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A STUDY OF FLEXIBILITY IN WRESTLERS AS COMPARED WITH OTHER SPORT GROUPS

BY

JOHN M. STERNER

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Department of
Physical Education, South Dakota
State College of Agriculture
and Mechanic Arts

August, 1963

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A STUDY OF FLEXIBILITY IN WRESTLERS

AS COMPARED WITH OTHER

SPORT GROUPS

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

A. C. Broadgaard

Thesis Adviser

A. C. Broadgaard

Head of the Major Department

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JMS

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CHAPTER I

INTRODUCTION

Flexibility in the human is relatively new in research. As a part of kinesiology it has not been studied extensively. In training programs of sport skills, heavy emphasis has been placed on strength development, flexibility, and endurance. Strength and endurance have been studied extensively and have contributed valuable information to physical education and athletics, but there seems to be little information related to flexibility.

Training the individual to move gracefully in a full range of movement has been one of the objectives of physical education. Metheny indicates that flexibility enables an individual to move more easily, more gracefully, and with a wider range of motion. In coordinated, graceful, and efficient movement the opposing muscles must be able to relax and to lengthen readily and easily. The joints to which the muscles are attached should be flexible enough to make a full range of movement possible enabling the individual to carry his body in an erect poised manner; thus flexibility is essential to good posture (1). Cureton states the following:

> Good flexibility usually indicates that there are no adhesions, abnormal joints, injuries, or muscle bound conditions of serious import. Body suppleness also indicates roughly a type of anatomical and physiological youthfulness, an important characteristic of gracefulness. People with

very inextensible tissues are apt to be awkward (2).

Olsen indicates that flexibility is one of the major potentials to be developed within the individual. One should appreciate the ability of a body to perform to its utmost efficiency, described with an ease and harmony of movement, and coupled with strength and power. Such a quality as freedom of movement, whether such movement be through participation of an athletic nature or a daily task of living, is essential to the individual for effective performance and body functioning (3). Rathbone wrote the following concerning flexibility:

> It must be remembered that flexibility is a characteristic of joints, and that relaxation, as well as contracting and maintaining tonus, and coordination are characteristic of the neuro-muscular system. A physically fit person is strong, has strength in his muscle, and is flexible. Flexibility is essential to comfort, and inflexibility can and does cause awkwardness in the individual which may affect physical condition (4).

In recent years, studies have been made to determine the characteristics of flexibility for the purpose of establishing norms for both sexes at different age levels, or for the purpose of comparing the differences in degrees of flexibility of participants in different sports or activities. Results of these studies have shown that there are differences in flexibility for comparable joints of those tested. These studies have indicated that the flexibility norms obtained were due to the individual's participation in a particular sport or due to growth characteristics

of various age groups. These studies have also indicated that flexibility is not a general characteristic in nature but that it is limited to specific body areas.

The author has found that flexibility characteristics of college wrestlers have not been determined and that no flexibility norms have been set up for wrestlers.

Need for the Study

Flexibility and its implication on athletic performance has not been studied extensively. The teaching of skills requires a knowledge and understanding of the range and movement of which joints are generally capable. It is known that flexibility characteristics are specific to each joint and that the range of movement of these joints required of the different sport groups varies considerably. There is limited knowledge concerning the effects of training for these sport groups and the part that flexibility plays in conducting these training programs. More research is needed to determine the place of flexibility in athletic training programs and this has been the motive for conducting this study.

Statement of the Problem

The purpose of this study was to investigate the area of flexibility as it applies to wrestlers when compared with the flexibility scores of football players, basketball

players, shot putters and discus throwers, and 18-year-old college freshmen non-athletes.

The wrestlers were measured according to Leighton's thirty measures of flexibility, and the Leighton Flexometer was employed as the measuring instrument (5).

Delimitations

1. The wrestlers used in this study were required to have had at least three years of experience in wrestling in order to allow ample time for these flexibility traits to develop.

2. Wrestlers who have experienced any serious difficulty with diseases of the joints were excluded from this study.

3. The subjects were limited to 41 varsity and freshman wrestlers from South Dakota State College and Mankato State College, Mankato, Minnesota.

Definition of Terms

It can be generally said that flexibility is full range of movement around a joint.

Forbes in his study indicated that the range of movement of a joint is determined by "the ligamentous support which consists of fibrous bonds and cartilage, the condition of the muscles and tendons, and the shape of its articulor surface (6)."

Cureton defines flexibility as the capacity of the body to move easily to the full range of joint flexion and extension without undue restriction in the joints or tissue (7). Rathbone states that flexibility is a characteristic of the joints and is found in the joints (8). Leighton defines flexibility as the normal range of movement of an anatomical segment about its joints (9).

For the purposes of this study, Leighton's definition of flexibility was used.

The goniometer is an instrument for measuring angles, especially those of solid bodies.

CHAPTER II

RELATED LITERATURE

Flexibility, as a measurable quality, was of little value before World War I. The measurement of motion of a joint first assumed importance beyond the field of clinical interest after World War I, when disability and pension boards began to demand that physicians have definite degree measurements for determining the actual disability of the individual involved. The instruments used for measuring flexibility were crude and were not too reliable. Springfield College, Springfield, Massachusetts, pioneered investigations for the application of flexibility to physical education. The literature concerning the measurement of joint motion reveals a notable lack of uniformity in technique and a corresponding disagreement concerning what is the normal range of motion. In many instances the norms quoted appeared to be set arbitrarily, rather than as the result of experimentation. In recent years data have been collected for determining the characteristics of flexibility, for the purpose of establishing norms for both sexes at different age levels, or for the purpose of comparing the differences in degree of flexibility of participants in different sports or activities.

In 1930 Cureton devised a series of flexibility

measures. These tests were standardized and norms were established. The tests were conducted on champion athletes. Measurements used were right and left ankle flexion, shoulder flexibility, trunk extension backwards, and trunk extension forward. Cureton then intercorrelated the various flexibility tests. Trunk flexion did not correlate significantly with the other three tests, nor did trunk flexion or shoulder extension correlate highly with any of the other measures. This research showed that the tests were fairly specific and that flexibility was not a general quality, but that all tests of flexibility will vary somewhat. The instruments used in the study were calipers and the 180-degree protractor (10).

Wellstone conducted a study in which flexibility was one of 35 measures used for predicting ability in gymnastics and tumbling. In testing for flexibility, three measurements were taken: flexibility of the shoulder girdle, forward trunk flexion, and flexibility of the back. Flexibility was determined in inches by the use of a tape from the point of flexion and extension. A formula was devised for determining a flexibility score:

$$\frac{\text{Shoulder flexion}}{\text{Span}} - \frac{\text{Abdominal flexion}}{\text{Height}} + \frac{\text{Back extension}}{\text{Height}}$$

The individual achieving a high score was considered the most flexible (11).

Wilmar and Elkins constructed an optical goniometer

for the measurement of the range of motion of the major joints. They attempted to develop a simplified measuring instrument which would provide consistent measurement for anyone using it. The instrument was essentially a reducing lens with a 360-degree scale attached. There were 520 observations made by 29 physicians and 18 technicians and secretaries. The authors stated that further study was needed on their instrument before any definite conclusions could be drawn (12).

In 1930, Benson developed a device for the purpose of measuring the range of motion in injured ankles and knees. Measurements were made immediately before and after therapeutic treatment had been given. The instrument was a hinged board with a 360 degree protractor fixed at the hinge. The subject placed his heel or knee on the angle and the number of degrees which the heel or knee moved was indicated on the protractor. This instrument was used primarily for indicating the range of motion of an injured joint and not for use in measuring the normal range of motion. The author concluded that prolonged dry heat was better than wet heat in treating injured joints because dry heat permitted greater mobility (13).

In 1942 Leighton introduced his device for measuring flexibility which he called the flexometer. The instrument had a flat circular, movable dial graduated in 360 degrees

with a weight attached to its center. A leather strap was fastened to any part of the subject's body being measured. The reliability and validity of this instrument was established by testing 56 male body-building students at the University of Oregon. There were 21 measures in all, and the reliability for each measure fell within a range of .889 to .995 (14).

Dorinson and Wagner, in 1948, used a protractor type of goniometer for measuring the range of motion of joints. This permitted the recorded figure to be a direct reading from the goniometer. More than 25 measures were used, and scores for each measure were recorded. The scores were listed in two separate figures, the difference between the two figures being the degree of flexibility (15).

Massey and Chaudet conducted an investigation of the effects of systematic, heavy resistive exercises on the range of joint movements of young male adults. An experimental group trained with weights for six and one-half months, while a control group participated in other kinds of physical activity. Measures in range of joint movement were selected as indicators of the effectiveness of the exercise program together with certain other variables. These measurements were recorded prior to training, midway through the training period, and at the end of training. The instrument used was the Leighton Flexometer. Seven

flexibility measures were taken: hip flexion extension, knee flexion, shoulder flexion extension, elbow extension, and hip flexion with knee bend. It was concluded that heavy resistive exercises to the extent engaged in by the experimental group did not result in an overall reduction in range of movement of the joints throughout the body. The author also concluded that heavy, resistive exercise causes either a reduction or an increase in range of movement, depending upon the training routine and manner in which the exercises are executed (16).

Haliski reported a study on 100 University of Oregon football players and compared them to Leighton's control group consisting of 56 members of a body-building class at the University of Oregon, and measured them by means of the Leighton Flexometer. The findings revealed that the football players were significantly more flexible than the non-football group in only the side-trunk-hip extension. The non-football players were more flexible in 13 of the measures used. When flexion of the right and left side measurements of similar joints were compared, the flexion of five right side and three left side joints was found to exceed the flexion of the corresponding opposite joint. Both groups revealed greater flexibility in the right side joints than in the left side joints. A comparison of linemen and backfield men showed that backfield men were more flexible in 12 of

the 21 measures that were compared. The evidence indicates that of the two groups studied, football players are less flexible in more of the body joints than are members of a college physical education class (17).

Forbes conducted a study in 1950 on 348 white, male public school students in California ranging in ages from approximately nine years to approximately 18 years with 52 18-year-old white subjects who were in the physical education service classes at Humbolt State College. The subjects were put into the following groups:

Group I	100 Cases	18 years old
Group II	50 Cases	16 years old
Group III	100 Cases	14 years old
Group IV	50 Cases	12 years old
Group V	100 Cases	10 years old

A new version of the Leighton Flexometer was used in finding the 19 measures of flexibility. The findings revealed a decrease in flexibility of boys in 12 of the 19 flexibility measures as they approached the age of 16 years. The subjects then showed an increase in flexibility in 10 of the 19 measurements in the period between 16 and 18 years of age. Neck rotation, shoulder rotation, and wrist flexion-extension continued to show a decrease in the range of movement from age 10 to 18 years. Six areas had increases in flexibility in the periods from 10 to 12 or from 10 to 14 years of age and thereafter revealed a gradual decrease. Hip flexion-extension failed to indicate an orderly descending

or ascending trend, but developed a fluctuating pattern of unaccountable significance. The 10-year-old boys were described as being the most flexible of the age groups studied because they excelled in 13 of the 19 flexibility measures. The 16-year-old group was ranked as lowest in flexibility of the five age divisions since the boys in this group were found to have less flexibility than any of the other age groups in 11 out of 19 possible variables. On the basis of arbitrarily designating five points as representing the highest of the mean flexibility scores for each joint measurement per age group, the author ranked the 10-year-olds as first with an accumulated average of 4.05 points, followed by the 12-year-olds with a 3.32 average, the 14-year-olds with a 3.00 score, the 18-year-olds with 2.63 points, and the 16-year-olds as last with a 2.00 point average in flexibility (18).

In using the measurements of flexibility as described by Leighton, Syverson compared the range of movement of baseball players to service course students, football players, swimmers, and basketball players. He found baseball players to be significantly more flexible than body-building students in Leighton's study in three of nine measurements compared. Freshman physical education students were significantly more flexible in two of the measurements used. Baseball players were significantly more flexible than

football players in five of the nine measurements compared. Swimmers were significantly more flexible in nine of the 30 measures, and baseball players more significant in four of them. Compared with basketball players, baseball players have more flexibility in 26 of 30 measurements. In a comparative ranking order, the degrees of flexibility in relation to the sport groups are as follows: Swimmers ranked first with the greatest amount of flexibility; baseball players, second; body-builders, third; basketball players, fourth; football players, fifth; and 18-year-old freshman physical education students, last (19).

Miller attempted to determine how age influenced the flexibility of boys. The study involved 138 boys ranging in age from eight through 18 who were from a non-profit, private school in Louisiana. A goniometer similar to the Leighton Flexometer was used as the measuring instrument. All the subjects were tested without the benefit of warmup, and the testing period preceded any activity period such as physical education. Eleven different measures were given to each subject. Each subject was given two tests of two trials each, with the mean average of the two trials correlated with each other. No attempt was made to measure maturation level, and subjects were grouped into three divisions: pre-adolescent, adolescent, and post-adolescent. An alternate group using five groups (with two-year age

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groups in each) to show a fine picture of the relationship of age to flexibility. Conclusions indicated that the trend for boys was to decrease in flexibility from eight to 18. Minor exceptions to the above were noted in elbow, hip flexion, and lateral movement of the trunk when flexibility increased slightly at the adolescent period and then declined sharply to a point below that of the younger age level (20).

Olsen conducted a study to investigate any possible relationship of flexibility with the ability of an individual to perform motor activities as measured by the Scott Motor Ability Battery Test. Seventy-three college freshman women at the University of Oregon in 1955 were measured. Measurements were made by using the Leighton Flexometer, employing Leighton's measures of flexibility. Findings of this study indicated no significant relationship between the areas of flexibility measured and general motor ability. However, in specific areas of flexibility results indicated that flexibility may be somewhat a factor in a higher degree of performance in certain kinds of motor activities (21).

Kingsley investigated flexibility in an attempt to determine the flexibility changes that occured in 28 ninth-grade boys who participated in 50 forty-five minute classes in beginning tumbling within a 20-week period. It dealt with the Leighton measures of flexibility, and the Leighton Flexometer was used in measuring the individual points.

Kingsley concluded that during this period of tumbling, flexibility did increase in most areas of the body especially if the flexibility of those articulations were below levels of flexibility possessed by comparable subjects. Eighteen flexibility measures showed significant increases for both tests (22).

Mathews, Shaw, and Woods investigated hip flexibility of elementary school boys as related to certain body segments. The flexibility measure used was the Kraus-Weber flexibility measure, which involves touching toes with hands, and the Wells Sit and Reach Test. Satisfactory co-efficients of objectivity were obtained for the flexibility tests, and the following conclusions were drawn: There is no significant relationship existing between flexibility of the hip joint and the length of body segment. Flexibility is independent of lower limb length, and flexibility is specific to each joint (23).

These same investigators studied the length of hip flexibility as related to length of body segments in college women and reported the following findings:

> Flexibility is most commonly defined as the range of joint motion, one must recognize that such factors as muscle extensibility, joint structure, condition of ligaments, and fascia surrounding joints, all in some manner affect the range of movement. It is generally recognized that adequate range of movement is important in athletic performances as a safety factor in preventing muscle injury (24).

Davies in a study of the relationship between selected

postural divergencies and motor ability stated, "Movement flexibility is affected by posture. Posture is affected by movement, but posture has no affect on motor ability (25)."

McCue conducted a study on flexibility measurement of college women. One hundred thirty college women with a mean age of 19.5 years were measured. A goniometer similar to the Leighton Flexometer was used, and the criteria for flexibility measurements were similar to those developed by Leighton. It was concluded that (a) the mean of the hip flexion for the underweight individual was significantly greater than the mean for overweight individuals; (b) overweight individuals had greater lumbar extension; (c) individuals who had a past history of more activity tended to be more flexible. A comparison of physical education major students with non-major students indicated no significant difference in flexibility. For the lower quartile group, flexibility significant increase was noted after a period of three weeks (26).

Dayton stated the following about flexibility:

> Exercise assists the normal range of motion, presents atrophy, and helps re-establish motion. Adequate strength and flexibility will help the athlete avoid injury by being able to get "out of the way" of a collision, or by allowing himself to get into a position to roll with the impact. An athlete lacks skill when his movements are awkward and he seems to expend great effort in accomplishing work. Flexibility coordinates movement (27).

Leighton investigated the flexibility characteristics

of three specialized skill groups of champion athletes. Because only champion athletes were selected, the available number of subjects was limited. The three skill groups consisted of five weight-lifters, each of whom at one time or another was a Mr. America or national weight-lifting champion; eleven gymnasts, all of whom were members of the 1953 national championship team; and nine wrestlers who were members of the 1953 national championship team. The measurements were made immediately following the completion of the season.

The means of each skill group were compared with the corresponding means of a group of 16-year-old boys. The analysis of the measurements showed that weight lifters and gymnasts had the highest flexibility performance ability. Each group exceeded the 16-year-old group in 15 of the 30 tests. The weight-lifters showed inferior ability in five tests and the gymnasts in six. Wrestlers showed superior performance ability in only eight of 30 movements compared with 15 for both the weight-lifters and the gymnasts. This study supported Leighton's previous findings that significant differences exist between the means of the characteristics of flexibility among skilled performers specializing in different activities. Of the groups studied only the weight-lifters showed superior performance ability in neck movements that aid in extending peripheral vision. All groups showed

low ability in shoulder flexion and extension (28).

Leighton in his report on the significance of flexibility stated the following:

> If flexibility is a specific factor and not a general factor, it would then follow that no test item can determine whether or not an individual is flexible save for the particular joint or joints involved in that movement.

Leighton further indicated these conclusions:

> 1. Flexibility as such seems to vary more with habitual activity patterns than with factors such as age.
>
> 2. Limiting range of movement may enhance some skills while extending flexibility may detract from that skill.
>
> 3. Little evidence has been found that age, as such, from 10 years to full maturity determines flexibility performance.
>
> 4. There appears to be a flexibility pattern in each case or group studied which parallels the skills and habits of body movement present and is peculiar to these latter.
>
> 5. There is evidence that it may not be possible to develop skills to a high degree without laying the ground work of a proper flexibility pattern for the skill (29).

CHAPTER III

PROCEDURE

Source of the Data

The data used in this study were obtained from measuring the flexibility of 41 wrestlers, none of whom had less than three years wrestling experience and each of whom had at least one year of college wrestling. This limitation was used in order to insure that the subjects had been exposed to training in wrestling sufficiently to allow for structural changes which might occur, such as changes in the joints. All of the subjects tested were between the ages of 18 and 24 years of age.

The subjects used had participated in either freshman or varsity wrestling at Mankato State College, Mankato, Minnesota, or South Dakota State College, Brookings, South Dakota.

The source of the mean flexibility averages for the football players was Haliski's study of flexibility in football players (30).

The basketball player and 18-year-old college student averages were obtained from Williams' study of flexibility in basketball players (31).

The source of the mean flexibility averages for shot putters and discus throwers was Lemiere's study of

flexibility in shot putters and discus throwers (32).

The Instrument Used in Measuring

The instrument employed in making the measurements was the Leighton Flexometer (See Figure I). It has a weighted 360-degree dial and a weighted pointer mounted in a case. The dial and pointer operate freely and independently; the movement of each is controlled by gravity. The instrument records movement while in any position which is 20 degrees or more off the horizontal. The zero mark on the dial and the tip of the pointer move freely to a position of rest and concide when the instrument is placed in any position off the horizontal, as indicated. Independent locking devices are provided for the pointer and the dial, which stop all movement of either, at any given position. While in use, the flexometer is strapped to the segment being measured. When the dial is locked at one extreme position (e.g. full extension of the elbow), the direct reading of the pointer on the dial is the arc through which the movement has taken place. In addition to the flexometer, a projecting wall corner or cabinet, a long bench or table, and a lowbacked armchair were also used (33).

Procedure in Measurement

The following three illustrations and explanations are samples of the procedure used for measuring the 28

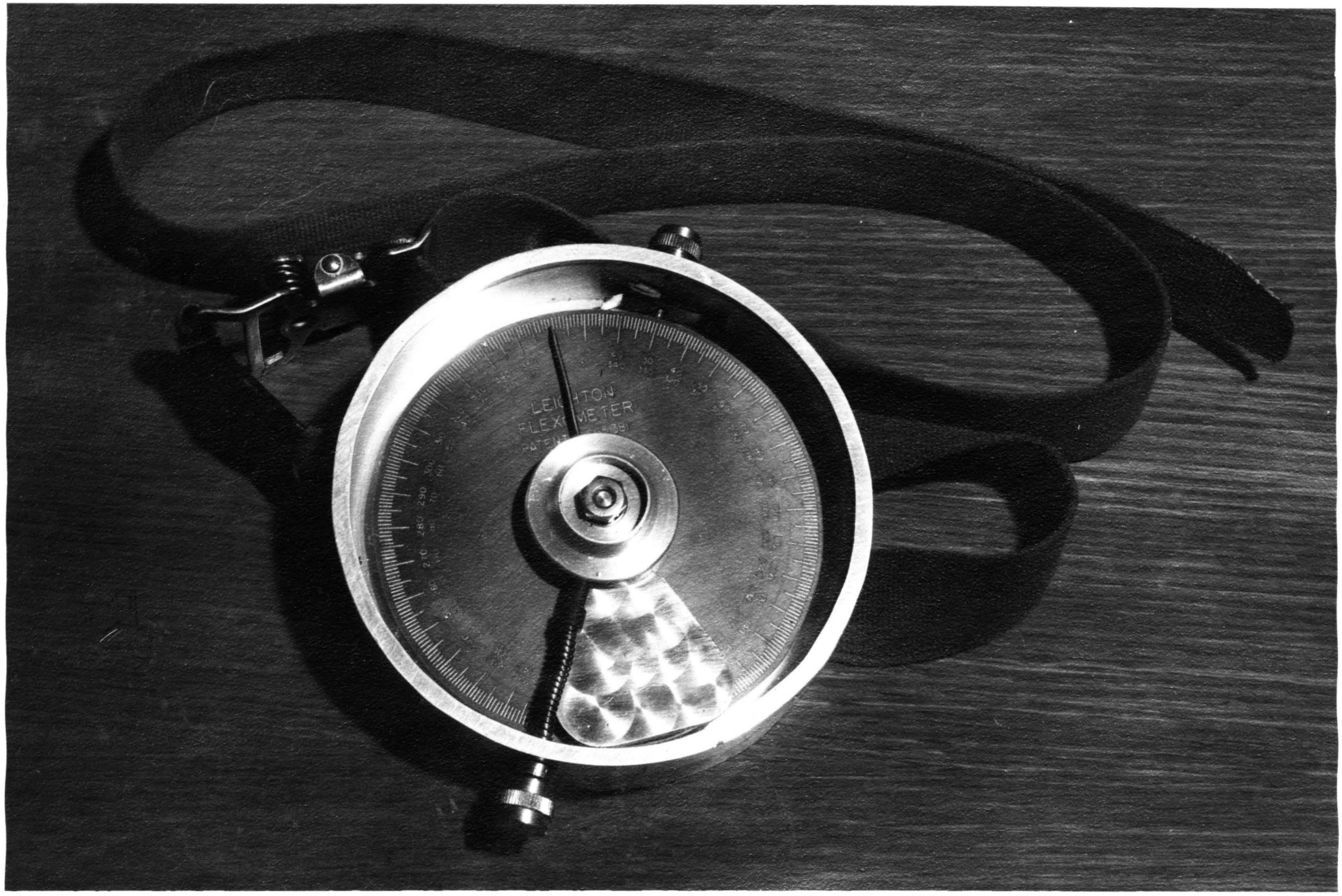

Figure I. The Leighton Flexometer

flexibility measures used in this study. For detailed explanation of all the measures see Appendix A.

1. Neck Flexion and Extension. Starting position--The subject took a supine position on the table, head and neck projecting over the end, shoulders touching the edge, arms at the sides. The instrument was then fastened to either side of the head over the ear. Movement Count: (a) The head was raised and moved to a position as near the end of the bench as possible, pointer locked; (b) the head was lowered and moved to a position as near the end of the bench as possible; (c) the subject relaxed, and the reading was taken. Shoulders were not to be raised from the bench during flexion nor back unduly arched during extension. Buttocks and shoulders remained on the bench during the movement. (See Figure II)

2. Shoulder Flexion and Extension. Starting position--Subject took a standing position at a projecting corner of a wall or cabinet; the arm to be measured was extended just beyond a projecting corner, the other arm being placed on the side with the back towards the wall, with shoulder blades, buttocks, and heels touching the wall. Instrument was then fastened to the side of the upper arm. Movement Count: (a) The arm was moved forward and upward in an arc as far as possible with the palm of the hand sliding against the wall; dial was then locked; (b) the arm was moved

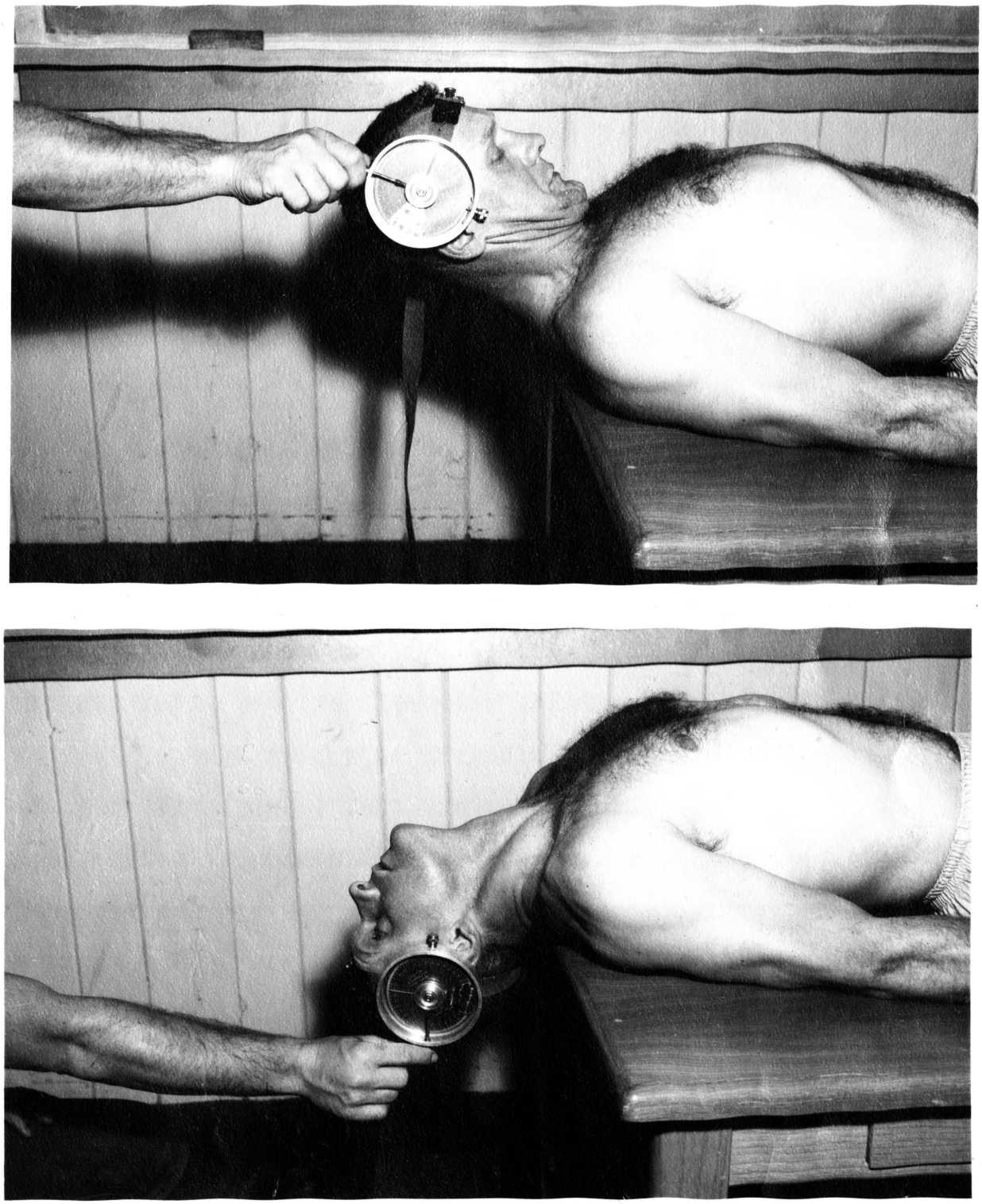

Figure II. Neck Flexion and Extension

downward and backward in an arc as far as possible with the palm of the hand sliding against the wall; the pointer was then locked; (c) subject relaxed and the reading was taken. Heels, buttocks, and shoulders touched the wall at all times during movement. The elbow of the arm being measured was kept straight. The palm of hand of the arm being measured was against the wall when the dial and pointer were locked. (See Figure III)

3. Ankle Flexion and Extension. Starting position--Subject took a sitting position on a bench with the left (right) leg resting on the bench and the foot projecting over the end of the bench with the knee straight. The instrument was then fastened to the inside of the left (right) foot. Movement Count: (a) The left (right) foot was turned downward as far as possible; the dial was locked; (b) the left (right) foot was turned upward and toward the knee as far as possible; the pointer was locked; (c) the subject relaxed and the reading was taken. The knee of the leg being measured was kept straight throughout the movement. No sideward turning of the foot was allowed. (See Figure IV)

Administration of the Measurements

1. The wrestlers wore only an athletic supporter and loosely fitted gym shorts.

2. The mechanics of the instrument was explained to each subject before the measurements were taken.

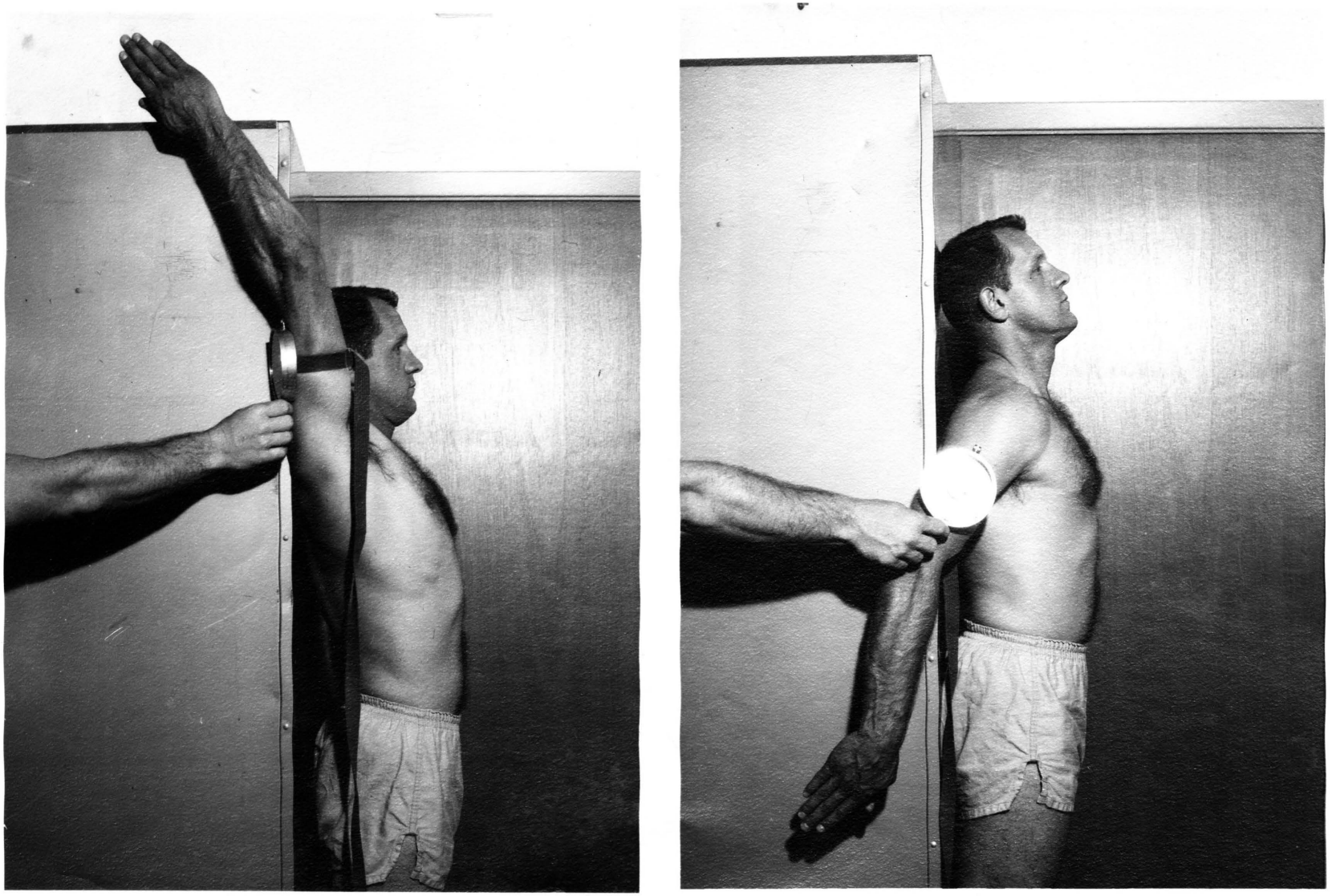

Figure III. Shoulder Flexion and Extension

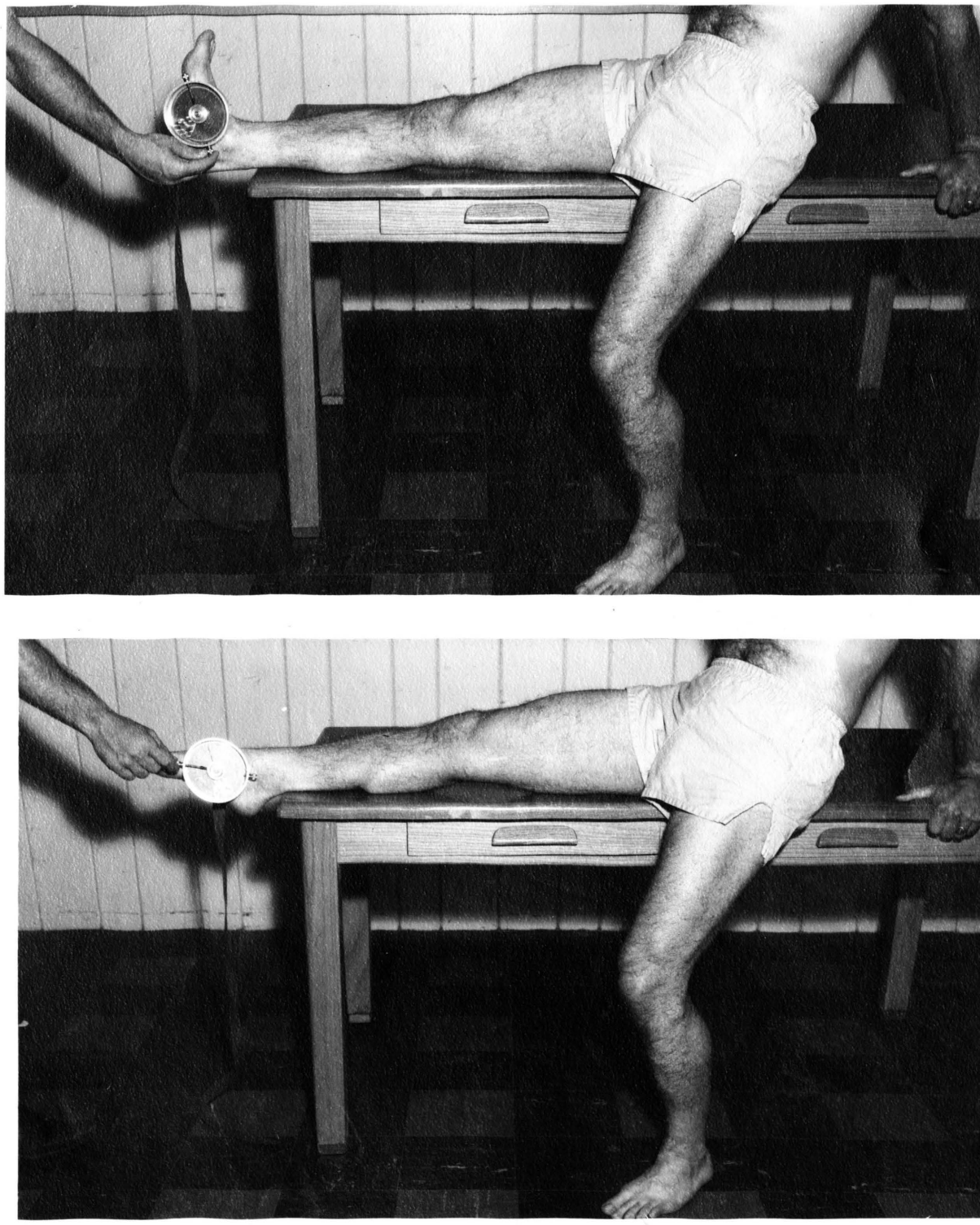

Figure IV. Ankle Flexion and Extension

3. The subject was not permitted to warm up.

4. The measurements were taken at all times of the day. No particular hours or room temperature were specified during which measurements were made.

5. Every measurement was repeated a second time.

6. The data from each wrestler were recorded on a card which appears in Appendix B.

7. All measurements were administered by the author of this study.

Treatment of the Data

The reliability of the tests was computed to determine whether the data from these measurements of flexibility were consistent to permit their comparison with other data whose reliability had already been established. This was done by correlating the first test with the second test. The means, ranges, standard deviations, and the differences between the means were computed for the measurements. The significance of the differences of the means was found to determine the critical ratio, t score, for each measurement.

CHAPTER IV

ANALYSIS AND TREATMENT OF DATA

The basic purpose of this study was to compare the flexibility of wrestlers with that of football players, shot putters, and discus throwers, basketball players, and 18-year-old college students in order to determine whether wrestlers have a greater or lesser degree of flexibility in specific joint areas.

Each wrestler was tested twice, using 28 flexibility measures developed by Leighton (34). To obtain a mean score of flexibility for each joint of the individual wrestlers, the author averaged the scores of the two tests. Using the individual mean score established for each joint measurement, the author then computed a mean score for all of the subjects. The range, standard deviation, reliability, and standard error of the flexibility measures were determined and listed in Table 1.

The reliability was established by correlating the first test with the second test. The reliability coefficients obtained were found to range from .715 to 1.000, with 18 of the measures above .906, seven above .812, two above .715, and one with 1.000. The reliability measure used was the rank-difference coefficient of correlation

Table 1. Range, Standard Deviation, Reliability, and Standard Error of the Flexibility Measures Obtained from 41 Wrestlers

Test Variables	Mean Score in Degrees	Range of Scores in Degrees	S.D.	Reliability	SE_M
R Shoulder FE	211.16	158-267	20.32	.885	3.34
L Shoulder FE	202.50	147-267	27.78	.949	4.57
R Shoulder AD-AB	163.47	133-220	24.00	.933	4.00
L Shoulder AD-AB	166.34	135-216	23.34	.915	3.82
R Elbow FE	157.24	134-192	11.69	.731	1.83
L Elbow FE	154.23	131-169	9.00	.952	1.41
R Radial-Ulnar SP	184.34	145-238	20.49	.906	3.20
L Radial-Ulnar SP	184.72	125-238	18.93	.867	2.96
R Radial-Ulnar FE	84.68	60-107	11.79	.827	1.84
L Radial-Ulnar FE	82.98	55-123	13.69	.912	2.14
R Wrist FE	135.34	72-193	25.06	.976	3.91
L Wrist FE	135.44	76-246	31.56	.952	4.93
R Knee FE	141.40	124-159	7.89	.985	1.23
L Knee FE	142.65	120-162	9.80	.894	1.53
R Ankle FE	60.44	38-153	18.49	.997	2.89
L Ankle FE	60.69	37- 77	8.78	.950	1.37
Hip FE	116.74	87-151	16.30	.897	2.58
Hip AD-AB	60.67	48- 81	7.60	.715	1.18
R Hip ROT	93.33	55-144	20.26	.988	3.16
L Hip ROT	89.07	49-123	18.52	.997	2.89
Trunk FE	190.38	114-244	22.83	.927	3.60
Trunk LF	129.05	85-174	22.44	.997	3.55
Trunk ROT	140.35	81-184	23.02	1.000	3.63
Neck FE	139.50	104-165	18.90	.988	2.95
Neck LF	113.66	75-196	27.07	.982	4.23
Neck ROT	177.23	96-221	23.41	.845	3.66
R Shoulder ROT	192.85	143-229	20.60	.812	3.22
L Shoulder ROT	191.80	152-249	19.35	.906	3.02

Key to Abbreviations: R right; L left; FE flexion-extension; AD-AB adduction-abduction; ROT rotation; SP supination-pronation; LF lateral flexion.

or rho, which was determined by the following formula (35):

$$\text{rho} = 1 - \frac{6(\Sigma D^2)}{N(N^2-1)}$$

The standard deviation was calculated from ungrouped scores by use of the following formula (36):

$$SD = \sqrt{\frac{\Sigma x^2}{N}}$$

The standard error of the mean was calculated by the following formula (37):

$$SE_M = \frac{SD}{\sqrt{N}}$$

The standard error of the difference between two means was computed by the following formula (38):

$$SE_D = \sqrt{SE_{M_1}^2 + SE_{M_2}^2}$$

The critical ratio, t score, was derived from the following formula (39):

$$t = \frac{M_1 - M_2}{SE_D}$$

The one percent level of confidence was selected for this study. Using 83 degrees of freedom for the comparison between wrestlers and shot putters, a t ratio of 2.65 was

needed to reject the null hypothesis. For all other comparisons, 139 degrees of freedom, a t ratio of 2.58 was needed to reject the null hypothesis.

For the basketball players, shot putters and discus throwers, and 18-year-old college students, mean scores of 28 flexibility measurements were compared with the means of the wrestlers. The 28 measures are listed in Tables 1, 2 3, 4, and 5. For the football players only nine mean scores were available and thus the comparison with the wrestlers was limited. These measures are indicated in Table 2.

Table 2 indicates the mean scores of wrestlers when compared with the shot putters and discus throwers to be statistically significant in the following areas: left ankle flexion-extension, hip adduction-abduction, trunk flexion-extension, trunk lateral flexion, and trunk rotation.

The shot putters and discus throwers showed measurements which were statistically significant at the one percent level of confidence in the following areas: right and left wrist flexion-extension and left shoulder rotation.

There was no statistically significant difference in the mean scores of the two groups for the following measures: right and left shoulder flexion-extension, right and left shoulder adduction-abduction, right and left elbow flexion-extension, right and left radial ulnar supination-pronation and flexion-extension, right and left knee

Table 2. A Comparison of Flexibility Measures Taken from Shot Putters and Discus Throwers and Wrestlers

Test Variable	41 Wrestler Means in Degrees	44 Shot Putters Means in Degrees	SD_D	M_1-M_2	t
R Shoulder FE	211.16	207.07	4.22	3.46	.82
L Shoulder FE	202.50	211.30	5.23	-8.80	1.68
R Shoulder AD-AB	163.47	171.70	4.43	-8.23	1.86
L Shoulder AD-AB	166.34	175.80	4.52	-9.46	2.10
R Elbow FE	157.24	150.98	2.37	6.26	2.64
L Elbow FE	154.23	152.58	2.12	1.65	.78
R Radial-Ulnar SP	184.34	174.60	4.14	9.74	2.35
L Radial-Ulnar SP	184.72	185.13	4.35	- .41	.09
R Radial-Ulnar FE	84.68	82.50	3.16	2.18	.69
L Radial-Ulnar FE	82.98	86.27	3.31	-3.29	.99
R Wrist FE	135.34	161.90	4.63	-26.56	5.73**
L Wrist FE	136.44	161.14	5.33	-24.70	4.63**
R Knee FE	141.40	137.69	1.78	4.40	2.08
L Knee FE	142.65	137.44	2.08	5.21	2.50
R Ankle FE	60.44	55.60	3.09	4.84	1.56
L Ankle FE	60.69	55.44	1.88	5.25	2.79*
Hip FE	116.74	110.06	3.86	6.68	1.73
Hip AD-AB	60.67	53.00	1.64	7.67	4.67*
R Hip ROT	93.33	85.75	3.97	7.58	1.94
L Hip ROT	89.07	87.70	3.57	1.37	.38
Trunk FE	190.38	64.95	4.31	125.43	29.10*
Trunk LF	129.05	101.20	4.02	27.85	6.93*
Trunk ROT	140.35	118.43	6.21	21.92	3.53*
Neck FE	139.50	137.50	3.60	2.00	.56
Neck LF	113.66	108.70	4.66	4.96	1.06
Neck ROT	177.23	182.16	4.61	-4.93	1.07
R Shoulder ROT	192.85	201.08	4.28	-8.23	1.92
L Shoulder ROT	191.80	206.75	4.37	-14.93	3.42**

Key to Abbreviations: R right; L left; FE flexion-extension; AD-AB adduction-abduction; ROT rotation; SP supination-pronation; LF lateral flexion;

* Wrestler Mean score significant at the .01 level.
** Shot putter mean score significant at the .01 level.

flexion-extension, right ankle flexion-extension, hip flexion-extension, right and left hip rotation, neck flexion-extension, neck lateral flexion, neck rotation, and right shoulder rotation.

Table 3 indicates that the 28 mean scores of wrestlers, when compared with the 28 mean scores of basketball players, are statistically significant at the one percent level of confidence in the following measures: right shoulder flexion-extension, right elbow flexion-extension, left knee flexion-extension, hip flexion-extension, hip adduction-abduction, trunk flexion-extension, trunk lateral flexion, trunk rotation, and neck rotation.

There was no significant difference at the one percent level of confidence between basketball players and wrestlers, and the null hypothesis was accepted as real in the following measures: left shoulder flexion-extension, right and left shoulder adduction-abduction, left elbow flexion-extension, right and left radial ulnar supination-pronation and flexion-extension, right and left wrist flexion-extension, right knee flexion-extension, right and left ankle flexion-extension, right and left hip rotation, neck flexion-extension, neck lateral flexion, and right and left shoulder rotation.

Table 4 indicates that the differences between 28 wrestler means, when compared with the 28 means of

Table 3. A Comparison of Flexibility Measures Taken from Basketball Players and Wrestlers

Test Variable	41 Wrestler Means in Degrees	100 Basketball Means in Degrees	SE_D	M_1-M_2	t
R Shoulder FE	211.16	198.50	3.71	12.66	3.41*
L Shoulder FE	202.50	206.30	4.79	-3.80	.79
R Shoulder AD-AB	163.47	160.54	4.17	2.93	.70
L Shoulder AD-AB	166.34	161.40	4.01	4.94	1.23
R Elbow FE	157.24	150.94	2.03	6.30	3.10*
L Elbow FE	154.23	152.10	1.65	2.13	1.29
R Radial-Ulnar SP	184.34	184.40	3.86	3.94	1.02
L Radial-Ulnar SP	184.72	180.90	3.53	3.80	1.08
R Radial-Ulnar FE	84.68	87.72	2.28	-3.04	1.33
L Radial-Ulnar FE	82.98	84.30	2.49	-1.32	.53
R Wrist FE	135.34	127.22	4.31	8.12	1.88
L Wrist FE	135.44	127.96	5.29	8.48	1.60
R Knee FE	141.40	138.29	1.51	3.11	2.06
L Knee FE	142.65	135.89	1.73	6.76	3.91*
R Ankle FE	60.44	57.66	3.05	2.78	.91
L Ankle FE	60.69	58.44	1.61	2.25	1.39
Hip FE	116.74	105.16	3.08	11.58	3.76*
Hip AD-AB	60-67	55.16	1.38	5.51	4.02*
R Hip ROT	93.33	87.86	3.63	5.47	1.50
L Hip ROT	89.07	84.20	3.41	4.87	1.43
Trunk FE	190.38	68.40	3.87	121.98	31.51*
Trunk LF	129.05	101.50	3.78	27.55	7.29*
Trunk ROT	140.35	122.74	4.26	17.61	4.13*
Neck FE	139.50	143.66	3.35	-4.16	1.24
Neck LF	113.66	99.78	4.61	13.88	3.01*
Neck ROT	177.23	110.82	4.24	66.41	15.66*
R Shoulder ROT	192.85	187.00	3.87	5.85	1.51
L Shoulder ROT	191.80	183.80	3.31	8.50	2.42

Key to Abbreviations: R right; L left; FE flexion-extension; AD-AB adduction-abduction; ROT rotation; SP supination-pronation; LF lateral flexion

* Wrestler mean score significant at the .01 level.

Table 4. A Comparison of Flexibility Measures Taken from 18 Year-Old College Students and Wrestlers

Test Variable	41 Wrestler Means in Degrees	100-18 Year Old College Students Means in Degrees	SE_D	M_1-M_2	t
R Shoulder FE	211.16	236.40	3.76	-25.24	6.71**
L Shoulder FE	202.50	236.50	4.98	-34.00	6.83**
R Shoulder AD-AB	163.47	176.90	4.25	-13.43	3.16**
L Shoulder AD-AB	166.34	177.10	4.09	-10.76	2.63*
R Elbow FE	157.24	148.60	2.17	8.64	3.98*
L Elbow FE	154.23	149.45	1.78	4.78	2.69*
R Radial-Ulnar SP	184.34	167.69	3.72	16.65	4.48*
L Radial-Ulnar SP	148.72	169.02	3.44	15.70	4.56*
R Radial-Ulnar FE	84.68	84.20	2.28	8.48	.21
L Radial-Ulnar FE	82.98	83.80	2.47	10.82	.33
R Wrist FE	135.34	126.50	4.11	8.84	2.15
L Wrist FE	136.44	126.40	5.14	10.04	1.95
R Knee FE	141.40	132.80	1.58	-8.66	5.44*
L Knee FE	142.65	131.55	1.83	11.10	6.07*
R Ankle FE	60.44	64.90	3.06	-4.46	1.46
L Ankle FE	60.69	64.30	1.67	-3.61	2.16
Hip FE	116.74	66.30	2.99	50.44	16.87*
Hip AD-AB	60.67	52.85	1.50	7.82	5.21*
R Hip ROT	93.33	92.80	3.44	.53	.15
L Hip ROT	89.07	92.10	3.58	-3.03	.85
Trunk FE	190.38	112.60	4.16	77.78	18.69*
Trunk LF	129.05	101.47	3.96	27.58	6.96*
Trunk ROT	140.35	126.50	4.01	13.85	3.45*
Neck FE	139.50	126.70	3.30	12.80	3.88*
Neck LF	113.66	97.55	4.54	16.11	3.55*
Neck ROT	177.23	159.30	4.24	17.93	4.23*
R Shoulder ROT	192.85	170.60	3.67	22.25	6.06*
L Shoulder ROT	191.80	171.30	3.47	20.50	5.91*

Key to Abbreviations: R right; L left; FE flexion-extension; AB-AD adduction-abduction; ROT rotation; SP supination-pronation; LF lateral flexion

* Wrestlers means score significant at .01 level.
** College students means score significant at .01 level.

18-year-old college students, are statistically significant at the one percent level of confidence in the following measures: right elbow flexion-extension, right and left radial ulnar supination-pronation, right and left knee flexion-extension, hip flexion-extension, hip adduction-abduction, trunk flexion-extension, trunk lateral flexion, trunk rotation, neck flexion-extension, neck lateral flexion, neck rotation, right and left shoulder rotation, left shoulder adduction-abduction, and left elbow flexion-extension.

Eighteen-year-old college freshmen, when their mean scores were compared with mean scores of wrestlers, showed a significant difference in the following measures: right and left shoulder flexion-extension and right shoulder adduction-abduction.

There was no statistical difference between wrestlers and 18-year-old college students at the one percent level of confidence, and the null hypothesis was accepted as real in the following measures: right and left radial ulnar flexion-extension, right and left wrist flexion-extension, and right and left ankle flexion-extension.

Table 5 shows the results of the comparison of nine mean scores of wrestlers and football players. The wrestlers showed significant difference at the one percent level of confidence in the following measures: left ankle flexion-extension, hip flexion-extension, hip adduction-abduction,

and trunk lateral flexion.

The football players showed a significant difference in right and left wrist flexion-extension.

In right ankle flexion-extension, neck flexion-extension, and neck rotation, there was no significant difference and the null hypothesis was accepted as real.

Summary of Findings

Table 6 indicates the measures in which the wrestlers' mean score was statistically significant when compared with the mean score of basketball players, shot putters and discus throwers, and 18-year-old college freshmen, at the one percent level of confidence.

Table 7 points out the measurements in which the wrestlers' mean score was statistically significant when compared with the mean score of football players at the one percent level of confidence.

Table 5. A Comparison of Flexibility Measures Taken from Football Players and Wrestlers

Variable	41 Wrestler Means in Degrees	100 Football Player Means in Degrees	SE_D	M_1-M_2	t
R Wrist FE	135.34	154.8	4.28	-19.46	4.55**
L Wrist FE	136.44	153.4	5.21	-16.96	3.26**
R Ankle FE	60.44	54.8	3.05	5.64	1.85
L Ankle FE	60.69	52.0	1.65	8.69	5.27*
Hip FE	116.74	91.3	3.26	25.44	7.80*
Hip AD-AB	60.67	56.7	1.42	3.97	2.80*
Trunk FE	129.05	110.07	3.78	18.35	5.02*
Neck FE	139.50	131.9	3.35	7.60	2.27
Neck ROT	177.23	171.4	3.84	5.83	1.52

Key to Abbreviations: R right; L left; FE flexion-extension; AD-AB adduction-abduction; ROT rotation; SP supination-pronation; LF lateral flexion

* Wrestler mean scores significant at the .01 level.
** Football players mean scores significant at the .01 level.

Table 6. Measurements of Flexibility in Which the Difference in Mean Scores is Significant Between Wrestlers and Basketball Players, Shot Putters, Discus Throwers and 18 Year Old College Freshmen

Test Variables	Basketball Players*	Shot Putters*	18 Year Old Students*
R Shoulder FE	Yes		
L Shoulder FE			
R Shoulder AD-AB			
L Shoulder AD-AB			Yes
R Elbow FE	Yes		Yes
L Elbow FE			Yes
R Radial-Ulnar SP			Yes
L Radial-Ulnar SP			Yes
R Radial-Ulnar FE			
L Radial-Ulnar FE			
R Wrist FE			
L Wrist FE			
R Knee FE			Yes
L Knee FE	Yes		Yes
R Ankle FE			
L Ankle FE		Yes	
Hip FE	Yes		Yes
Hip AD-AB	Yes	Yes	Yes
R Hip ROT			
L Hip ROT			
Trunk FE	Yes	Yes	Yes
Trunk LF	Yes	Yes	Yes
Trunk ROT	Yes	Yes	Yes
Neck FE			Yes
Neck LF	Yes		Yes
Neck ROT	Yes		Yes
R Shoulder ROT			Yes
L Shoulder ROT			Yes

Key to Abbreviations: R right; L left; FE flexion-extension; AD-AB adduction-abduction; ROT rotation; SP supination-pronation; LF lateral flexion

* Yes indicates that mean scores of the wrestlers were significant at the .01 level when compared with the three other groups.

Table 7. Measurements of Flexibility in Which the Difference in Mean Scores is Significant Between Wrestlers and Football Players

Test Variables	Football Players*
R Wrist FE	
L Wrist FE	
R Ankle FE	
L Ankle FE	Yes
Hip FE	Yes
Hip AD-AB	Yes
Trunk FE	Yes
Neck FE	
Neck ROT	

Key to Abbreviation: R right; L left; FE flexion-extension; AD-AB adduction-abduction; ROT rotation; SP supination-pronation; LF lateral flexion

* Yes indicates that mean scores of the wrestlers were significant at the .01 level of confidence when compared with the football players.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The basic purpose of this study was to determine the extent of flexibility of wrestlers as compared with football players, basketball players, shot putters and discus throwers, and 18-year-old college freshman non-athletes.

The measurements of flexibility for wrestlers were determined from 41 freshman and varsity wrestlers of South Dakota State College and Mankato State College during the 1962-63 school year. The measurements for the other groups had been previously established by other studies.

With the exception of football players all the subjects were measured by 28 standard flexibility measures established by Leighton, and the measuring instrument used was the Leighton Flexometer.

Because just nine measurements of flexibility for football players were available, the comparison with wrestlers was based on this number.

The data from the measurements on wrestlers were analyzed statistically to determine whether any or all of these scores differed significantly from those previously established for basketball players, football players, shot

putters and discus throwers, and 18-year-old college freshman non-athletes.

Conclusions

The following conclusions were drawn from the data presented in this study:

1. The scores of wrestlers when compared with those of basketball players were statistically greater in 10 of 28 flexibility measures.

2. The scores of wrestlers when compared with those of shot putters and discus throwers were significantly greater in only five of 28 flexibility measurements compared. The shot putters and discus throwers had statistically larger scores in three of the 28 measures, and there was no statistical significance between the two groups in 20 of the 28 flexibility measures.

3. The scores of wrestlers showed statistically greater differences in 15 of 28 flexibility measures when compared with those of 18-year-old college freshman non-athletes. The scores of the 18-year-old college freshmen had statistically greater differences in three of the 28 measures. There was no statistically significant difference between the two groups in 10 of the 28 flexibility measures compared.

4. When nine flexibility scores of wrestlers were compared with nine flexibility scores of football players,

the wrestlers showed statistically more significance in four of the nine measures. Football players showed a greater statistical difference in two of the nine measures. There was no statistical difference between the two groups in three of the nine measures.

5. The only flexibility measures in which wrestlers showed a statistically greater difference when compared with all of the other groups were the following: hip flexion-extension, hip adduction-abduction, and trunk flexion-extension, lateral flexion, and rotation. It is noted that the nature of the sport of wrestling demands considerable action in the trunk and pelvic region.

6. There was not enough evidence in this study to indicate that wrestlers were significantly more flexible in terms of total flexibility. The wrestlers had a statistically greater difference in only a few specific joint measures, and the number of these differences were not enough to conclude that wrestlers in this study were more flexible than the sport groups with which they were compared.

7. The wrestlers showed greater difference in just over half of 28 scores when compared with 18-year-old college freshmen. It is assumed that either the wrestlers possessed more flexibility in the beginning or that their flexibility resulted from their participation in wrestling.

Recommendations

1. There is a need for a study to determine why specific sport groups possess certain flexibility characteristics.

2. There is a need for a study to determine if flexibility is acquired or if it is inherited.

3. There is a need for a study to determine whether a training program for men stressing flexibility will actually increase the flexibility of the individuals and whether this increase in flexibility will affect the performance of the individuals involved in selected motor skills.

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APPENDIX A

PROCEDURE IN MEASUREMENT

1. Neck flexion and extension. Starting position--Supine position on bench, head and neck projecting over end, shoulders touching, edge, arms at sides. Instrument fastened to either side of head over ear. Movement--Count (1) head raised and moved to position as near chest as possible, dial locked, (2) head lowered and moved to position as near end of bench as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Shoulders may not be raised from bench during flexion nor back unduly arched during extension. Buttocks and shoulders must remain on bench during movement.

2. Neck Lateral Flexion. Starting position--Sitting position in low-backed armchair, back straight, hands grasping chair arms, upper arms hooked over back of chair. Instrument fastened to back of head. Movement--Count (1) head moved in arc sideward to the left as far as possible, dial locked, (2) head moved in arc sideward to the right as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Position in chair may not be changed during movement. Shoulders may not be raised or lowered.

3. Neck Rotation. Starting position--Supine position on bench, head and neck projecting over, shoulders touching edge and arms at sides of bench. Instrument fastened to

top of head. Movement--Count (1) head turned left as far as possible, dial locked, (2) head turned right as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Shoulders may not be raised from bench.

4. Shoulder Flexion and Extension. Starting position--Standing position at projecting corner of wall, arm to be measured extending just beyond projecting corner, arms at sides, back to wall; shoulder blades, buttocks, and heels touching wall. Instrument fastened to side of upper arm. Movement--Count (1) arm moved forward and upward in an arc as far as possible, palm of hand sliding against wall, dial locked, (2) arm moved downward and backward in an arc as far as possible, palm of hand sliding against wall, pointer locked, (3) subject relaxes, reading taken. Caution--Heels, buttocks, and shoulders must touch wall at all times during movement. Elbow of arm being measured must be kept straight. Palm of hand of arm being measured must be against wall when dial and pointer are locked.

5. Shoulder Adduction and Abduction. Starting position--Standing position with arms at sides, left (right) side of body toward wall, shoulder touching same, left (right) fist doubled with knuckles forward, thumb side of fist touching hip and opposite side of fist touching wall, feet together, knees and elbows straight. Instrument fastened to back of right (left) upper arm. Movement--

Count (1) palm of right (left) hand pressed against side of leg, dial locked, (2) arm moved sideward, outward, and upward in an arc as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Left (right) fist must be kept in contact with the body and wall at all times. Knees, body, and elbows must be kept straight through movement. Arm must be raised directly sideward, not forward or backward. Heels of feet may not be raised from floor.

6. Shoulder Rotation. Starting position--Standing position at projecting corner of wall, arm to be measured extended sideward and bent to right angle at elbow, shoulder extended just beyong projecting corner, opposite arm at side of body, back to wall; shoulder blades, buttocks, and heels touching wall. Instrument fastened to side of forearm. Movement--Count (1) forearm moved downward and backward in an arc as far as possible, dial locked, (2) forearm moved forward, upward, and backward in arc as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Upper arm being measured must be held directly sideward and parallel with the floor during movement. Heels, buttocks, and shoulders must touch wall at all times.

7. Elbow Flexion and Extension. Starting position--Squatting or sitting position facing table or bench with upper portion of arm being measured resting back down across nearest table corner so that the elbow extends

just beyond one edge and the armpit is resting against the adjacent edge. Instrument fastened to back of wrist, Movement--Count (1) wrist moved upward and backward in an arc to position to near shoulder as possible, dial locked, (2) wrist moved forward and downward until arm is forcibly extended, pointer locked, (3) subject relaxes, reading taken. Caution--Upper arm may not be tilted or moved during measurement.

8. Radial-Ulnar Supination and Pronation. Starting position--Sitting position in standard armchair, back straight, forearms resting on chair arms, fists doubled and extended beyond ends of chair arms, wrist of arm to be measured held straight. Strap is grasped in hand, fastening instrument to front of fist. (Common chair and table of suitable height may be substituted for armchair.) Movement--Count (1) thumb-side of fist turned outward and downward as far as possible, dial locked, (2) thumb-side of fist turned upward, downward, and inward as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Body and forearm must remain stationary, except for specified movement, throughout measurement. No leaning of the body may be permitted.

9. Wrist Flexion and Extension. Starting position--Sitting position in standard armchair, back straight,

forearms resting on chair arms, fists doubled and extended beyond ends of chair arms, palm of hand to be measured turned up. Instrument fastened to thumb-side of fist. (Common chair and table of suitable height may be substituted for armchair.) Movement--Count (1) fist moved upward and backward in an arc as far as possible, dial locked, (2) fist moved forward, downward, and backward in an arc as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Forearm may not be raised from chair arm during movement.

10. Ulnar and Radial Flexion. Starting position--Sitting position in standard armchair, back straight, forearms resting on chair arms, fists doubled and extended beyond ends of chair arms, thumb-side of hand to be measured turned up. Instrument fastened to back of hand. (Common chair and table of suitable height may be substituted for armchair.) Movement--Count (1) fist moved upward and backward in an arc as far as possible, dial locked, (2) fist moved downward and backward as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Forearm may not be raised from chair arm during movement. Fist may not be turned inward or outward during measurement.

11. Hip Extension and Flexion. Starting position--Standing position, feet together, knees stiff, arms extended above head, hands clasped with palms up. Instrument fastened

to either side of hip at height of umbilicus. Movement--Count (1) bend backward as far as possible, dial locked, (2) bend forward as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Knees may not be bent but must remain straight throughout movement. Feet may not be shifted. Toes and heels may not be raised.

12. Hip Adduction and Abduction. Starting position--Standing position, feet together, knees straight, arms at sides. Instrument fastened to back of either leg. Movement--Count (1) starting position, dial locked, (2) leg to which instrument is not attached is moved sideward as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Body must remain in upright position throughout movement. Knees must be kept straight with the feet assuming a position on line and parallel.

13. Hip Rotation. Starting position--Sitting position on bench with left (right) leg resting on and foot projecting over end of bench, knee straight, right (left) leg extending downward, foot resting on floor. Instrument fastened to bottom of left (right) foot. Movement--Count (1) left (right) foot turned outward as far as possible, dial locked, (2) left (right) foot turned inward as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Knee and ankle joints must remain locked throughout movement. Position of hips may not be changed

during measurement.

14. Knee Flexion and Extension. Starting position--Prone position on box or bench with knees at end of and lower legs extending beyond end of bench, arms at sides of and hands grasping edges of bench. Instrument fastened to outside of either ankle. Movement--Count (1) foot moved upward and backward in an arc to position as near buttocks as possible, dial locked, (2) foot moved forward and downward, until leg is forcibly extended, pointer locked, (3) subject relaxes, reading taken. Caution--Position of upper leg may be changed during movement.

15. Ankle Flexion and Extension. Starting position--Sitting position on bench with left (right) leg resting on and foot projecting over end of bench, knee straight, right (left) leg extending downward, foot resting on floor. Instrument fastened to inside of left (right) foot. Movement--Count (1) left (right) foot turned downward as far as possible, dial locked, (2) left (right) foot turned upward and toward the knee as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Knee of leg being measured must be kept straight throughout movement. No sideward turning of the foot may be allowed.

16. Trunk Extension and Flexion. Starting position--Standing position, feet together, knees straight, arms extended above head, hands clasped with palms up. Instrument

fastened to either side of chest just below armpit at nipple height. Movement--Count (1) bend backward as far as possible, dial locked, (2) bend forward as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Knees must be kept straight throughout movement. Feet may not be shifted. Toes and heels may not be raised from floor.

17. Trunk Lateral Flexion. Starting position--Standing position, feet together, knees straight, arms at sides. Instrument fastened to middle of back at nipple height. Movement--Count (1) bend sideward to the left as far as possible, dial locked, (2) bend sideward to the right as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Both feet must remain flat on floor, heels may not be raised during measurement. Knees must be kept straight throughout movement. Subject may bend sideward and backward, but must not be allowed to bend forward.

18. Trunk Rotation. Starting position--Supine position on bench, legs together, knees raised above hips, lower legs parallel to bench and body. Assistant holds subject's shoulders. Instrument fastened to middle rear of upper legs, strap going around both legs. Movement--Count (1) knees lowered to the left as far as possible, dial locked, (2) knees brought back to starting position and

lowered to the right as far as possible, pointer locked, (3) subject relaxes, reading taken. Caution--Subject's shoulders must not be permitted to rise from the bench during movement. Knees must be moved directly sideward at the height of the hips, not above or below (40).

APPENDIX B

SAMPLE OF THE FORM USED FOR RECORDING DATA

Name _____ Age _____ Date _____

Position Wrestling Height _____ Weight _____

Experience: 1. High School _____
2. Service _____
3. College _____

Joint	Degrees Right 1st	Right 2nd	Left 1st	Left 2nd
Shoulder				
Flex-Ext				
Add-Abd				
Rotation				
Elbow				
Flex-Ext				
Radial-Ulnar				
Sup-Pro				
Flex-Ext				
Wrist				
Flex-Ext				
Knee				
Flex-Ext				
Ankle				
Flex-Ext				
Inv-Ever				

Joint	Degrees Right 1st	Right 2nd	Left 1st	Left 2nd
Hip				
Flex-Ext				
Add-Abd				
Rotation				
Trunk				
Flex-Ext				
Lat-Flex				
Rotation				
Neck				
Flex-Ext				
Lat-Flex				
Rotation				

APPENDIX C

Raw Data
41 Wrestlers
Subjects

Test Variables	1	2	3	4	5	6	7	8	9	10	11
R Shoulder FE	158	183.5	224	186	222.5	217.5	207	184.5	208.5	187	218.5
L Shoulder FE	171	180.5	240	177.5	187	196.5	195.5	217	168.5	173.5	147
R Shoulder AD-AB	142.5	178	160	153	150.5	161.5	170	155.5	145.5	152	209.5
L Shoulder AD-AB	155	160.5	157	167	198.5	153	160	164	150.5	135.5	216
R Elbow FE	149	156.5	168	152	165.5	173	154	134.5	151	163	152
L Elbow FE	146	162	165	159.6	148	137.5	150	131.5	156.5	167.5	147.5
R Radial-Ulnar SP	167.5	192	238.5	198	207.5	157.5	188.5	170	189.5	145.5	176.5
L Radial-Ulnar SP	159.5	197.5	209	171	206.5	176.5	198	170.5	167.5	188.5	183.5
R Radial-Ulnar FE	73	73.5	107.5	101.5	76	84.5	82	72	99	100	88
L Radial-Ulnar FE	60	82.5	76	86	78	75	88.5	81.5	89.5	106.5	72.5
R Wrist FE	113	132.5	174.5	129.5	140.5	97.5	137	144.5	149.5	193.5	132
L Wrist FE	95	126.5	155.5	131.5	119.5	76	127.5	155.5	147.5	179	113.5
R Knee FE	124	143.5	154.5	149.5	153	145	147	147.5	143.5	154.5	131
L Knee FE	120	145	157	151	162	151	153	144	151	155.5	144.5
R Ankle FE	153.5	41.5	63	73	72	60	50	59.5	71	77	49.5
L Ankle FE	60.5	51	75	73.5	59	58.5	54.5	64.5	71	74.50	61
Hip FE	108.5	108.5	127.5	151	139	105.5	146.5	109.5	120.5	156.5	113
Hip AD-AB	68	63.5	55	81	53	52.5	68	62	69.5	70.5	53.5
R Hip Rotation	55	84	121.5	109	93.5	80	136.5	81	89.5	110.5	99.5
L Hip Rotation	49.5	69.5	121.5	99	78	94.5	116.5	95.5	94	89.5	84
Trunk FE	176.5	171	114.5	212	221.5	185.5	220.5	182	179.5	227.5	179
Trunk LF	132	129.5	142	201	137.5	127	158	140.5	121	133.5	108.5
Trunk ROT	111	129.5	184	164	157.5	172.5	171	140	137.5	136.5	113.5
Neck FE	112	112	165	132.5	163	111	144	150	147	148	120
Neck LF	82	114	114	134.5	102.5	110	116	119.5	82	116	75.5
Neck ROT	138	184	192	175	194	179	201	185	179.5	189.5	175.5
R Shoulder ROT	143	168.5	224	202.5	186	222.5	202.5	173	158.5	204.5	171
L Shoulder ROT	152.5	184	249.5	199	204	203	213	193	162	195	182.5

Subjects

Test Variables	12	13	14	15	16	17	18	19	20	21	22
R Shoulder FE	187	214	233.5	235	207.5	206.5	214	227	209.5	197.5	204.5
L Shoulder FE	171	218.5	191.5	210.5	189.5	217	220	200	199	212	224
R Shoulder AD-AB	159.5	145	218.5	144.5	148.5	145.5	164.5	152	133	146	167.5
L Shoulder AD-AB	157	146	181.5	137.5	150.5	196	156	214.5	214.5	145.5	168
R Elbow FE	148.5	165.5	158	154	154.5	166	146	159.5	134	159	169.5
L Elbow FE	148	158.5	142	146.5	142	168.5	159.5	163	154	146.5	164
R Radial-Ulnar SP	161.5	178	161.5	197	178	188.5	185	206.5	203	206	215
L Radial-Ulnar SP	166	181.5	125.5	202.5	200	238	196.5	198	191.5	203.5	212.5
R Radial-Ulnar FE	86.5	86.5	83.5	64.5	81.5	102.5	76	102	93	97.5	87.5
L Radial-Ulnar FE	85.5	79.5	69	65	93	77	113.5	84	86	90.5	85
R Wrist FE	138.5	174	117.5	142.5	110.5	160	139	138.5	126.5	124	176
L Wrist FE	145.5	143.5	122	230	132.5	167	123	246	139	115	163
R Knee FE	148.5	136	143	159	140	144	138.5	149.5	144.5	135	133.5
L Knee FE	151	143	139.5	134.5	135	145	135	153.5	152.5	129.5	125
R Ankle FE	62	67.5	74	59.5	49.5	74	46	52	51	46.5	64
L Ankle FE	51	80.5	66	67	48.5	68.5	54.5	63.5	68	57.5	55
Hip FE	111.5	127	141.5	128	91	112.5	129.5		115.5	91.5	132
Hip AD-AB	59.5	61	64.5	53	51.5	65	51.5	69.5	59.5	59.5	72.5
R Hip Rotation	61	94.5	81	98.5	123	144.5	93	121	84	89.5	86
L Hip Rotation	63	92.5	76.5	95.5	115	123.5	84.5	103	82.5	83.5	93.5
Trunk FE	177	199	196	178.5	167	207	201		182.5	155	204.5
Trunk LF	127.5	122	98	119	87	174.5	128		123.5	106	140.5
Trunk ROT	166	132.5	122.5	101.5	81.5	176	131.5		179	130	161
Neck FE	134.5	139.5	140	142.5	113.5	157	155	119.5	134.5	119.5	148.5
Neck LF	110.5	91	88.5	101	92.5	165.5	91	118	122	84	141.5
Neck ROT	197.5	189	146.5	169.5	139	221	167	188	188	170	174.5
R Shoulder Rot	179.5	161	182	178.5	182.5	229.5	226.5	217	180.5	193.5	227
L Shoulder ROT	179	166	175	185	203.5	223.5	192.5	183	186	217	202.5

Subjects

Test Variable	23	24	25	26	27	28	29	30	31	32	33
R Shoulder FE	224.5					209	207	201	186.5	206	204.5
L Shoulder FE	202.5					206	174	195.5	179.5	211.5	195.5
R Shoulder AD-AB	146.5						152.5	137.5	146	151.5	157
L Shoulder AD-AB	153						160	150	158.5	148.5	139.5
R Elbow FE	169.5	165	160	156	184.5	192.5	157	150.5	146.5	153	158
L Elbow FE	165	162.5	155.5	154	159.5	160	157	151	146	162	154
R Radial-Ulnar SP	183.5	179.5	151	180	183.5	194.5	176	175	165.5	190.5	192
L Radial-Ulnar SP	199	165.5	159.5	181.5	197.5	212.5	179.5	166	163.5	194.5	190.5
R Radial-Ulnar FE	85.5	78	76	103.5	92.5	96.5	74	87	82.5	85	77
L Radial-Ulnar FE	85	89.5	77	123.5	85	84	72	84.5	69.5	91.5	77
R Wrist FE	119	141	169	139.5	142.5	134.5	120	138	110.5	172	141.5
L Wrist FE	143.5	147.5	156	165	143	115.5	127	128.5	117	162	140
R Knee FE	146	152	137	140.5	140.5	146	152	133	136	139	145
L Knee FE	143.5	153.5	137	144	146	138.5	149	136.5	136	132	143
R Ankle FE	58	82.5	58.5	69.5	59.5	50.5	62	38.5	47	66.5	72.5
L Ankle FE	56.5	70.5	66	63	67	59	59.5	37	53.5	50	75
Hip FE	105	131.5	127	134.5	145.5	112.5	124.5	87.5	109	122.5	117.5
Hip AD-AB	62.5	63.5	50.5	55	58.5	685	74.5	65	65.5	64.5	66
R Hip Rotation	85	87	105.5	125.5	67	73	69	137.5	77.5	92.5	94
L Hip Rotation	66	117.5	71.5	123.5	71.5	91	63.5	123	74.5	68	92
Trunk FE	168	202	198	223.5	160.5	176	202.5	176	177.5	204.5	211.5
Trunk LF	110.5	129	132	153.5	132.5	124.5	167	114	139.5	121	148.5
Trunk ROT	169.5	153	118.5	103	154.5	128	144.5	144	167.5	160	155
Neck FE	150.5	147.5	154	150	139.5	149	147.5	140	151	124.5	204
Neck LF	132	126	109	183.5	126.5	86	134	95.5	133.5	83.5	128.5
Neck ROT	185	193.5	183	143	179.5	180.5	202	203.5	189.5	180.5	204
R Shoulder ROT	203	222	220.5	197.5	207.5	193	183	183.5	175.5	184	192.5
L Shoulder ROT	202.5	202	211	165.5	219.5	177	163.5	196.5	196.5	177	200.5

Subjects

Test Variable	34	35	36	37	38	39	40	41
R Shoulder FE	267	196.5	222	242.5	242.5	215	237.5	218.5
L Shoulder FE	257.5	151.5	212	267.5	262	237	222.5	209
R Shoulder AD-AB	208.5	150.5	187	200	220.5	203	182.5	138.5
L Shoulder AD-AB	197.5	136.5	203	210	180	198	196	150
R Elbow FE	169	160.5	144	139	145	159	169.5	155
L Elbow FE	163.5	155	143	136.5	139.5	154	169	153
R Radial-Ulnar SP	176	202.5	156.5	154	197.5	154	212.5	218.5
L Radial-Ulnar SP	175.5	199.5	153.5	158	167.5	168.5	212	186
R Radial-Ulnar FE	82	83.5	62.5	60.5	70.5	92.5	95	70
L Radial-Ulnar FE	77	77	63.5	55	67.5	100.5	104	74.5
R Wrist FE	100	161	93	121.5	72.5	109.5	112	161
L Wrist FE	111	131	81.5	118	91.5	109	125	138.5
R Knee FE	134	136	131.5	128.5	131.5	130.5	146	138.5
L Knee FE	132	150.5	135	133	132	132.5	150.5	136
R Ankle FE	49	73	41.5	43.5	41	49.5	57	42.5
L Ankle FE	53.5	77.5	60	48	52	47	62	53.5
Hip FE	122.5	115	116	94	115	113.5	126.5	101
Hip AD-AB	57.5	56	56	48	56.5	56	49	51
R Hip Rotation	79	115	82.5	92.5	57.5	94.5	81.5	85
L Hip Rotation	79.5	111.5	83	83	63.5	91.5	90	83.5
Trunk FE	214	208	187.5	202	183.5	187	202.5	193.5
Trunk LF	126.5	147	95.5	128	105.5	85.5	116	139
Trunk ROT	141.5	163	109.5	116.5	132	92.5	137	131
Neck FE	157	153.5	132.5	123	111	104	144	128.5
Neck LF	196	155.5	81.5	97	116.5	85.5	112	106
Neck ROT	95.5	126	167.5	190.5	162.5	159	193.5	184
R Shoulder ROT	190.5	215.5	183.5	184.5	174	179	210.5	194
L Shoulder ROT	182.5	208.5	192	168.5	171	176.5	187	208