THE EFFECTS OF RESISTANCE TRAINING ON UPPER BODY STRENGTH AND ENDURANCE OF ELEMENTARY SCHOOL CHILDREN

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CHAPTER I

INTRODUCTION

The majority of elementary school children in this country struggle to perform one pull-up (Pate, Ross, Baumgartner, and Sparks, 1987). During the past 35 years, numerous testing and incentive programs have had little effect upon increasing upper body muscular strength and endurance in children (Hunsicker and Reiff, 1977; Ross, Dotson, Gilbert, and Katz, 1985). There exists extraordinary room for improvement.

Physical education teachers must assume some responsibility for improving these fitness levels. The elementary physical education teacher may have an advantage over the secondary teacher in developing remedial strength programs. For example, the 17th annual Gallup poll named physical education as the favorite subject of elementary school children (Ross and Pate, 1987). Also, elementary physical education enrollment rates have been estimated to be as high as 97% compared to approximately 50% in the last two years of high school (Ross and Gilbert, 1985). In an attempt to exploit the more favorable physical education environment, this study dealt with the elementary school aged child.

Upper body muscular strength and endurance are only two of several important physical fitness categories outlined by the American Alliance for Health, Physical Education, Recreation, and Dance (AAHPERD) in their Physical Best program (AAHPERD, 1988). Other categories were aerobic endurance, body composition, flexibility, abdominal strength and endurance. However, this study focused only upon the upper body muscular strength and endurance component.

Dr. Frederick R. Rogers, an early pioneer in physical fitness assessment, said that the development of muscular strength is of prime importance in any physical education program (Rogers, 1934). In contemporary time, the American Alliance program of Physical Best emphasizes two ideas that make strength and endurance acquisition important (AAHPERD, 1988). First, strength and endurance facilitate routine daily activities, such as pulling, pushing, and lifting. Second, they provide the ability to rescue oneself from a dangerous situation. A strong upper body acts as an emergency reserve system. Consequently, there is a crucial need to improve upper body strength in children.

Purpose of the Study

The purpose of this study was to test the effects of resistance training on upper body muscular strength and endurance in elementary school students.

Extent of the Study

Delimitations

This study was delimited to:

1. A sample of 180 third, fourth, and fifth grade subjects selected from two elementary schools in Wichita, Kansas.

2. The measurement of upper body muscular strength and endurance by a modified pull-up test.

3. Students enrolled in physical education class with parent or guardian consent.

Limitations

The results of this study may have been limited by the following:

1. There was no random selection of subjects, only random assignment.

2. The relative body weight was not considered when assigning subjects to treatment groups.

Assumptions

The following assumptions were made:

1. It was assumed that the subjects performed no additional strength training outside of physical education class.

2. All subjects were sufficiently motivated to perform their treatment group exercises to the best of their abilities.

3. All subjects gave their maximum effort on the pretest and the posttest.

4. Instructions were accurately followed in performing the treatment group exercises.

Hypotheses

The following hypotheses were tested at the .05 level of significance:

1. There will be no significant difference in mean pretest and posttest modified pull-up scores for the control group.

2. There will be no significant difference in mean pretest and posttest modified pull-up scores for the weight training group.

3. There will be no significant difference in mean pretest and posttest modified pull-up scores for the modified pull-up group.

4. There will be no significant difference among the three research groups in mean posttest modified pull-up scores.

Conceptual Definitions

Epiphysis: The compact tissue layer around the enlarged ends of bone where growth and ossification occurs (Crouch, 1985).

Muscular endurance: Endurance is a submaximal effort by the muscles of the body that permits extended work time by resisting fatigue (Jensen & Schultz, 1977).

Muscular strength: Strength is the ability a muscle or muscle groups to apply force (Jensen & Schultz, 1977).

Physical education: A planned course of study in which students learn primarily through movement (Dauer & Pangrazi, 1986).

Physical fitness: A healthy state where the body is able to perform daily tasks at a relatively high level vigor and alertness (Dauer & Pangrazi, 1986).

Prime movers: Muscles that perform the major work load when performing a specific body movement (Rasch & Burke, 1978).

Functional Definitions

Failure: The point at which the subject can not perform another repetitive exercise due to fatigue.

Hand weight: A resistance training device known also as a dumbbell.

CHAPTER II

LITERATURE REVIEW

National Fitness Testing

More than three decades ago, the first clue to American children's physical fitness deficiencies became evident (Krause & Hirschland, 1954). Kraus demonstrated that American youth were in some ways inferior to European youth. Comparisons of 4,264 American children were made with 2,870 European children on strength and flexibility measures. Over 57% of the United States children failed the tests, while only 8.7% of the European children failed.

The impact of perceived physical inferiority of American children caused President Eisenhower to organize the National Conference of Fitness in American Youth (Wear, 1955). One important out-growth of this conference was the construction of a seven item youth physical fitness test. National norms for the seven item youth physical fitness test were compiled in 1958 by the American Association of Health, Physical Education, and Recreation (Hunsicker & Reiff, 1977). Follow-up national testing occurred in the decades of the sixties, seventies, and the eighties. These tests were significant because they demonstrated consistent youth physical fitness deficiencies.

The most recent national testing program was the National Child and Youth Fitness Study (NCYFS), which was funded by the U. S. Public Health Service (McGinnis, 1985). In 1984 the first NCYFS gathered fitness data from a national random sample of 10,275 students. Using subjects between the ages of 10 to 18, test items included: skinfold assessment, sit and reach, bent knee sit-up, chin-ups, and the one mile walk/run. This five item test was important because it indicated that children were receiving insufficient physical activity and that this in turn was impeding physical fitness improvement.

In 1986, a NCYFS II study was conducted for children ages six to nine (Ross and Pate, 1987). Data were collected on 4,678 children across the country. Two test items were modified from the 1984 test. The six and seven year olds were tested in the one-half mile run and the six through nine year olds were tested in the modified pull-up. This study was important since it was the first national test to assess the fitness of children ages six to nine, and describe their patterns of physical activity.

The Modified Pull-up Test Development

Early Testing

The need to find a more discriminating measure of upper body muscular strength and endurance led to a variety of modified pull-up tests. McCloy (1931) used a spring dynamometer that had one end attached to the subject's waist

and the other end to the floor to modify the pull-up. When the subject attempted to pull-up, the dynamometer registered the number of pounds of force exerted. The subject's pull-up score was equal to the registered force plus their body weight.

Metheny and others (1945) included a girl's modified pull-up test in their fitness testing battery that was administered to over 20,000 high school female subjects. In this test, the subject pulled-up on a bar from a horizontal trunk position with the knees bent at 90 degrees and soles of the feet touching the floor.

The 50's and 60's

Ismail and Cowell (1961) utilized the Purdue Motor Fitness Test Battery for developing a profile of pre-adolescent boys. Their research incorporated the straddle modified pull-up.

Edgren and Gruber (1963) recommended the use of the modified pull-up when administering the Purdue Motor Fitness Test Batteries for fourth, fifth, and sixth grade boys and girls. This modified pull-up was accomplished by having the subject pull his/her partial weight on a doorway gym bar. Each subject's starting position was a position suspended under the bar with the upper body parallel to the floor, knees bent 90 degrees, and the feet flat on the floor. Subjects pulled up and touched their chest on the bar.

Another variation of the modified pull-up, for females, was defined by Mathews (1968). The subjects pulled up on rings that were attached to a horizontal bar. The body axis was longitudinally straight and rigid with the heels touching the floor.

The Indiana Motor Fitness Test, for boys and girls, incorporated the straddle chinning method of modified pull-up (Mathews 1968). Each subject lay on the floor in a supine position while a partner stood over him or her, feet straddled. The subjects would lock hands and the supine person would pull-up, keeping the body rigid.

Attempts to modify the pull-up test were noted in the AAHPER Physical Fitness Test Battery (1958) and the Oregon Motor Fitness Test (Johnson & Nelson 1969). The flexed-arm hang was used for female subjects. The individual was expected to hang from a horizontal bar in a static position. Scores were recorded in seconds elapsed while the subject held the chin over the bar. This isometric exercise was used to estimate upper body strength and endurance.

Sparks used a desk pull-up test to determine the upper body strength of American school children living in Germany (Sparks, 1965). Sparks found it to be a more convenient measure of muscular strength and endurance than the pull-up test. The Sparks desk pull-up had an acceptable validity coefficient (r=.65) and a high reliability coefficient (r=.97) when administered to elementary and junior high school subjects.

Baumgartner Test

A unique apparatus was developed to measure modified pull-ups in the 1970's (Baumgartner, 1978). This Baumgartner device was a slanted wide-board on rollers that permitted an individual to pull-up while lying in a prone position. Validity, reliability, and percentile norms for elementary age children were calculated, by Jackson, Bruya, Baun, Richardson, Weinberg, and Caton (1982) using the Baumgartner modified pull-up board. Jackson, et al. (1982) found that the Baumgartner pull-up had high test-retest reliability and high construct validity with male and female subjects. Further improvements and additional norms were presented by Baumgartner, East, Frye, Hensley, Knox, and Norton (1984).

DeMello trained third, fourth, and fifth grade subjects with the Baumgartner modified pull-up device and the Vermont or desk modified pull-up device (DeMello, 1990). Significant upper body strength gains were achieved with both devices during a 12 week period. Training results were measured by executing a maximum pull-up or maximum flexed arm hang test score and comparing that to control group scores.

Modified Pull-up Tests in the 80's and 90's

Cotten (1990) demonstrated that the NCYFS II modified pull-up had satisfactory reliability while testing 363

subjects in kindergarten through sixth grade. The intra-class reliability of a single test administration ranged from .71 to .90, for females, and .56 to .82 for males.

Both Cotten (1990) and Engelman and Morrow (1991) reported that a subject's relative body weight had effect upon the performance of the modified pull-up. However, body weight effects were less impacting on modified pull-up scores than the traditional pull-up and flexed arm hang scores.

The modification of the pull-up continues to be used in a variety of tests. The Fitnessgram program directs the use the flexed arm hang as part of their testing program (The Institute for Aerobics Research, 1983). The Chrysler Fund-AAU Physical Fitness Program also incorporates the flexed arm hang (1989).

NCYFS I pull-up test results indicated that 30% of 10 and 11 year old boys could not perform one pull-up. For girls, 60% of the subjects between the ages of 10 and 18 were unable to pull-up. These high failure rates in pulling-up necessitated the use of a modified pull-up test on NCYFS II. Woods, Burgess, and Pate (1989) correlated resistance exercises on a universal gym to the modified pull-up, the flexed arm hang, and the pull-up scores for 9 and 10 year old subjects. The researchers found that the modified pull-up was a more satisfactory test of upper body

strength and endurance in children than the pull-up and flexed arm hang tests.

The modified pull-up is easier to perform because it does not require the individual to pull-up the entire body weight. Being easier to accomplish, the modified pull-up permits more discriminating collection of data. Children who would score zero on a pull-up test are still able to receive a numerical score on the modified test.

Ghent used the modified pull-up in an exercise program for kindergarten children (Ghent, 1990). Although there was no significant improvement between experimental and control groups on the modified pull-up, the children given practice on the modified pull-up improved from pretest ($\bar{X}$=4.7) to post-test ($\bar{X}$=6.43) in modified pull-up scores. The control group made a lesser improvement from pretest ($\bar{X}$=5.48) to posttest ($\bar{X}$=6.64).

Table I (page 13) gives a summary of selected youth physical fitness tests that incorporate types of modified pull-up testing.

Muscular Strength and Endurance Factors

Maturation, training, and gender are three important factors that help determine a child's muscular strength and endurance. Only one of these factors, training, may be manipulated by researchers, while the other two variables are situational and must be considered in interpreting research implications.

TABLE I

PULL-UP STRENGTH AND ENDURANCE ASSESSMENT ON SELECTED YOUTH PHYSICAL FITNESS TESTS

Name of Test	Type of Test	Age/Grade
Indiana Motor Fitness (1945)		
Girls	Mod. pull-up	4-8 gr.
Boys	Pull-up	
Oregon Motor Fitness (1962)		
Girls	Flex. arm hang	4-12gr.
Boys	Pull-up	
AAHPERD Youth Fitness (1958, 1965, 1976)		
Girls	Flex. arm hang	9-17 yrs.
Boys	Pull-up	
Sparks Fitness Test (1965)		
Girls and boys	Mod. pull-up	1-12 gr.
NCYFS II (1985)		
Girls and boys	Mod. pull-up	6-9 yrs.
Physical Best Program (1988)		
Girls and boys	Pull-up	5-18 yrs.
Presidential Physical Fitness Award Program (1987)		
Girls and boys	Pull-up	5-18 yrs.
Chrysler Fund-AAU (1990)		
Girls	Flex. arm hang	6-17 yrs.
Boys	Pull-up	

Gender

Gender has been an important variable in muscular strength and endurance development. Males tend to

out-perform females in tests of upper body muscular strength and endurance (Ross, Pate, Delpy, Gold, & Svilar, 1987; Ross, Dotson, Gilbert, & Katz, 1985). However, Ricci, Figura, Felici, & Marchetti (1988) noted no gender differences in the electromyographic and biomechanical aspects of pull-up performance and suggest that gender differences may be socially and culturally caused. How gender strength differences relate to various combinations of hereditary or environmental factors is not completely understood, but females tend to score lower on various tests of upper body muscular strength and endurance.

Maturation

Maturation is the series of steps a child follows to becoming an adult (Gallahue, 1982). Each child seems to have his or her own maturational time table. The onset of puberty appears to affect the level of muscular strength and endurance (Sailors & Berg, 1987). During puberty, boys tend to have noticeable increases in strength, while girls, in the absence of strength training, tend to level-off in their measured strength (Gallahue, 1982).

Age and genetics affect the assessment of strength in children (Pangrazi and Corbin, 1990). There appear to be periods where strength and endurance gains are more accelerated. Ellis, Carron, and Bailey (1975) conducted a seven year longitudinal study on 106 boys, beginning at age 10, to monitor physical performance. Using the flexed arm

hang to measure upper body strength and endurance, the authors found that the greatest increment of improvement occurred during the 11th and 12th years of age.

Hensley, East, and Stillwell (1982) examined body fatness in grades one through four as it related to the performance on the Baumgartner modified pull-up. They found that the relationship between the sum of skinfolds and the performance on the modified pull-up was substantially greater than for other physical performance test items. However, Hensley, East, and Stillwell did say that the correlation between modified pull-up scores and height or weight is low (-.27 to .03). The accumulation of body weight at different maturity levels may effect fitness test performance, but the research does not support this position.

Training

Training effects relate to the experiences and environment in which children have been exposed. Many studies demonstrate the receptiveness of children to muscular strength and endurance training. For example, Hutinger (1955) demonstrated that a horizontal ladder workout significantly improved performance on push-ups, pull-ups, and pushing and pulling strength. This three month experiment was conducted with third grade girls and boys exercising during a daily physical education period.

Baumgartner and Wood (1984) used the modified pull-up board as a training device for third through sixth grade girls and boys. The treatment group significantly out performed the control group in post test strength and endurance scores after a 12 week training program.

Clarke, Vaccaro, and Andersen (1984) found that seven to nine year old boys improved in shoulder strength endurance while engaged in wrestling. It was a three month wrestling program.

These child studies show that muscular strength and endurance can be improved through a system of over-load training prior to puberty. Also, it appears that a child's strength gains may not occur uniformally from one year to the next. A rapid growth increase
may affect strength development.

Weight Training for Children

Early Studies

Weight training programs for children have been a relatively recent phenomenon. One early weight training study was completed by Kusinitz and Keeney (1958). The subjects were junior high school boys ranging in age from 12 to 17 years. After an eight week training program, the experimental subjects demonstrated a greater improvement in push-ups and pull-ups. That same year, Healy (1958) studied the effects of two methods of weight training on children with cerebral palsy 8 to 16 years old. The subjects had

significant increases in strength after an eight week training period.

Research in the 80's and 90's

Hagberg, Ehsani, Goldring, Hernandez, Sinacore, and Holloszy (1984) found that an adolescent weight training group maintained lower blood pressure readings. These adolescents had a history of abnormally high blood pressure. The five month resistance training program had followed a five month running endurance program. This study is significant because it discredits the myth that resistance training elevates blood pressure. The children ranged in age from 8 to 16.

Since the muscles, ligaments, and tendons may be up to five times stronger than the bony insertions of tendons and ligaments, weight training for preadolescents should be low resistance with a high repetition of movement (Watkins & Docherty, 1986). Working with unreasonably heavy resistances could cause physical harm to the child's epiphysis (Watkins & Docherty, 1986). There has been no evidence to show that preadolescent children engaged in weight training experienced harmful effects during properly supervised training (Legwold, 1982; Gabbard & Crouse, 1988).

Prepubescent children should not engage in "weight lifting", only weight training (Bar-Or, 1989). Weight training involves low resistance with high repetition movements. Weight lifting involves maximum resistance with

low repetitive movements. Gumbs, Segal, Halligan, and Lower (1982) document a serious wrist injury to a 12 year old boy who unwisely engaged in weight lifting.

McGovern (1983) conducted a circuit weight training program for fourth, fifth, and sixth grade children. The 12 week training program produced significant muscular strength gains in the experimental group when compared to a control group who participated in a similar duration physical education class. Although the experimental group increased in strength, none of these boys and girls gained in muscular girth. The young children did not acquire larger physiques through weight training.

An eight week weight training program for prepubescent boys revealed an increase in shoulder strength and an increase in body weight with no increase in percent of body fat (Servedio, Bartels, Hamlin, Teske, Shaffer, & Servedio, 1985). Additionally, their was no increase in blood pressure, no decrease in flexibility, and no change in resting heart rate in the weight training subjects.

Watkins and Docherty (1986) worked out a formula to prescribe the proper amount of resistance training for children engaged in weight training on the bench press. For untrained 10 to 12 year olds, the boys should use 45% of body weight and the girls 40% of body weight. When in doubt, it is safer for children to weight train with less resistance rather than with more resistance.

Pfeiffer and Francis studied prepubescent, pubescent, and postpubescent male weight trainers (Pfeiffer & Francis, 1986; Pfeiffer, 1985). They found that after a nine week resistance program, the prepubescent group demonstrated significantly greater strength gains on three of the 16 post tests. This study illustrated that prepubescent children can make significant strength gains through a weight training program.

Sewall and Micheli (1986) found that prepubescent boys and girls made significant strength gains in a progressive resistive training program. The 10 and 11 year old children performed various weight training exercises for a nine week period. No injuries were reported by the researchers during weight training.

A 14 week strength training program using hydraulic resistance equipment indicated that prepubertal male subjects had significantly greater strength gains than the control group (Weltman, Janney, Rians, Strand, Berg, Tippitt, Wise, Cahill, and Katch, 1986). This study also revealed that there was no damage to epiphyses, bone, or muscle as a result of resistance training.

Within the past 10 to 15 years, scientific research and understanding has altered views on children engaging in weight training (Duda, 1986; Pangrazi & Hastad, 1989). In recent years, the Academy of Pediatrics, the National Strength and Conditioning Association, and the American Orthopaedic Society for Sports Medicine have supported the

use of weight training by prepubescent children. The prepubescent's ability to gain muscular strength through training has been well established in the literature (Bar-Or, 1989; Hakkinen, Mero, & Kauhanen, 1989).

During a 14 week strength training program with prepubescent males, a very low injury rate was discovered among participants (Rians, Weltman, Cahill, Janney, Tippett, & Katch, 1987). The supervised weight training did not adversely affect bone, muscle, or epiphyses. Also, the exercise program did not adversely affect growth, body flexibility, or motor performance.

A 12 week study of upper body resistance exercises on prepubescent girls and boys was conducted in a school based setting (Siegel, 1988). Some of the exercises were performed with hand held weights, stretch tubing, and self-supporting movements. The research indicated that training responses for both girls and boys included significance strength gains. Siegel used pull-ups, flexed arm hang, hand grip, elbow flexion, sit and reach, and body composition for post test analysis.

Jacobson and Kulling (1989) consolidated the recent literature pertaining to weight training effects on prepubescent children. Their conclusions were that weight training was beneficial to prepubescent children with no record of bone epiphyses damage, no growth tissue or muscle damage, no decrease in body flexibility, and no sustained hypertension.

Thirteen 10 year-old boys participated in a 19 week resistance weight training program that featured two acute bouts of heavy resistance exercise during the second week and 19th week (Blimkie, MacDougall, Sale, Thonar, Smith, and Garner, 1989). Subjects trained three days per week three to five sets per session and at an intensity level of 75% to 85% of their capacity. The researchers discovered significant strength gains and surprising little trauma to the muscle, articular cartilage, and collagen.

Nine 10, and 11 year old male subjects significantly increased maximum repetitions in a series of strength and endurance exercises. The 20 week program with three days per week exercise sessions produced positive results in the bench press, leg press, and isometric elbow flexion and knee extension, isokinetic elbow flexion and knee extension strength (Ramsay, Blimkie, Smith, Garner, MacDougall, and Sale, 1990).

TABLE II

SUMMARY OF SELECTED RESISTANCE TRAINING STUDIES

Author	Duration	Subjects	Age	Importance
Hagberg et al. (1984)	20 wks	M & F	8-16	No high blood pres.
McGovern (1983)	12 wks	M & F	9-12	Strength gains.

TABLE II (Continued)

Author	Duration	Subjects	Age	Importance
Pfeiffer (1985)	9 wks	M	8-21	Strength gains.
Blimkie, MacDougall et al. (1989)	19 wks	M	10	Strength gains, no injury.
Ramsay, Blimkie et al. (1990)	20 wks	M	9-11	Mus. endur. gains.
Rians, et al. (1987)	14 wks	M	7-9	No injury.
Servedio et al. (1985)	8 wks	M	9-12	Strength gains.
Sewal and Micheli (1986)	9 wks	M & F	10-11	Strength gains.
Siegal et al (1988)	12 wks	M & F	8	Strength gains.
Weltman et al. (1986)	14 wks	M	6-11	Strength gains.

Table II (page 21) summarizes selected research studies which feature resistance training programs for children.

CHAPTER III

PROCEDURES

Introduction

The procedures in this chapter are divided into preliminary and operational procedures. The preliminary procedures refer to the selection of subjects, attaining consent, selection of a dependent variable, and the employment of equipment. The operational procedures were the specific steps taken to give instructions to subjects, collect data, give treatment, and statistically analyse the data.

Preliminary Procedure

Selection of Subjects

Two schools within the Wichita Public School District were selected for the study. Both schools enrolled students of a similar socio-economic status. The schools were convenient since the researcher was their assigned physical education teacher. In 1989 57% of the third, fourth, and fifth grade children at these schools could not pull themselves up on a horizontal bar. Therefore, both schools had a need for a strength improvement program.

Obtaining Consent

Permission to conduct the study with human subjects was secured through the Oklahoma State University Institutional Review Board (OSU IRB) and the Wichita Public School's Research Council (RC) (see Appendices A and B). All third, fourth, and fifth grade physical education students with parent consent were eligible to participate in the project. Signed individual consent forms were collected prior to the study (see Appendix C).

Selecting a Dependent Variable

The modified pull-up has been more frequently used as an assessment tool for upper body muscular strength and endurance (Pate et al., 1987). Modified pull-ups were determined to be more discriminating on a fitness test than the traditional pull-up and have substantially eliminated the zero score problem in testing. For a description of the modified pull-up see Appendix D.

Equipment

Equipment was secured in advance through purchase order or individual construction. Hand weights were purchased from a $460.00 Mini Grant through the Wichita Public Schools. Modified pull-up testing equipment was constructed similar to that used in the NCYFS II (Pate et al., 1987). The bar height on the testing equipment was adjustable to

correspond to variations in physical size of the subjects. Modified pull-up training equipment was made by crossing a nine foot pipe (one and one quarter inch in diameter) over two saw horses. The training device bar was 36" high and, unlike the testing equipment, was not adjustable.

Operational Procedures

Random Assignment of Subjects

Subjects were randomly assigned to three research groups from a pool of 180 subjects returning consent forms. A stratified random assignment was made from gender and grade level subgroups. Two groups were experimental groups while the other was the control group. Table III gives the composition of the three research groups.

TABLE III

COMPOSITION OF RESEARCH GROUPS

Grade and Gender	Weight Training	Modified Pull-up	Control
3rd grade males	10	10	9
3rd grade females	8	8	8
4th grade males	10	9	9
4th grade females	10	10	10
5th grade males	11	11	12
5th grade females	11	12	12
Totals	60	60	60

Pretest Instructions

All subjects received instructions on how to perform the modified pull-up (see Appendix E). Instructions were in accordance with those described by Pate, Ross, Baumgartner, and Sparks (1987) and were audio tape recorded and demonstrated by the researcher. All subjects were pretested together during their physical education classes. Scores on the pretest were recorded in whole numbers which were equal to the number of modified pull-ups performed.

Pretreatment Instructions

All subjects received general instructions designed to orient them to the 10 week research project, score sheet use, and their assignment to a treatment group. Appendix F gives verbatim instructions that were audio taped and played to all subjects.

Treatment Group Instructions

Following random assignment to the three research groups, audio taped instructions were played for each group. Verbatim instructions presented to subjects were placed in Appendices G, H, and I.

Data Collection

Data from the pretest and posttest were recorded before and after the 10 week training period. Raw scores data were numerical scores equal to the number of modified pull-ups

performed by each subject. Pretest and posttest instructions were the same, and the tests were administered and recorded by the author.

Training

Following the pretest, the two experimental groups engaged in resistance training three days per week for 10 weeks. One group trained with hand weights while the other group trained on the modified pull-up equipment. All training took place during each scheduled physical education class. Training sessions were completed in the first five minutes of each class. Weight training subjects performed exercises of low resistance and high repetition. Each experimental group subject was shown the proper techniques and the appropriate safety rules associated with resistance training. Each subject kept track of their individual progress on a score sheet (Appendix J).

The weight training group used hand weights. These weights were in size increments of 3, 5, 8, 10, 13, 15, 17, 19, 21, and 23 pounds.

The modified pull-up device was wider than the testing modified pull-up device and permitted the simultaneous exercise of three to four subjects. The horizontal bar was approximately 36 inches above the floor. Gymnastic mats were appropriately placed under the bar for safety.

While the experimental groups were performing resistance exercises, the control group performed stretching

exercises for the lower back and hamstrings. The stretching exercises were a preparation for the subsequent sit-and-reach flexibility fitness testing and had no influence on upper body strength and endurance. Individual daily progress was recorded on a score sheet (Appendix I).

Weight Training Group Procedures

Weight training group subjects used the hand weights to perform one maximum set of bent-over rowing exercises with each arm. The subjects continued exercising until they encountered failure. Subjects were asked not to perform any additional sets of exercises during that training day.

The rowing was executed slowly in a bent-over position with the feet spread slightly wider than shoulder width. One hand grasped the weight and the other hand was placed on a firm support to insure balance and safety. The body was bent-over at the waist with the weight held so that the arm and hand were in a neutral anatomical position, the palm facing inward and the arm perpendicular to the floor. This grip allowed the shoulder to extend and the elbow to flex in a manner similar to the modified pull-up body movement.

Performing the bent-over one-arm row required two noticeable movements at the elbow and shoulder joints. The elbow flexed and the upper arm extended in a straight path. The rowing exercise and the modified pull-up exercise were similar. Prime mover muscles for elbow flexion are: biceps brachii, brachialis, and brachioradialis (Rasch & Burke,

1978). For shoulder extension the prime mover muscles are the pectoralis major (sternal) initially, followed by the latissimus dorsi and teres major.

Subjects lifted the weight vertically from the floor with the elbow flexing until the upper arm was extended past the horizontal position. Slowly the weight was lowered in the same path to complete one repetition of the exercise.

Subjects completed the exercise while gripping the weight with the right hand and then repeated the same exercise using the left side. All subjects were encouraged to give their best effort.

All weight training subjects began with a three pound weight on the first day of treatment. If they were able to complete 20 mechanically correct repetitions with each arm, they moved up to the 5 pound weight for the next treatment day. The weight increments : 3, 5, 8, 10, 13, 15, 17, 19, 21, and 23. Weight increments were determined by the manufacturer's specifications and reflected the most gradual incremental steps possible.

The rationale for placing a 20 repetition standard upon the subjects was to properly condition the subject's bodies while reinforcing the proper movement form. Subjects were reminded not to increase the resistance until they met the 20-repetition standard.

Modified Pull-up Group Procedure

The modified pull-up group performed exercises using a modified pull-up device. Each subject was encouraged to

perform repetitive exercises until failure occured. Subjects were encouraged to increase the number of exercise repetitions as the training sessions progressed.

Modified pull-up group subjects were supine under the bar and perpendicular to it. Their shoulders were directly under the bar. Subjects gripped the one and one-quarter inch diameter bar with an over-hand pronated grip. No adjustment to the 36 inch heighth of the bar was made throughout the training period in order to train the group more quickly.

Control Group Procedures

Control group subjects performed stretching exercises that were unrelated to strength development. After a stretching warm up each subject recorded their daily score on the stretch and reach board.

Statistical Analysis

The differences among the three group's performances on the pretest and the posttest were examined using a three-way repeated measures ANOVA: training groups x gender x time. The dependent variable was the score attained on the modified pull-up test.

Analysis of the data was completed in four steps:

1. The comparison of pretest and posttest modified pull-up means by the control group.

2. A comparison of pretest and posttest modified pull-up means by the weight training group.

3. The comparison of pretest and posttest modified pull-up means by the modified pull-up group.

4. The comparison of the posttest modified pull-up means for the three research groups.

The Newman-Keuls Multiple Range Test was used as a post hoc mean comparison test. An alpha level of .05 was used throughout. Statistical computations were completed using the BMDP Statistical Software package (Dixon, 1981).

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

The purpose this study was to test the effects of resistance training on upper body strength and endurance of third, fourth, and fifth grade elementary children. A three-way repeated measures ANOVA was used to analyze the data. The Newman-Keuls Multiple Range Test was used in all post hoc comparisons, and a .05 alpha level was used throughout.

Initially, 180 subjects were pre-tested. Of this number, 170 (94.4%) completed the 10 week experimental study and were posttested. The 170 subjects were distributed in the three research groups as follows: Weight training group 56 subjects, Modified pull-up group 59 subjects, and Control group 55 subjects. The attrition of 10 subjects was due to students transferring from the two participating elementary schools.

Hypotheses Testing and Analysis

Four hypotheses were tested in this research study. The following is an evaluation of the results. Normative data are presented in Table IV.

First Hypothesis

It was hypothesized that there would be no significant difference in mean pretest and posttest modified pull-up scores for the control group. The control group improved from a mean of 7.05 on the pretest to a mean of 9.27 on the posttest. The data provided a basis for rejecting the first hypothesis.

TABLE IV

MEAN ± STANDARD DEVIATION FOR TREATMENT GROUPS

Test	Pretest	Posttest
Wt. Train. (n=56)	$\bar{X}$=6.86 ±4.665	$\bar{X}$=8.86 ± 4.826
Mod. Pull-up (n=59)	$\bar{X}$=7.64 ± 4.582	$\bar{X}$=11.98 ± 6.922
Control (n=55)	$\bar{X}$=7.05 ± 4.730	$\bar{X}$=9.27 ± 4.090

Second Hypothesis

It was hypothesized that there would be no significant difference in mean pretest and posttest modified pull-up scores for the weight training group. The weight training group improved from a mean of 6.86 on the pretest to a mean

of 8.86 on the posttest. The data provided a basis for rejecting the second hypothesis.

Third Hypothesis

It was hypothesized that there would be no significant difference in mean pretest and posttest modified pull-up scores for the modified pull-up group. The modified pull-up group improved from a mean of 7.64 on the pretest to a mean of 11.98 on the posttest. The data provided a basis for rejecting the third hypothesis.

Fourth Hypothesis

It was hypothesized that there would be no significant difference among the three research groups in mean posttest modified pull-up scores. The modified pull-up mean score was 11.98 as compared to a mean of 9.27 for the control and 8.86 for the weight training group. This data provided a basis for rejecting the fourth hypothesis. A post hoc Newman-Keuls Multiple Range Test indicated that the modified pull-up group performed significantly better on the posttest than the other two groups.

Results by Gender

The repeated measure ANOVA summary listed in Table 6 indicated a significant main effect for gender. This finding was consistent with the research literature showing that males out-perform females in tests of strength

(Hunsicker & Reiff, 1977; Ross, Pate, Delpy, et al., 1987; Ross & Gilbert, 1985). In anticipation of this a stratified random assignment of subjects by gender and grade level was performed as a precaution. Table III (page 26) indicates the result of the stratified random assignment.

TABLE V

REPEATED MEASURES ANOVA SUMMARY

Source	SS	df	MS	F
Between Groups				
Group	269.40	2	134.70	3.29*
Gender	176.72	1	176.72	4.31*
Group x Gender	17.67	2	8.83	.22
Error Between Groups	6719.41	164	40.97	
Within Groups				
Time	695.02	1	695.02	68.66*
Time x Group	94.17	2	47.08	4.65*
Time x Gender	14.77	1	14.77	1.46
Time x Gender x Group	.43	2	.22	.02
Error Within Groups	1660.10	164	10.12	

* $p < .05$

Discussion of the Results

Weight training in elementary school

Weight training at the elementary level was a useful innovation. In this research the following safeguards were

employed: 1. Have effective and qualified supervision; 2. Use proper lifting mechanics; 3. Lift light weights with high repetitions; and 4. Use a progressive system where each child begins with a low resistance and gradually increases the resistance through training. During the 10 week session of training no injuries occurred that could be attributed to weight training.

The literature review demonstrated that weight training in the elementary physical education class was unusual. Suitable equipment is not available in many elementary schools, although improvised weight equipment has been used (Siegel, 1988). For this research, a small grant ($470) was received through the Wichita Public Schools to purchase hand weights. Each school had 11 small adjustable hand weights with a reserve supply of three and five pound plates in addition to 9 nonadjustable hand weights. The adjustable hand weights had threaded ends where the weight plates could be screwed-on for safety. The quality of the weight equipment added to the safety of the research.

Enthusiasm was not a problem for the children. The introduction of the weights immediately aroused the interest of the children in the weight training group. Individual weights were of sufficient number to limit the waiting time during training. Since children appeared eager to exercise during their scheduled physical education day, the continuation of an elementary level weight training program has merit.

Modified Pull-up Training in Elementary School

The modified pull-up was a more productive training method than the weight training and the control method. In this instance training was very specific to the task requirements of the pretest and the posttest. Results indicate that practicing the test is an effective training method to improve upper body muscular strength and endurance.

Given that these results are not generalizable beyond the sample tested, the modified pull-up training method was superior to the weight training or control method. Modified pull-up gains were attributed to training rather than gender and maturation since the stratified random assignment gave each group equivalent representation of males and females in the third, fourth, and fifth grade.

The control group demonstrated strength gains without the benefit of resistance training exercises. Baumgartner and Wood (1984) found a similar score improvement in their control subjects. Two possible explanations for control group improvement are physical maturity and learning through reactive arrangements.

Physical Maturity

The time duration between pretest and posttest was nearly 12 weeks. It is possible that the subjects scored higher due to increased maturity. The literature indicates

that physical fitness test scores frequently improve with the increased age of the child (Hunsicker & Reiff, 1977; Ross, Dotson et al., 1985; Ross, Pate, Delpy et al., 1987). Research conducted with young preadolescent children was likely to confront this problem. Campbell and Stanley (1963) indicated that maturation was a validity threat difficult to avoid.

Reactive Arrangements

Another plausible explanation for control group improvement was that learning took place after the pretest and this helped the subjects score higher on the posttest. Campbell and Stanley (1963) suggested an effect called "reactive arrangements." Reactive arrangements prompt subjects in educational research to develop certain attitudes that have an effect on their performance. Since all three treatment groups trained in the same room during the same physical education class, the control group may have altered their behavior based upon the observed activities of the other two training groups.

Possible Intervening Factors

Factors such as the subject's height, body weight, fitness level, and prior experience have influence upon muscular strength and endurance testing. Cotten (1990) and Engelman and Morrow (1991) reported that body weight effected modified pull-up scores. Effects of these factors

were reduced by random assignment of subjects to groups and were not considered as prominently affecting the results.

Weight Training Effects

It was surprising that weight training subjects did not out-perform the control subjects since they had engaged in a specific training program to improve upper body strength while the control subjects did not. Possible explainations for this are 1. A deficiency in work intensity during the training period; or 2. Improper exercise techniques precluded the desired strength development; or 3. Specificity of training did not relate to the posttest.

The goal was for each child to exercise to a point of muscular failure on each training day. It appeared that each weight training subject was following the pretreatment instructions, but it could not be determined how motivated each subject was in pushing himself or herself to a higher strength threshhold. The goal was to build strength rather than maintain strength. Apparently the weight training group did not increase measured strength through their training as the modified pull-up group had.

Children were given specific instructions as to the lifting technique. Possibly these were not followed accurately and the mechanics of movement were disrupted. If the elbow was too far from the body or the movement was not executed through a full range of motion then the training effects would be diminished. Improper techniques alter the

training of the prime mover and accessory muscles necessary for the modified pull-up.

Theoretically, it may have been appropriate to conclude that the rowing exercise would increase performance on the modified pull-up posttest. However, the specificity of weight training actually may not have translated into greater ability on the posttest. Subjects may have increased muscular strength and endurance but not in relation to the movement required for the modified pull-up.

TABLE VI

GROUP MEANS ± STANDARD DEVIATIONS
FOR PRE AND POST TESTS
BY GENDER

Group	Pretest	Posttest
Male wt. train. (n=28)	$\bar{X}$=7.46 ± 5.117	$\bar{X}$=9.14 ±4.213
Female wt. train. (n=28)	$\bar{X}$=6.25 ± 4.168	$\bar{X}$=8.57 ± 5.433
Male pull-up (n=29)	$\bar{X}$=8.59 ± 4.602	$\bar{X}$=12.48 ± 6.754
Female pull-up (n=30)	$\bar{X}$=6.73 ± 4.448	$\bar{X}$=11.50 ± 7.162
Male control (n=30)	$\bar{X}$=8.20 ± 4.992	$\bar{X}$=9.97 ± 3.882
Female control (n=30)	$\bar{X}$=5.68 ± 4.090	$\bar{X}$=8.44 ± 4.253

Gender Differences

In each training group, the males out-performed the females on the modified pull-up (see Table VI). It is evident that females pretested lower than the males, but the females made greater posttest gains in all treatment groups.

With respect to the research of Ricci et al. (1988), the performance of males and females on tests of upper body strength and endurance may be culturally influenced. Biomechanically, females have the potential to perform equivalently to males. The gains on the posttest give support for the argument that females are capable of greater upper body strength and endurance than national fitness norms indicate.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter includes a brief summary of the research with a listing of findings, conclusions, and recommendations for further study.

Summary

Unsatisfactory physical fitness scores have challenged elementary physical education programs to seek solutions to the fitness dilemma. One important component of physical fitness testing programs has been muscular strength and endurance. The purpose of this study was to test the effects of resistance training on upper body muscular strength and endurance in third, fourth, and fifth grade elementary students.

One hundred and eighty subjects from two Wichita, Kansas elementary schools participated in the study. Subjects were placed in three research groups by a stratified random assignment to insure an equal mix of grade level and gender. All subjects were pretested in the modified pull-up during the fall semester, 1990.

Following the pretest, subjects received 10 weeks of treatment, three days per week, during their scheduled physical education class. One treatment group participated in a progressive weight training program using light hand weights to perform one set of high repetition exercises until failure. A second group trained for one maximum set until failure on the modified pull-up, which was also the dependent variable in the study. The third group participated in hamstring and lower back stretching exercises and served as a control group. Following the 10 weeks, all subjects were posttested using the modified pull-up procedure. There was an attrition factor of 10, and 170 subjects completed the study.

Results of the three-way repeated measures ANOVA indicated significant pretest to posttest improvement by each of the three treatment groups. Mean posttest group scores were compared using the Newman-Keuls Multiple Range Test for post hoc examination. Findings indicated that the modified pull-up group performed significantly better than the other two groups on
posttest scoring.

Summary of the Findings

The summary of the findings are outlined according to hypothesis.

Hypothesis #1

There will be no significant difference in mean pretest

and posttest modified pull-up scores for the control group. (Rejected)

Hypothesis #2

There will be no significant difference in mean pretest and posttest modified pull-up scores for the weight training group. (Rejected)

Hypothesis #3

There will be no significant difference in mean pretest and posttest modified pull-up scores for the modified pull-up group. (Rejected)

Hypothesis #4

There will be no significant difference among the three research groups in mean posttest modified pull-up scores. (Rejected)

Conclusions

Based upon the findings and limitations of this study, the following conclusions are appropriate:

1. Third, fourth, and fifth grade children can significantly improve their upper body muscular strength and endurance through resistance training exercises.

2. The modified pull-up training was superior to the weight training or control in improving modified pull-up scores. As an in school training device, the modified pull-up was quite suitable for elementary students.

Recommendations for Future Research

Relative to this study, the following recommendations are made for future study:

1. Conduct a similar study over a longer duration, i.e. 20 weeks to 30 weeks.

2. Conduct a similar study with repeated measures testing before treatment, at the mid-way point, and after treatment.

3. Conduct a comparable research project with the treatment groups training apart from the other treatment groups.

4. Perform a similar research project using the Baumgartner modified pull-up device as the dependent variable.

5. Create a comparable study using different subgroups based upon age, race, and/or socio-economic status.

6. Conduct a similar study using a posttest-only research design.

REFERENCES

American Alliance for Health, Physical Education, and Dance (1988). Physical Best: A Physical Fitness Education and Assessment Program. Reston, VA: American Alliance.

Bar-Or, O. (1989). Trainability of prepubescent child. Physician and Sportsmedicine, 17,(5), 65-82.

Baumgartner, T. A. & Wood, S. S. (1984). Development of shoulder-girdle strength-endurance in elementary children. Research Quarterly for Exercise and Sport, 55(2), 169-171.

Baumgartner, T. A. (1978). Modified pull-up test. Research Quarterly, 49(1), 80-84.

Baumgartner, T. A., East, W.B., Frye, P.A., Hensley, L.D., Knox, D. F., & Norton, C. J. (1984). Research Quarterly for Exercise and Sport. 55(1), 64-68.

Blimkie, C. J. R., MacDougall, D., Sale, D., Thonar, E., Smith, K., & Garner, S. (1989). Soft-tissue trauma and resistance training in boys. Medicine and Science in Sports and Exercise, 21(2), 89.

Campbell, D. T. & Stanley, J. C. (1963). Experimental and quasi-experimental designs for research on teaching. In N. L. Gage (Ed.), Handbook of Research on Teaching (pp. 171-246). Chicago: Rand McNally.

Chrysler Fund-AAU Physical Fitness Program (1990). 1990-91 Test Manual. Bloomington, IN.

Clarke, D. H., Vaccaro, P., & Andersen, N. M. (1984). Physicological alterations in 7 to 9 year old boys following a season of competitive wrestling. Research Quarterly for Exercise and Sport, 55(4), 318-322.

Cotten, D. J. (1990). An Analysis of the NCYFS II modified pull-up test. Research Quarterly for Exercise and Sport, 61(3), 272-274.

Crouch, J. E. (1985). Functional Human Anatomy (4th ed.). Philadelphia: Lea & Febiger.

Dauer, V. P. & Pangrazi, R. P. (1986). Dynamic Physical Education for Elementary School Children. New York: Macmillan.

DeMello, J. F. (1990). A comparison of modified pull-up strength training devices in elementary school children. In C. Chamberland & R. J. Moffatt (Eds.). Completed Research in H., P.E., R., and D. (p. 78). Reston, VA: AAHPERD Pub.

Dixon, W. J. (Ed.). (1981). BMDP Statistical Software. Berkeley, CA: University of California Press.

Duda, M. (1986). Prepubescent strength training gains support. Physician and Sportsmedicine, 14(2), 157-161.

Edgren, H. D. & Gruber, J. J. (1963). Teacher's handbook of indoor and outdoor games. Englewood Cliffs, NJ: Prentice-Hall.

Ellis, J. D., Carron, A. V., & Bailey, D. A. (1975). Physical performance in boys from 10 to 16 years. Human Biology, 47(3), 263-281.

Engelman, M. E. & Morrow, J. R. (1991). Reliability and skinfold correlates for traditional and modified pull-ups in children grades 3-5. Research Quarterly for Exercise and Sport, 62(1), 88-91.

Gabbard, C. P. & Crouse, S. (1988). Children and exercise: myths and facts. Physical Educator, 45(1), 39-43.

Ghent, S. E. (1990). Effects of practice on physical fitness scores of preschool children. In C. Chamberland & R. J. Moffate (Eds.). Completed research in H., P.E., R., and D. Vol. 31 (pp 433-4). Reston, VA: AAHPERD Pub.

Gumbs, V. L., Segal, D., Halligan, J. B., & Lower, G. (1982). Bilateral distal radius and ulnar fractures in adolescent weight lifters. American Journal of Sports Medicine, 10(6), 375-379.

Hagberg, J. M., Ehsani, A. A., Goldring, D., Hernandez, A., Sinacore, D. R., & Holloszy, J. O. (1984). Effect of weight training on blood pressure and hemodynamics in hypertensive adolescents. Journal of Pediatrics, 104(1), 147-151.

Hakkinen, K., Mero, A., & Kauhanen, H. (1989). Specificity of endurance, sprint and strength training on physical performance capacity in young athletes. Journal of Sports Medicine and Physical Fitness, 29(1), 27-35.

Healy, A. (1958). Two methods of weight-training for children with spastic type of cerebral palsy. Research Quarterly, 29, 389-395.

Hensley, L. D., East, W. B., & Stillwell, J. L. (1982). Body fatness and motor performance during preadolescence. Research Quarterly for Exercise and Sport, 53(2), 133-140.

Hunsicker, P. (1958). AAHPER physical fitness battery. Journal of Health, Physical Education, and Recreation, 29(6), 24-25.

Hunsicker, P. & Reiff, G. G. (1976). AAHPER Youth Fitness Test Manual. Washington, D.C.: AAHPER Publications.

Hunsicker, P. & Reiff, G. (1977). Youth fitness report: 1959-1965-1975. Journal of Physical Education and Recreation, 48(1), 31-33.

Hutinger, P. W. (1955). Effect of systematic horizontal ladder exercises upon upper body strength of third grade' children. Research Quarterly, 26(2), 159-162.

Institute for Aerobic Research (1983). Fitnessgram Instructor's Manual. Dallas, TX.

Ismail, A. H. & Cowell, C. C. (1961). Purdue motor fitness test batteries and a development profile for pre-adolescent boys. Research Quarterly, 33(4), 553-558.

Jackson, A., Bruya, L., Baun, W., Richardson, P., Weinberg, R., & Caton, I. (1982). Research Quarterly for Exercise and Sport, 53(2), 163-164.

Jacobson, B. H. & Kulling, F. A. (1989). Effect of resistive weight training in prepubescents. Journal of Orthopaedic and Sports Physical Therapy, 11(3), 96-99.

Jensen, C. R. & Schultz, G. W. (1977). Applied Kinesiology (2nd ed.). New York: McGraw-Hill.

Johnson, B. L. & Nelson J. K. (1969). Practical Measurements For Evaluation In Physical Education. Minneapolis: Burgess Publishing.

Kraus, H. & Hirschland, R. P. (1954). Minimum muscular fitness tests in school children. Research Quarterly, 25, 178-188.

Kusinitz, I. & Keeney, C. E. (1958). Effects of progressive weight training on health and physical fitness of adolescent boys. Research Quarterly, 29, 294-301.

Legwold, G. (1982). Does lifting weights harm a prepubescent athlete? Physician and Sportsmedicine, 10(7), 141-144.

McCloy, C. H. (1931). A new method of scoring chinning and dipping. Research Quarterly, 2, 132-143.

McGinnis, J. M. (1985). Introduction: the national children and youth fitness study. Journal of Physical Education, Recreation, and Dance, 56(1), 44.

McGovern, M. B. (1983). Effects of circuit weight training on the physical fitness of prepubescent children (Doctoral dissertation, Northern Illinois University). Dissertation Abstracts International, 45(2), 452A.

Malina, R. M. (1989). 1988 C. H. McCloy Research Lecture: children in the exercise sciences. Research Quarterly For Exercise And Sport, 60(4), 305-317.

Mathews, D. K. (1968). Measurement in Physical Education (3rd ed.). Philadelphia: W. B. Saunders.

Metheny, E., Bookwalter, C., Burch, G., Carpenter, A., Espenschade, A., Glassow, R., Hodgson, P., Purbect, M., & Rogers, E. (1945). Physical performance levels for high school girls. Journal of Health, Physical Education, and Recreation, 16(6), 308-311.

Pangrazi, R. P. & Corbin, C. B. (1990). Age as a factor relating to physical fitness test performance. Research Quarterly for Exercise and Sport, 61(4), 410-414.

Pangrazi, R. P. & Hastad, D. N. (1989). Physical Fitness in the Elementary Schools: A Teacher's Manual (2nd ed.). Reston, VA: American Alliance for Health, Physical Education, Recreation, and Dance.

Pate, R. R., Ross, J.. G., Baumgartner, T. A., & Sparks, R. E. (1987). The modified pull-up. Journal of Physical Education, Recreation, and Dance, 58(9), 71-73.

Petersen, B. M. (1962). Arm and shoulder girdle strength in children in primary grades. (Master's thesis, Colorado University, Micro Card A 1647).

Pfeiffer, R. P. (1985). Effects of a strength training program on muscle development in prepubescent, pubescent, and postpubescent boys. Unpublished doctoral dissertation, Brigham Young University, Provo, UT.

Pfeiffer, R. P. & Francis, R. S. (1986). Effects of strength training on muscle development in prepubescent, pubescent, and postpubescent males. Physician and Sportsmedicine, 14(9), 134-140.

President's Council on Physical Fitness and Sports (1973). Youth Physical Fitness. Washington, D.C.: US Government Printing Office.

Ramsay, J. A., Blimkie, C., Smith, K., Garner, S. MacDougall, J. D., & Sale, D. G. (1990). Strength training effects in prepubescent boys. Medicine and Science in Sports and Exercise, 22(5), 605-614.

Rasch, P. J. & Burke, R. K. (1978). Kinesiology and Applied Anatomy. Philadelphia: Lea & Febiger.

Rians, C. B., Weltman, A., Cahill, B. R., Janney, C. A., Tippett, S. R., & Katch, F. I. (1987). Strength training for prepubescent males: Is it safe? American Journal of Sports Medicine 15(5), 483-489.

Ricci, B., Figura, F., Felici, F., & Marchetti, M. (1988). Comparison of male and female functional capacity in pull-ups. Journal of Sports Medicine, 28(2), 168-175.

Rogers, F. R. (1934). The significance of strength tests in revealing physical condition. Research Quarterly, 5(3), 43-46.

Ross, J. G., Dotson C. O., Gilbert, G. G., and Katz, S. J. (1985). New standards for fitness measurement. Journal of Physical Education, Recreation, and Dance, 56,(1), 20-24.

Ross, G. R. & Pate, R. R. (1987). A summary of the findings. Journal of Physical Education, Recreation, and Dance, 58(9), 51-56.

Ross, G. R., Pate, R. R., Delpy, L. A., Gold, R. S., & Svilar, M. (1987). New health-related fitness norms. Journal of Physical Education, Recreation, and Dance, 58(9), 66-70.

Ross, J. G. & Gilbert, G. G. (1985). A summary of the findings. Journal of Physical Education, Recreation, and Dance, 56(1), 45-50.

Sailors, M. & Berg, K. (1987). Comparison of responses to weight training in pubescent boys and men. Journal of Sports Medicine, 27(1), 30-37.

Servedio, F. J., Bartels, R. L., Hamlin, R. L., Teske, D., Shaffer, T. & Servedio, A. (1985). The effects of weight training, using olympic style lifts, on various physiological variables in pre-pubescent boys (Abstract). Medicine and Science in Sports and Exercise, 17(2), 288.

Sewall, L. & Micheli, L. J. (1986). Strength training for children. Journal of Pediatrics Orthopedics, 6(2), 143-146.

Siegel, J. A. (1988). The effects of upper body resistance exercise on prepubescent children (Doctoral dissertation, University of Connecticut) Dissertation Abstracts International, 49, 12A.

Sparks, R. E. (1965). Modification of the AAHPER youth physical fitness test. (Doctoral dissertation, Springfield College: Microcard A1768).

Watkins, J. & Docherty, D. (1986). Training loads for the development of upper limb muscular strength and endurance in pre-adolescents. In J. A. MacGregor & J. A. Moncure (Eds.), Sport and Medicine (pp. 61-65). London: E. & F. N. Spon.

Wear, C. L. (1955). Fitness of American youth. Physical Educator, 12(4), 123-124.

Weltman, A., Janney, C., Rians, C. B., Strand, K., Berg, B., Tippitt, S., Wise, J. C., Cahill, B. R., & Katch, F. I. (1986). The effects of hydraulic resistance strength training in pre-pubertal males. Medicine and Science in Sports and Exercise, 18(6), 629-638.

Woods, J. A., Burgess, M. L., & Pate, R. R. (1989). Validity of field tests of upper body strength. Medicine and Science in Sports and Exercise, 21(2), 112.

APPENDIX A

OKLAHOMA STATE UNIVERSITY

INSTITUTIONAL REVIEW

BOARD PERMISSION

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Proposal Title: The Effects of Resistance Training on Upper Body Strength and Endurance of Elementary School Children

Principal Investigator: Steve Edwards/Bert Jacobson/Todd Russell

Date: April 26, 1990 IRB # AS-90-049

This application has been reviewed by the IRB and

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

Renewal or Continuation [ ]

Approval Status Recommended by Reviewer(s):

Approved [X] Deferred for Revision [ ]

Approved with Provision [ ] Disapproved [ ]

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

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

Signature: Steven W Edwards Date: May 15, 1990

Chair of Institutional Review Board

APPENDIX B

WICHITA PUBLIC SCHOOLS RESEARCH COUNCIL PERMISSION

WICHITA PUBLIC SCHOOLS
ADMINISTRATIVE CENTER
217 North Water
Wichita, Kansas 67202

Division of Compensatory and Accountability Services

March 1, 1990

Mr. Todd Russell
1531 Woodrow Ct.
Wichita, KS 67203

Dear Mr. Russell:

I am happy to confirm the Research Council's approval of your research proposal on "The Effects of Resistance Training on Upper Body Strength and Endurance in Elementary Students." Your population sample will consist of 3rd, 4th, and 5th grade pupils at Riverside and Woodland Elementary Schools. The pupils in these three grades will be divided into three groups. Group I will exercise with light hand weights using a rowing exercise; Group II will exercise using the modified pull-up bar; and Group III will be the control group and will perform stretching exercises that are not strength related.

Before starting your project, as anticipated at the beginning of the 1990-1991 fall semester, please contact Diana Cubbage, Area I Superintendent (ext. 4400), who will assign someone to work with you in arranging for your study through the pricipals of the selected schools.

When you have completed your dissertation, please forward a copy to Leonard H. Wesley, Jr., Division Director, Compensatory and Accountability Services, 217 North Water, Wichita, KS 67202. Your dissertation will be kept on file and will be available to interested school and community people on a check out basis.

I am happy the Research Council could be of service to you. If we can assist you in future research endeavors, please let me hear from you.

Sincerely,

Leonard H. Wesley, Jr.

Leonard H. Wesley, Jr.
Division Director and
Research Council Chairperson

hlk

cc: Bert H. Jacobson (OSU)
Ron Naso
Area Superintendents
Research Council Members

APPENDIX C

PARENT CONSENT LETTER

August, 1990

To: Parents/guardians of 3rd, 4th, and 5th graders; Woodland and Riverside Elementaries.
From: Todd Russell, physical education (PE) teacher.
Subject: Consent to participate in a research project.

As a requirement for a doctoral degree from Oklahoma State University, I am conducting a research study at Woodland and Riverside Elementaries. This letter explains the research project.

In 1989, approximately 57% of the Woodland/Riverside 3rd, 4th, and 5th grade children could not pull themselves up on a chinning bar. This is cause for some concern in a child's physical fitness assessment. The purpose of the study is to find a practical method of increasing a child's muscular strength and endurance during a PE class program.

The research study is entitled: "The effects of resistance training on upper body strength and endurance in elementary students." Each 3rd, 4th, and 5th grade PE student involved in this study, will be randomly selected and randomly assigned into one of three groups. Group I (treatment group) will perform resistance training exercises with light hand weights; Group II (treatment group) will perform modified (inclined) pull-ups on a low horizontal bar; and Group III (control group) will work on non-strength related stretching exercises.

Participation in the 10 week study is voluntary and the results will be kept confidential. A child may withdraw from the study at any time without penalty. In respect to a safe environment, there will be no greater safety risk than is normally incurred in PE class.

Please discuss this study with your child and if willing sign and return the consent form (attached). Contact me if any questions arise (Home, 267-8919), or contact Ms. Terri Maciula, OSU Research Services Office (405-744-5700). Children not participating in the research will perform stretching exercises similar to Group III's activity, but will not receive the experimental treatment nor be counted statistically.

PARENT/GUARDIAN RESEARCH CONSENT FORM

I, (parent/guardian) _____, hereby authorize Todd Russell, the Woodland and Riverside Elementary physical education teacher, to include my child, (name)_____ in a confidential strength development research project during fall, 1990.

I have read the take-home letter describing the research project and visited with my child. I know that the study is voluntary and will take place during my child's physical education class for a 10 week duration.

Parent signature _____ date_____

APPENDIX D

DESCRIPTION OF THE MODIFIED PULL-UP

The child is positioned on his/her back with the shoulders directly below a bar that is set at a height one or two inches beyond the child's reach (Pate, Ross, Baumgartner, & Sparks, 1987).

An elastic band is suspended across the uprights parallel to and about seven to eight inches below the bar.

In the "start" or "down" position, the child's buttocks are off the floor, the arms and legs are straight, and only the heels are in contact with the floor.

An overhand grip (palm away from body) is used and thumbs are placed around the bar.

A pull-up is completed when the chin is hooked over the elastic band. The movement should be accomplished using only the arms and the body must be kept straight.

The child executes as many pull-ups as possible, keeping the hips and knees extended through each attempt.

APPENDIX E

VERBATIM PRETEST INSTRUCTIONS

As part of our physical fitness testing, each person will perform the modified pull-up exercise. To insure that everyone receives the proper instructions, I have tape recorded the directions. Please watch as I demonstrate.

I hold onto the bar with an over-hand grip, hands shoulder width apart. My shoulders are under the bar. My body is as "straight as a board." My feet are together; only my heels touch the floor. Now, pull the body up-ward with the elbows inward, toward the chest. Notice that my chin is hooked over the elastic cord. Continue to keep your body as "straight as a board."

Then, lower the body slowly. You have just completed one exercise repetition. Without resting between repetitions, do as many repetitions as you can until you can not complete another. I will count how many modified pull-ups you complete and write down this number. Please give your best effort so that I can get an accurate score for you.

Remember, this is one of many physical fitness tests that you will do this year. This is not competition. We do not have winners or losers.

Are there any questions about what I have described? (Review if necessary).

APPENDIX F

VERBATIM PRETREATMENT INSTRUCTIONS

In physical education class we are beginning a 10 week research project. The purpose of the research is to learn about upper body muscular strength and endurance in children. Since it is a scientific study, all people will not be completing the same tasks.

I have divided the class into three exercise groups by a method of random assignment. In other words, you were placed in a group by drawing names out of a hat. One group will train with small hand weights, a second group will perform modified pull-ups, and the third group will work with the stretch and reach board.

All exercises will be completed in the first 5 to 8 minutes of each physical education class. We will not spend the whole class time on this project. After the exercises are completed, you should immediately sit down in your work area. When everone is finished, we will begin other skills, games, or fitness activities.

It is important to follow exercise directions carefully. Do only the exercises that you have been assigned to perform. Stay away from the other exercise groups when you are finished. Always work safely and be courteous to others by not commenting about their exercises. Remember, all people have different abilities and as your

physical education teacher I want everyone to have a fair chance to develop their own unique abilities.

Every person will have a score sheet with your name printed on it. The score sheet will tell how many days you exercised. Notice that it looks like a zig-zag ladder of open rectangles (instructor holds-up the score sheet). Starting at the bottom you will move toward the top, one block for each day you exercise. I will explain more about the score sheet when you get into your group.

You will not be allowed to change exercises until after the 10 week period is completed. However, if you are interested, I will give you time after the ten week study to try the other forms of exercise equipment.

APPENDIX G

VERBATIM WEIGHT TRAINING INSTRUCTIONS

To improve your upper body muscular strength and endurance, you will perform a rowing exercise with a small hand weight. Watch as I demonstrate.

I place my feet shoulder width apart and bend over at the waist. One hand grasps the weight while the other is placed on a support for balance. The palm of my hand faces inward while holding the weight. As I lift the weight, the elbow moves close to the body. I lift the weight under my chest and shoulder as I move the elbow as high as possible. Slowly, lower the weight toward the floor. This is one exercise repetition.

Without resting, do as many exercise repetitions as you can while you count the total number. Repeat the same exercise with the other arm, using the same movement. For safety, it is important to lift the weight only as I have demonstrated. Do not experiment with other exercise movements on your own.

Notice the hand weights progressively increase in size (5 lb., 8 lb., 10 lb., 12 lb., 16 lb., 18 lb., 21 lb. and 23 lb.). If you are able to perform 20 repetitions, with each arm, using proper form, you may move up to the next weight size. However, you will have to wait until the next class period in order to move up to the next weight. Increasing

the size of the weight suggests that you are getting stronger.

There is a score sheet with your name on it. Please write on the score sheet the size (number of pounds) of hand weight you used today. For example, today everyone will mark "5" since all will start with a 5 pound weight. Write in the first block labled "start" (Instructor holds-up the score sheet). Each day you will fill-in the next open block with that day's exercise repetitions. After the 10 weeks of training, all blocks should be marked as we approach the "finish". This score sheet is important since it will help us keep a written record of your progress.

Are there any questions about the use of the hand weights and the score sheet? (Review, if necessary.)

Remember, the purpose is to increase our upper body muscular strength and endurance. This is not competition. We do not have winners or losers. It is important to do your best and to keep working to improve, each day.

Work safely. You may quietly begin with the 5 pound hand weight. Please sit quietly when finished.

APPENDIX H

VERBATIM MODIFIED PULL-UP INSTRUCTIONS

To improve your upper body muscular strength and endurance, you will perform the modified pull-up with the low horizontal bar. Watch as I demonstrate.

I hold onto the bar with an over hand-grip, hands shoulder width apart. My shoulders are under the bar. My body is as "straight as a board." My feet are together; only my heels touch the floor. Now, pull the body up-ward with the elbows inward toward the chest. Continue to keep your body as "straight as a board". Then, lower the body slowly. You have just completed one exercise repetition. Without resting between repetitions, do as many repetitions as you can. For safety, it is important to perform the exercise only as I have demonstrated. Do not experiment with other exercise movements on your own.

There is a score sheet with your name on it. Please write on the score sheet the number of repetitions you could consecutively complete without stopping or resting. (For example, if you performed 5 repetitions today you will mark a "5" on your score sheet. Write in the first block labeled "start" (Instructor holds-up the score sheet).

Each successive day you will fill-in the next open block with that day's exercise repetitions. After 10 weeks of training, all blocks should be marked as we approach the

"finish". This score sheet is important since it will help us keep a written record of your progress.

Are there any questions about the use of the modified pull-up and the score sheet? (Review, if necessary.)

Remember, the purpose of this exercise is to increase our upper body muscular strength and endurance. This is not competition. We do not have winners or losers. It is important to do your best and to keep working to improve, each day.

Work safely. You may quietly begin your modified pull-ups with no more than three people on the bar at one time. Sit quietly when finished.

APPENDIX I

VERBATIM CONTROL GROUP

INSTRUCTIONS

To improve your flexibility in your lower back and the hamstring muscles on the back of your legs, you will perform two stretching exercises. Work with me as we perform the first stretching exercise.

The first exercise is called the "number 4" stretch. Please sit on the floor with your feet together, straight-out to your front. Now, bend one leg back so that the sole of the foot is resting against the inside of the straight-leg knee. Very gradually reach-out, bending at the waist, toward your front foot. You should begin to feel a stretch behind the leg. Hold your position for a silent count of 20. Now, switch feet and stretch the other leg, also for a silent count of 20. It is important not to "bob" your upper body for this may be harmful to your muscles. Stretching should be a slow, gradual and relaxed process.

For the second exercise, we will use a stretch and reach board. The board will measure, in inches, the length of our forward stretch.

Sit with your legs straight. The feet are placed under the board with the soles of the feet squarely against the wood surface. Extend your hands placed on top of each other. Reach out with the finger tips, palms down, as far forward as possible, along the yard stick. It is usually

helpful to have another person hold your knees down so you get an accurate reading in inches.

There is a score sheet with your name on it. Please write on your score sheet the number of inches that you stretched without bobbing. Write in the first block labled "start" (hold-up the score sheet). For example, you would record a 5 if you stretched 5 inches in today's exercises. Each successive day you will fill-in the next open block. After the 10 weeks of training, all blocks should be marked as we approach the "finish". This score sheet is important since it will help us to keep a written record of your progress.

Are there any questions about the the two stretching exercises and the use of the score sheet? (Review, if necessary.)

Remember, the purpose of the two flexibility exercises is to help make our body's bend better. This is not competition. We do not have winners or losers. It is important to do your best and to keep working to improve, each day.

Work safely. You may quietly begin your "number 4" stretch. Sit quietly when finished.

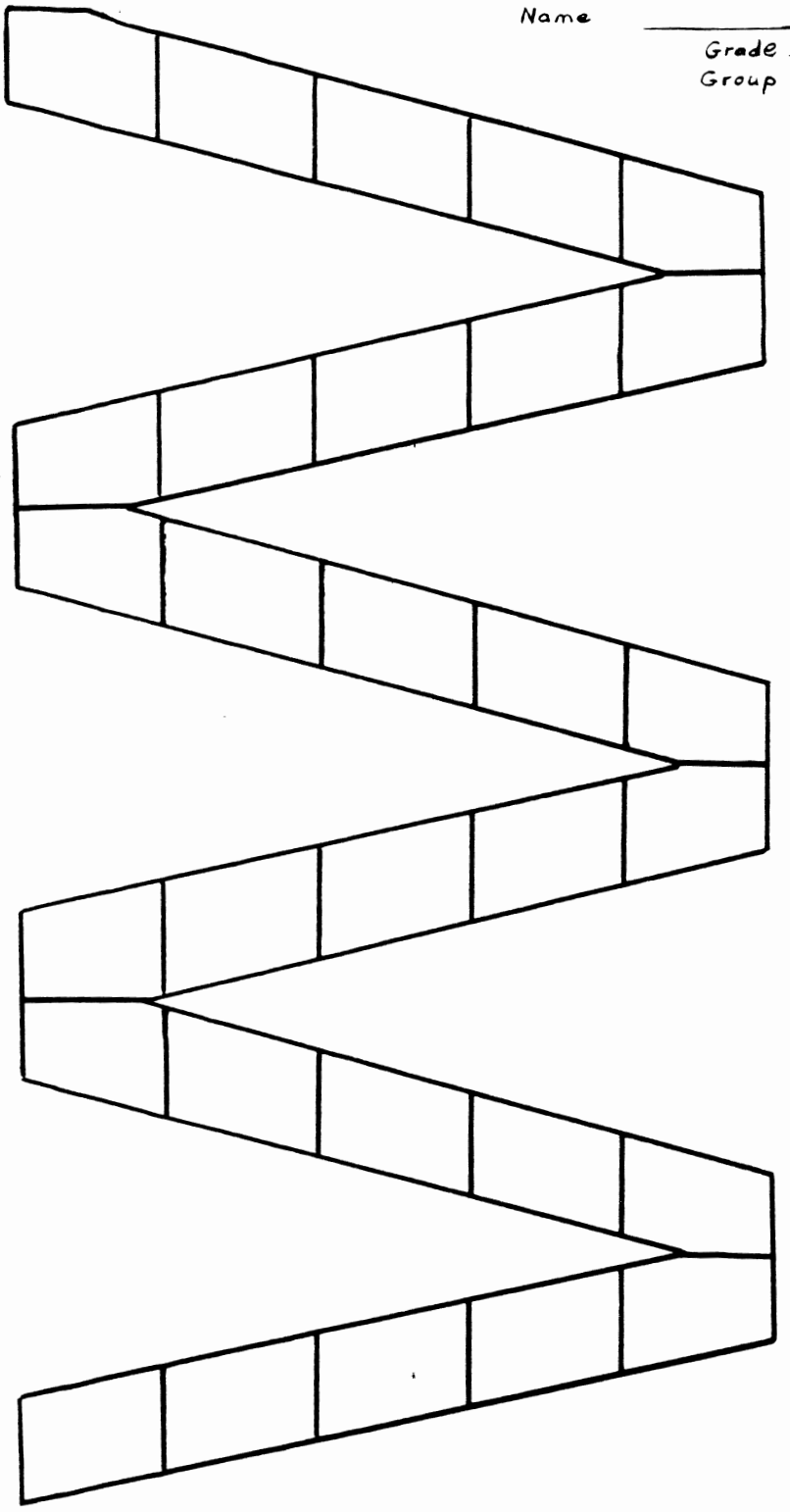
APPENDIX J

SCORE SHEET

Name _____

Grade _____

Group _____



VITA

TODD T. RUSSELL

Candidate for the Degree of

Doctor of Education

Thesis: THE EFFECTS OF RESISTANCE TRAINING ON UPPER BODY MUSCULAR STRENGTH AND ENDURANCE OF ELEMENTARY SCHOOL STUDENTS

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Personal Data: Born in Burlington, Vermont, April 11, 1943.

Education: Graduated from Wethersfield High School, Wethersfield, Connecticut in June, 1961. Received a Bachelor of Arts Degree in Biology from Ottawa University, Ottawa, Kansas in May, 1966; received a Master of Arts Degree in Physical Education from Wichita State University in May, 1973; received a Master of Education Degree in Sports Administration from Wichita State University in May, 1986; completed requirements for a Doctor of Education degree at Oklahoma State University in May, 1991.

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