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The purpose of this study was to investigate, under controlled conditions, the results of supplementary pull-up repetitions in junior high school boys.

For six weeks at three days a week, forty-five students were divided into a control group which performed pull-up repetitions exclusively, and three experimental groups which performed pull-ups and one supplementary training exercise; the straight arm hang, the bent arm hang, and the simulated pull-up.

An analysis of variance of the raw data from the pull-up pre-test showed no significant difference in the initial pull-up performance of the four equated groups.

An analysis of variance found no significant differences in the gains between the four groups at the conclusion of the training program. The t tests found that all four groups increased significantly in pull-up performance.

Under the conditions of this study, junior high school boys can increase their pull-up performance by attempting maximum pull-up output three days a week for six weeks; however, the three supplementary exercises had no significant effects upon group gains as compared to the control group.

THE VALUE OF THREE SUPPLEMENTARY EXERCISES DESIGNED TO INCREASE PULL-UP PERFORMANCE IN JUNIOR HIGH SCHOOL BOYS

by

Victor H. Lutz

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Approved by

Director

APPROVAL SHEET

This thesis has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

Thesis Director Marvin Bernstein Jr

Oral Examination Committee Members Gail M. Hennis

Rosemary McGee

Lawrence J. Sorohan

Jan 24, 1969
Date of Examination

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CHAPTER I

INTRODUCTION

Physical educators have a professional responsibility toward the students they teach. Working through the media of physical activities, these instructors strive toward developing the abilities and fulfilling the needs of their pupils. In recent years the American public has been made aware of the inadequate level of physical fitness of our young people. The President's Council on Youth Fitness has publicized the necessity for constructive programs to correct the inadequacies. (12:1) Physical education teachers and administrators constantly seek guidance in the use of tests which evaluate the physical proficiency and progress of students.

Numerous tests have been designed combining a wide variety of factors to measure fitness. Most test items which represent fitness factors are in the form of exercises such as pull-ups and sit-ups, or skill activities such as a softball throw and a shuttle run. Fitness tests are usually composed of a battery of test items. The examples that follow are similar to the many fitness tests that are available.

The American Association for Health, Physical Education, and Recreation Youth Fitness Test, (A.A.H.P.E.R. Youth Fitness Test), has as its purpose, "to measure status and achievement in the physical fitness objective." (2:184) The test consists of a seven item battery which includes pull-ups to measure arm

and shoulder strength; sit-ups to measure abdominal strength and endurance; a shuttle run to measure speed and agility; a standing broad jump to measure power; a 50-yard dash to measure speed; a softball throw for distance to measure arm and shoulder girdle strength and coordination; and a 600-yard run-walk to measure endurance.

The Basic Fitness Tests has as its purpose, to evaluate the degree and progression of fitness in students. (12:4) The test consists of a nine item battery which includes a twist and touch exercise to measure "extent flexibility" (stretching the trunk and back muscles); a bend, twist and touch exercise to measure "dynamic flexibility" (making repeated, rapid flexing movements); a shuttle run or a softball throw to measure "explosive strength" (using energy for a burst of effort); a hand grip test to measure "static strength" (maximum force exerted for a brief period); a pull-up test to measure "dynamic strength" (exerting force repeatedly or continuously over a period of time); leg lifts to measure "trunk strength" (limited to abdominal muscles); a cable jump test to measure coordination; a balance test to measure equilibrium; and a 600 yard run-walk to measure "stamina" (prolonged exertion using maximum effort).

The New York State Physical Fitness Test has as its purpose, "to measure status and progress in physical fitness". (2:234) The test consists of a seven item battery which includes a posture test to evaluate lateral and antero-posterior posture; a target throw to measure accuracy; pull-ups to measure strength; a side step test to measure agility; a 50-yard dash to measure speed; a squat stand to measure balance; and a treadmill exercise to measure en-

durance.

Norms are often developed for fitness tests. "Norms give some conception of the general level of a score in a known population, and also put scores from different test items on a comparable basis". (14:108) When students attempt the items of a fitness test, results are compared with the norms of that test, and degrees of fitness are determined through the comparisons.

One of the items found in many of the fitness tests is the pull-up exercise. The norms that are established for pull-ups indicate a rather low performance rate. Percentile scores for the following three fitness tests are given as examples:

For the A.A.H.P.E.R. Youth Fitness Test, percentile scores reveal that a twelve year old boy, performing seven pull-ups, using the overhand grip method, is ranked in the 95th. percentile. If a boy of the same age successfully performs two repetitions, he is ranked in the 50th. percentile; the completion of one pull-up ranks a boy of the same age in the 40th. percentile. There are no attempts recorded after the 30th percentile. (2:193)

For the Basic Fitness Tests, using norms established for more than 20,000 students in 45 cities in the United States, (12:7) a twelve year old boy is ranked in the 99th. percentile if he performs nine pull-ups using the underhand grip method. If a boy the same age successfully completes one pull-up, he is ranked in the 50th. percentile. No repetitions are recorded after the 40th. percentile. (12:55)

For the New York State Physical Fitness Test using norms that are

categorized in grades instead of ages, a seventh grade boy is ranked in the 93rd. percentile if he completes a minimum of nine pull-ups using the underhand grip method. A boy in the same grade, performing a minimum of two pull-ups, is ranked in the 50th. percentile; the completion of one pull-up ranks a boy of the same grade in the 31st. percentile. No repetitions are recorded after the 30th. percentile. (2:247)

The following interpretations are given for the percentiles of the three tests already mentioned:

A.A.H.P.E.R. Youth Fitness Test. For every one hundred, twelve year old boys who perform the pull-up test item, only five will accomplish more than seven repetitions; fifty will not do more than two pull-ups; and out of that fifty, thirty will not perform a single pull-up.

Basic Fitness Tests. For every one hundred, twelve year old boys who perform the pull-up test item, only one will complete more than nine repetitions; fifty will not do more than one pull-up; and out of that fifty, forty will not perform a single pull-up.

New York State Physical Fitness Test. For every one hundred seventh grade boys who perform the pull-up test item, seven will do more than nine repetitions; fifty will not accomplish more than two pull-ups; and out of that fifty, thirty will not perform a single pull-up.

The percentile tables for the three tests also show low performance in the pull-up test item for boys thirteen through seventeen years of age. After reviewing these results, it seems evident that there is a definite need for a

remedial program designed to increase pull-up performance in boys.

The writer first became interested in this problem while working with Y.M.C.A. gym classes composed of boys in the twelve through fourteen year old age bracket. It was noticed that very few individuals in the classes were able to complete more than three or four pull-ups. If a program could be devised that would gain prompt results and would be readily discernible to the participants, then perhaps such a program would act as a motivational force toward increasing pull-up achievement. A need for further study into possible methods of training is evident.

Statement of the problem

The purpose of this study was to investigate, under controlled conditions, the results of supplementary pull-up exercise training toward increasing pull-up repetitions in junior high school boys.

Hypothesis

There was a significant difference between the control group and the supplementary exercise groups.

Definition of terms

For the purposes of this study, the following terms are defined:

Pull-up. The basic exercise for this study. Each subject begins by hanging from a crossbar using an overhand grip with hands placed approximately shoulder width apart. Arms and legs are straight and feet do not touch the floor.

Each subject pulls his body upward until his chin clears the crossbar. He returns to a straight arm hang. This completed action represents one repetition.

Simulated pull-up. One of the supplementary exercises of this study. The subject begins by grasping a three-foot section of one-half inch wooden dowelling using an overhand grip as in the pull-up. Both feet are on the floor and the arms are held straight above the head as in the hang position of the pull-up. The subject exerts strain as he pulls the dowelling to a level below his chin and returns it to the straight arm position above his head.

Straight arm hang. One of the supplementary exercises of this study. The subject uses the basic pull-up grip and hangs with feet off the floor and arms straight. He keeps this position as long as possible.

Bent arm hang. One of the supplementary exercises of this study. The subject uses the basic pull-up grip and hangs with feet off the floor and arms bent. The attempt begins with the chin above the crossbar and the elbows close to the body. The attempt ends when the muscles are relaxed or the arms are allowed to come to a straight arm hang position.

Plus repetition. An incompleted pull-up repetition. The subject is unable to clear the crossbar with his chin but does manage to raise his body high enough so that any part of his head clears the crossbar.

Minus repetition. An incompleted pull-up repetition. The subject is unable to reach the plus repetition position but does manage to raise his body high enough so that he forms a ninety degree angle at the elbow joint of his arm.

Overhand grip. The position of the hands for the pull-up and supple-

mentary exercises. The palms are placed on the crossbar so that they face away from the subject. All fingers are curled over the crossbar and both thumbs are curled under it.

Clear. The particular height which must be attained by the chin during the pull-up. This action occurs whenever the chin touches the top of the crossbar or goes above it.

Basic assumptions

1. The Wetzel Grid is an accepted method of classifying junior high school boys into homogeneous groups according to individual body type or build. (2:346)

2. The pull-up is an accepted exercise for the demonstration of strength and endurance of the arms and shoulder girdle muscles. (26, 34, 35)

Delimitations

This study was limited to the following factors:

1. A total of forty-five seventh, eighth and ninth grade students were used from one institution, Curry School, which is part of the School of Education of the University of North Carolina at Greensboro. The ages ranged from twelve years to fifteen years, four months.

2. The testing program was administered in a small room with little ventilation and no control of the temperature or humidity.

3. The subjects could not be controlled outside of the training program.

Significance

The value of research effectively demonstrating the superiority of one type of exercise over another has important implications for the physical educator and the student. If the results of the program are significant, this study can lead to similar research concerning other specific exercises using supplementary practices. Time consuming, unnecessary routines can be discarded, and the highly efficient, precise systems of exercise that are developed can be substituted. The participants will be given the opportunity to attain faster and better results which should lead to a reaction of clearer understanding and appreciation of the tasks which physical educators attempt to undertake and fulfill.

CHAPTER II

REVIEW OF LITERATURE

In order to facilitate the direction of this study, certain areas of the literature pertaining to pull-ups and other related fields were reviewed.

The writer felt that an analysis of the muscular movement of a pull-up may be helpful in understanding the execution of such an exercise. Scott, (35:335) in describing this action, relates the muscular nomenclature involved in the various positions.

Grip. The flexor profundus digitorum, flexor longus pollicis and flexor sublimus digitorum are the muscles employed during the actual hand grasp of the crossbar.

Elbow flexion. During elbow flexion the biceps, brachialis anticus, pronator teres, and the brachioradialis muscles are used.

Arm depression. When arm depression takes place the latissimus dorsi, teres major, and the lower pectoralis major are brought into action.

Scapula movement. For the accompanying scapula movement, the pectoralis minor, rhomboids and third part of the trapezius are under stress.

During the action of the arms, certain parts of the body must be kept firm in order to permit maximum shoulder muscle effort. The trunk is kept rigid by the erector spinae, abdominals, intercostals, and the diaphragm. The tension of these muscles also works as a counteraction against the hyperextension

of the spine accomplished by the flexion of the latissimus dorsi. This would further prevent the leg swing which counterbalances the hyperextension of the back.

When the chin surpasses the level of the crossbar, the return to the starting position is made by the general relaxation of the same muscles of the elbow and shoulder that were activated during the upward motion. Scott confirms this analysis by stating that ". . . slow controlled lowering of body weight uses the same muscles which are required to lift the weight." (35:410)

Ferguson, (10:151) in describing pull-up action, states that ". . . tension should be felt in the middle of the upper back, the shoulders, chest, and the front of the upper arms." Hamlin and Waterman (15) relate the movement of a pull-up as ". . . strenuous, vigorous action of depressor muscles of the upper arm and flexors of the forearm."

McCloy (27) states that during a pull-up, the pectoralis major stops its action about half way up, and the latissimus dorsi, teres major, biceps, and brachialis progressively pull as the angle of the arm becomes more acute. Hooks (16:92) lists the primary muscles used in the pull-up as the biceps, brachialis, and latissimus dorsi.

A knowledge of the muscles used in the performance of the pull-up leads one to realize that strenuous muscular effort must take place in order to complete a repetition. Some individuals are able to perform more pull-ups than others. The literature gives various reasons for this, most of which ultimately relate to strength. Ferguson (10:17) states that if an athlete cannot begin the

pull-up, there is a strength deficiency in the upper back and shoulder area. If failure occurs during the final half of the upward motion, a strength deficiency may exist in the upper arms (biceps), or the chest.

Scott (35:336) specifies reasons why there is a difficulty in attempting pull-ups. She suggests that resting inertia, at the start of the pull-up sometimes makes it impossible to begin upward motion unless aid is given. She also notes that in the starting position of the pull-up, muscles are fully stretched so that the angle of application to the lever is extremely small. Flexion of the arm causes upward movement of the body and the angle of pull improves. A lack of arm and shoulder girdle strength and also a deficiency in finger strength can cause the forces of inertia and insufficient angular pull to prevent the upward movement of a pull-up.

Another factor which bears mentioning is the force of gravity. Broer (4:320) relates this force to pull-up performance by stating that, ". . . for exercises in which the weight of the body itself or of a body part is lifted or lowered slowly, gravity supplies the resistance against which the muscles must work."

The amount and composition of an individual's weight seem to be important determinants in strength and endurance testing which, in turn, often involve the pull-up exercise. This classification of weight distribution in human beings is usually referred to as somatotyping. The three body types are most commonly described as endomorphic (fat), mesomorphic (muscular), and ectomorphic (slim). The writer has found some disagreement in the studies

which classify body type in relation to strength and endurance.

Sills and Everett, (36) in a study on performance of extreme somatotypes relating to motor and strength tests, found that the mesomorphs are stronger than the endomorphs or ectomorphs; and, in turn, the endomorphs are stronger than the ectomorphs. They feel that excess weight is a handicap to the endomorphs and insufficient strength is a handicap to the ectomorphs. Sills and Everett conclude that consideration should be given body types in formulating standards for achievement in strength tests.

Hunsicker and Greey, (17) in their summary of studies in human strength, state that body type is related to strength and those possessing a high mesomorphic component have the greatest amount of strength. Leedy et al (22) recognize the percent of lean body mass as an important factor in moving the whole body rather than the actual amount of lean body mass. Cureton and Larson (7) state that ". . . strength is one type of physical fitness which is high in mesomorphic types."

Miller, (29) in using a different system of somatotyping, finds his study to show that maximum performance in strength items are generally found in the athletic or stocky, football builds, classified as "A_2" and "A_1" by the Wetzel Grid. Bookwalter (3) disagrees with such findings in his study using the Wetzel Grid. His results indicate that the middle five groupings (A_2, A_1, M, B, B_2) scored best on physical fitness tests which included strength items such as the pull-up. The worst scores are registered by the obese group (A_3 and A_4); the thin group (B_3 and B_4) are considerably higher than the obese type, but lower

than the muscular and average groups. Bookwalter summarizes by saying that size and shape seem to have an influence on physical performance.

McCloy, (27) in his study on new methods of scoring pull-ups, finds a negative relationship concerning body type and pull-up performance. According to his calculations, height and weight have practically no correlation with number of pull-up repetitions achieved. He feels that the increase in strength that is gained by an increase in weight is counterbalanced by the fact of having to elevate the added weight.

Although there is disagreement concerning classification of body types in relation to tests of strength and endurance, the review of literature provided valuable insight into possibilities of classifying the groups for this study according to body build.

Information relating to strength and endurance was another area which was examined. Dewitt, (9) in his research on types of pull-up tests, reports that pull-ups ". . . have been and probably always will be used as one of the means to develop arm and shoulder-girdle strength and endurance." A difficulty arises when an attempt is made to ascertain the meaning and importance of the strength and endurance that pull-ups are found to develop or measure. It was neither necessary nor advisable to review the vast stores of information concerning the various topics of strength and endurance. Therefore, the writer only relates the knowledge which was found to give needed background for this study.

Rath, (33) in a study dealing with the strength index of ninth grade boys, concludes that researchers in physical education generally agree that strength

is the most important factor in all forms of motor ability. Hooks (16:5) emphatically states that ". . . the data collected so far indicates conclusively that the best athletes are strong in the arms and shoulders, and further that strength in this body area is generally an indication of potential athletic excellence."

Clarke (6:58) states that:

> Bodily strength must always be of primary concern to the physical educator, as upon it depends the individual's ability to learn physical skills, to maintain body vigor, and to resist fatigue. Moreover, endurance is based upon strength.

Mathews et al (24:319) feel that the physical educator must have an understanding of the physiological factors underlying exercise in order to establish scientific conditioning programs. They list five physiological changes which result from these programs, with increase in strength and increase in muscular endurance being the first two.

Difficulty arises when an attempt is made to define strength. Davis (8:63) sums up the situation by commenting that a review of literature concerning strength and its development reveals that ". . . an adequate definition of strength does not exist." To some, strength depicts the ability to exert one maximum exertion against resistance; to others, strength is the ability of a muscle to exert a number of repetitions using a specific amount of weight which will cause fatigue after a brief period of time. For the purpose of this study, the writer is inclined to accept the latter concept involving strength.

As shown in previous statement, endurance is often mentioned in strength studies. Pull-ups are associated with endurance; however, it is

doubtful that this factor is of any great importance when an individual is unable to perform a single pull-up. In relation to this, Davis (8:67) defines endurance as the ability to continue prolonged activity, ". . . and that muscular endurance is needed for activities which are continuous and performed at a slow rate of speed." Executing pull-ups would fit into this category if such exercises were not limited to one or two repetitions.

Karpovich (19:419) states that endurance may be thought of in terms of how long a certain exercise can be continued, or how many times one movement has been repeated. He lists "chinning" as an example of a direct test for endurance. Steinhaus (37:60) defines muscular endurance as the ability to lift the same weight many times, and that this endurance is directly related to strength. The stronger a muscle, the fewer motor units it must employ to lift a weight. By rotating these units the strong muscle can keep up an activity for a greater period of time than can a weak muscle which must use all of its units at one time.

Rasch (32) very suitably sums up the accomplishments which occur when training develops endurance. There is an increase in the efficiency of movement thereby reducing the energy expenditure required to perform the task. There is an increase in the rate at which oxygen can be taken up and transported to the muscles. Finally, there is an increase in the ability to ignore the discomforts associated with fatigue and oxygen debt.

Concerning pull-ups in particular, studies involving such an exercise have been conducted in numerous ways and for a variety of purposes. Before

relating these findings, the writer feels that a brief statement should be made regarding the different terminology used in naming the exercise in question. The literature discloses such words as "chinning," "chin-ups," and "pull-ups" for this activity. This seems to be done merely as a matter of preference as no differences can be found that are relative to any particular name given to the exercise. The writer uses the term "pull-up" in this study and does so as a matter of choice.

To continue, McCloy (26) used pull-ups both individually and as part of a composite event in testing muscular endurance in a factor analysis study. He found, in the individual events, that pull-ups ranked highest in muscular endurance. Circulorespiratory endurance, muscular contraction speed, and mesomorphic build were the other three parts of the study that were investigated. Results in these categories concerning pull-ups were not significant. It was noted that in the single event the rather low correlation between pull-ups and muscular endurance was probably due to the lack of high repetitive performance of the exercise. The correlation was much higher between an endurance composite event and the muscular endurance factor. This can probably be attributed to the addition of sit-ups and push-ups in the composite event. Participants usually are able to do more of these two exercises than the more strenuous pull-ups.

Studies involving energy cost of both pull-ups and push-ups have been conducted showing interesting results. Mathews and Golnick (23) found that the energy cost of pull-ups and push-ups was not significantly related to bicep

girth or total number of pull-ups and push-ups performed. Hamlin and Waterman (15) found that the energy cost of pull-ups was more than twice as great as for push-ups.

Research has been done on the position of the forearm during action involved in pull-up performance. Dewitt (9) found that a man can do approximately two more pull-ups using the "palms-in" method than can be done with the "palms-out" method. He examined a third way of executing the pull-up calling it the "kip-kick" method. This movement produced more repetitions than either of the more conventional actions; however, Dewitt felt that chinning tests indicated strength and were not meant to include skill as a factor in total performance. He concluded that the "kip-kick" method should not be used as a substitute for tests of shoulder and arm strength endurance. Rasch (31) conducted a study relating to the position of the forearm and the amount of elbow flexion that can be exerted when an individual is standing erect. He found that the greatest tension could be attained at a mid-position and the least tension in the pronated or "palms-out" position. The supranated or "palms-in" position yielded tension measurements between the two extremes. He noted that other studies in this area confirmed his findings. Rasch concluded that the reduction of strength of elbow flexion, shown when the hand was pronated, was probably due to changes in the length of mechanical advantage of the pronator teres muscle.

McCraw (28) compared the effects of three different positions of the hands during the pull-up movement and a similar isometric contraction. It was

found that the results of this study both substantiated and contradicted those of previous investigations. Subjects did obtain higher scores while chinning with palms turned in than they did with the "palms-out" method. This confirms Dewitt's findings. (9) However, taking into consideration the day to day performance, McCraw (28) found the differences that occur using the same method are likely to be as large as those obtained from the different hand position methods. He suggested that hand position is immaterial in chinning as the strength of all the muscles involved in the activity should be of concern and not just the flexor muscles of the forearm. Finally, McCraw states that the study indicates a lack of reliability in the pull-up exercise resulting from day to day variations, and further study is needed to improve the retest reliability of this and similar items.

Studies have been conducted which measure the effects of exercise programs on pull-up performance. Hutinger (18) examined the effects of systematic horizontal ladder exercise training on upper body strength. Using third grade children, these subjects were given strength tests at the beginning and end of a three-month period. The experimental group was subjected to a designed program of exercises on the horizontal ladder while the control group did not perform this activity. It was found that the experimental group made significant gains in strength as measured by pull-ups and other methods of pushing and pulling. Hutinger concluded that the horizontal ladder was an effective apparatus for increasing the upper body strength of third grade children.

Kusinitz and Keeney (21) found, that after eight weeks, the experimental

group increased their ability to do pull-ups and the control group did not. The experimental group used a progressive resistance training program, three times a week, for eight weeks, whereas the control group did no supplementary exercising. The program included the performance of weight lifting exercises using the muscles involved in the pull-up movement.

McCartney (25) conducted a study using the pull-up exercise to measure the improvement of strength in two experimental groups. None of the subjects was able to perform a single pull-up repetition on the pretest. The subjects worked with weights, each group using a different method of strength training. Results after six weeks showed improvement in pull-up performance was accomplished by both groups. There was no significant difference between the two groups. Such findings may prove to be relative regarding a study on supplementary exercises designed to increase pull-up repetitions.

In conclusion, this review of literature has revealed interesting and worthwhile information concerning the pull-up exercise. Some questions will remain unanswered until further research is accomplished.

CHAPTER III

PROCEDURE

The purpose of this study was to investigate, under controlled conditions, the effectiveness of supplementary muscle training toward increasing pull-up performance, as compared to the execution of the pull-up without such additional training.

Selection of subjects

The seventh, eighth and ninth grade boys of Curry School, a part of the School of Education of the University of North Carolina at Greensboro, were designated as subjects for this study. The program procedure was explained to the school principal and physical education instructor; and they, in turn, granted permission to conduct the study. A total number of 49 students was enrolled in two separate classes, thirty in the seventh and eighth grade section, and nineteen in the ninth grade section. Forty-five students were accepted for the prescribed program. Of the four that were excluded from the study, two pupils were physically handicapped, one was too old, and one was engaged in a special weight lifting program.

Classification

The subjects were divided into four groups, eleven in group one (control),

eleven in group two (straight arm hang), eleven in group three (bent arm hang), and twelve in group four (simulated pull-up). In order to attempt to equalize these groups, each student was classified according to a subjective body-type rating, the Wetzel Grid, and a pre-test using pull-ups.

After the groups were equated, an analysis of variance was used to determine if there were significant differences between the pre-test pull-up scores of the four groups prior to the beginning of the training program. Before such classification was done, the investigator was introduced to the selected subjects. At this time an initial explanation was given concerning the purpose, length, and procedure of the study.

Subjective Classification. The writer used empirical judgment to initially somatotype the subjects. Each boy, dressed in gym shorts, socks and gym shoes, was observed for overall body build. Individuals were classified as slim (s), muscular (m), chubby (c), or fat (f). A plus and minus system was used to give a wider range of classification in each area (plus for better, minus for less). The slim category showed a lack of normal body tissue; the muscular category displayed well proportioned muscular development; the chubby category gave evidence toward a heaviness and softness of over proportioned body tissue; and the fat category portrayed an abundance of adipose tissue. The upper body and arms were considered to be most important; however, the lower trunk, thighs and legs, especially if found to be heavy or fat, were regarded as significant factors in a subject's later pull-up performance.

Wetzel Grid. After the subjective classification was completed, the

students were subjected to an established "body type" test called the Wetzel Grid. The portion of the Grid used for this study consisted of a panel which had a set of nine adjacent, parallel physique channels running obliquely from southwest to northeast. Crossing these channels from northwest to southeast at regular intervals was a set of short, parallel lines giving the panel a football gridiron appearance. The body types were represented as obese or fat (A_4), stocky, athletic, or football builds (A_3 and A_2), medium builds (A_1, M, and B_1), and extreme slender builds (B_2, B_3, B_4). Each subject's body build classification was determined when his measured height and weight figures fell within one of the channels. These measurements, designated in inches and pounds, were read into the grid panel by plotting weight on the vertical scale and height on the horizontal scale. (2:345) Gym shorts, socks and gym shoes were worn by the subjects when height and weight were obtained.

Additional information was recorded for possible future usage. Height was taken to the nearest quarter inch. Weight was read to the closest quarter pound. Chest measurements were made using a cloth tape placed in a level plane around the body at the "nipple line." Age was designated in years accompanied by accumulative months starting from the most recent birthdate.

Pre-test. After both classifications of body types were made, each subject was given a preliminary test which consisted of attempting as many pull-ups as possible. Directions and demonstrations were given regarding body position and movement to be used in performing pull-ups. Results were recorded along with the measured data received prior to the pre-test. Using the

information derived from the two classifications and the pull-up pre-test, the investigator placed all forty-five subjects into four groups keeping in mind the importance of having as much homogeneity as possible between groups but not within groups.

Equipment

The equipment needed for this study did not consist of any complex apparatus. Two adjustable crossbars were available at Curry School. These bars were found to be suitable for the study as they could be raised or lowered to coincide with the height of each subject. Also, two benches were obtained from the same school to be used as mounting stands so that the subjects would not have to jump for the crossbar.

A three-foot section of one-half inch wooden dowelling was purchased from a hardware store to be used as a crossbar for the simulated pull-up supplementary exercise. This dowelling was accidentally broken during the third week of testing, but it was replaced by an identical one without any delay in the exercise routine.

Two stop watches were secured from the Physical Education Department of the University of North Carolina at Greensboro. These were used for timing purposes in two of the supplementary exercises. One watch failed to operate properly after the fourth week and was replaced by one of identical calibration. The investigator did not test the watches for exactness as the use of these timing devices was for motivational purposes rather than any specific

measurement directly related to the outcome of the study.

A score card was designed and reproduced for each subject which included space for recording preliminary measurement information, daily pull-up repetitions, supplementary exercise progress, and comments on performance. (See Appendix)

Finally, a Rolloflex Camera was secured from Curry School along with flash equipment. Black and white pictures were taken of the various exercise positions using "one-twenty" Tri-X film. The results were reproduced in quadruplicate to be used as illustrations in this study. (See Appendix)

Exercise program

The taking of measurements and statistics and the giving of the pre-test took place on the thirteenth of April. The selected individuals were equated into four groups, and the starting date for the study was set for April eighteenth. The entire program was run for six weeks with the final test given on May thirtieth. Testing days were established on Monday, Wednesday, and Friday for the six weeks period with two separate sessions for each day. The seventh and eighth grade subjects met at eleven o'clock, and the ninth graders met at two o'clock. On Friday, April fifteenth, a rehearsal or preliminary running of the program was performed for the purpose of examining the actual procedures that were to be used for the succeeding six weeks.

In both classes the students were assigned to their prearranged exercise groups. For each group a student leader was appointed to assist in such

duties as passing out and collecting score cards each day, and reporting absences to the recorder.

A group rotation system was decided upon so that each exercise would receive an equal opportunity to be executed first. This impartiality was designed to keep the subjects "interested" in the training program, especially after the newness of the activity had passed.

On the rehearsal day, groups one, two, three, and four performed in that order. A record of time and problems which arose was kept by the examiner's assistant. This assistant, a student teacher in physical education, acted as recorder for the study throughout the entire six weeks period.

The purpose and procedure of the study were again explained to the students with special emphasis given to motivation and the importance of each boy doing his best. Regarding absences, the subjects were informed that anyone missing two consecutive days of testing, or more than three days for the total six weeks, would be dropped from the study. Students who were unable to attend physical education class, or missed a whole day of school on one of the testing days, were instructed to make up the missed session either after school or on the very next school day. Subjects who missed school on Friday were asked to attempt their routine at home on Saturday. The investigator emphasized that under no circumstances, other than the previously described absence situations, should the subjects practice any of the exercise routines on their own time.

Only one group at a time was allowed in the room containing the pull-up

apparatus. The room was small and ventilation was poor so that cramped conditions could have affected performance. As each group entered the room, further information was given concerning their particular supplementary exercise. Also, each subject removed his shirt during the time his group performed their exercise activity. This was done to insure uninhibited movement of the arms and shoulders and to permit observation of muscular effort.

Group I--control. For the control group no exercise program was prescribed except regular pull-up attempts. One method of procedure was used by all four groups in executing pull-ups. Each subject began by standing on a bench which was placed beneath the crossbar and slightly behind it. Proper hand grip was assumed after which the body was lowered into a straight arm hang position. The examiner gave verbal instructions to begin the exercise as soon as it appeared that a subject had no movement advantage for the first repetition. The examiner stood facing the subject, keeping his hands in a position so as to prevent kicking or forward action of the subject's legs. A verbal count of repetitions was employed with the accumulative total given each time the subject cleared the crossbar with his chin. The examiner used the words "all the way down" to remind the students that the arms must return to a straight hanging position before upward movement could begin again. Before a subject started his attempts, he was informed of his previous day's performance and his best output. The plus and minus system, previously described in the definition of terms, was initiated when the students displayed an inability to accomplish a complete pull-up repetition. Subjects were urged to reach "minus" or "plus"

positions until they no longer were able to maintain muscular tension in the arms. This system was found to be of value, especially for those who could not do any pull-ups. To all the subjects, a minus or plus over their previous effort meant that progress was achieved.

For the supplementary exercise groups, all subjects in one group performed their pull-ups first and then they were allowed to execute their additional training exercise.

Group II--straight arm hang. For this exercise both crossbars were used at the same time. The students stood on the benches while securing a suitable hand grip. The examiner, with a stop watch in each hand, gave a verbal signal for both boys to lower their bodies to a straight arm hang position. When the legs of the subjects touched the arms of the examiner, forward motion was stopped and both watches were started. One watch was used for each subject. Time was kept until a boy lost his grip and dropped from the crossbar. Minutes, seconds, and tenths of a second were recorded on each score card. Every subject was informed of his previous day's achievement and best record before beginning the supplementary exercise.

Two different motivational methods were employed during the straight arm hang. At first, the subjects were told to maintain their grip for as long as possible. Only after completing their exercise were they informed of the time results. After two weeks a change was made in the routine. From the third through the sixth week, accumulative seconds were announced to the subjects as they performed the supplementary exercise. Emphasis was given to the length

of time left whenever a subject's previous record was approached.

Both subjects seldom released the crossbar at the same time so that it was necessary to allow the last of the two to finish before performance times were recorded or new subjects were permitted to ready themselves for the straight arm hang.

Group III--bent arm hang. For this exercise only one crossbar at a time was used. Each subject was instructed to stand on a bench while securing a suitable hand grip. The examiner, with a stop watch in one hand, assisted each boy into the proper starting position. This was accomplished by placing one arm around the subject's lower legs and lifting upward until the boy's shoulders were even with the crossbar. The subject was given a moment to steady himself, and then a verbal command was given to begin the exercise; assistance was terminated and the watch was started.

An attempt was considered to be in progress, and time was kept, until muscle tension was relaxed; or, while still under stress, the arms reverted to a straight arm hang position. Methods of recording time and promoting motivation were the same as described for the straight arm hang supplementary exercise. Subjects were instructed to employ two techniques during this exercise. The first was to maintain the starting position above the bar for as long as possible. The second was to avoid dropping too fast when the muscles were no longer able to maintain the starting position.

Group IV--simulated pull-up. One student at a time attempted this exercise. Each subject in the group performed the routine as described in the

definition of terms in chapter one of this study. The examiner stood facing the subject during the downward pull, and then positioned himself behind the subject during the upward return motion. Only one repetition was performed each training day throughout the six weeks program. During this time, each subject was urged to attempt maximum output throughout the entire simulated pull-up. Arm movement was conducted slowly and effort was emphasized through verbal encouragement at various stages of the actual performance.

After the second week of the program, a notice was posted on the locker room bulletin board each Monday for the previous completed week. This notice contained the names of pull-up leaders in each group, supplementary exercise leaders for groups two and three, and best gains in pull-ups for all groups.

Final test

After six weeks of training, forty-two subjects were allowed to take the final test. Three subjects, all of whom were in the bent arm hang group, were dropped from the study because of absences. The day for the final test was previously set for Monday, May thirtieth during regular physical education classes. Each subject was instructed to perform as many pull-ups as possible. No changes in methods of performance were made, and supplementary exercises were not included in the final test. Subjects were tested according to the same group rotation used throughout the six weeks period. Total number of completed pull-ups, along with minus or plus effort, was entered on the score card in the final examination space.

Treatment of data

Four statistical investigations were undertaken in this study. An analysis of variance, as described by Ferguson, (11:237) was used with the pre-test pull-up scores to determine if there were significant differences between the four groups before the training program began. An analysis of variance was again used with the pre-test pull-up scores to determine if there were significant differences between the four groups before the training program began; however, this time, the subjects who failed to complete the six weeks study were not included in the calculations.

After the six weeks training program was completed, the group gains of the three experimental groups and the control group were subjected to an analysis of variance to determine if significant differences existed between the four groups. The use of t tests, as described by Ferguson, (11:138) was included to determine the significant gains in pull-up repetitions of each group as calculated through initial and final performance tests of the four groups.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

All subjects participating in this study were given a preliminary pull-up test. The results were used to aid in the formation of the control group and the three experimental groups. After the groups were established, the preliminary pull-up test results were subjected to an analysis of variance to determine any initial significant differences between the four groups. The results, found in Table I, page 32, revealed an F ratio of .932 which was not significant at the five per cent level.

Three of the subjects in one of the groups failed to complete the training program. A significant difference may have existed between the four groups if the three subjects in question were also excluded from the data in the analysis of variance procedure used in Table I, page 32. The preliminary pull-up tests of only those subjects who started and finished the study were subjected to an analysis of variance to determine if there were initial significant differences between the four groups. The results, found in Table II, page 33, revealed an F ratio of 1.13 which was not significant at the five per cent level.

The assumption was made that prior to the initiation of the six weeks training program, no significant differences were found between preliminary pull-up tests of the four equated groups.

At the end of the training program, each subject was given a final

TABLE I

ANALYSIS OF VARIANCE OF THE PRELIMINARY PULL-UP TEST OF THE FOUR EQUATED GROUPS OF SUBJECTS

Source of Variation	Sum of Squares	Degrees of Freedom	Estimate Variance	F Ratio
Between	30.21	3	10.07	.932*
Within	442.98	41	10.80	
Total	473.19	44		

* - not significant at 5 per cent level
F at .05 = 2.84
F at .01 = 4.30

TABLE II

ANALYSIS OF VARIANCE OF THE PRELIMINARY PULL-UP TEST OF THE FOUR EQUATED GROUPS OF SUBJECTS EXCLUDING SUBJECTS WHO DID NOT FINISH THE STUDY

Source of Variation	Sum of Squares	Degrees of Freedom	Estimate Variance	F Ratio
Between	38.39	3	12.80	1.13*
Within	432.21	38	11.37	
Total	470.60	41		

* - not significant at 5 per cent level
F at .05 = 2.85
F at .01 = 4.34

pull-up test. The investigator wished to know if any of the supplementary exercises helped to significantly increase pull-up performance beyond that of the control group. In order to determine this information, an analysis of variance was used. (11:237) The results, found in Table III, page 35, revealed an F ratio of .232 which was not significant at the five per cent level.

Since the F ratio was not found to be significant, the hypothesis, stating that there was a significant difference between the control group and the supplementary exercise groups, was not accepted.

A change in procedure was made in collecting the necessary raw data for an analysis of variance. An examination of individual performances for the six weeks disclosed a decrease in number of repetitions for many of the subjects on the final test as compared to the previous training day. This problem could be attributed to anxiety associated with taking the final test. The investigator decided, therefore, that the highest pull-up score achieved on either the final test or the last training day would be used in the statistical analysis. In order to be consistent, a decision was also made to accept the higher of the two pull-up scores received by each subject on the pre-test and the rehearsal day. (See Appendix) Subjects who missed one of the two days, either at the start or the end of the study, were retained for use in the statistical analysis providing they met the rest of the requirements.

Another decision was made concerning the raw score data. The fractions, which resulted from the plus and minus system used in recording partial pull-ups, were not retained when calculating the differences between initial and

TABLE III

ANALYSIS OF VARIANCE OF GAINS AMONG GROUP MEANS OF THE THREE EXPERIMENTAL GROUPS AND THE CONTROL GROUP

Source of Variation	Sum of Squares	Degrees of Freedom	Estimate Variance	F Ratio
Between	10.55	3	3.52	.232*
Within	562.02	38	14.76	
Total	572.57			

* - not significant at 5 per cent level
F at .05 = 2.85
F at .01 = 4.34

final performances. By working with whole numbers and disregarding the plus or minus deviations, the figures obtained in each of the four groups varied very little from the totals found when such fractions were included. (See Appendix)

One final statistical procedure was undertaken in this study in order to substantiate the apparent gains in pull-up repetitions of each of the four groups. All the subjects with the exception of two boys gained in pull-up performance for the six weeks of training. (See Table IV, page 37) In order to determine if there were significant group gains in pull-up performance, t tests were used for each of the four groups. The results of the t tests, found in Table V, page 38, show that there were significant gains in pull-up performance for all four groups at the five per cent level.

Although group gains were significant for all four groups, an analysis of variance indicated no apparent significant difference between any of the four groups.

Several interpretations may be considered in attempting to explain the lack of significant difference between the gains of the four groups.

The number of subjects in each group may have been too small. A high or low performance increase by one or two individuals might affect the total group. For example, in the control group, the writer noticed that three subjects were attempting to overtake the leader in their group. With this type of motivation, greater or faster achievement may have occurred than in the other sections in which no such competition was evident.

The aspects of motivation and effort may have been inconsistent. During

TABLE IV

PULL-UP PERFORMANCE TOTALS FOR THE PRE TEST AND FINAL TEST, SHOWING INDIVIDUAL GAINS, GROUP GAINS, AND GROUP MEANS

Group I			Group II			Group III			Group IV		
Pre	Final	Gain	Pre	Final	Gain	Pre	Final	Gain	Pre	Final	Gain
0	0	0	0	5	5	0	3	3	0	8	8
0	4	4	0	6	6	2	10	8	0	6	6
2	10	8	0	2	2	0	9	9	0	5	5
3	12	9	1	9	8	2	15	13	0	3	3
4	15	11	3	16	13	4	12	8	0	0	0
5	10	5	5	12	7	6	15	9	2	14	12
6	16	10	5	15	10	8	20	12	2	11	9
7	20	13	6	14	8	8	18	10	4	13	9
8	21	13	7	15	8				5	14	9
8	18	10	8	15	7				6	16	10
10	22	12	11	21	10				7	26	19
									10	17	7
Total gain		95			82			72			97
Mean		8.636			7.636			9.000			8.083

TABLE V

SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE PRE-TEST AND FINAL TEST PERFORMANCES OF THE FOUR EXERCISE GROUPS

	Pre-Test	Final Test	t	Significant at .05 %	Significant at .01 %
Group I	53	148	7.13	1.812	2.764
Group II	46	130	8.78	1.812	2.764
Group III	30	102	8.41	1.895	2.998
Group IV	36	133	5.94	1.796	2.718

a six weeks program, students may become disinterested in performing the same activity especially if it entails maximum effort each day. There was no way of determining either the motivation or the effort of each subject. Stimulating remarks and recognition of progress were integrated into the study. Some students appeared to respond to these stimulants while others seemed unaffected.

The supplementary exercises of this study may not have differed sufficiently with respect to muscular action, or all three exercises may not have contributed to the building of strength in the muscles which are used in performing pull-ups. The results of the analysis of variance seem to bear evidence of this possibility.

The straight arm hang and bent arm hang supplementary exercise groups did not show consistent progress during the six-week period of training. The subjects were asked to surpass their previous performance each time they attempted the exercise; however, none of the subjects were able to accomplish such a task. Some individual times declined after a certain limit while other showed a net weekly increase but irregular daily gains. Motivational techniques failed to improve the situation. In addition, the three subjects who failed to finish the program were from the bent arm hang exercise group. Such circumstances may lead to the assumption that these exercises may not have been appropriate for this study.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of the study was to investigate, under controlled conditions, the results of supplementary pull-up exercise training toward increasing pull-up repetitions in junior high school boys.

Forty-five students from the seventh, eighth, and ninth grade physical education classes at Curry School were selected for this study. The subjects were divided into a control group and three experimental groups. For six weeks, on Mondays, Wednesdays, and Fridays, the control group performed pull-ups exclusively while each of the three experimental groups executed pull-ups and a supplementary training exercise. Group two executed a straight arm hang exercise, group three a bent arm hang exercise, and group four a simulated pull-up exercise.

The raw data from the pull-up pre-test were treated statistically through an analysis of variance to determine any initial difference in the equating of the four groups according to pull-up performance. No significance difference was found.

An analysis of variance was used to determine any differences in gains between the four groups as a result of the exercise training program. No significant difference was found.

The significance of pull-up gains of all four groups were statistically examined by the use of t tests. All four groups significantly increased in pull-up performance.

The writer concludes that under the conditions of this study, junior high school boys can increase their pull-up performance by attempting maximum pull-up output three days a week for six consecutive weeks. The conclusion is also made that the three supplementary exercise programs had no significant affects upon the group gains in pull-up performance as compared to the control group.

The writer hopes that this study will lead to further investigation into the area of supplementary exercise training related to pull-up performance. The following recommendations are given as guide lines toward improving any future undertakings:

(1) More subjects should be used from a larger and more representative population.

(2) The exercises of this study should be replaced by those of a more distinctive nature. Such exercises should lead to greater progressive resistance training.

(3) Care should be taken to control environmental conditions. This may help to curtail the fluctuations in daily performances which may be attributed to heat and humidity problems.

(4) Strive for homogeneity within groups as well as between groups. A study using subjects who are unable to perform any pull-ups may be of value.

(5) Before subjects attempt the pull-up exercise, powder or chalk should be applied to the hands to eliminate the possibility of grip loss due to perspiration.

(6) Research should be conducted concerning strength and endurance factors relative to pull-up performance.

(7) A more thorough investigation should be undertaken to determine the use and value of supplementary exercises in related skills.

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BIBLIOGRAPHY

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APPENDIX

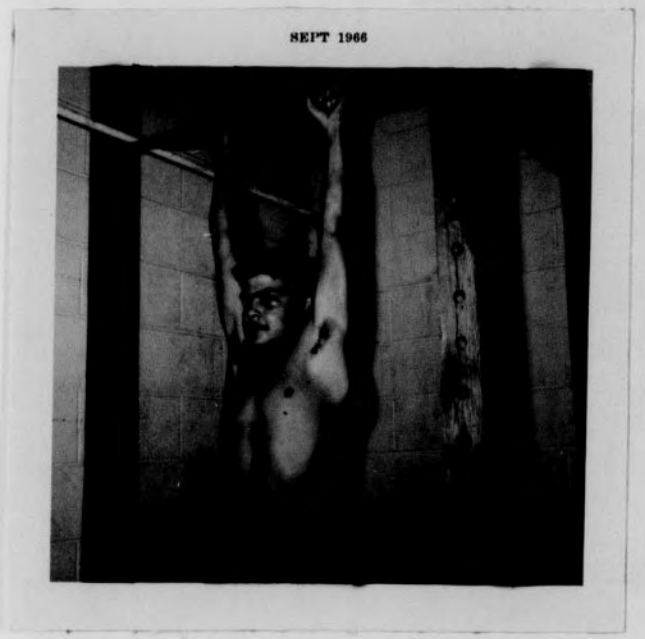
SUBJECT PERFORMANCE SHOWING
PRETEST-REHEARSAL DAY SCORES AND
FINAL TEST-PREVIOUS DAY SCORES*

GROUP I				GROUP II				GROUP III				GROUP IV			
P.	R.	F.	PD.	P.	R.	F.	PD.	P.	R.	F.	PD.	P.	R.	F.	PD.
0	0	0	0	0	0	3	5	0	0	3	2	0	0	8	9
0	0	2	4	0	0	3	6	0	2	8	10	0	0	6	7
2	1	7	10	0	0	1	2	0	0	9	A	0	0	4	5
2	3	11	13	1	1	7	9	2	2	15	13	0	A	3	2
4	4	11	15	2	3	16	15	2	4	12	9	0	0	0	0
5	4	10	A	4	5	12	12	6	6	15	14	2	2	14	13
6	6	16	15	4	5	15	13	7	8	19	20	2	2	11	10
7	A	18	20	6	5	12	14	8	8	18	17	4	4	13	12
8	8	17	18	7	7	15	14	D	D	D	D	4	5	14	14
8	8	17	18	8	8	14	15	D	D	D	D	6	6	15	16
10	10	19	20	11	10	17	21	D	D	D	D	7	A	26	24
												8	10	7	16

*P-Pretest
R-Rehearsal Day
F-Final Test
PD-Previous Day
A-Absent
D-Dropped from study

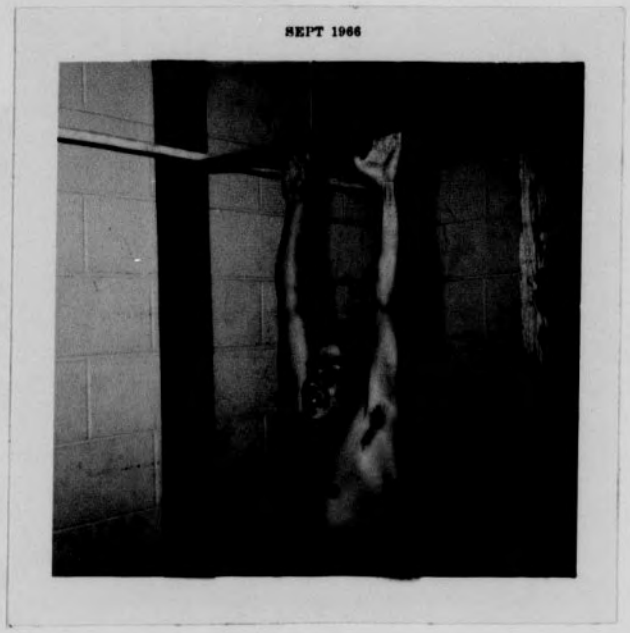
ILLUSTRATIONS OF STRAIGHT ARM HANG EXERCISE AND PULL-UP EXERCISES

FIGURE 1



Straight arm hang exercise
and
starting position pull-up
exercise

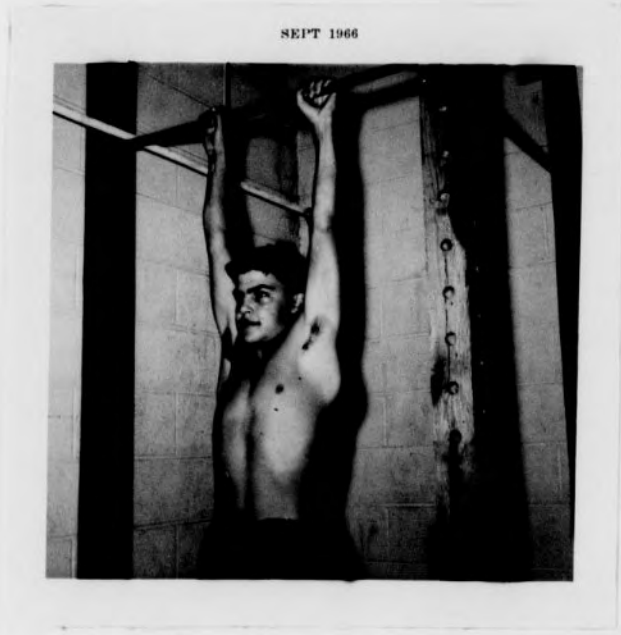
FIGURE 2



Termination of straight arm
hang exercise

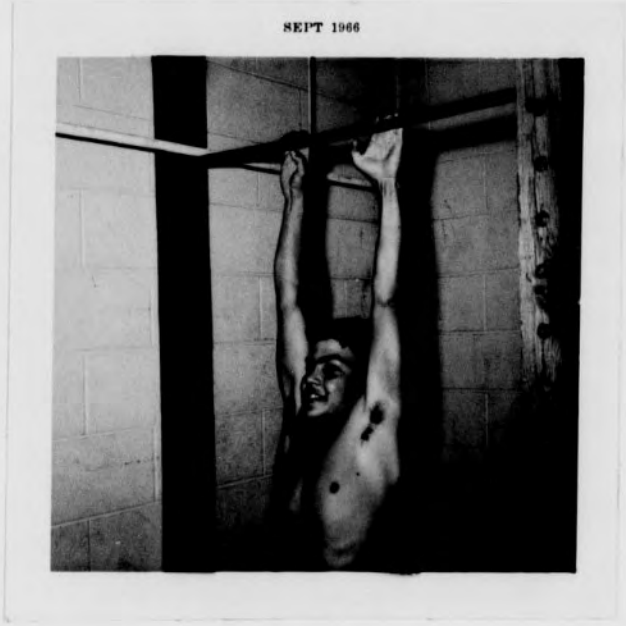
ILLUSTRATIONS OF STRAIGHT ARM HANG EXERCISE AND PULL-UP EXERCISES

FIGURE 1



Straight arm hang exercise
and
starting position pull-up
exercise

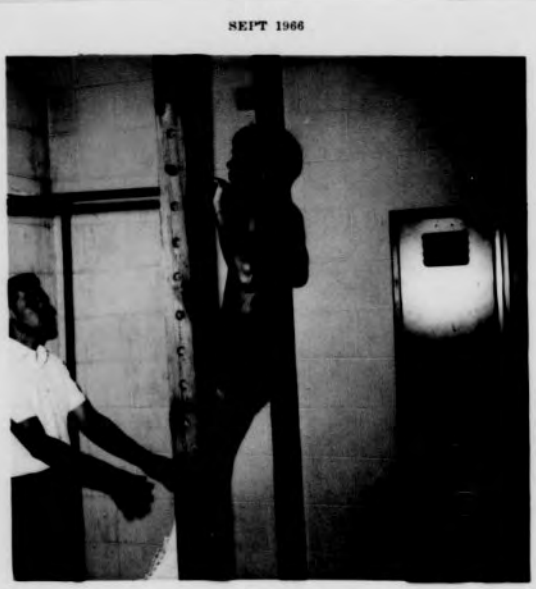
FIGURE 2



Termination of straight arm
hang exercise

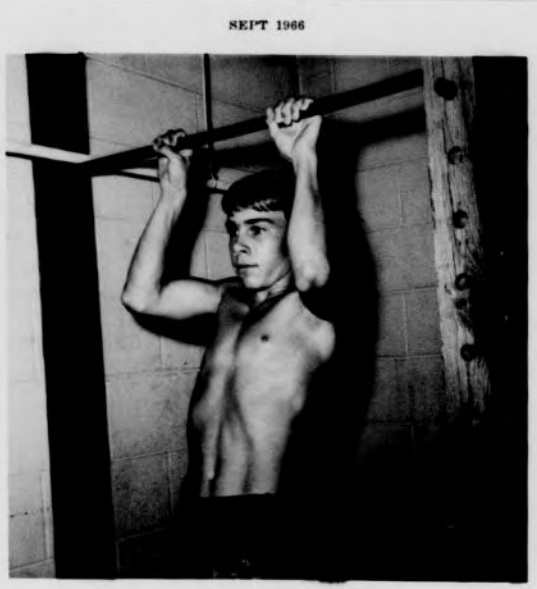
ILLUSTRATIONS OF BENT ARM HANG
EXERCISE AND PULL-UP EXERCISE

FIGURE 3



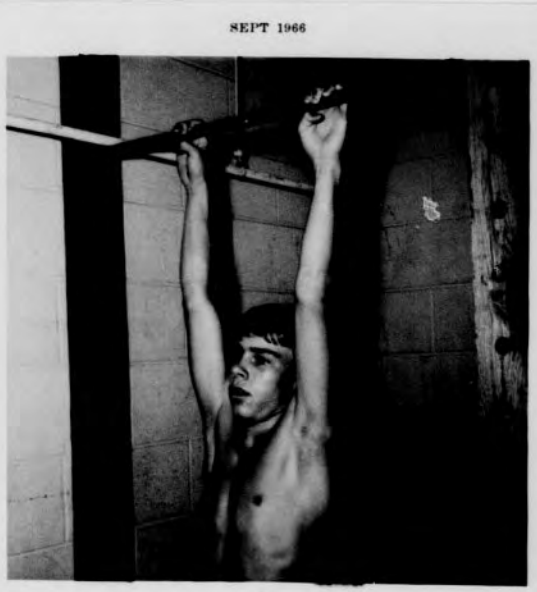
Start of bent arm hang exercise and completion of pull-up exercise

FIGURE 4



Continuation of bent arm hang exercise

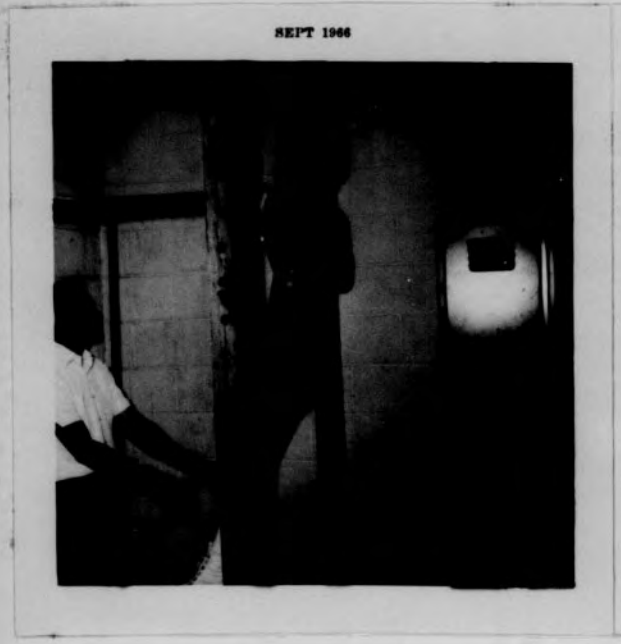
FIGURE 5



Termination of bent arm hang exercise

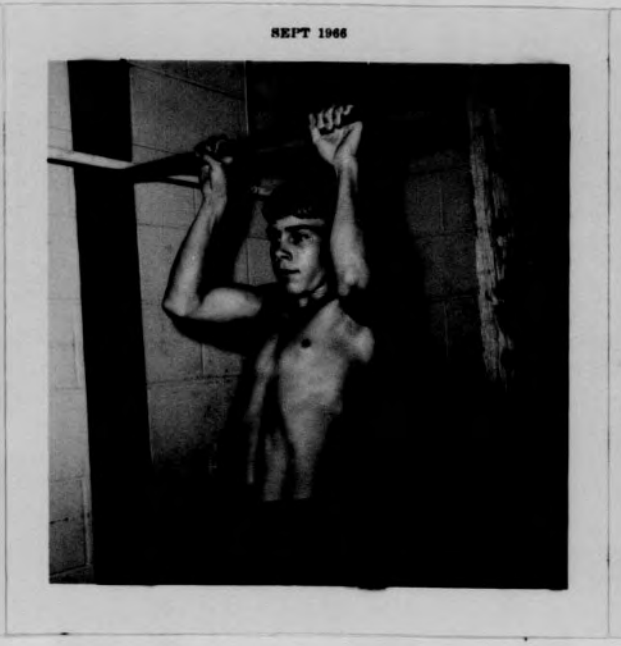
ILLUSTRATIONS OF BENT ARM HANG
EXERCISE AND PULL-UP EXERCISE

FIGURE 3



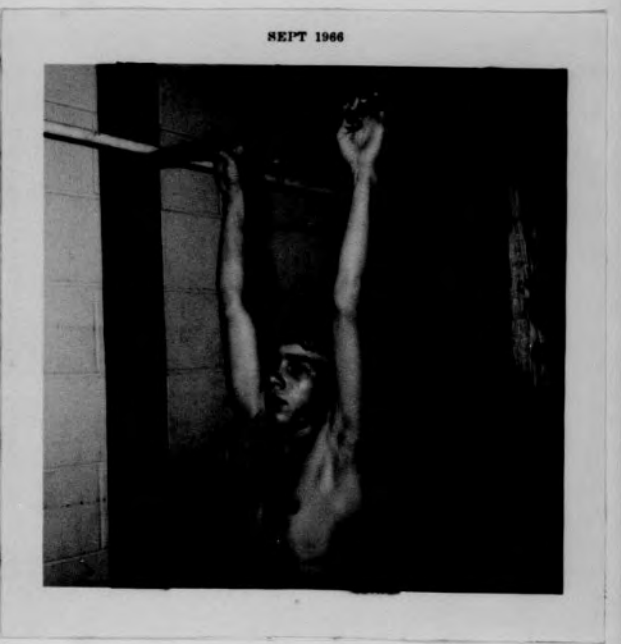
Start of bent arm hang exercise and completion of pull-up exercise

FIGURE 4



Continuation of bent arm hang exercise

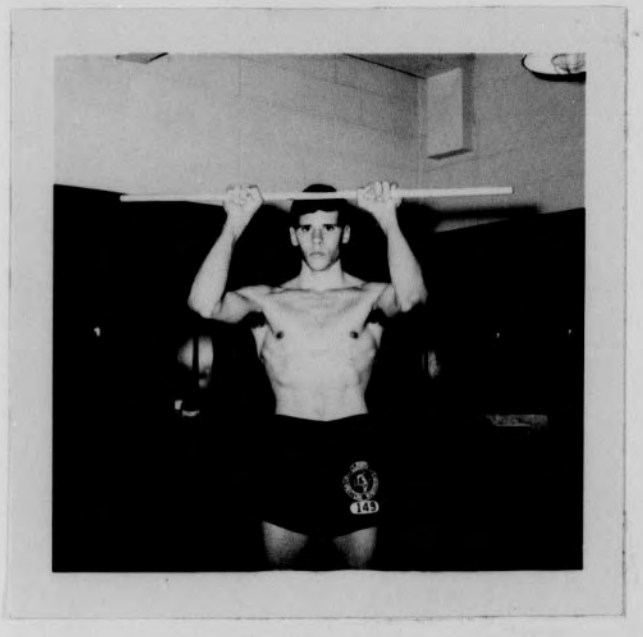
FIGURE 5



Termination of bent arm hang exercise

ILLUSTRATIONS OF SIMULATED PULL-UP EXERCISE

FIGURE 6



Simulated pull-up exercise
front view-downward motion

FIGURE 7

Simulated pull-up exercise
rear view-upward motion

ILLUSTRATIONS OF SIMULATED PULL-UP EXERCISE

FIGURE 6

Simulated pull-up exercise
front view-downward motion

FIGURE 7

Simulated pull-up exercise
rear view-upward motion

ILLUSTRATIONS OF PLUS AND MINUS REPETITIONS

FIGURE 8

Minus repetition

FIGURE 9

Plus Repetition

ILLUSTRATIONS OF PLUS AND MINUS REPETITIONS

FIGUR E 8

Minus repetition

FIGURE 9

Plus Repetition

SAMPLE SCORE CARE

TEST 2

Kit Barker — Age 14-8 — Hgt 69¼ — Wgt 120½ — Chest 32½ — WGC B3 — SC S — assist Grade 9

Date	Pull-ups	Sup-Exer	Comments
4-13	2+	-	Pre Test
4-15	3+	1:30	S good effort
4-18	3+	1:14	S told to clamp thumb over fore finger
4-20	4+	1:15.4	Not getting chin high Not smooth
4-22	4-	1:21	Two not all way
4-25	4	1:18	started on 5, last 2 were
4-27	3+	1:31.9	- on last try
4-29	4-	1:12.2	kick on one
5-2	5	1:19.3	Two not clear
5-4	5	1:37	Not clearing well
5-6	4	1:31.4	two just touch
5-9	5	1:41	S good effort
5-11	5	1:46	S worked hard
5-13	5-	1:36	almost +
5-16	6	1:29.5	almost -
5-18	9+	1:17	S tired - couldn't hold looked good
5-20	16	1:18.3	started strong urged on by group
5-23	15-	1:12.7	S not giving as much effort
5-27	12	1:08	didn't touch two
5-29	15+	1:03	S very warm day
Final	16		good arms - not much leg action