A COMPARATIVE STUDY OF THE DIFFERENCES OF ARM AND SHOULDER GIRDLE STRENGTH BETWEEN JUNIOR HIGH SCHOOL GIRLS AGES 12 THROUGH 16

A THESIS

SUBMITTED IN PARTIAL FULLFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN PHYSICAL EDUCATION IN THE GRADUATE SCHOOL OF THE TEXAS WOMAN'S UNIVERSITY

COLLEGE OF HEALTH, PHYSICAL EDUCATION AND RECREATION

BY

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DENTON, TEXAS
AUGUST, 1970

ACKNOWLEDGMENTS

The author wishes to express her sincere appreciation to Doctor Joel Rosentswieg for his sustained efforts, assistance and interest in directing this study. Grateful acknowledgment is made to Doctor Frank C. Hostetler and Doctor Berton E. Lyle, Jr., whose helpful recommendations were incorporated into this study.

Appreciation is extended to the Principal of Louis Jordon Christen Junior High School for his permission in making possible the conduct of this study. To the students who also assisted in the test administration, a grateful thank you is extended.

The author is particularly indebted to her parents, Mr. and Mrs. Jose A. Campos for their encouragement and supporting influence throughout the year during the completion of the study.

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CHAPTER I

INTRODUCTION

Measures of strength have long been of interest to the discipline of physical education. It has always been obvious that a certain amount of strength is necessary for any degree of muscular work, and it has been recognized that the individual with superior strength can perform a task with less effort than an individual deficient in strength. Optimal strength, because of its importance to human behavior, may be considered a prerequisite for human effectiveness.[1]

The measurement of strength is a logical and necessary part of physical education programs.[2] Strength testing in the form of weight lifting is as old as history. In this country, Sargent's Inter-

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[1] H. Harrison Clarke, Muscular Strength and Endurance in Man (Englewood Cliffs, New Jersey: Prentice-Hall Incorporate, 1966), p. 2.

[2] Marjorie U. Wilson, "A Study of Arm and Shoulder Girdle Strength of College Women in Selected Test" (unpublished Master's Thesis, University of Iowa, 1943), p. 1.

collegiate Strength Tests mark a shift of emphasis from anthropometric measurements to the measurement of actual muscular work of an individual.[1] In 1880, the Sargent tests were introduced at Harvard University in connection with physical examinations and were soon required for entrance in competitive athletics by fifteen colleges and universities.[2]

Considerable research of strength in men has appeared in the literature during the past seventy years. McCloy, in 1932, published a formula for the computation of chinning and dipping strength.[3] McCloy's formula has been statistically determined to correlate approximately .95 with actual arm strength in males.[4] McCloy's Athletic Strength, a measure of arm strength minus three times the weight, has, in the past, been considered an accurate predictor of athletic ability for boys.[5]

Research pertaining to strength of college women is meager. Carpenter completed an extensive

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[1]Dudley A. Sargent, "The Physical Test of a Man," American Physical Education Review, XXVI (April, 1921), 23.

[2]Ibid., p. 24.

[3]Charles H. McCloy, The Measurement of Athletic Power (New York: A. S. Barnes and Company, 1932), p. 15.

[4]Ibid.

[5]Charles H. McCloy, "The Apparent Importance of Arm Strength in Athletics," Research Quarterly, V (March, 1934), 8.

investigation of strength of women in 1938.[1] The relationship of strength in women and athletic ability was measured by Carpenter in 1941, and it was found that a coefficient correlation of .395 ocurred. Carpenter, in another study of arm strength in women, found high correlations between arm and shoulder girdle strength and body weight, and between total strength and shot put ability.[2] In an analysis of the relationship of various factors to athletic performance in women, Carpenter reported that total weight in relation to "dead weight" which is not represented by muscle, has a significant relationship to the strength factor.[3]

A review of the literature indicates that most studies of strength conducted in the United States of America have been done with males. The relatively few studies of strength of women have most frequently measured females of college age. The present delineated study is concerned with the differences in measurement of arm and shoulder girdle strength among different age groups of junior high school age girls.

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[1] Aileen Carpenter, "A Critical Study of the Factors Determining Effective Strength Test for Women," Research Quarterly, IX (December, 1938), 3.

[2] Aileen Carpenter, "An Analysis of the Relationship of Factors of Velocity, Strength, and Dead Weight to Athletic Performance," Research Quarterly, XII (March, 1941), 34.

[3] Ibid.

Statement of the Problem

A comparative study of the differences of arm and shoulder girdle strength between junior high school girls of different age groups was investigated. The tests that were compared were the following: the modified pull-up, the modified push-up, traveling across the horizontal ladder, the bent arm hang, and the push and pull test. The study was conducted from January sixth to March twenty-fifth, 1970, at Louis Jordon Christen Junior High School in Laredo, Texas.

Definitions and/or Explanations of Terms

Within the content of this study, several terms are used which may be unfamiliar to the reader. In order that a common basis of understanding may be achieved, these terms are defined or explained as they are used throughout the investigation.

Arm and Shoulder Girdle Strength: for the purpose of this study the major muscle groups involved in the movement of the arm and the shoulder were the following: the biceps, the brachioradialis, the pronator teres, the flexor carpi radialis, the palmaris longus, the flexor carpi ulnaris, the flexor digitorium

sublimis, the pronator quadratus, the triceps, the pectorales, the deltoids, the trapezius, the latissimus dorsi, the subcapularus, the teres major, the minor subclavius, and the supra-infraspinatus. The term arm and shoulder girdle strength was used in this study as synonomous with the entire group of muscles.

Modified Pull-Up: In the present study the modified pull-up was used as a measure of arm strength. This test was modified to enable the feet to remain in contact with the floor. The horizontal bar was adjusted to the height at the base of the sternum for each student. The subjects were instructed to grasp the bar with the palms downward and to slide the feet under the bar until the legs and the trunk were completely extended with the arms forming a ninety degree angle at the juncture of the chest. The weight of the body rested on the heels. Keeping the trunk extended the subject pulled the body upward touching the chest to the bar as many times as possible. When the hips sagged or rose during the performance, the movement was recorded as one-half a repetition. The scoring was based on the total number of re-

petitions a subject could do.[1]

Modified Push-Up: The modified push-up is a commonly accepted measure of dynamic strength. The subject knelt on a mat or pad and placed the hands on the floor directly below the shoulders, while the feet were raised. The test consisted of bending the arms and at the same time lowering the body until the chest touched the floor, then pushing up with the arms until they were straight. The body remained in a straight line from head to knees throughout the test. No resting was permitted between push-ups. Scoring was based upon the total number of repetitions possible.[2]

Horizontal Ladder: The horizontal ladder used in the present study was a device horizontal to the floor and supported approximately seven feet above the ground. Each subject was instructed to travel in a continous movement alternating hands from rung to rung. The ladder consisted of fifteen rungs and the subject's strength was scored according to the number of rungs traveled. The subjects traveled the ladder in one way only. There was no time factor in-

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[1] Clarke, Muscular Strength and Endurance in Man, pp. 208-9.

[2] Ibid.

volved in the individual performance of the test.

Hanging in Arm-Flexed Position: The subject stood on a stool or other support, placing her hands shoulder width apart, palms outward, on a one-inch standard horizontal bar with elbows flexed to permit the chin to be above the level of the bar. The support was then removed. The subject being tested held her chin slightly above the level of the bar as long as possible. The scoring was based upon the number of seconds the student was able to maintain the position. The chin was not allowed to rest on the bar. Time was recorded from the removal of the support until the chin touched or fell below the level of the bar.[1]

Hand-dynamometer: The hand-dynamometer used in this investigation was a spring loaded device that measures strength in units of pounds. The hand-dynamometer, a Narragansett model, was placed between the jaws of a push and pull attachment. With the palms of the hands facing each other in front of the chest and with the forearms horizontal, the subject

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[1]Clarke, Application of Measurement to Health and Physical Education, pp. 208-9.

grasped the handles of the push and pull attachment. The position of the hands and arms for pulling strength proved to be the same as that for pushing strength. The subject pulled on the handles as vigorously as possible. The scores were recorded separately for pulling and pushing. There was one single trial permitted per test. Neither hands nor the push and pull apparatus were permitted to touch the chest. Scoring was based on the number of pounds of pressure exerted.[1]

Purpose of the Study

The general purpose of the study was to compare arm and shoulder girdle strength of five age groups (twelve, thirteen, fourteen, fifteen, and sixteen) of junior high school girls. Specifically, one hypothesis was tested:

> There is no significant difference in arm and shoulder girdle strength between junior high school girls, age twelve through sixteen, as measured by five different tests: the modified pull-up, the modified push-up, the hanging in arm-flexed position, traveling across the horizontal ladder, and the push and pull test measured by the hand-dynamometer.

Delimitations of the Study

The study was delimited to 206 junior high

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[1] *Ibid.*

school girls, age twelve through sixteen, enrolled in the required physical education classes at Louis Jordon Christen Junior High School in Laredo, Texas during the school year 1969-1970. The study was further delimited to three testing periods with a two week interval in an attempt to avoid physical and mental fatigue factors that could affect the test results.

Summary

Measures of strength have long been of interest to the discipline of physical education. Recent emphasis on physical fitness has brought about a renewed interest in strength and the interest has further emphasized the fact that strength is a logical and necessary part of physical education programs.

A comparative study of the differences of arm and shoulder girdle strength between junior high school girls of different age groups was investigated. The tests that were employed in the comparison were the following: the modified pull-up, the modified push-up, traveling across the horizontal ladder, the bent arm hang, and the push and pull test.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

In this chapter the related studies pertaining to the strength of women and the specific tasks used to measure arm and shoulder girdle strength are presented. It is noted that research pertaining to strength of women is meager.

Carpenter[1] reported the results of an extensive investigation of strength in women in 1938. She studied the effect of strength and athletic ability and found a positive correlation of .395 in college women. One phase of the study attempted to determine the relationship between the ability to perform pull-ups and chin-ups and to determine which of these two measures was the better index of shoulder girdle strength. Pull-ups were favored in this study.[2]

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[1] Aileen Carpenter, "A Critical Study of the Factors Determining Effective Strength for Women," Research Quarterly, IX (December, 1938), 3-27.

[2] Ibid.

In a later study concerned with athletic performance, Carpenter[1] found a positive correlation of .509 between shoulder girdle strength and shot put performance. Factor analytic techniques were used and three basic factors of athletic performance determined: strength, power, and dead weight. It was noted that the weight factor had a negative relationship to all measures taken except with the strength factor, shot put performance, shoulder girdle strength and total strength. The strength factor, as would be expected, was closely related to total strength as measured in the study, and the broad jump, while the velocity factor was primarily related to the track and field activities and had a correlation of almost zero with the strength and weight measures.

Wilson,[2] in a study of arm and shoulder girdle strength of college women analyzed several selected tests in relation to strength and attempted to evaluate and classify the selected performance tests. The performance tests used were: the bent arm hang, the push-up (knees), the modified pull-up, and the push and pull test. Fifty-two physical education major students were

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[1]Aileen Carpenter, "An Analysis of the Relationship of Factors of Velocity, Strength, and Dead Weight to Athletic Performance," Research Quarterly, XII (March, 1944), 34-9.

[2]Marjorie U. Wilson, "A Study of Arm and Shoulder Girdle Strength of College Women in Selected Tests," Research Quarterly, XVI (May, 1955), 159-62.

selected as subjects in the belief that they could be motivated more readily to approximate maximal strength output in comparison with an unspecified group of students. Wilson concluded that: Strength can be measured by performance tests with a relatively high degree of validity.

Hutinger[1] conducted a study to determine the effect of systematic horizontal ladder activities on upper body strength of sixty-two third grade boys and girls. He determined whether a specified amount of time spent in practice on the horizontal ladder would result in significant changes in strength. The six tests of strength that were administered at the beginning and the end of the three month period were: push-ups, pull-ups, grip right, grip left, pulling strength, and pushing strength. Hutinger computed *t*-ratios to determine if there were significant differences between the obtained means of the two groups. The experimental group made statistically significant gains in push-ups, pull-ups, and pushing strength.

Espenschade and Meleney[2] conducted a study

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[1]Paul W. Hutinger, "Effect of Systematic Horizontal Ladder Exercises Upon Body Strength of Third Grade Children," Research Quarterly, XVI (May, 1955), 159-62.

[2]Anna S. Espenschade and Helen E. Meleney, "Motor Performances of Adolescent Boys and Girls of Today in Comparison With Those of Twenty-Four Years Ago," Research Quarterly, XXXII, No. 2 (May, 1961), 186-9.

in 1958 to compare performance scores of adolescent boys and girls in a number of motor skills with the scores of students of the same age, grade, and school who had performed the same tests during the 1934-1935 school year. Identical administrative procedures were followed. The measures included height and weight, 50 yards dash, standing broad jump, jump and reach, softball throw for distance, the Brace Test, and three dynamometric strength measures: grip, "push" and "pull". The instruments used for the later measures were the same ones utilized in the earlier study, but were recalibrated to ensure accuracy. Espenchade and Meleney concluded that:

> Boys and girls of today are taller and heavier than those of the same age, grade, and school of 24 years ago. Girls average one inch taller and six pounds heavier. Differences for boys are over two inches and ten pounds. Better nutrition and almost certain maturity must account for these differences.
>
> Both boys and girls of today are significantly poorer than those of earlier periods in dash and broad jump but better in the jump and reach. Boys of today are superior also in throwing for distance and in the Brace Test.
>
> In dynamometer strength measures, both boys and girls of today are superior in the "pull". Present day boys also excel in the grip. Girls of the earlier period were superior in the "push".[1]

Wessel and Nelson[2] conducted a study to in-

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[1] Ibid.

[2] Janet A. Wessel and Richard C. Nelson, "Relationship Between Grip Strength and Achievement in Physical Education Among College Women," Research Quarterly, XXXII, No. 2 (May, 1961), 244-8.

vestigate the relationship between strength and achievement in physical education among 200 college women by comparing dynamometric grip strength with grades they received in the instructional physical education courses. They also compared the results obtained on college women with those of college men as reported in a companion study by Tinkle and Montoye.[1] A table of random numbers was used by Wessel and Nelson to secure the sample from Michigan State University students. The results indicated grip strength among college women was significantly related to achievement in physical education instructional courses as measured by the grades these students received. Grip strength was found to be directly related to, and probably dependent upon, body weight and only indirectly related to height in college women. The relationship between grades received in physical education and grip strength among college women substantiated the results of the college men's study as reported by Tinkle and Montoye.[2]

Eckert and Day[3] conducted a study to examine the relationship between strength and work load during the performance of push-ups on college women. Fifteen

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[1] Ibid.

[2] Ibid.

[3] Helen M. Eckert and June Day, "Relationship Between Strength and Work Load in Push-Ups," Research Quarterly, XXXVIII, No. 3 (October, 1967), 380-3.

well-conditioned women, who had been thoroughly trained in the correct technique for modified push-ups, were tested for maximal pushing strength in two positions through the use of a special harness and a cable tensiometer, and for the number of complete push-ups they were able to perform at the rate of forty-one push-ups per minute. The amount of weight supported by the hands was determined through a spring balanced scale. The Pearson-Product Moment technique was used to calculate the coefficient of correlation for reliability between the highest strength score and the average to two other strength scores. Eckert and Day concluded that:

> For well-conditioned women, there is a statistically significant positive relationship between work load in the performance of women's push-ups and maximal strength in the push-up position.

Hinson[1] conducted a study to examine, through electromyography, the muscular activity required to perform four types of push-up exercises and to determine the existence of patterns of muscular contractions among adult women. Ten women were selected at random from among a group of volunteers who were able to execute no more than five knee push-ups. Ten more women who were able to perform ten or more full push-ups were

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[1]Marilyn M. Hinson, "An Electromyographic Study of the Push-Up for Women," Research Quarterly, XXXX, No. 2 (May, 1969), 305-8.

similarly identified. The muscles studied were: the triceps brachii, the deltoid, the pectoralis major, the trapezius, the serratus anterior, the rectus abdominis, and the external oblique. The recorded data were analyzed by averaging, for each muscle, the measurements taken from all subjects. The four push-up exercises were then compared by muscle to muscle. Hinson concluded that:

> The full push-up appeared to require little more muscular activity than that required by the bench push-up and there was no dependency upon the use of equipment. Unless other justification is presented for the retaining of the bench push-up one might question its usefulness.
>
> Whereas strength was a factor which differentiated one group from the other, analysis indicated a greater level of muscular movement for the low strength subjects than for the high strength subjects executing a given task. This implies to the investigator a lack of efficiency and/or coordination for those of lower strength levels.[1]

Cotten and Marwitz[2] conducted a study to determine the relationship between two methods of doing the flexed-arm hang and pull-ups. Fourteen undergraduate women physical education majors who were enrolled in a tumbling class participated in this study. In performing the flexed-arm hang

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[1] Ibid.

[2] Doyice J. Cotten and Bonnie Marwitz, "Relationship Between Two Flexed-Arm Hangs and Pull-Ups for College Women," Research Quarterly, XXXX, No. 2 (May, 1969), 415-16.

the subject gripped a high bar with an overhand grip and raised her body to a position where the chin was above the bar. A stop watch was started as soon as the subject assumed the flexed hanging position. The watch was stopped when the subject's chin touched the bar, her head tilted backwards to keep her chin above the bar, or her chin dropped below the bar. In performing the modified flexed-arm hang the subject assumed the hanging position as in the flexed-arm hang. A stop watch, started as soon as she assumed the flexed hanging position, was stopped when the angle at the elbow became greater than 90 degrees.

In performing the pull-up each subject was instructed to perform as many pull-ups as possible from a high bar, using an overhand grip. The subjects who could not complete one pull-up were awarded a partial score in order to have some identification of the arm strength of each student. Once a subject completed the first pull-up, her score was recorded in whole numbers only.

Intercorrelations were computed, using the better score of two trials for each item to compare the two methods of doing the flexed-arm hang with pull-ups. The resulting correlation coefficients were compared using a t-test for the significance of the difference between the two correlation coefficients for correlated samples. Cotten and

Marwitz concluded that:

> The correlation between the criterion for arm strength, pull-ups, and the modified flexed-arm hang was significantly higher than that between the criterion and the flexed-arm hang. Hence the modified flexed-arm hang appears to be a better measure of arm strength than the flexed-arm hang.

From the survey of related literature it was determined that a paucity of studies concerning the strength of young women existed and that there is a need to pursue the study of arm and shoulder girdle strength among junior high school girls due to the lack of studies involving subjects of this age.

Summary

The related literature appears as far back as 1938 when Carpenter made extensive investigations of the strength of college women. Carpenter found a positive correlation between shoulder girdle strength and body weight and a similar correlation between total strength of college women in 1943. Wilson analyzed several selected performance tests in relation to strength and attempted to evaluate and classify the selected performance tests. Wilson concluded that strength can be measured by performance tests with a relatively high degree of validity. Hutinger, in 1955, conducted a study on the effect of systematic horizontal ladder activities on upper

body strength of third grade children. He found that this type of activity increased strength.

Espenschade and Meleney conducted a study in 1959 to compare the motor performance of adolescent boys and girls with similar subjects that were measured on the same test in 1934-1935. Differences favoring both age periods were found. Wessel and Nelson conducted a study in 1961 to investigate the relationship between strength and achievement in physical education among 200 college women by comparing grip strength. The results indicated grip among college women was signficantly related to achievement in physical education instructional courses as measured by grades.

Eckert and Day, in 1967, conducted a study to examine the relationship between strength and work load during the performance of push-ups on fifteen college women. Their findings concluded that for well-conditioned women, there is a statistically significant positive relationship between work load in the performance of women's push-ups and maximal strength in the push-up position.

Hinson, in 1969, conducted a study to examine, through electromyography, the muscular activity required to perform four types of push-up exercises and to determine the existence of patterns of muscular contractions among them. It was concluded that the full push-up appeared to require little more muscular

activity than that required by the bench push-up and there was no dependency needed for the use of equipment. The justification for retaining the bench push-up was thus questioned. Strength was a factor which differentiated one group from the other and analysis indicated a greater level of muscular involvement for the low strength subjects than for the high strength subjects executing a given task.

Cotten and Marwitz, in 1969, conducted a study to find the relationship between two flexed-arm hangs and pull-ups. It was found that the correlation between the criterion for arm strength, which was performance on pull-ups, and the modified flexed-arm hang was significantly higher than that between the criterion and the flexed-arm hang. The modified flexed-arm hang appeared to be better measure of arm strength than the flexed-arm hang.

The review of the related literature involving arm and shoulder girdle strength indicated that no study had been found that used junior high school girls as subjects. A need for such an investigation led to the pursuance of this study. The procedures in the conduct of the study using junior high school girls as subjects is delineated in Chapter III.

CHAPTER III

PROCEDURES OF THE STUDY

The purpose of the study was to compare arm and shoulder girdle strength of twelve, thirteen, fourteen, fifteen, and sixteen year old junior high school girls. The procedures that were employed in the conduct of the study are presented in this chapter.

Sources of Data

Both human and documentary sources were utilized in the conduct of the study. The human sources consisted of 222 junior high school girls enrolled in the seventh, eighth, and nineth grades. The subjects used were enrolled in the required physical education classes at Louis Jordon Christen Junior High School, Laredo, Texas, during the school year 1969-1970. The other human sources which provided advice and guidance were selected authorities in the field of physical education. Books, pamphlets, periodicals, research studies, theses, dissertations, and other unpublished materials were utilized as documentary sources.

Preliminary Procedures

Selected literature related to pertinent aspects of the study were surveyed, studied, and assimilated. Upon the basis of this material a tentative outline was developed and then presented at a Graduate Seminar of the College of Health, Physical Education and Recreation of the Texas Woman's University in Denton, Texas. A revised copy of the outline was filed as a prospectus of the approved study in the office of the Dean of Graduate School.

Criteria for Selection of Tests

Prior to the selection of the tests, criteria for the selection were established. A survey of authoritative sources, Willgoose,[1] Bovard,[2] and Scott and French,[3] indicated that a test should meet the following minimum criteria: validity, reliability, objectivity, and administrative feasibility.

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[1]Carl E. Willgoose, Evaluation in Health Education and Physical Education (New York: McGraw-Hill Book Company, Inc., 1961), p. 24.

[2]John F. Bovard, Frederick W. Cozens, and E. Patricia Hagman, Tests and Measurements in Physical Education (Philadelphia: W. B. Saunders Company, 1949), p. 327.

[3]M. Gladys Scott and Esther French, Measurement and Evaluation in Physical Education (Dubuque: William C. Brown Company, 1959), p. 19.

Selection and Description of Tests

Prior to selection of tests to be used, the investigator surveyed the related literature to determine the tests most frequently used in the measurement of arm and shoulder girdle strength. The criteria for the selection of the tests of most investigations reviewed were based on reliability, validity, objectivity, and administrative feasibility.

Excessive expenses were not incurred in the construction of the testing equipment. The construction and assembly of the horizontal ladder amounted to sixty-five dollars. No personal cost was involved in the construction of the equipment used for the modified pull-up. The hand-dynamometer and the modified pull-up instruments were made available to the investigator by the College of Health, Physical Education and Recreation of the Texas Woman's University.

The following six tests, deemed appropriate for the age group studied, have been used in previous studies of arm and shoulder girdle strength. The modified push-up, the modified pull-up, the flexed arm hang, the horizontal ladder, and the push and pull test were the tests selected for the investigation.

Description of the Tests

In performing the modified push-up the subject

kneels and places the hands on the floor directly below the shoulders while the feet are raised. The test consists of bending the arms while lowering the body until the chest touches the floor, then pushing up with the arms until they are straight. The modified push-up has a reliability reported as high as .93, and a reported validity of .72 with the Rogers Short Index.[1]

For the modified pull-up test the subject grasps the bar with the palms downward and the feet are slid under the bar until the legs and the trunk are completely extended with the arms forming a ninety degree angle at the juncture of the chest. The weight of the body rests on the heels. Keeping the trunk extended the subject pulls the body upward touching the bar with the chest as many times as possible. When the hips sagged or rose during the performance, the movement was recorded as one-half a repetition. The validity was reported as .80 when correlated with the Rogers Short Index.[2] A reliability for boys of .92 has been reported.[3]

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[1] Barry L. Johnson and K. Nelson, Practical Measurements for Evaluation in Physical Education (Minneapolis, Minnesota: Burgess Publishing Company, 1969), p. 284.

[2] Scott and French, Measurement and Evaluation in Physical Education, p. 296.

[3] Johnson and Nelson, Practical Measurements for Evaluation in Physical Education, p. 243.

For the flexed-arm hang the subject stands on a stool placing her hands shoulder width apart, palms outward, grasping a one-inch standard horizontal bar with elbows flexed to permit the chin to be level with the bar. The support is removed and the subject maintains the flexed-arm hang position as long as possible. The time is then recorded from the beginning of the hang until the position can no longer be maintained. The flexed-arm hang has been reported as having a reliability as high as .90.[1] Face validity was accepted for this test.

In performing the horizontal ladder test the subject is instructed to travel in a forward continuous movement alternating the hands from rung to rung. The ladder consisted of fifteen rungs and the subject's strength was recorded according to the number of rungs traveled. The subjects traveled one way only. There was no time factor involved in the individual performance of the test. Hutinger used the horizontal ladder in a study and concluded that the horizontal ladder is an effective apparatus in increasing upper body strength.[2] No reliability or validity coefficients

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[1] Johnson and Nelson, Practical Measurements for Evaluation in Physical Education, p. 276.

[2] Paul W. Hutinger, "Effect of Systematic Horizontal Ladder Exercises Upon Body Strength of Third Grade Children," Research Quarterly, XXVI, No. 2 (May, 1955), 159.

were available for this test.

The push and pull test required the subject to place the hand-dynamometer between the jaws of a push and pull attachment and then with the palms of the hands facing each other in front of the chest grasp the handles and push inward. After a minute rest period, the subject then pulls on the handles with the same vigor. It is observed that the position of the hands and arms for pushing strength is the same as the pulling strength. Neither the hands nor the push and pull apparatus should touch the chest. Before the test the subjects were given instructions on how to ensure that they employ specific input as well as output strength. The scores for pushing and pulling were recorded separately. There was a single score for the pulling strength observed and another score for the pushing strength. Scoring was based on the number of pounds of pressure exerted. The reliability was .91 for successive trials by sixty-two college women at the University of Iowa. The validity was .49 when correlated with the Rogers Short Index.[1]

Selection of Subjects

Permission was obtained from the Principal of

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[1]Scott and French, Measurement and Evaluation in Physical Education, p. 292.

Louis Jordon Christen Junior High School located in Laredo, Texas, to conduct the study and to use 265 girls enrolled in the required physical education classes taught by the investigator. The subjects that participated in the study were seventh, eighth, and nineth grade girls. All subjects were required to participate in the testing with the following exceptions: girls age seventeen and over, girls having medical excuses and girls with physical deformities limitating the ability to perform the selected tests. From the enrollment of 265 girls, 222 participated in the study. The detailed procedures of the study were explained to the participants and their cooperation was solicited. The girls were assured that the scores that were made on the tests would not be used in determining their scholastic physical education grade.

Selection and Training of Student Assistants

Students were used as assistants in the administration of the tests. Two students at each of the five stations assisted in obtaining scores and starting tests. The assistants also aided in the prevention of inappropriate performance on the part of the subjects. The assistants selected were composed of students that did not fit the age category,

possessed medical excuses or had some type of physical deformity. It was observed that the students that served as assistants performed their required duties with responsibility and pride. The assistants participated in a training program under supervision and guidance for one month prior to commencement of the testing program. The training of the assistants was done afterschool hours. In the training program the assistants first learned to perform the individual tests, and later they were taught how to detect errors by using examples of wrong procedures.

Administration of the Tests

Before the testing session began, the subjects were informed that they would be used in a comparative study of six tests of arm and shoulder girdle strength. The subjects were informed further, that they would be graded on their cooperation and not on the scores made on the study. The five physical education classes were divided into five squads per class with each squad consisting of an average of ten subjects. The subjects in each squad were instructed to work as couples in order to develop the correct form used in the performance of the tests. The student assistants and the investigator demonstrated the administrative techniques that would be employed throughout the testing period. All subjects were measured at the beginning of the

testing period for their weight and height with a Toledo balance type scale.

During the first week of testing each group concerned themselves with practice on each of the tests to be measured. The practice involved participation in each test at each station. A complete rotation of the actual tests was performed once. The purpose of this was to be sure that each subject knew how to perform each test in order to maintain knowledge in minimizing learning errors. The assistants kept record of the scores on cards that were constructed especially for the study. A copy of this form may be found in the appendices. One rotation was scored on three different occasions, each two weeks apart.

The equipment that was used in the administration of the tests included the following items:

a. A one-tenth second stop watch

b. Eight tumbling mats

c. A horizontal ladder positioned seven feet from the ground

d. A Naragansett hand-dynamometer with the push and pull attachment

e. A modified pull-up instrument devised by Dr. Berton Lyle, Jr. A picture of this instrument, with all dimensions, may be found in the appendices.

Each day after classes assembled they parti-

cipated in a short calisthenic period prior to the testing. This was done as a precaution against injury and possibly to ensure better performance through warm-up. At the beginning of the testing period each of five squads per class were placed at a specific station. The stations were numbered from one through five. The arrangement of the tests followed in this order: modified push-up, flexed arm hang, horizontal ladder, modified pull-up, and the push and pull test. The subjects were told that the test were to be performed three separate times for scoring purposes and that there would be a two week interval between commencement of each performance on the whole testing cycle. Students who performed the test inaccurately were stopped and required to attempt the test once again after adequate rest. Each squad started at a different station and were rotated by command.

Treatment of the Data

The analysis of variance was used to treat the data. The ANOVA is a technique for testing the null hypothesis that several samples were drawn at random from the same population. Pearson-Product Moment Coefficients of Correlation were obtained to determine reliability coefficients and simple intercorrelations

between variables studied. The treatment of the data was computed on the mean score of three trials as suggested by Whitley and Smith.[1]

Summary

This chapter outlined the procedures entailed in the comparative study of arm and shoulder girdle strength upon the performance of 222 students enrolled at Louis Jordon Christen Junior High School located at Laredo, Texas, during the school year of 1969-1970. The subjects that participated in the study did not have to meet any special requirements of physical skill or strength. The six tests used in the study of arm and shoulder girdle strength were: the modified push-up, the modified pull-up, the flexed arm hang, the horizontal ladder walk, and the push and pull test. In the procedures used in the conduct of the study the subjects were placed in squads. Each squad was introduced to each test as well as the rotation system prior to actual testing so as to familiarize each subject with the procedures of the test administration. Each squad was rotated on command. Three trials were provided for each test with each trial approximately two weeks apart.

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[1] J. D. Whitley and L. E. Smith, "Larger Correlations Obtained by Using Average Rather than "Best" Strength Scores," Research Quarterly, XXXIV, No. 2 (May, 1963), 248-49.

ANOVA was the principal statistical technique employed. Product Movement coefficients of correlation were determined also. All data was compiled in tables to facilitate interpretation.

The analysis and subsequent interpretations of the findings are presented in Chapter IV.

CHAPTER IV

PRESENTATION OF THE DATA

In this chapter the analysis of the data will be presented. In addition, an interpretation of the data, with appropriate tables are included. The formulas used in all computations are general and can be found in any book of statistics.

The data was obtained from 222 subjects enrolled in five required physical education classes at Louis Jordon Christen Junior High School, Laredo, Texas. Five different age groups were compared on six selected strength tests involving arm and shoulder girdle.

Descriptive data of different age groups was determined. Table 1 presents the mean and variance of the subjects on the Bent Arm Hang Test.

TABLE 1

DESCRIPTIVE DATA OF THE BENT ARM HANG TEST FOR THE FIVE AGE GROUPS OF JUNIOR HIGH SCHOOL GIRLS*

STATISTIC	AGE GROUP				
	12	13	14	15	16
$\bar{X}$	2.7295	6.1920	5.4571	5.2216	5.2731
V	11.8308	34.7002	31.9698	43.7131	19.7652

*Values are recorded in seconds.

The mean time that the twelve year old students were able to hold this required position was 2.7295 seconds, and the variance was 11.8308 seconds; the mean time that the thirteen year old students were able to hold this required position was 6.9120 seconds, and the variance was 34.7002 seconds; the mean time that the fourteen year old students were able to hold this required position was 5.4571 seconds, and the variance was 31.9698 seconds; the mean time that the fifteen year old students were able to hold this required position was 5.2216 seconds, and the variance was 43.7131 seconds; and the mean time that the sixteen year old students were able to hold this required position was 5.2731 seconds, and the variance was 19.7652 seconds.

Scores of the five different age groups upon the Bent Arm Hang Test were compared through the application of a one-way analysis of variance for unequal groups. Based upon the data collected, at the assigned significance level of .05, there was no significant difference between twelve, thirteen, fourteen, fifteen, and sixteen year old students with respect to scores upon the Bent Arm Hang Test. The thirteen year old students performed better (i. e. longer) than did all other age groups, while the twelve year old students did poorest. Table 2, page 35 presents a summary of the one-way analysis of variance with respect to the Bent Arm Hang Test.

TABLE 2

SUMMARY TABLE FOR ANALYSIS OF VARIANCE OF BENT ARM HANG SCORES

Source	SS	df	ms	F
Between Age Groups	191.9668	4	47.9917	1.4694
Within Age Groups	7087.2354	217	32.6600	
Total	7279.2022	221		

F(4,400) P .05 = 2.39

The Horizontal Ladder Test required the students to travel hand over hand as many rungs as they could. The mean number of rungs traveled for the twelve year old students was 7.3500 rungs, and the variance was 31.0611 rungs; the mean number of rungs traveled for the thirteen year old students was 9.7493 rungs, and the variance was 26.0503 rungs; the mean number of rungs traveled for the fourteen year old students was 8.9377 rungs, and the variance was 31.5306 rungs; the mean number of rungs traveled for the fifteen year old students was 8.0363 rungs, and the variance was 35.7695 rungs; and the mean number of rungs traveled for the sixteen year old students was 9.6059 rungs, and the variance was 21.8744 rungs. In the Horizontal Ladder Test the thirteen year old students performed best and the twelve year old students performed poorest. This is similar to that found in the Bent Arm Hang Test. Table 3, page 36 presents the descriptive data for the Horizontal Ladder Test.

TABLE 3

DESCRIPTIVE DATA OF THE HORIZONTAL LADDER TEST FOR THE FIVE AGE GROUPS OF JUNIOR HIGH SCHOOL GIRLS*

STATISTIC	AGE GROUP				
	12	13	14	15	16
$\bar{X}$	7.3500	9.7493	8.9377	8.0363	9.6059
V	31.0611	26.0503	31.5306	35.7695	21.8744

*Values recorded in number of rungs traveled.

Based upon the data collected there was no significant difference between the twelve, thirteen, fourteen, fifteen, and sixteen year old students with respect to scores upon the Horizontal Ladder Test. Table 4 presents the summary table of the one-way analysis of variance for the Horizontal Ladder Test.

TABLE 4

SUMMARY TABLE FOR ANALYSIS OF VARIANCE OF HORIZONTAL LADDER SCORES

Source	SS	df	ms	F
Between Age Groups	149.1909	4	37.2977	1.2436
Within Age Groups	6508.0064	217	29.9908	
Total	6657.1973	221		

F(4,400) P .05 = 2.39

Descriptive data of the different age groups on the Modified Push-Up Test was determined. Table 5, page 37 presents this data.

TABLE 5

DESCRIPTIVE DATA OF THE MODIFIED PUSH-UP TEST FOR THE FIVE AGE GROUPS OF JUNIOR HIGH SCHOOL GIRLS*

STATISTIC	AGE GROUP				
	12	13	14	15	16
$\bar{X}$	10.5242	11.4923	10.8866	11.8065	11.1359
V	24.1600	19.5071	12.3675	15.9198	10.7082

*Values recorded in number of push-ups (modified).

The Modified Push-Up Test revealed the following data: the mean number of times the skill could be completed for the twelve year old students was 10.5242 modified push-ups, and the variance was 24.1600 modified push-ups; the mean number of times the skill could be completed for the thirteen year old students was 11.4923 modified push-ups, and the variance was 19.5071 modified push-ups; the mean number of times the skill could be completed for the fourteen year old students was 10.8866 modified push-ups, and the variance was 12.3675 modified push-ups; the mean number of times the skill could be completed for the fifteen year old students was 11.8065 modified push-ups, and the variance was 15.9198 modified push-ups; and the mean number of times the skill could be completed for the sixteen year old students was 11.1359 modified push-ups, and the variance was 10.7082 modified push-ups. Performance scores in the modified push-up favored the fifteen year old students. The twelve year old students maintained the lowest rank scores. The thirteen year old students performed almost as well as did the fifteen year old

students indicating high relative ability in this test as with all tests previously reported.

There was no significant difference between the twelve, thirteen, fourteen, fifteen, and sixteen year old students with respect to scores upon the Modified Push-Up Test. Table 6 presents a summary of the one-way analysis of variance with respect to the Modified Push-Up Test.

TABLE 6

SUMMARY TABLE FOR ANALYSIS OF VARIANCE OF MODIFIED PUSH-UP SCORES

Source	SS	df	ms	F
Between Age Groups	39.7577	4	9.9394	0.16104
Within Age Groups	3533.4591	217	16.2832	
Total	3573.2168	221		

F(4,400) P .05 = 2.39

Descriptive data of the different age groups was determined. Table 7 presents the mean and the variance of the subjects on the Modified Pull-Up Test.

TABLE 7

DESCRIPTIVE DATA OF THE MODIFIED PULL-UP TEST FOR THE FIVE AGE GROUPS OF JUNIOR HIGH SCHOOL GIRLS*

STATISTIC	AGE GROUP				
	12	13	14	15	16
$\bar{X}$	10.3176	13.0206	11.7076	12.4483	12.7122
V	35.1150	31.7981	14.4765	14.2726	12.9806

*Values recorded in number of modified pull-ups.

The Modified Pull-Up Tests showed the following

data: the mean number of times the skill could be completed for the twelve year old students was 10.3176 modified pull-ups, and the variance was 35.1150 modified pull-ups; the mean number of times the skill could be completed for the thirteen year old students was 13.0206 modified pull-ups, and the variance was 31.7981 modified pull-ups; the mean number of times the skill could be completed for the fourteen year old students was 11.7076 modified pull-ups, and the variance was 14.4765 modified pull-ups; the mean number of times the skill could be completed for the fifteen year old students was 12.4483 modified pull-ups, and the variance was 14.2726 modified pull-ups; and the mean number of times the skill could be completed for the sixteen year old students was 12.7122 modified pull-ups, and the variance was 12.9806 modified pull-ups. The thirteen year old students performed the greatest number of modified pull-ups and the sixteen year old students were next best. The twelve year old students scored the poorest in this test.

There was no significant difference between the twelve, thirteen, fourteen, fifteen, and sixteen year old students with respect to scores upon the Modified Pull-Up Test. The results of the Modified Pull-Up Test are introduced in Table 8. Table 8, page 40 presents a summary of the one-way analysis of variance with respect to the Modified Pull-Up Test.

TABLE 8

SUMMARY TABLE FOR ANALYSIS OF VARIANCE OF MODIFIED PULL-UP SCORES

Source	SS	df	ms	F
Between Age Groups	141.2821	4	35.3205	1.6589
Within Age Groups	4620.1993	217	21.2912	
Total	4761.4814	221		

F(4,400) P .05 = 2.39

Descriptive data of the different age groups for the Pull Test was determined. Table 9 presents the mean and the variance of the students on the Hand-Dynamometer Pull Test.

TABLE 9

DESCRIPTIVE DATA OF THE HAND-DYNAMOMETER PULL TEST FOR THE FIVE AGE GROUPS OF JUNIOR HIGH SCHOOL GIRLS*

STATISTIC	AGE GROUP				
	12	13	14	15	16
$\bar{X}$	28.9538	30.5896	33.6722	35.6730	36.9995
V	50.3026	56.6584	56.3145	75.0258	57.4338

*Values recorded in pounds.

The Pull Test revealed the following data: the mean number of pounds pulled for the twelve year old students was 28.9538 pounds, and the variance was 50.3026 pounds; the mean number of pounds pulled for the thirteen year old students was 30.5896 pounds, and the variance was 56.6584 pounds; the mean number of pounds pulled for the fourteen was 33.6722 pounds, and the variance was 56.3145 pounds; the

mean number of pounds pulled for the fifteen year old students was 35.6730 pounds, and the variance was 75.0258 pounds; and the mean number of pounds pulled for the sixteen year old students was 36.9995 pounds, and the variance was 57.4338 pounds.

There were significant differences between the groups with respect to the Pull Test. Table 10 presents a summary table of the one-way analysis of variance with respect to the Pull Test.

TABLE 10

SUMMARY TABLE FOR ANALYSIS OF VARIANCE OF HAND-DYNAMOMETER SCORES FOR THE PULL TEST

Source	SS	df	ms	F
Between Age Groups	1488.0907	4	372.0226	6.1114**
Within Age Groups	13209.5301	217	60.8734	
Total	14697.6208	221		

*F(4,400) P .05 = 2.39
**F(4,400) P .01 = 3.36

Duncan's Multiple Range Test was applied to the data to compare the mean scores of the Pull Test for the five different age groups. Significant differences were found between the twelve and thirteen year old students when compared to the fifteen and sixteen year old students with respect to the Pull Test. No differences were found between the fourteen year old students and the younger and older students. Table 11, page 42 presents the differences of means by the Duncan's Multiple Range Test.

TABLE 11

DUNCAN'S MULTIPLE RANGE TEST FOR
HAND-DYNAMOMETER PULL TEST

AGE GROUPS	12	13	14	15	16
$\bar{X}$ VALUES	28.9538	30.5896	33.6722	35.6730	36.9995
28.9538		1.6358	4.7184	6.7192*	8.0457*
30.5896			3.0826	5.0834*	6.4099*
33.6722				2.0008	3.3273
35.6730					1.3265

SHORTEST SIGNIFICANT RANGES

P .01 $R_2 = 4.7931$

$R_3 = 5.0038$

$R_4 = 5.1355$

$R_5 = 5.2408$

The order of performance on the Pull Test was consistent with age, with the oldest students performing better than the younger age groups. The two oldest age groups were significantly better than the twelve and thirteen year old students. For isometric strength measures weight would seem to be important and the older students appeared to be taller and heavier than the younger subjects.

Descriptive data of the different age groups in the Push Test was determined. Table 12 presents the mean and the variance of the students on the Hand-Dynamometer Push Test.

TABLE 12

DESCRIPTIVE DATA OF THE HAND-DYNAMOMETER PUSH TEST
FOR THE FIVE AGE GROUPS OF JUNIOR HIGH SCHOOL GIRLS*

STATISTIC	AGE GROUP				
	12	13	14	15	16
$\bar{X}$	29.7780	31.3841	34.3272	35.1274	35.6063
V	72.2155	72.4636	43.8200	61.9862	97.1982

*Values recorded in pounds.

The Push Test revealed the following data: the mean number of pounds pushed for the twelve year old students was 29.7780 pounds, and the variance was 72.2155 pounds; the mean number of pounds pushed for the thirteen year old students was 31.3841 pounds, and the variance was 72.4636 pounds; the mean number of pounds pushed for the fourteen year old students was 34.3272 pounds, and the variance was 43.8200 pounds; the mean number of pounds pushed for the fifteen year old students was 35.1274 pounds, and the variance was 61.9862 pounds; and the mean number of pounds pushed for the sixteen year old students was 35.6063 pounds, and the variance was 97.1982 pounds.

A one-way analysis of variance for unequal groups was used to compare the scores of the five different age groups upon the Push Test. A significant difference between the groups was found. Table 13 presents a summary table of the one-way analysis of variance with respect to the Push Test.

TABLE 13

SUMMARY TABLE FOR ANALYSIS OF VARIANCE OF THE HAND-DYNAMOMETER SCORES FOR THE PUSH TEST

Source	SS	df	ms	F
Between Age Groups	681.4405	4	215.3101	3.3345*
Within Age Groups	14011.5313	217	64.5692	
Total	14872.7718	221		

F(4,400) P .05 = 2.39

Duncan's Multiple Range Test was applied to the data

to compare the mean scores of the Push Test of the five different age groups. This was done since the null hypothesis was rejected and it was necessary to find out where the difference existed. A significant difference was found between the twelve year old students when compared to the fifteen and sixteen year old students with respect to the Push Test. Table 14 presents the Duncan's Multiple Range Test.

TABLE 14

DUNCAN'S MULTIPLE RANGE TEST FOR HAND-DYNAMOMETER PUSH TEST

AGE GROUPS	12	13	14	15	16
$\bar{X}$ VALUES	29.7780	31.3841	34.3274	35.1274	35.6063
29.7780		1.6061	4.5494	5.3494*	5.8283*
31.3841			2.9433	3.7433	4.2222
34.3274				0.8000	1.2789
35.1274					0.4789

SHORTEST SIGNIFICANT RANGES

P .01 $R_2 = 4.9565$

$R_3 = 5.1744$

$R_4 = 5.3106$

$R_5 = 5.4195$

The Push Test results followed an identical sequence to the Pull Test. The order of performance on the Push Test was consistent with age, with the oldest students performing better than the younger age groups. The two oldest age groups were significantly better than the twelve year old students. No difference was found between the thirteen, fourteen, fifteen, and sixteen year old students.

Because the related literature did not establish the reliability of any of the tests used for junior high school girls it was considered imperative to determine reliability coefficients of correlation for the six different arm and shoulder girdle strength tests. The Pearson-Product Moment Technique of Correlation was used to determine the coefficients of reliability. A two-week interval period between each testing period was provided. This longer than typical time element may account for the fact that the reliability scores are relatively low. Individual self-assurance was examplified in the second and third trail performance of all tests, as in almost every instance the reliability increased with the number of trials and the additional knowledge of what to expect. The evaluation of the coefficients of correlation for reliability are based on these proposed by Barrow and McGee.[1]

The Bent Arm Hang Test (0.8786) and the Horizontal Ladder Test (0.8641) had the highest test-retest reliability scores within the six tests employed in the measurement of arm and shoulder girdle strength. The Modified Push-Up Test (0.7235) was considered to have poor reliability. The Modified Pull-Up Test (0.6334) and the Hand-Dynamometer Pull Test (0.6837) had questionable reliability scores. The Hand-Dynamometer Push Test had the lowest

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[1]Harold M. Barrow and Rosemary McGee, A Practical Approach to Measurement in Physical Education (Philadelphia: Lea and Febiger, 1964), p. 42.

recorded reliability score (0.5583). This coefficient of correlation for reliability was not considered acceptable. The two dynamometric tests were the only tests that obtained significant differences between any of the age groups. The validity of the Hand-Dynamometer Push Test could be questioned on the basis of the low reliability received.

In the following page, tables of reliability scores will be presented of the six selected arm and shoulder girdle strength tests.

RELIABILITY COEFFICIENTS OF CORRELATION FOR THE THREE TRIALS OF THE SELECTED STRENGTH TESTS

BENT ARM HANG

	Trial one	Trial two	Trial three
Trial one		0.8786	0.8239
Trial two			0.8483

HORIZONTAL LADDER

	Trial one	Trial two	Trial three
Trial one		0.8070	0.8079
Trial two			0.8641

MODIFIED PUSH-UP

	Trial one	Trial two	Trial three
Trial one		0.5523	0.4840
Trial two			0.7235

MODIFIED PULL-UP

	Trial one	Trial two	Trial three
Trial one		0.6234	0.5044
Trial two			0.6334

PULL HAND-DYNAMOMETER

	Trial one	Trial two	Trial three
Trial one		0.6565	0.6741
Trial two			0.6837

PUSH HAND-DYNAMOMETER

	Trial one	Trial two	Trial three
Trial one		0.5583	0.4894
Trial two			0.6837

An intercorrelation table of the six different tests was determined. Table 15 presents a summary of the intercorrelations of arm and shoulder girdle strength.

TABLE 15

SIMPLE CORRELATIONS BETWEEN MEASURES OF ARM AND SHOULDER GIRDLE STRENGTH

	Mod. Push-Up	Mod. Pull-Up	Horizontal Ladder	Arm Hang	Push	Pull
Push-Up		0.4802*	0.2280*	0.1826	0.1841	0.1101
Pull-Up			0.3569*	0.3608*	0.1630	0.0948
Ladder				0.4556*	0.0668	-0.0309
Hang					-0.0171	-0.0568
Push						0.6747*

P .05 = 0.1946

Analysis of the table of intercorrelations indicates that the Modified Push-Up Test correlate significantly at the .05 level with the Modified Pull-Test (0.4802), and with the Horizontal Ladder Test (0.2280). The correlations are significant but low. The Modified Push-Up Test had only a chance relationship with the Bent Arm Hang Test (0.1826), the Push Test (0.1841), and Pull Test (0.1101). The Modified Pull-Up Test correlate significantly at the .05 level with Horizontal Ladder Test (0.3569), and with the Bent Arm Hang Test (0.3608) as well as with the Modified Push-Up Test. These correlations shows low degrees of relationship. The Modified Pull-Up Test had only a chance relationship with the Push Test (0.1630), and with the Pull Test (0.0948). The Horizontal Ladder Test correlate signficantly with Bent Arm Hang Test (0.4556). There is only a chance relationship

between the Horizontal Ladder Test scores and the Push Test (0.0668), and Pull Test (-0.0309). The Bent Arm Hang Test had a negative but chance relationship with the Push Test (-0.0171), and with the Pull Test (-0.0568). The Push Test correlates significantly with the Pull Test (0.6747). This shows a moderate relationship.

It would appear that the six tests selected to measure arm and shoulder girdle strength in the present investigation are fairly descrete. The relationship between the dynamic and static tests may be accounted for but the independence of the four dynamic tests were unexpected.

Summary

In this chapter the data was presented and analyzed. Descriptive data for each age group studied on each test measured was given in narrative and tabular form. ANOVA was used to test the hypothesis that there were no differences in arm and shoulder girdle strength for the selected age groups of junior high school girls.

Based upon the findings, the investigator failed to reject the null hypothesis with the exception of two specific tests, the Hand-Dynamometric Push Test and Pull Test. Duncan's Multiple Range Test was applied to the data of the Push Test and the Pull Test to determine where the obtained differences existed. It was found that the fifteen and sixteen year old students differed significantly from the twelve and thirteen year old students on the Pulling Test, and from the twelve

year old students on the Pushing Test. No other differences were significant.

Reliability scores were reported to facilitate the interpretation of the different tests and between the three trials on each strength test. This was done because reliability scores were unavailable for junior high school girls for the tests used in the study. One of the two tests to reach significance, the Hand-Dynamometric Push Test had a reliability too low to enable the investigator to place much credence in the test.

Intercorrelations between the six tests used in the study indicated that the static tests had acceptable correlations. The dynamic tests appeared to be fairly descrete.

Chapter V will present the summary, conclusion, a discussion of the findings, and recommendations for further studies.

CHAPTER V

SUMMARY, CONCLUSION, DISCUSSION OF THE FINDINGS AND RECOMMENDATIONS FOR FURTHER STUDIES

Summary of the Investigation

The present study was undertaken to compare the differences of arm and shoulder girdle strength between junior high school girls of the different age groups, twelve through sixteen. Six tests were administered to 222 girls enrolled in the required physical education classes in Louis Jordon Christen Junior High School, Laredo, Texas. The testing period lasted from January sixth to March twenty-fifth during the school year of 1969-1970. The following six tests were used in the present study: the Bent Arm Hang, the Horizontal Ladder, the Modified Push-Up, the Modified Pull-Up, and the Push Test, and the Pull Test as measured by the Hand-Dynamometer.

A survey of related literature concerning the differences of arm and shoulder girdle strength between junior high school girls revealed that most studies with respect to women have been at the college level. Carpenter[1]

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[1]Carpenter, "A Critical Study of the Factors Determining Effective Strength for Women," p. 3.

reported the results of an intensive investigation of strength in women in 1938. The effect of strength and athletic ability in college women was studied and Carpenter found a positive correlation of .395. One phase of the study attempted to determine the relationship between the ability to perform pull-ups and chin-ups and to determine which of these two measures was the better index of shoulder girdle strength. Pull-ups were favored in this study.

Wilson[1] performed a study of arm and shoulder girdle strength of college women and analyzed several selected performance tests in relation to strength. She found that strength can be measured by performance tests with a relatively high degree of validity. Wessel and Nelson[2] conducted a study to investigate the relationship between strength and achievement in physical education among 200 college women by comparing dynamometric grip strength with the grades received in physical education service courses. They found that grip strength among college women was significantly related to achievement in physical education service courses as measured by the grades the students received.

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[1] Wilson, "A Study of Arm and Shoulder Girdle Strength of College Women in Selected Tests," p. 258.

[2] Wessel and Nelson, "Relationship Between Grip Strength and Achievement in Physical Education Among College Women," p. 244.

Eckert and Day[1] conducted a study to examine the relationship between strength and work load during the performance of push-ups by college women. It was noted that for well-conditioned women, there was a statistically significant positive relationship between work load in the performance of women's push-ups and maximal strength in the push-up position.

Hinson[2] conducted a study to examine, through electromyography, the muscular activity required to perform four types of push-up exercises and to determine the existence of patterns of muscular contractions among adult women. Hinson found that the full push-up appeared to require little more muscular activity than that required by the bench push-up and that strength was a factor which differentiated one group from the other. Analysis of the data indicated a greater level of muscular involvement for the low strength subjects than for the high strength subjects.

Cotten and Marwitz[3] conducted a study to determine the relationship between two methods of doing the flexed-arm hang and pull-ups using fourteen undergraduate women physical education majors. They found that the

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[1]Eckert and Day, "Relationship Between Strength and Work Load in Push-Ups," p. 380.

[2]Hinson, "An Electromyographic Study of the Push-Up for Women," p. 305.

[3]Cotten and Marwitz, "Relationship Between Two Flexed-Arm Hangs and Pull-Ups for College Women," p. 415.

modified flexed-arm hang appeared to be a better measure of arm strength than the flexed-arm hang.

Two hundred and twenty-two girl students from Louis Jordon Christen Junior High School enrolled in five physical education classes were divided into five squads per class with each squad consisting of an average of ten subjects. The subjects in each squad were instructed to work in pairs to develop the correct form used in the performance of the tests. The student assistants and the investigator demonstrated the administrative techniques that would be employed throughout the testing period. One complete rotation of all tests was scored on three different occassions, each two weeks apart.

The analysis of variance was used to treat the data. The ANOVA is a technique for testing the null hypothesis that several samples were drawn at random from the same population. The Pearson-Product Moment Method of Correlation was used to determine the reliability coefficients and simple intercorrelations between the variables used. The treatment of the data was computed on the mean score of the three trials.

Findings of the Study

The hypothesis that guided the present investigation stated that there would be no significant difference in arm and shoulder girdle strength between junior

high school girls, ages twelve through sixteen, as measured by six selected tests. The results of the testing of the hypotheses are presented below:

A. There is no significant difference in the ability to perform the Bent Arm Hang Test between twelve, thirteen, fourteen, fifteen, and sixteen year old junior high school girls.

> This hypothesis was accepted. The analysis of variance failed to indicate significant differences in the different age groups of junior high school girls measured.

B. There is no significant difference in the ability to perform the Horizontal Ladder Test between twelve, thirteen, fourteen, fifteen, and sixteen year old junior high school girls.

> This hypothesis was accepted. The analysis of variance failed to indicate significant differences in the different age groups of junior high school girls measured.

C. There is no significant difference in the ability to perform the Modified Push-Up Test between twelve, thirteen, fourteen, fifteen, and sixteen year old junior high school girls.

> This hypothesis was accepted. The analysis of variance failed to indicate significant differences in the different age groups of junior high school girls measured.

D. There is no significant difference in the ability to perform the Modified Pull-Up Test between twelve,

thirteen, fourteen, fifteen, and sixteen year old junior high school girls.

This hypothesis was accepted. The analysis of variance failed to indicate significant differences in the different age groups of junior high school girls measured.

E. There is no significant difference in the ability to perform the Push Test as measured by the Hand-Dynamometer between twelve, thirteen, fourteen, fifteen, and sixteen year old junior high school girls.

This hypothesis was rejected. Analysis by Duncan's Multiple Range Test indicated significant differences in the fifteen and sixteen year old age groups as compared to the twelve and thirteen year old junior high school girls measured.

F. There is no significant difference in the ability to perform the Pull Test as measured with the Hand-Dynamometer between twelve, thirteen, fourteen, fifteen, and sixteen year old junior high school girls.

This hypothesis was rejected. Analysis by Duncan's Multiple Range Test indicated significant differences in the fifteen and sixteen year old age groups as compared to the twelve year old junior high school girls measured.

The literature did not report the reliability for junior high school girls of the individual tests used in this study. Coefficients of correlations were determined for the three trials of each test used in the study. Each

trial was separated by approximately two weeks. The Bent Arm Hang (0.8786) and the Horizontal Ladder Test (0.8641) had the highest reliability scores within the six tests employed in the measurement of arm and shoulder girdle strength. These scores were considered acceptable. The reliability of the Modified Push-Up (0.7235) was considered poor. The Modified Pull-Up Test (0.6334) and the Hand-Dynamometer Push Test had the lowest recorded coefficient of reliability (0.5583) and could not be accepted as a reliable test in this study. It should be noted that the two dynamometric tests were the only measures found to differ significantly among the groups.

Intercorrelations

Intercorrelations were determined for each of the six arm and shoulder girdle strength tests used in the study. The two static tests, the Push Test and the Pull Test, had a moderate relationship. All of the dynamic tests had low correlations.

Conclusion of the Study

As a result of the statistical findings of this investigation, it may be concluded that there is no significant difference in the arm and shoulder girdle strength of girls age twelve, thirteen, fourteen, fifteen, and sixteen. Because only two tests found significant

differences between the subjects and one of these tests was found relatively unreliable it may be assumed that the selected tests either did not adequately discriminate between the different age groups of junior high school girls in arm and shoulder girdle strength or that there are no actual differences in the arm and shoulder girdle strength of adolescent age girls.

Discussion

The results for most of the tests indicated that the thirteen year old students performed better than the other subjects. This finding is believed to be peculiar but it is in agreement with Espenschade[1] who indicated that girls reach their peak in performance of fundamental motor skills at the age of thirteen. However, it should be noted that the selected tests were chosen as strength measures and the component of strength does not reach the maximum in thirteen year old girls.[2]

Recommendations for Further Studies

The following suggestions have been recommended for further investigations:

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[1] Anna Espenschade, "Motor Development," in Science and Medecine of Exercise and Sports, ed. by Warren R. Johnson (New York: Harper and Row, 1960), p. 432.

[2] Ibid., p. 426

A. A comparative study of arm and shoulder girdle strength between junior high school boys and girls ages twelve through sixteen.

B. The determination of valid and reliable tests of strength for junior high school girls in arm and shoulder girdle strength.

L.J. Christen Jr. High

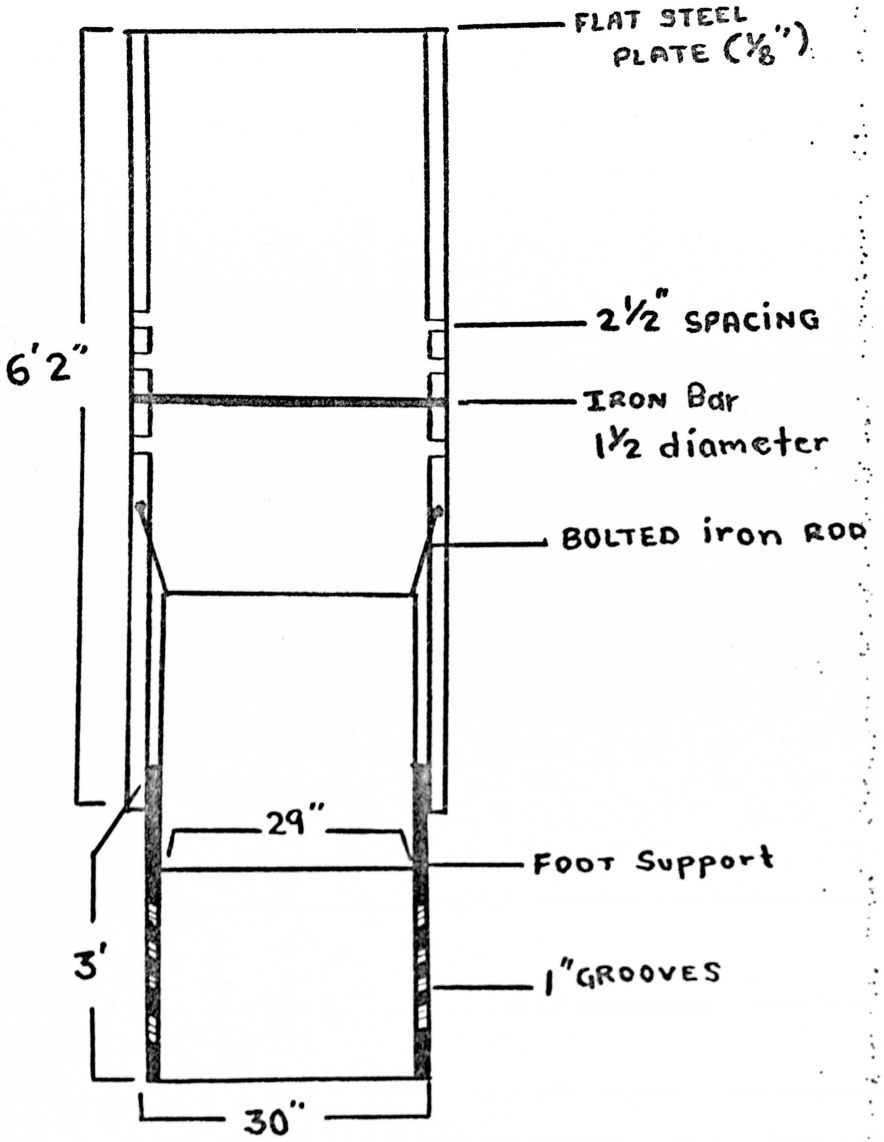
WEIGHT & HEIGHT: _____

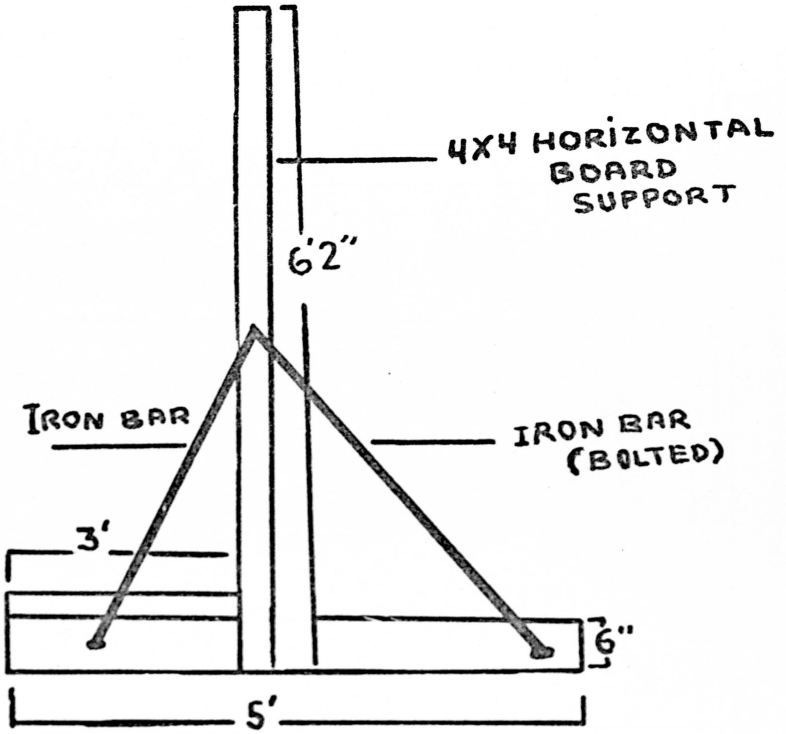
NAME: _____

GRADE: _____

AGE: _____

	1st	2nd	3rd
MODIFIED PULL-UP			
MODIFIED PUSH-UP			
HORIZONTAL LADDER			
PUSH AND PULL			
BENT-ARM-HANG			


FLAT STEEL PLATE (1/8")
2 1/2" SPACING
6'2"
IRON Bar 1 1/2 diameter
BOLTED iron ROD
29"
FOOT Support
3'
1" GROOVES
30"


4X4 HORIZONTAL BOARD SUPPORT
6'2"
IRON BAR
IRON BAR (BOLTED)
3'
6"
5'

RAW SCORES FOR THE 12 YEAR OLD SUBJECTS PARTICIPATING IN THE HORIZONTAL LADDER AND THE BENT ARM HANG TESTS

	Horizontal Ladder Test					Bent Arm Hang Test			
Subject	1st	2nd	3rd	$\bar{X}$	Subject	1st	2nd	3rd	$\bar{X}$
1	5	14	15	11.33	1	6.3	7.7	9.0	7.67
2	15	14	15	14.67	2	4.3	1.5	1.5	6.43
3	0	0	0	0.00	3	0	0	0	0.00
4	3	0	0	1.00	4	0	0	0	0.00
5	1	12	8	7.00	5	0	0	0	0.00
6	3	5	3	3.67	6	0	0	0	0.00
7	14	15	15	14.67	7	3.0	2.1	2.7	2.60
8	0	3	4	2.33	8	0	0	0	0.00
9	15	15	14	14.67	9	4.0	4.2	4.0	4.67
10	4	5	8	5.67	10	2.0	0	1.5	1.17
11	5	14	15	11.33	11	7.0	10.1	13.1	10.67
12	6	6	7	6.33	12	6.0	7.6	7.2	6.93
13	11	15	15	13.67	13	4.0	4.2	4.4	4.20
14	15	15	15	15.00	14	3.5	4.3	5.0	4.27
15	5	8	7	6.67	15	0	0	0	0.00
16	14	13	15	14.00	16	2.3	6.1	4.3	4.23
17	0	0	0	0.00	17	0	0	0	0.00
18	5	7	5	5.67	18	0	0	0	0.00
19	15	15	15	15.00	19	5.0	4.0	4.5	4.50
20	0	0	0	0.00	20	0	0	0	0.00
21	2	4	0	2.00	21	0	0	0	0.00
22	7	12	3	7.33	22	5.2	5.8	4.8	5.27

RAW SCORES FOR THE 12 YEAR OLD SUBJECTS PARTICIPATING IN THE MODIFIED PUSH-UP AND MODIFIED PULL-UP TESTS

Subject	Modified Pull-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$	Subject	Modified Push-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$
1	7	5	6	6.00	1	21	13	21	18.33
2	22	38	17	25.67	2	15	14	15	14.67
3	4	9	10	7.67	3	6	9	1	5.33
4	9	6	9	8.00	4	16	13	9	12.67
5	2	5	17	8.00	5	2	5	12	6.33
6	8	10	10	9.33	6	9	9	8	8.67
7	4	3	6	4.33	7	5	4	6	5.00
8	0	2	3	1.67	8	3	2	3	2.67
9	12	21	12	15.00	9	18	17	20	15.00
10	4	15	14	11.00	10	9	9	12	10.00
11	25	20	22	22.33	11	13	21	23	19.00
12	8	6	15	9.67	12	17	17	13	15.67
13	17	18	16	17.00	13	15	8	10	11.00
14	11	5	13	9.67	14	10	6	5	7.00
15	15	16	15	15.33	15	14	14	15	14.33
16	14	10	11	11.67	16	14	11	10	11.67
17	6	6	5	5.67	17	4	8	10	7.33
18	10	3	4	5.67	18	6	5	7	6.00
19	9	10	9	9.33	19	7	7	9	7.67
20	1	4	7	4.00	20	8	3	6	5.67
21	10	10	8	9.33	21	14	17	10	13.67
22	30	30	26	28.67	22	24	32	36	30.67

RAW SCORES FOR THE 12 YEAR OLD SUBJECTS PARTICIPATING BOTH IN THE PUSH AND PULL TESTS AS MEASURED BY THE HAND-DYNAMOMETER

	Push Test					Pull Test			
Subject	1st	2nd	3rd	$\bar{X}$	Subject	1st	2nd	3rd	$\bar{X}$
1	16	20	30	32.00	1	18	28	18	21.33
2	36	44	66	48.67	2	34	38	56	42.67
3	30	32	30	30.67	3	30	24	32	28.67
4	30	40	34	34.67	4	28	38	50	38.67
5	22	30	44	32.00	5	20	32	30	27.33
6	26	24	24	24.67	6	24	16	28	22.67
7	16	16	20	17.33	7	30	20	22	24.00
8	42	40	42	41.33	8	30	32	30	30.67
9	48	38	46	44.00	9	28	26	32	28.67
10	14	16	16	15.33	10	14	20	20	18.00
11	36	30	26	30.67	11	30	40	42	37.33
12	28	24	30	27.33	12	30	36	32	32.67
13	26	20	20	22.00	13	24	26	24	24.67
14	26	26	30	27.33	14	20	18	30	22.67
15	20	24	30	24.67	15	22	26	26	24.67
16	24	16	20	20.00	16	18	22	18	19.33
17	26	26	20	24.00	17	22	28	30	26.67
18	24	36	30	30.00	18	32	38	32	34.00
19	24	40	40	34.67	19	20	36	36	30.67
20	40	40	36	38.67	20	44	42	42	42.67
21	20	40	30	30.00	21	20	22	36	26.00
22	30	30	26	29.33	22	24	32	36	30.67

RAW SCORES FOR THE 13 YEAR OLD SUBJECTS PARTICIPATING IN THE HORIZONTAL LADDER AND THE BENT ARM HANG TESTS

Horizontal Ladder Test					Bent Arm Hang Test				
Subject	1st	2nd	3rd	$\overline{X}$	Subject	1st	2nd	3rd	$\overline{X}$
1	14	15	15	14.67	1	2.7	2.0	3.0	2.57
2	9	13	3	8.33	2	4.0	5.4	6.5	5.30
3	15	15	15	15.00	3	5.0	8.4	9.9	7.77
4	15	14	15	14.67	4	5.4	8.1	7.3	6.93
5	15	14	15	14.67	5	21.7	28.1	12.1	20.67
6	0	3	4	3.33	6	0	0	0	0.00
7	3	6	7	5.67	7	6.0	10.4	6.6	7.77
8	4	4	15	7.67	8	5.5	3.9	3.8	4.40
9	0	0	0	0.00	9	0	0	0	0.00
10	15	12	15	14.00	10	6.5	6.6	11.8	7.13
11	14	15	9	12.67	11	9.0	1.0	3.0	4.33
12	10	9	14	11.00	12	7.0	10.0	10.5	9.13
13	7	7	15	9.67	13	7.9	3.9	3.9	5.23
14	15	15	15	15.00	14	9.1	2.7	8.8	6.67
15	0	0	0	0.00	15	0	0	0	0.00
16	14	15	15	14.67	16	0	3.2	4.0	2.40
17	0	0	0	0.00	17	0	0	0	0.00
18	5	15	6	8.67	18	4.3	0	2.0	2.10
19	0	0	0	0.00	19	0	0	0	0.00
20	1	14	15	10.00	20	5.4	6.2	5.4	5.77
21	11	15	15	13.67	21	8.9	11.0	2.1	7.33
22	0	0	0	0.00	22	0	0	0	0.00

23	15	15	15	15.00	23	9.1	9.7	11.5	10.10
24	0	0	0	0.00	24	1.5	2.8	2.2	2.73
25	3	3	2	6.67	25	4.2	2.8	2.7	3.23
26	4	15	4	8.00	26	10.5	9.3	10.0	7.73
27	14	15	15	14.67	27	6.5	6.9	7.0	6.80
28	15	15	15	15.00	28	3.0	5.3	7.7	4.33
29	14	15	15	13.67	29	0	0	0	0.00
30	14	15	15	14.67	30	5.2	5.4	6.9	5.83
31	15	8	6	8.00	31	16.8	19.5	11.0	15.80
32	8	15	15	12.67	32	1.5	3.5	1.7	2.23
33	7	6	7	6.67	33	1.6	3.0	1.8	2.13
34	9	6	9	8.00	34	1.6	2.0	3.0	2.20
35	4	4	4	4.00	35	3.0	3.0	4.3	3.43
36	8	10	12	10.00	36	3.4	3.1	4.3	3.63
37	15	15	8	12.67	37	21.5	20.5	25.6	22.33
38	15	15	15	15.00	38	6.2	9.1	9.7	8.33
39	15	15	15	15.00	39	10.4	9.7	10.5	10.20
40	15	15	15	15.00	40	9.0	9.5	30.0	16.13
41	8	14	15	12.33	41	2.2	2.1	6.7	3.67
42	1	3	1	1.67	42	0	0	0	0.00
43	15	15	15	15.00	43	13.5	17.7	28.2	18.80
44	4	5	6	5.00	44	5.0	5.1	6.1	5.40
45	7	15	15	12.33	45	5.5	9.3	10.6	8.43
46	15	15	15	15.00	46	7.5	7.8	7.7	7.67
47	1	5	2	2.67	47	0	1.0	3.8	1.60
48	4	4	4	4.00	48	7.7	4.5	11.2	7.80
49	15	8	10	11.00	49	6.2	7.5	8.8	7.17

50	4	3	4	3.67	50	9.5	9.0	9.6	9.37
51	1	1	3	3.33	51	0	0	0	0.00
52	5	14	15	11.33	52	3.7	4.4	5.2	4.43
53	9	15	15	13.00	53	6.0	10.0	8.2	8.67
54	15	15	15	15.00	54	7.0	7.0	5.3	6.43
55	15	15	14	14.67	55	7.0	6.5	6.1	6.53
56	8	15	15	12.67	56	3.4	3.2	5.4	4.00
57	3	2	3	2.67	57	0	0	0	0.00
58	15	15	15	15.00	58	0	0	0	0.00
59	3	8	10	7.00	59	4.0	1.0	5.0	3.33
60	3	15	15	11.00	60	6.3	13.7	13.8	11.27
61	3	15	12	10.00	61	2.0	3.9	2.0	2.63
62	7	14	3	8.00	62	0	0	0	0.00
63	10	15	15	16.67	63	5.7	9.2	11.9	8.96
64	15	15	15	15.00	64	7.8	8.9	9.0	8.57
65	12	3	15	10.00	65	7.0	5.1	7.4	6.60

RAW SCORES FOR THE 13 YEAR OLD SUBJECTS PARTICIPATING IN THE MODIFIED PUSH-UP AND MODIFIED PULL-UP TESTS

Subject	Modified Pull-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$	Subject	Modified Push-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$
1	10	6	12	9.33	1	6	8	10	8.00
2	14	19	18	17.00	2	19	12	18	16.33
3	3	10	5	6.00	3	8	6	8	7.33
4	12	17	21	16.67	4	9	12	13	11.33
5	12	19	21	17.33	5	9	10	13	10.67
6	12	13	9	11.33	6	6	5	6	5.67
7	8	10	8	8.67	7	12	14	14	13.33
8	21	19	10	16.67	8	18	18	19	18.33
9	8	10	9	9.00	9	0	5	3	2.67
10	18	24	24	18.67	10	3	5	12	6.67
11	15	9	11	11.67	11	12	10	6	19.33
12	12	11	11	11.33	12	17	11	10	12.67
13	3	0	10	4.33	13	14	12	10	12.00
14	15	25	25	21.67	14	15	15	13	14.33
15	9	11	6	8.67	15	5	8	4	5.67
16	15	19	17	17.00	16	20	20	20	20.00
17	6	9	7	7.00	17	10	10	10	10.00
18	11	7	19	12.33	18	15	20	20	18.33
19	0	3	3	2.33	19	5	6	6	15.67
20	14	13	14	10.33	20	9	11	10	10.00
21	9	19	15	14.33	21	20	20	15	18.33
22	5	6	5	5.33	22	12	15	8	12.00

23	6	13	13	10.67	23	12	12	18	14.00
24	10	10	10	10.00	24	10	5	9	8.00
25	10	7	10	9.00	25	5	7	7	6.33
26	11	22	14	15.67	26	10	13	15	12.67
27	17	15	20	17.33	27	5	10	10	8.33
28	16	19	16	17.00	28	6	16	16	12.67
29	6	6	10	8.67	29	2	4	8	4.67
30	15	3	8	8.67	30	11	3	10	8.00
31	25	20	23	22.67	31	15	13	15	14.33
32	11	16	20	15.67	32	11	13	16	13.33
33	7	8	11	9.00	33	7	8	11	8.00
34	9	13	11	11.00	34	9	9	9	9.00
35	10	10	11	10.33	35	13	8	10	10.67
36	10	10	6	8.00	36	9	10	6	8.33
37	16	15	12	14.33	37	13	14	15	14.00
38	20	25	18	21.00	38	10	10	13	11.00
39	13	14	25	17.33	39	13	13	15	13.67
40	15	24	32	23.33	40	15	24	32	23.33
41	15	6	14	11.67	41	11	16	11	12.67
42	13	11	12	12.00	42	9	5	6	6.67
43	27	25	29	27.00	43	10	17	19	15.33
44	11	34	10	18.33	44	14	4	9	9.00
45	14	18	18	16.67	45	18	10	12	16.00
46	17	15	15	15.67	46	8	8	8	8.00
47	8	9	12	9.67	47	10	8	13	10.33
48	9	10	10	9.67	48	5	5	8	6.00
49	15	15	11	13.67	49	3	6	6	5.00

50	17	19	20	18.67	50	9	10	16	11.67
51	9	11	11	10.33	51	11	10	14	11.67
52	13	16	11	13.33	52	15	15	15	15.00
53	12	11	12	11.67	53	10	11	13	11.33
54	15	17	16	16.33	54	12	22	25	19.67
55	6	10	17	11.00	55	5	3	6	4.67
56	20	25	23	22.67	56	10	20	25	18.33
57	10	6	8	8.00	57	9	4	6	6.33
58	11	20	14	15.00	58	5	14	16	11.67
59	15	16	12	14.33	59	8	15	15	12.67
60	12	20	20	17.33	60	7	9	13	9.67
61	13	10	10	11.00	61	18	10	10	12.67
62	11	16	16	14.33	62	3	6	10	9.67
63	19	20	21	20.00	63	16	16	16	16.00
64	19	20	20	19.67	64	19	24	20	21.00
65	15	18	18	17.00	65	13	23	25	23.33

RAW SCORES FOR THE 13 YEAR OLD SUBJECTS PARTICIPATING IN THE PUSH AND PULL TESTS AS MEASURED BY THE HAND-DYNAMOMETER

	Push Test					Pull Test			
Subject	1st	2nd	3rd	$\bar{X}$	Subject	1st	2nd	3rd	$\bar{X}$
1	34	28	32	31.33	1	24	20	16	20.00
2	32	36	36	34.67	2	30	40	40	40.00
3	30	26	30	28.67	3	30	40	28	32.00
4	22	32	30	28.00	4	32	24	26	26.67
5	22	28	32	27.33	5	24	30	28	27.33
6	36	22	28	28.67	6	30	38	42	36.67
7	28	24	24	25.33	7	34	36	32	34.00
8	24	28	22	24.67	8	28	32	32	30.67
9	22	22	24	18.67	9	28	28	20	25.33
10	28	26	36	30.00	10	34	34	34	34.00
11	38	38	42	39.33	11	42	42	42	42.00
12	18	22	28	22.67	12	30	30	34	31.33
13	18	22	38	23.33	13	20	22	42	28.00
14	34	38	42	38.00	14	32	34	34	33.33
15	28	26	24	29.33	15	26	28	30	28.00
16	54	42	52	50.00	16	46	30	42	38.67
17	68	84	40	64.00	17	56	58	56	56.67
18	28	40	34	34.00	18	24	24	18	18.67
19	42	28	30	33.33	19	38	34	36	36.00
20	38	24	28	38.00	20	28	28	28	28.00
21	28	28	30	32.00	21	30	32	34	31.33
22	44	40	34	42.67	22	20	20	22	20.33

23	28	24	30	27.33	23	30	32	30	30.67
24	35	34	30	33.33	24	16	22	20	19.33
25	18	30	30	19.33	25	34	32	46	37.33
26	28	30	34	31.33	26	34	34	34	34.00
27	40	38	40	42.67	27	28	34	24	31.33
28	18	28	30	25.33	28	28	40	28	40.67
29	24	22	24	22.67	29	20	24	26	21.33
30	28	22	30	27.33	30	28	26	28	27.33
31	30	40	38	32.67	31	24	48	36	35.33
32	24	24	32	26.67	32	46	42	48	46.00
33	36	28	40	34.33	33	44	32	36	37.33
34	26	28	28	27.33	34	20	18	22	16.67
35	24	30	28	37.33	35	24	30	28	27.33
36	16	13	34	21.33	36	30	24	30	28.00
37	32	26	48	35.33	37	28	18	40	28.67
38	26	42	50	39.33	38	46	39	38	38.67
39	38	42	50	43.33	39	42	48	60	52.67
40	20	34	18	24.00	40	30	36	34	38.00
41	32	32	34	32.67	41	34	24	40	32.67
42	16	14	22	37.33	42	26	12	26	21.33
43	18	22	20	24.00	43	20	20	20	20.00
44	20	28	28	25.33	44	18	20	40	26.00
45	24	24	34	28.67	45	32	34	30	32.00
46	18	20	20	19.33	46	20	24	30	24.67
47	28	18	34	26.67	47	26	26	30	27.33
48	30	48	58	45.33	48	28	34	40	34.00
49	24	36	32	32.00	49	38	26	18	27.33

50	30	30	36	32.00	50	30	20	30	26.67
51	38	30	34	34.00	51	36	40	40	42.00
52	18	34	34	37.33	52	16	18	14	16.00
53	28	40	40	36.00	53	30	26	26	27.33
54	60	40	42	40.33	54	30	30	34	31.33
55	16	18	30	18.00	55	14	16	20	16.67
56	38	58	50	48.67	56	34	26	36	32.00
57	24	24	40	29.33	57	28	34	30	30.67
58	30	40	28	32.33	58	38	40	44	40.67
59	28	26	28	24.00	59	28	24	26	26.00
60	24	12	32	22.00	60	32	32	34	32.67
61	20	22	34	24.00	61	30	28	24	27.33
62	34	32	44	46.67	62	28	30	28	32.00
63	22	32	33	28.67	63	20	26	30	25.33
64	24	32	42	32.67	64	32	32	42	32.67
65	40	30	44	38.00	65	40	30	44	31.33

RAW SCORES FOR THE 14 YEAR OLD SUBJECTS PARTICIPATING IN THE HORIZONTAL LADDER AND THE BENT ARM HANG TESTS

	Horizontal Ladder Test					Bent Arm Hang Test			
Subject	1st	2nd	3rd	$\bar{X}$	Subject	1st	2nd	3rd	$\bar{X}$
1	15	15	15	13.67	1	2.5	2.8	3.0	2.77
2	15	12	15	14.00	2	3.3	4.2	6.2	4.57
3	6	14	15	11.67	3	15.7	20.3	19.7	18.57
4	15	15	15	15.00	4	10.0	17.5	13.2	13.57
5	4	2	4	3.33	5	8.2	5.3	2.8	5.43
6	15	15	15	15.00	6	10.5	10.5	6.7	9.23
7	4	9	9	7.33	7	3.9	4.7	8.8	5.80
8	3	6	15	8.00	8	7.3	7.0	7.0	7.10
9	3	2	1	2.00	9	0	0	0	0.00
10	0	0	0	0.00	10	0	0	0	0.00
11	14	15	15	14.67	11	2.6	0	3.0	1.87
12	3	1	1	1.67	12	0	0	0	0.00
13	5	7	8	6.67	13	0	0	4.1	1.37
14	4	4	5	4.33	14	6.3	7.3	7.3	6.97
15	7	6	0	4.33	15	0	0	0	0.00
16	0	0	0	0.00	16	0	0	0	0.00
17	1	2	1	1.33	17	0	0	0	0.00
18	5	15	15	11.67	18	2.0	0	3.0	1.77
19	14	15	15	14.67	19	12.2	13.9	18.9	15.00
20	6	8	9	7.67	20	8.6	12.6	18.6	13.27
21	15	15	15	15.00	21	8.1	10.3	10.5	9.63
22	15	15	15	15.00	22	3.0	5.0	6.7	4.90

23	13	15	15	15.00	23	4.5	6.5	3.9	4.97
24	15	15	15	15.00	24	8.5	13.0	10.1	10.53
25	15	15	15	15.00	25	5.0	5.0	6.2	5.40
26	15	15	15	15.00	26	7.2	5.6	7.1	6.63
27	7	3	5	5.00	27	10.0	6.4	6.4	7.60
28	6	8	3	5.67	28	1.7	1.3	2.5	1.83
29	8	9	15	10.67	29	6.2	7.1	8.4	7.23
30	0	1	2	1.00	30	0	0	0	0.00
31	15	15	15	15.00	31	7.2	8.1	8.2	7.83
32	3	8	15	8.67	32	6.0	14.0	10.8	10.00
33	1	2	3	2.00	33	0	0	0	0.00
34	9	15	15	13.00	34	0	2.8	1.3	1.37
35	15	15	15	15.00	35	3.6	8.5	8.5	6.83
36	7	5	6	6.00	36	5.0	6.9	7.2	6.33
37	3	2	0	1.67	37	0	0	0	0.00
38	10	15	15	11.67	38	5.1	5.8	8.1	6.33
39	3	0	0	1.00	39	0	0	0	0.00
40	7	6	6	6.33	40	8.2	5.2	7.0	6.80
41	6	0	4	3.33	41	0	0	0	0.00
42	15	14	15	14.67	42	6.6	7.9	8.0	7.50
43	4	4	4	4.00	43	3.0	5.0	3.6	3.87
44	15	15	15	15.00	44	2.4	3.1	2.1	2.80
45	14	15	15	14.67	45	6.9	5.0	4.0	5.30
46	6	2	4	4.00	46	4.0	4.2	5.0	4.40
47	15	15	15	15.00	47	5.7	7.0	6.8	6.50
48	2	2	0	1.33	48	0	0	0	0.00
49	7	15	15	12.33	49	3.0	5.1	5.7	4.60

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50	13	15	14	14.00	50	7.7	8.5	6.6	7.60
51	7	5	2	4.67	51	1.5	0	2.5	1.33
52	0	2	1	1.00	52	0	0	0	0.00
53	10	15	15	13.33	53	3.0	3.0	7.5	4.50
54	14	15	15	14.67	54	0	0	4.5	1.50
55	2	4	3	3.00	55	3.3	4.0	3.8	3.70
56	0	0	0	0.00	56	0	0	0	0.00
57	10	15	15	13.33	57	28.2	38.7	38.5	35.13
58	14	15	15	14.67	58	9.0	14.8	9.8	8.61
59	6	15	15	12.00	59	3.0	5.6	5.1	4.27

RAW SCORES FOR THE 14 YEAR OLD SUBJECTS PARTICIPATING IN THE MODIFIED PUSH-UP AND MODIFIED PULL-UP TESTS

Subject	Modified Pull-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$	Subject	Modified Push-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$
1	13	15	12	13.67	1	12	14	11	12.33
2	10	9	8	9.00	2	10	9	10	9.67
3	15	3	3	7.00	3	5	6	2	4.33
4	22	23	18	21.00	4	15	19	18	17.33
5	3	5	5	4.33	5	11	12	12	11.67
6	6	10	10	8.67	6	6	5	7	6.00
7	6	11	18	11.67	7	12	10	20	14.00
8	22	17	12	17.00	8	16	17	10	14.33
9	10	19	15	14.67	9	10	11	10	10.33
10	10	6	16	10.67	10	10	10	11	10.33
11	5	9	8	7.33	11	8	8	6	7.33
12	6	10	10	8.67	12	10	6	7	7.67
13	8	8	10	8.67	13	12	4	9	8.33
14	11	13	15	13.00	14	9	7	15	10.33
15	11	10	11	10.67	15	8	10	9	9.00
16	8	9	9	8.67	16	9	4	11	7.67
17	9	7	6	7.33	17	12	14	15	13.67
18	15	12	12	13.00	18	8	16	17	13.67
19	12	9	6	9.00	19	12	20	20	16.67
20	10	20	16	15.33	20	12	14	14	13.67
21	13	15	15	14.33	21	12	15	15	14.00
22	6	8	15	9.67	22	10	12	25	15.67
23	15	18	10	14.33	23	24	12	15	17.00
24	11	24	14	16.33	24	7	8	11	8.67

25	12	15	14	13.67
26	6	18	7	10.33
27	10	10	11	10.33
28	15	10	9	11.33
29	14	20	12	15.33
30	9	11	13	11.00
31	2	5	8	5.00
32	14	14	7	11.67
33	4	6	5	5.00
34	10	9	11	10.00
35	16	9	10	11.67
36	8	7	10	8.33
37	6	14	15	11.67
38	10	12	15	12.33
39	7	9	9	8.33
40	8	13	10	10.33
41	10	10	8	9.33
42	29	13	19	20.33
43	6	11	9	8.67
44	9	11	7	8.33
45	15	15	15	15.00
46	18	18	16	17.33
47	14	12	17	14.33
48	4	0	11	5.00
49	9	9	6	7.00
50	7	17	18	14.00
51	13	14	10	12.33

25	13	15	14	14.00
26	13	18	5	10.33
27	10	10	11	10.33
28	15	10	9	11.33
29	11	18	19	16.00
30	9	8	11	9.33
31	2	5	8	5.00
32	14	14	7	11.67
33	7	8	5	6.67
34	10	9	11	10.00
35	16	9	10	11.67
36	13	16	15	14.67
37	6	14	15	11.67
38	10	12	15	12.33
39	7	12	8	9.00
40	9	6	5	6.67
41	9	3	10	7.33
42	10	10	10	10.00
43	7	8	10	8.33
44	13	13	10	12.00
45	10	18	13	13.67
46	14	18	17	16.33
47	14	19	15	15.33
48	5	3	7	5.00
49	11	9	10	10.00
50	16	12	16	16.00
51	9	5	10	8.00

52	5	13	16	8.00	52	10	16	13	13.00
53	10	10	12	10.67	53	11	5	10	8.67
54	8	7	10	8.33	54	6	6	13	8.33
55	15	21	10	15.33	55	15	18	18	17.00
56	6	7	7	6.67	56	8	9	2	6.33
57	19	21	22	20.67	57	10	19	24	21.00
58	18	22	20	20.00	58	5	7	9	7.00
59	11	12	8	10.33	59	2	8	8	6.00

RAW SCORES FOR THE 14 YEAR OLD SUBJECTS PARTICIPATING IN THE PUSH AND PULL TESTS AS MEASURED BY THE HAND-DYNAMOMETER

Push Test					Pull Test				
Subject	1st	2nd	3rd	$\bar{X}$	Subject	1st	2nd	3rd	$\bar{X}$
1	52	36	34	37.33	1	40	38	40	39.33
2	24	22	18	21.33	2	38	30	34	34.00
3	28	34	40	34.00	3	32	30	28	30.00
4	44	42	48	44.67	4	40	38	52	43.67
5	36	44	30	36.67	5	26	26	46	32.67
6	30	24	22	25.33	6	24	26	28	26.00
7	26	33	48	35.33	7	30	26	34	30.00
8	28	36	54	39.33	8	30	46	38	38.00
9	42	42	50	44.67	9	40	42	42	41.33
10	22	24	32	26.00	10	22	38	20	26.67
11	36	26	44	35.33	11	26	23	41	30.00
12	30	34	34	32.67	12	20	32	30	24.00
13	32	42	42	38.67	13	32	34	40	35.33
14	22	36	38	32.00	14	14	22	20	18.67
15	28	34	34	32.00	15	24	48	22	34.67
16	32	36	44	37.33	16	32	44	42	38.00
17	44	32	46	40.67	17	50	34	38	40.67
18	24	36	32	30.67	18	30	34	34	32.67
19	38	38	46	40.67	19	38	42	40	40.00
20	34	32	36	34.00	20	28	34	30	30.67
21	16	47	48	35.33	21	32	28	32	30.67
22	48	32	38	39.33	22	42	36	42	40.00
23	22	18	34	24.67	23	34	34	24	30.67
24	34	20	32	28.67	24	34	36	36	35.33
25	24	34	28	28.67	25	34	30	36	33.33

26	24	36	58	39.33	26	38	20	30	29.33
27	46	40	40	42.00	27	48	50	60	62.67
28	40	34	34	36.00	28	50	34	34	39.33
29	32	24	34	29.33	29	26	34	34	31.33
30	40	46	38	41.33	30	36	30	34	33.33
31	24	36	32	30.67	31	26	42	26	31.33
32	30	60	50	46.67	32	30	32	34	32.00
33	52	38	40	43.67	33	38	36	30	34.67
34	30	30	34	31.33	34	30	26	34	25.33
35	40	30	42	37.33	35	34	30	28	30.67
36	48	34	60	51.33	36	44	38	42	41.00
37	30	20	20	16.67	37	30	30	30	30.00
38	38	36	53	42.00	38	28	28	40	32.00
39	28	24	28	26.67	39	38	34	34	35.33
40	34	34	32	33.33	40	32	38	48	39.33
41	26	22	26	24.67	41	16	22	30	22.57
42	30	30	32	30.67	42	30	32	24	28.67
43	40	56	40	45.33	43	56	56	60	54.00
44	24	24	40	29.33	44	32	32	30	30.67
45	38	20	32	30.00	45	30	34	32	32.00
46	24	28	40	30.67	46	38	40	38	38.67
47	40	40	28	36.00	47	38	36	32	35.33
48	36	40	50	42.00	48	40	38	42	40.00
49	46	36	48	43.33	49	42	50	52	48.00
50	42	42	28	37.33	50	50	44	44	46.00
51	28	24	26	26.00	51	30	28	30	29.33
52	30	24	26	26.67	52	26	20	38	28.00
53	16	24	24	21.33	53	14	14	16	14.67

54	38	32	32	34.00	54	30	34	28	30.67
55	28	20	22	23.33	55	38	32	36	35.33
56	28	36	28	29.33	56	28	40	32	35.00
57	22	40	46	36.00	57	18	28	28	24.67
58	30	22	26	26.00	58	24	24	26	24.67
59	22	30	32	28.00	59	26	28	28	20.67

RAW SCORES FOR THE 15 YEAR OLD SUBJECTS PARTICIPATING IN THE HORIZONTAL LADDER AND THE BENT ARM HANG TESTS

	Horizontal Ladder Test					Bent Arm Hang Test			
Subject	1st	2nd	3rd	$\bar{X}$	Subject	1st	2nd	3rd	$\bar{X}$
1	8	0	15	5.67	1	4.4	7.5	13.6	8.30
2	1	2	2	1.67	2	0	0	0	0.00
3	3	2	1	2.00	3	4.0	6.4	7.3	5.90
4	0	0	0	0.00	4	0	0	0	0.00
5	15	15	15	15.00	5	18.0	10.7	14.7	14.47
6	15	7	15	12.33	6	1.0	5.1	7.1	4.40
7	2	1	0	1.00	7	0	0	0	0.00
8	15	15	15	15.00	8	11.0	10.3	11.3	10.87
9	15	14	14	14.33	9	20.0	35.7	17.0	24.23
10	7	15	15	12.33	10	2.5	1.5	1.3	1.77
11	15	15	15	15.00	11	6.3	1.3	1.0	2.87
12	0	0	0	0.00	12	5.2	4.3	6.2	5.23
13	0	0	0	0.00	13	0	0	0	0.00
14	15	13	15	14.33	14	3.8	3.9	3.7	3.80
15	15	15	15	15.00	15	0	0	0	0.00
16	5	6	6	5.67	16	3.0	1.0	2.0	2.00
17	0	0	0	0.00	17	0	0	0	0.00
18	0	0	0	0.00	18	0	0	0	0.00
19	15	8	14	12.33	19	7.9	3.0	5.7	5.53
20	10	6	4	6.67	20	0	0	0	0.00
21	3	1	8	4.00	21	0	0	0	0.00
22	6	4	3	4.33	22	9.2	9.5	9.0	9.23
23	15	1	15	15.00	23	5.0	7.2	2.5	4.23
24	6	6	6	6.00	24	0	0	0	0.00
25	15	15	15	15.00	25	11.0	15.7	22.6	16.43

26	6	9	15	10.00	26	7.5	10.4	11.5	9.80
27	4	3	3	3.33	27	7.0	4.3	3.0	4.77
28	9	15	15	13.00	28	12.7	17.5	23.5	10.67
29	15	15	15	15.00	29	10.7	8.8	13.3	10.93
30	0	0	0	0.00	39	0	0	0	0.00
31	15	15	15	15.00	31	3.7	6.3	9.0	6.33
32	0	0	0	0.00	32	0	0	0	0.00
33	15	12	14	13.67	33	0	0	0	0.00
34	15	15	15	15.00	34	14.6	20.4	14.6	16.53
35	1	2	0	1.00	35	0	0	0	0.00
36	6	8	3	5.67	36	4.2	6.1	5.1	5.13
37	5	2	2	3.00	37	0	0	0	0.00
38	0	0	0	0.00	38	4.0	11.7	10.3	8.67
39	30	30	0	2.00	39	0	0	0	0.00
40	15	15	15	15.00	40	0	0	0	0.00
41	15	15	15	15.00	41	2.5	0	1.0	1.17
42	15	15	15	15.00	42	7.0	4.7	8.5	6.73
43	1	6	6	4.33	43	3.1	7.1	7.8	6.00
44	0	0	0	0.00	44	0	0	0	0.00
45	14	15	15	14.67	45	5.0	4.4	5.5	6.77
46	2	6	2	3.33	46	10.5	17.5	16.3	11.43
47	1	1	1	1.00	47	8.0	4.0	2.0	5.43
48	8	15	15	12.67	48	1.0	2.5	0	1.17
49	12	15	15	14.00	49	0	0	0	0.00
50	7	9	7	7.67	50	8.6	3.1	8.6	6.77
51	14	6	14	11.33	51	3.4	3.8	3.9	3.43
52	15	15	15	15.00	52	7.2	9.4	14.6	10.43
53	10	3	4	5.67	53	8.1	9.1	9.1	8.77

54	10	3	4	5.67	54	0	2.4	1.9	1.
55	10	13	15	12.67	55	0	0	0	0.

RAW SCORES FOR THE 15 YEAR OLD SUBJECTS PARTICIPATING IN THE MODIFIED PUSH-UP AND MODIFIED PULL-UP TESTS

Subject	Modified Pull-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$	Subject	Modified Push-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$
1	15	15	10	13.33	1	10	11	12	11.00
2	15	14	13	14.00	2	23	23	22	22.67
3	20	13	11	14.67	3	12	14	10	12.00
4	10	10	12	10.67	4	12	10	8	10.00
5	16	14	14	14.67	5	9	7	7	7.67
6	10	14	14	12.33	6	13	13	13	13.00
7	7	5	9	7.00	7	4	14	9	9.00
8	19	24	19	20.67	8	10	18	19	15.67
9	18	15	16	16.33	9	20	17	12	16.33
10	10	11	9	10.00	10	11	10	12	10.67
11	15	13	15	14.33	11	6	10	10	8.67
12	6	8	12	8.67	12	10	8	12	10.00
13	3	7	5	5.00	13	5	12	13	9.33
14	16	14	20	16.67	14	11	18	17	15.33
15	17	16	15	16.00	15	15	15	15	15.00
16	21	18	21	20.00	16	9	20	15	14.67
17	15	14	9	12.67	17	11	10	14	11.67
18	14	14	16	14.67	18	17	9	17	14.33
19	9	6	8	7.67	19	15	6	9	10.00
20	10	9	8	9.00	20	20	10	15	15.00
21	9	10	11	10.00	21	10	10	10	10.00
22	6	6	8	6.67	22	8	3	6	5.67
23	5	14	10	9.67	23	6	5	15	8.67
24	28	10	13	17.00	24	12	13	10	12.33

25	10	17	20	15.67	25	10	12	20	14.00
26	18	19	14	17.00	26	17	15	15	15.67
27	11	10	7	8.67	27	6	8	10	8.00
28	11	16	14	13.67	28	9	10	9	9.33
29	14	20	20	18.00	29	10	10	15	11.67
30	9	9	9	9.00	30	12	10	7	9.67
31	15	14	19	16.00	31	10	13	15	12.67
32	3	9	10	7.33	32	3	4	3	3.33
33	10	7	11	9.33	33	15	10	12	12.33
34	11	21	11	14.33	34	13	25	20	19.33
35	3	7	9	6.33	35	5	8	10	7.67
36	7	3	15	8.33	36	18	11	15	14.67
37	6	6	9	7.00	37	6	5	5	5.33
38	14	16	14	14.67	38	6	14	16	12.00
39	6	9	6	7.00	39	6	9	8	7.67
40	7	9	8	8.00	40	7	8	7	7.33
41	14	10	5	9.67	41	7	21	20	16.00
42	10	16	21	15.67	42	19	30	20	23.00
43	20	18	17	18.33	43	6	8	12	8.67
44	3	10	18	10.33	44	12	10	14	12.00
45	9	8	13	10.00	45	14	13	10	12.00
46	15	20	19	18.00	46	7	9	16	10.67
47	16	9	10	11.67	47	18	16	12	15.33
48	9	11	11	10.33	48	12	11	11	11.33
49	15	15	16	15.33	49	10	12	15	12.33
50	14	14	12	13.67	50	10	14	12	12.00
51	12	11	10	11.00	51	16	7	9	10.67
52	15	13	10	12.67	52	18	11	21	16.67
53	20	20	18	19.33	53	8	22	24	18.33

54	7	8	20	11.67	54	5	7	5	5.67
55	10	11	13	11.33	55	5	10	10	8.33

RAW SCORES FOR THE 15 YEAR OLD SUBJECTS PARTICIPATING IN THE PUSH AND PULL TESTS AS MEASURED BY THE HAND-DYNAMOMETER

Push Test					Pull Test				
Subject	1st	2nd	3rd	$\bar{X}$	Subject	1st	2nd	3rd	$\bar{X}$
1	22	28	30	26.67	1	28	30	30	29.67
2	40	42	40	40.67	2	46	32	36	38.00
3	26	30	32	29.33	3	40	42	40	44.00
4	46	38	38	38.67	4	36	40	50	44.67
5	36	50	36	38.67	5	28	20	30	39.33
6	26	38	24	26.00	6	30	38	40	36.00
7	28	30	30	29.33	7	38	34	36	36.00
8	34	38	44	38.67	8	54	40	52	48.67
9	35	50	50	46.00	9	40	40	36	36.67
10	48	48	34	34.33	10	14	22	22	19.33
11	20	26	20	22.00	11	30	28	40	32.67
12	38	34	46	39.33	12	32	32	34	34.67
13	40	26	28	31.33	13	38	38	32	36.00
14	32	34	24	30.00	14	22	24	24	23.33
15	30	26	32	29.33	15	40	50	50	46.67
16	44	40	44	42.67	16	22	47	35	34.67
17	38	34	40	37.33	17	26	28	30	29.34
18	22	28	28	26.00	18	34	38	40	37.33
19	28	28	34	30.00	19	38	36	36	36.67
20	24	28	34	38.67	20	36	40	36	37.33
21	30	30	54	38.00	21	50	45	46	47.00
22	44	50	36	43.33	22	14	14	28	18.67
23	38	30	24	30.67	23	56	34	44	44.67
24	42	38	36	38.00	24	28	20	20	22.67

25	30	42	34	35.33	25	42	38	38	39.33
26	40	40	40	40.00	26	42	36	58	45.33
27	28	30	20	26.00	27	32	38	32	34.00
28	28	26	32	28.67	28	26	24	42	32.67
29	36	34	32	34.00	29	30	30	32	30.33
30	50	46	56	50.67	30	54	52	46	50.67
31	40	32	44	38.67	31	48	50	50	49.33
32	38	26	24	29.33	32	48	50	50	49.33
33	48	26	36	36.67	33	28	44	48	40.00
34	46	38	48	44.00	34	36	26	38	33.33
35	36	38	36	36.67	35	36	48	38	40.67
36	22	24	20	22.00	36	28	32	30	30.00
37	24	28	30	28.00	37	24	22	18	21.22
38	36	40	40	38.67	38	28	24	28	26.67
39	52	48	48	49.33	39	34	42	40	38.67
40	54	30	50	44.67	40	42	52	50	48.00
41	34	54	54	47.33	41	32	44	30	35.43
42	32	32	40	34.67	42	34	52	72	57.33
43	38	38	36	37.33	43	28	30	24	27.33
44	30	38	40	36.00	44	38	38	36	35.33
45	28	26	20	24.67	45	36	38	48	40.67
46	24	30	30	26.67	46	28	28	28	28.00
47	42	42	44	42.67	47	30	24	22	25.33
48	22	22	22	22.00	48	48	40	46	44.67
49	34	38	44	38.67	49	22	22	20	21.33
50	40	48	32	40.00	50	40	48	44	44.00
51	22	28	22	24.00	51	40	46	42	42.67

52	32	26	24	27.33	52	24	20	28	24.00
53	40	42	40	40.67	53	30	30	32	30.67
54	24	56	44	41.33	54	38	38	40	38.67
55	34	34	34	34.00	55	30	36	30	32.00

RAW SCORES FOR THE 16 YEAR OLD SUBJECTS PARTICIPATING IN THE HORIZONTAL LADDER AND THE BENT ARM HANG TESTS

Horizontal Ladder Test					Bent Arm Hang Test				
Subject	1st	2nd	3rd	$\bar{X}$	Subject	1st	2nd	3rd	$\bar{X}$
1	5	15	4	8.00	1	7.5	9.7	9.3	6.67
2	14	14	15	14.33	2	2.0	6.3	5.1	4.47
3	2	2	4	2.67	3	7.2	6.2	8.3	7.23
4	9	15	15	13.00	4	5.0	3.0	13.1	7.33
5	5	4	4	4.33	5	3.0	2.0	6.6	3.53
6	11	14	8	11.00	6	0	0	0	0.00
7	15	15	15	15.00	7	11.6	13.6	7.6	10.93
8	15	15	15	15.00	8	0	0	0	0.00
9	15	8	15	12.67	9	14.4	15.5	19.5	16.47
10	15	15	15	15.00	10	7.2	12.7	11.0	10.30
11	15	15	15	15.00	11	2.5	8.0	8.2	6.23
12	6	7	15	9.33	12	4.0	13.0	9.3	8.77
13	0	0	4	1.33	13	0	0	0	0.00
14	3	3	3	3.00	14	2.0	3.0	0	1.67
15	9	7	15	10.33	15	7.2	8.3	11.0	8.83
16	1	3	4	2.67	16	0	0	0	0.00
17	1	2	2	1.67	17	0	0	0	0.00
18	7	14	12	11.00	18	10.0	6.0	5.0	7.00
19	6	5	15	8.67	19	4.0	2.0	7.3	4.43
20	3	6	3	4.00	20	7.2	2.3	5.3	4.93
21	15	15	15	15.00	21	0	0	0	0.00

RAW SCORES FOR THE 16 YEAR OLD SUBJECTS PARTICIPATING IN THE MODIFIED PUSH-UP AND MODIFIED PULL-UP TESTS

Subject	Modified Pull-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$	Subject	Modified Push-Up Scores Per Trial 1st	2nd	3rd	$\bar{X}$
1	6	17	17	13.33	1	8	10	9	9.00
2	12	15	11	12.67	2	16	9	9	11.33
3	16	10	12	12.67	3	16	8	10	11.33
4	10	13	18	13.67	4	6	8	10	8.00
5	10	9	12	10.33	5	18	16	10	14.67
6	5	17	21	14.33	6	6	16	20	14.00
7	15	15	15	15.00	7	7	9	9	8.33
8	9	23	16	16.00	8	10	9	12	10.33
9	20	15	15	16.67	9	10	9	11	10.00
10	18	19	20	19.00	10	15	18	16	16.33
11	10	10	12	10.67	11	10	10	12	10.67
12	11	7	13	10.33	12	8	9	13	10.00
13	7	8	14	9.67	13	4	10	13	9.00
14	13	14	15	14.00	14	19	20	15	18.00
15	11	17	20	16.00	15	14	15	10	13.00
16	10	13	13	12.00	16	11	16	18	15.00
17	3	5	5	4.33	17	2	5	5	4.00
18	10	12	16	12.67	18	7	15	10	10.67
19	17	19	21	19.00	19	8	15	10	11.00
20	10	10	14	11.33	20	14	13	14	13.67
21	5	7	8	6.67	21	5	7	7	6.33

RAW SCORES FOR THE 16 YEAR OLD SUBJECTS PARTICIPATING IN THE PUSH AND PULL TESTS AS MEASURED BY THE HAND-DYNAMOMETER

	Push Test					Pull Test			
Subject	1st	2nd	3rd	$\bar{X}$	Subject	1st	2nd	3rd	$\bar{X}$
1	28	28	54	37.33	1	28	18	54	33.33
2	46	46	50	47.33	2	38	34	38	36.67
3	48	48	30	42.00	3	52	50	40	47.33
4	46	46	44	45.33	4	42	48	50	46.67
5	48	40	50	56.00	5	46	46	40	44.00
6	34	24	34	27.33	6	30	30	28	29.33
7	38	38	40	38.67	7	38	40	54	44.00
8	62	62	64	66.00	8	56	52	56	54.67
9	40	22	58	40.00	9	48	42	40	43.33
10	42	40	46	42.67	10	38	44	48	43.33
11	24	38	36	32.67	11	24	34	36	31.33
12	24	26	30	26.67	12	40	34	40	38.00
13	24	26	28	26.00	13	32	30	34	32.00
14	38	38	40	48.67	14	36	42	22	33.33
15	30	26	36	30.67	15	32	30	32	31.33
16	32	22	40	31.33	16	42	40	40	40.67
17	36	38	32	35.33	17	38	40	38	36.67
18	28	22	28	26.00	18	30	26	26	28.67
19	24	32	30	28.67	19	22	34	32	29.33
20	22	50	36	36.00	20	36	50	52	46.00
21	20	24	24	22.67	21	42	38	38	39.33

BIBLIOGRAPHY

Books

Barrow, Harold M., and McGee, Rosemary. A Practical Approach to Measurement in Physical Education. Philadelphia: Lea and Febiger, 1964.

Bovard, John F., Cozens, Frederick W., and Hagman, E. Patricia. Tests and Measurements in Physical Education. Philadelphia: W. B. Saunders Company, 1949.

Clarke, H. Harrison. Muscular Strength and Endurance in Man. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1966.

Espenschade, Anna. "Motor Development." Science and Medicine of Exercise and Sports. Edited by Warren R. Johnson. New York: Harper and Row, 1960.

Johnson, Barry L., and Nelson K. Practical Measurements for Evaluation in Physical Education. Minneapolis, Minnesota: Burgess Publishing Company, 1969.

McCloy, Charles H. The Measurement of Athletic Power. New York: A. S. Barnes and Company, 1932.

Scott, M. Gladys, and French, Esther. Measurement and Evaluation in Physical Education. Dubuque, Iowa: Wm. C. Brown and Company Publishers, 1959.

Willgoose, Carl E. Evaluation in Health Education and Physical Education. New York: McGraw-Hill Book Company, Inc., 1961.

Periodicals

Carpenter, Aileen. "A Critical Study of the Factors Determining Effective Strength for Women." Research Quarterly, IX (December, 1938), 3-27.

_____. "An Analysis of the Relationship of Factors of Velocity, Strength, and Dead Weight to Athletic Performance." Research Quarterly, XII (March, 1944), 34-39.

Cotten, Doyice J., and Marwitz, Bonnie. "Relationship Between Two Flexed-Arm Hangs and Pull-Ups for College Women." Research Quarterly, XXXX (May, 1969), 415-16.

Eckert, Helen M., and Day, June. "Relationship Between Strength and Work Load in Push-Ups." Research Quarterly, XXXVIII (October, 1967), 380-83.

Espenschade, Anna S., and Meleney, E. "Motor Performance of Adolescent Boys and Girls of Today in Comparison With Those of Twenty-Four Years Ago." Research Quarterly, XXXII (May, 1961), 186-189.

Hinson, Marliyn M. "An Electromyographic Study of the Push-Up for Women." Research Quarterly, XXXX (May, 1969), 305-308.

Huntinger, Paul W. "Effect of Systematic Horizontal-Ladder Exercises Upon Body Strength of Third Grade Children." Research Quarterly, XXVI (May, 1955), 159-162.

McCloy, Charles H. "The Apparent Importance of Arm Strength in Athletics." Research Quarterly, V (March, 1934), 8.

Sargent, Dudley A. "The Physical Test of a Man." American Physical Education Review, XXVI (April, 1921), 23.

Wessel, Janet A., and Nelson, Richard C. "Relationship Between Grip Strength and Achievement in Physical Education Among College Women." Research Quarterly, XXXII (May, 1961), 244-248.

Whitley, J. D., and Smith, L. E. "Larger Correlations Obtained by Using Average Rather Than "Best" Strength Scores." Research Quarterly, XXXIV (May, 1963), 248-249.

Wilson, Marjorie U. "A Study of Arm and Shoulder Girdle Strength of College Women in Selected Tests." Research Quarterly, XV (October, 1944), 258-267.

Unpublished Materials

Wilson, Marjorie U. "A Study of Arm and Shoulder Girdle Strength of College Women in Selected Tests." Unpublished Master's Thesis, University of Iowa, 1943.