.17	62	- 3.2	10.24
6.	60	- 5.36	28.73	56	- 9.2	84.64
7.	65	- .36	.13	78	12.8	163.84
8.	67	1.64	2.69	74	8.8	77.44
9.	70	4.64	21.52	70	4.8	23.04
10.	66	.64	.41	51	-14.2	201.64
11.	64	- 1.36	1.85	40	-25.2	635.04
12.	78	12.64	159.77	63	- 2.2	4.84
13.	78	12.64	159.77	78	12.8	163.84
14.	69	3.64	13.25	70	4.8	23.04
15.	67	1.64	2.69	60	- 5.2	27.04
16.	67	1.64	2.69	56	- 9.2	84.64
17.	57	- 8.36	69.89	56	- 9.2	84.64
18.	63	- 2.36	5.57	70	4.8	23.04
19.	61	- 4.36	19.01	70	4.8	23.04
TOTAL	1242		815.79	1239		1809.16

Mean Score of Group "A" = 65.3

Mean Score of Group "B" = 65.2

STANDARD ERROR OF THE MEANS OF PAIRED OBSERVATIONS IN RIGHT SIDE TRUNK AND HIP FLEXION

Formulae Applied:

$$SD = \sqrt{\frac{d^2}{N}} \qquad SE = \frac{SD}{\sqrt{N}}$$

Control Group?

SD

$$SD = \sqrt{\frac{1053.16}{19}} \qquad SE = \frac{7.445}{4.3589}$$

$$= 7.445 \qquad = 1.707$$

Experimental Group A

$$SD = \sqrt{\frac{815.79}{19}} \qquad SE = \frac{6.552}{4.3589}$$

$$= 6.552 \qquad = 1.503$$

Experimental Group B

$$SD = \sqrt{\frac{1809.16}{19}} \qquad SE = \frac{9.758}{4.3589}$$

$$= 9.758 \qquad 2.238$$

Standard Error of the Mean of Control Group = 1.707

Standard Error of the Mean of Group A = 1.503

Standard Error of the Mean of Group B = 2.238

SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MEANS OF PAIRED OBSERVATIONS

TEST: Right Side Trunk and Hip Flexion

GROUPS: Experimental Group A $S_{\bar{D}_1} = 1.503$

Control Group $S_{\bar{D}_2} = 1.707$

$S_{\bar{D}_1} - S_{\bar{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2 - 2rS_{\bar{D}_1} \times S_{\bar{D}_2}}$$

$$= \sqrt{(1.503)^2 + (1.707)^2 - (2)(.98)(1.503)(1.707)}$$

$$= \sqrt{.1442}$$

$$= .38$$

$$\text{"t"} \quad \frac{M_1 - M_2}{S_{\bar{D}_1} - S_{\bar{D}_2}} = \frac{65.3 - 61.2}{.38} = 10.78$$

"t" at the .05 level = 2.10

Group A significantly more flexible than Control Group at the .05 level.

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
THE MEANS OF PAIRED OBSERVATIONS

TEST: Right Side Trunk and Hip Flexion

GROUPS: Experimental Group B $S_{\bar{D}_1} = 2.238$

Control Group $S_{\bar{D}_2} = 1.707$

$S_{\bar{D}_1} - S_{\bar{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2 - 2rS_{\bar{D}_1} \times S_{\bar{D}_2}}$$

$$= \sqrt{(2.238)^2 + (1.707)^2 - (2)(.99)(2.238)(1.707)}$$

$$= \sqrt{.358}$$

$$= .598$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\bar{D}_1} - S_{\bar{D}_2}} = \frac{65.2 - 61.2}{.598} = 6.68$$

"t" at the .05 level = 2.10

Group B significantly more flexible than Control Group at the .05 level.

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
THE MEANS OF PAIRED OBSERVATIONS

TEST: Right Side Trunk and Hip Flexion

GROUPS: Experimental Group A $S_{\bar{D}_1} = 1.503$

Experimental Group B $S_{\bar{D}_2} = 2.238$

$S_{\bar{D}_1} - S_{\bar{D}_2}$ = the standard error of the difference between the means of Paired Observations

$$= \sqrt{S_{\bar{D}_1}^2 + S_{\bar{D}_2}^2 - 2rS_{\bar{D}_1} \times S_{\bar{D}_2}}$$

$$= \sqrt{(1.503)^2 + (2.238)^2 - (2)(.99)(1.503)(2.238)}$$

$$= \sqrt{.675}$$

$$= .82$$

$$\text{"t"} = \frac{M_1 - M_2}{S_{\bar{D}_1} - S_{\bar{D}_2}} = \frac{65.3 - 65.2}{.82} = .12$$

"t" at the .05 level = 2.10

No significant difference at the .05 level.

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