A Comparison of the Effects of Weight Training on Strength and Girth Measures of Prepubescent and Postpubescent Boys

Brian C. Jones

The College at Brockport
Title of Thesis: A Comparison of the Effects of Weight Training on Strength and Girth Measures of Prepubescent and Postpubescent Boys

Author: Brian C. Jones

Date Submitted to the Department of Physical Education and Sport: 6/8/89

Accepted by the Department of Physical Education and Sport, State University of New York, College at Brockport, in partial fulfillment of the requirements for the degree Master of Science in Education (Physical Education).
A Comparison of the Effects of Weight Training on Strength and Girth Measures of Prepubescent and Postpubescent Boys

A THESIS

presented to the
Department of Physical Education and Sport
State University of New York
College at Brockport
Brockport, New York

In Partial Fulfillment
of the Requirements for the Degree
Master of Science in Education
(Physical Education)

by
Brian C. Jones
May 1989
This study was designed to investigate the effects of a weight training program on strength and girth measures of prepubescent and postpubescent boys. Forty-nine subjects participated in this study. Thirty-four subjects were trained and 15 were untrained. The trained group consisted of 16 prepubescent subjects and 18 postpubescent subjects. The untrained group consisted of seven prepubescent and eight postpubescent subjects. All subjects were given a pretest which consisted of two girth measures and five strength measures. The trained group participated in an eight-week weight training program. The untrained group participated in regular physical education classes. At the conclusion of the eight weeks, both groups were posttested using the same procedures as the pretest. Data were analyzed using multivariate and univariate analyses. The trained group significantly outperformed the untrained group and both prepubescent and postpubescent boys improved their performance. It was also found that although overall performance generally favored postpubescent boys, pubescent status was not a significant factor on the development of strength and girth measures employed in this study.
ACKNOWLEDGEMENTS

I would like to take this opportunity to thank all those individuals who made the completion of this study possible.

I would first like to send my deep appreciation to my advisors Dr. Joseph P. Winnick and Dr. Francis X. Short. Without their professionalism, guidance, and patience this study would not have been possible.

I would also like to thank Steven Sanders and Robin Fake for their help on the typing and computer graph work involved in this study.

Finally and most importantly I would like to thank my wife Susan, and my children, Shane, Nathan, Kelly, and Katie Sue who patiently awaited the completion of this study.
# Table of Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter I</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Background</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Statement of the Problem</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Definitions</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Delimitations</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Limitations</td>
<td>6</td>
</tr>
<tr>
<td>Chapter II</td>
<td>Review of the Literature</td>
<td>8</td>
</tr>
<tr>
<td>Chapter III</td>
<td>Methods and Procedures</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Subject Selection</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Measuring Physical Maturity</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Subject Grouping</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Testing Procedures</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>28</td>
</tr>
<tr>
<td>Chapter IV</td>
<td>Data Analysis and Results</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Descriptive Statistics</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Inferential Statistics</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Discussion</td>
<td>46</td>
</tr>
<tr>
<td>Chapter V</td>
<td>Summary, Findings, Conclusions, and Recommendations</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Findings</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Conclusions</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Recommendations</td>
<td>50</td>
</tr>
<tr>
<td>References</td>
<td></td>
<td>51</td>
</tr>
</tbody>
</table>
List of Tables

3.1 Mean Ages and Subject Numbers in the Study 34
4.1 Observed Means and Standard Deviations for Pretest Scores 36
4.2 Observed Means, Standard Deviations and Adjusted Means for Posttest Scores 37
4.3 Multivariate F Ratios for Strength and Girth 41
4.4 Pubescence and Time F Ratios for Trained Group Only 46

List of Figures

3.1 Site of Girth Measure of the Right Bicep Extended 27
3.2 Site of Girth Measure of the Chest 28
3.3 Bench Press 30
3.4 Sit-ups 30
3.5 Leg Press 31
3.6 Tricep Extensions 31
3.7 Bicep Curls 31
3.8 Rowing 31
3.9 Chin-ups 31
3.10 Military Press 31
4.1 Trained and Untrained Observed Mean Scores 38
4.2 A Comparison of Prepubescent and Postpubescent Trained Subjects on Selected Measures of Strength and Girth 40
4.3 Adjusted Posttest Mean Scores for Group and Pubescence 43
Appendices

Appendix A  Parent Permission Letter
Appendix B  Record Sheets
Appendix C  60% Weight Chart
Appendix D  Raw Data Print-out
Appendix E  Commands to Run SPSS-X Subprogram Manova
Chapter I

A coach or physical educator at the junior high school level has to deal with a very complex reality—that is the varying levels of physical maturity among boys of the same chronological age. It is not unusual to find a 4'10" physically immature boy cooperating with or competing against a 5'10" physically mature boy. This difference in size not only creates problems in grouping youngsters for activities but raises the question as to whether or not boys with differing physical maturity attain the same benefits from activity, particularly, strength training.

Weight training has become an offering in most junior high schools and is becoming increasingly popular with coaches of junior high sports teams. Yet, whether or not weight training is beneficial to the prepubescent individual is a question that remains controversial (Smith, 1984).

Recently the National Strength and Conditioning Association (NSCA) developed a position paper on prepubescent strength training (NSCA, 1984). The NSCA (1984) states that, "weight training can be both safe and efficacious for the prepubescent." The NSCA also points out that along with the benefits, there are potential risks. The benefits of prepubescent strength training are strength gains, injury protection, increased self-image, improved motor performance and an introduction to coaching techniques. The potential risks of strength training are acute musculoskeletal
injuries, chronic musculoskeletal injuries, hypertension and weight lifters black out. The NSCA explains that it is imperative that the supervisor of a prepubescent strength and conditioning program possess appropriate levels of strength training and conditioning knowledge. The athlete must be able to place confidence in their instructor. It is also important that the coach be concerned about all-around physical development rather than just the development of strength. The NSCA suggests that the prepubescent athlete's strength program include exercises for speed, power, flexibility, muscular endurance, agility and coordination.

The NSCA (1984) states that "proper techniques and weight room conduct must be introduced at the onset of training because good habits reduce the chance of injury."

There are many experts in the field that look at weight training for the prepubescent as a waste of time. For example, Legwold (1982) states that "weight training is like spitting into the ocean for the prepubescent."

Krogman (1972) also explains that there is little for the athlete to gain in terms of muscle mass and strength until testosterone and other androgens are released at puberty.

The issue of hormone release at puberty appears to play a very important role in the capability of the individual to develop muscle mass and strength. The androgen testosterone developed in the males testes, plays a vital role in the
physical development of males during puberty. Burger (1981) states "the many physical changes associated with puberty in males occurs in the androgen sensitive tissues, such as, the larynx, apocrine sweat glands, skeletal muscles, bone epiphyses, external genitalia, facial and pubic hair follicles. The androgens primarily secreted by the testis, thus mediate the familiar changes associated with the sexual maturation including increased phallic size and muscle mass."

Kroopman (1972) and Corbin (1980) state that postpubescent boys do have larger muscle mass than prepubescent boys. Postpubescent boys can also benefit more from a given expenditure of effort than prepubescent boys because of their increased muscle mass.

**Significance**

The results of this study are important for the physical educator and coach because one of the primary objectives of physical educators and coaches is to develop physical fitness, including strength. A most practical and efficient activity for developing strength is weight training. The results of this study will help the physical educator decide if physical activity, and weight training in particular, is an effective means of gaining strength and muscle mass. It is possible that spending more time on general activity for the prepubescent is just as effective as an extensive weight program. If weight training is used,
the results of this study may help to personalize programs. For example, a prepubescent individual may benefit from only certain exercises. The results of this study may also support the contention that classes or teams be grouped according to their level of development. The results may support grouping postpubescent and prepubescent individuals separately in certain activities because of size and safety reasons. On tests where physical strength is a major factor in attaining scores, such as, throwing for distance, kicking for distance or lifting weight, it may not be reasonable to assume that the prepubescent individual will achieve as high a score as the postpubescent individual.

If weight training is not effective for the prepubescent boy, an implication may be to delete or deemphasize it in physical education programs. Prepubescent individuals may get more benefit from other activities. However, if weight training does lead to increased strength for the prepubescent individual it may as well be included in their physical education classes and preparation for out of class sport activities.
**Statement of the Problem**

This study was designed to compare the effects of weight training on strength and girth measures of prepubescent and postpubescent seventh grade boys.

**Definitions**

**Weight Training.**

Weight training refers to a systematic, well planned program of exercises in which participants use weights to increase the resistance of various bodily movements (Fisher, 1962).

**Strength.**

Strength is the ability to exert force against a resistance. For the purpose of this study, strength will be the ability to lift a maximum weight for one repetition.

**Muscle Girth.**

Muscle girth refers to the circumference of a relaxed muscle.

**Prepubescent.**

Individuals who have not yet developed secondary sex characteristics according to Tanner's classification of childhood development (NSCA, 1984).

**Postpubescent.**

Individuals who have developed secondary sex characteristics according to Tanner's classification of childhood development (NSCA, 1984).
In this study, boys who are one or two on a scale of five on Tanner's scale of pubescent development were labeled prepubescent. Boys who scored three or higher on Tanner's scale of pubescent development were labeled postpubescent.

**Circuit Training.**

Circuit training refers to a training system in which exercises are arranged so that a variety of muscle groups can be exercised in succession. Individuals must complete a prescribed number of sets and repetitions at each station before moving on to the next successive station. In each session, different individuals start at different stations and progress until the desired number of sets at each station has been completed. It is important to follow the order of stations. Weight loads are changed according to repetitions which can be lifted maximally.

**Delimitations**

This study is delimited to a sample of seventh grade boys at the Brockport Middle School, Brockport, New York.

**Limitations**

The training program was limited to eight weeks. Due to vacations, absences, and many other outside conflicts, it was difficult to have all the participants at all the training sessions. However, all subjects in the experimental group attended at least 20 of the 24 sessions. This study was also limited to using...
pubic hair development as the only means of pubescent assessment. More sophisticated methods, such as x-rays, to determine skeletal age were not available to the investigator. This study did not take into account the "Hawthorne" effect. The control group was not seen on special occasions during this study so that they would develop some social cohesiveness during the study.
CHAPTER II

Review of the Literature

Pubescent development and the release of hormones, as stated earlier in the introduction, appear to play an important role in the acquisition of strength and muscle size. This chapter will review one study that investigates the assumption that increases in strength and girth measures are directly related to higher levels of physical maturity. This chapter will also report on studies that question whether adolescents can improve strength and girth measures as a result of participating in a weight training program. Four studies will be reviewed that compare prepubescent individuals who participated in strength training programs with prepubescents who did not participate in strength training programs. This chapter will conclude with a study that investigates the effect of a resistive exercise program on prepubescent, pubescent, and postpubescent males.

Deguis (1962) performed a study to investigate the relationship of pubescent development to certain physical and motor factors of boys 10, 13, and 16 years of age. The study was also conducted to determine the feasibility of using pubescent development as a simple method of assessing maturity rather than the more complex method of skeletal age.
Subjects in the study consisted of a random sample of 237 caucasian boys 10, 13, and 16 years of age in the Medford, Oregon, public schools. The number of boys at each age were: 86 - 10 years; 65 - 13 years; 86 - 16 years. Each boy was tested for pubescent development. The method used to assess pubescent development was developed by Gruelich (1950), which rates the individual on a scale of one to five. Each level represents a successive stage of development of the penis, scrotum, and pubic hair.

The anthropometric measures taken on each of the subjects were: standing height, body weight, chest girth, hip width, upper arm girth, calf girth, and lung capacity. Physique was classified as endomorphic, mesomorphic, ectomorphic and mid-types. Strength measures consisted of left grip, back lift, leg lift, elbow flexion, shoulder inward rotation, Strength Index, Physical Fitness Index, and the mean of twelve cable tension strength tests. Tests of motor ability included the standing broad jump, and the 60-yard shuttle run. The nine strength tests are most relevant to this study.

Groups four and five were combined to form one group of postpubescent subjects. The postpubescent group was compared to group two which was considered prepubescent and to group three which was at a stage of development between prepubescent and postpubescent. In viewing the
strength test means, it was found that groups four
and five performed significantly higher than group two
on all nine strength tests. They performed higher than
group three on six of the nine strength test items.
Exceptions included elbow flexion, shoulder inward rotation,
and shoulder flexion. This pattern suggested that greater
differences in pubescent development are associated with
greater strength differences (Degutis, 1962).

This study also revealed that a point near 13 years
of age for boys appears to be a practical and effective time
to identify pubescent status. At age 13, there are
boys at each level with a predominance of boys at stage two
and three. Those boys at stage one can be labeled as pre-
pubescent and those at stages four and five can be labeled
advanced in pubescent development.

Keeney and Kusenitz (1958) conducted a study which
was designed to determine the effects of a two-month
systematic weight training program on the physical
fitness of boys in early adolescence. Forty-six
adolescent males from a New York City junior high school, ranging from 12 to 17 years of age participated in the study. All the boys took part in a pretraining test which was designed to determine their physical fitness before they began training. The test included items to measure anthropometric status, muscular strength, muscular endurance, flexibility, speed, agility, and circulatory-respiratory function. The subjects were equated, using the Wilcoxon Sum of Ranks Test, so that group means were not significantly different. A coin was then tossed to determine which group would become the experimental group.

The experimental group participated in the weight training program for eight weeks, three times a week, for 45 minutes each session. The experimental group also participated in regular physical education classes. The control group received no treatment other than regular physical education classes.

Beginning weights for each subject were determined by finding the weight that could be lifted for a maximum of eight repetitions. When the participants progressed to 12 repetitions, the load was increased to permit a return to eight maximum repetitions. The training program consisted of curls, pull-ups, sit-ups and rowing.
At the conclusion of the training periods, both groups were retested. Pre and posttraining scores were compared for significance of mean differences. The Wilcoxon Signed Ranks Test for paired observations was used to compare the pre and posttraining results.

The experimental groups showed significant gains in eight of the nine anthropometric measures. The only anthropometric measure not found significant was weight. The control group only showed a significant increase in height.

The experimental group showed significant improvement in seven of the eight performance tests. There were no significant gains for the experimental group in the standing broad jump. The control group made significant gains on push-ups, the burpee test, dodge run, and trunk extension. In no cases did the control group out-perform the experimental group. However, this study did not deal with level of pubescent development.

The results of this study show that adolescent boys can increase their level of physical fitness by participating in a systematic, progressive, weight training program.

Pitman (1960) also compared the effects of a weight training program on physical fitness and anthropometric measures of junior high school boys. Seventy-six
junior high boys ranging from 11 to 15 years of age were tested. Forty boys were randomly selected to be part of the experimental group and 36 boys were selected to be members of the control group.

Both groups were administered the Junior AAU Physical Fitness Test. This fitness test consisted of chins, standing broad jump, push-ups, sit-ups, 60-yard dash, and the one mile run-walk. Bodily measurements of height, weight, neck, upper right arm, right wrist, chest, upper right thigh, right calf and right ankle were also taken.

The experimental group participated in regular physical education classes along with exercises done in the study. They were not allowed to participate in any outside sport activities. The control group participated in their regular physical education class and also in any other outside activities which they chose. Some members of the control group participated in midget football, biddy basketball, and little league baseball.

The six exercises which the experimental group performed included deep knee bends, bench press, snatch, clean, curls, and abdominal raises.

The experimental group performed these exercises for three sets, three days a week, during a six month time span. Individuals increased dosages so they could perform three sets of five repetitions for each exercise, except for abdominal raises. Abdominal raises were performed for two
sets of 15 repetitions each day.

The data were analyzed using the mean difference between pre and posttest scores for both groups. The experimental group showed significant increases over the control group in combined bodily measurements of the neck, right upper arm, right wrist, chest, waist, upper right thigh, right calf, and right ankle.

The experimental group showed significant increases over the control group on five of the Junior AAU test items. Those items were chins, standing broad jump, sit-ups, 60-yard dash, and the one mile run-walk.

The results of this study support the contention that a well planned systematic weight training program can increase anthropometric bodily measures and physical fitness measures, including strength, in junior high school boys ages 11 to 15.

Fisher (1966) performed a similar study in which the effects of weight training on underdeveloped junior high boys was studied. The purposes of this study were to:

1) Develop a weight training program for the physically underdeveloped junior high boy.

2) Compare the results of this program with those of the normal physical fitness program.

3) Determine the feasibility of incorporating a weight training program into a junior high school physical education curriculum.
The California Physical Performance Test was used to determine if an individual was physically underdeveloped. This performance test included pull-ups, sit-ups, standing broad jump, 50 yard dash, 600 yard dash, softball throw, and shuttle run. Anthropometric measures of the right bicep, right forearm, chest expanded, right thigh, and right calf were also taken. Four hundred boys were tested and those scoring at the bottom 20 percent were selected as being underdeveloped. Forty boys were then selected for the experimental group and 38 for the control group.

The experimental group trained for 30 minutes each day, three times a week for 10 weeks along with regular physical education classes. The control group only took part in regular physical education classes.

The experimental group training program consisted of curls, two arm press, bent arm rowing, shoulder shrugs, heel raises, three-quarter squats, straight leg lifts, pull-overs, sit-ups, and chest press.

The posttest was administered in the same way as the pretest. Differences in mean scores were used to determine observed t ratios. These t ratios were used to determine if significant differences existed between the two groups at the completion of the study.

Differences in favor of the experimental group did exist on all test items except for the measurement of the right
thigh. However, none of these differences were found to be significant at the .05 level of significance. Thus, even though gains were made by the group of underdeveloped boys, these gains cannot be attributed to the treatment.

Cahill (1985), as reported by Dudas (1986), conducted a study which compared strength gains of 18 prepubescent boys who participated in a supervised strength training program with a control group of 10 prepubescent boys who did not engage in a supervised strength training program.

The experimental group performed concentric exercises and showed significant strength gains in forearm flexion and knee extension, while the control group showed no significant gains.

Sewall and Micheli (1986), compared prepubescents who took part in a nine-week progressive resistance program with age matched subjects who did not participate in a progressive resistance program.

The training group consisted of eight boys and two girls. The control group consisted of seven boys and one girl. The investigator used Tanner’s five levels of physical maturity to determine maturity for each subject. For all the individuals tested, only two were at stage two, the rest were at stage one.

The test group trained 25 to 30 minutes, three times
a week for eight weeks. The control group took part in regular daily activities but no strength training.

The four motions tested were knee flexion, knee extension, shoulder flexion and shoulder extension. The experimental group showed a mean strength increase of 42.9 percent while the control group only showed a mean strength increase of 9.5 percent. All motions tested showed gains in favor of the experimental group but only shoulder extension showed a significant increase at the .05 level of confidence.

The results of this study indicate that prepubescents who take part in a supervised, progressive resistance strength program can make significant strength gains in shoulder extension over those members of a control group who did not participate in a supervised, progressive resistance strength program. However, this study did not include postpubescent subjects and compare their results to prepubescents.

Servedio, Bartels, Hamlin, Teske, Shaffer, and Servedio (1985) conducted a study in which physiological variables were evaluated in two groups of prepubescent boys. These two groups were tested before and after an eight week weight training program and were called weight lifters and controls. Measurements were taken of strength, body composition, body size, and flexibility. Mean ages of subjects were 11.9 +/- 0.5 and relative maturity was 1.4 +/- 0.6 (Tanner maturity scale).
The weight lifting group consisted of six members of a local weight lifting club who trained three times a week for eight weeks. The six control group members were classmates of the weight lifters but did not lift any weights.

The weight lifters exhibited significantly greater strength gains in shoulder flexion than the control group on the posttest. There was significant increase in body weight for both groups but there was no change in percent of body fat or flexibility.

The results, thus, supports the contention that prepubescent youngsters can achieve a positive training effect through a weight training program.

Weltman, Janney, Reans, Strand, Berg, Spitt, Wise, Cahill, and Katch (1986) investigated the effects of a hydraulic resistance strength training program on prepuberal males. Thirty-two boys between the ages of six to 11 volunteered for this study. All subjects were evaluated prior to the experiment by a physician to determine pubertal status, as determined by the Tanner rating scale and also to rule out any medical conditions contraindicating strength training. Of the original 32 subjects, only three were eliminated because of advanced pubertal status at Tanner stage two. The remaining subjects were all at Tanner stage one. Nineteen subjects were then assigned to the experimental group and 10 to the control group. The mean
The age of the control and experimental groups combined was 8.2 +/- 1.3 years.

The strength training subjects participated in a closely supervised, three-day a week, 14-week training program. The control group participated in normal daily activities during the 14-week period. None of the control group subjects participated in weight training during the experimental period. Strength training was performed in circuit fashion, which consisted of eight hydraulic fitness machines and additional stations of sit-ups and push-ups. Three circuits were completed daily.

Pre and postmeasures of strength were taken using an isokinetic dynamometer. Each subject was measured at 30 and 90 degrees for knee flexion, elbow flexion, knee extension and elbow extension. Anthropometric measures of the head, neck, shoulders, chest, waist, umbilicus, buttocks, thighs, knees, calves, ankles, deltoids, biceps flexed, biceps extended, forearms, and wrists were also taken.

The results of this study showed that the training group gained in all eight motions tested. There were significant
two-way interactions in five of the eight motions, indicating that the change was significantly better for the training group. The only significant interactions found for anthropometric measures were at the shoulders, chest, and abdomen.

The major finding of this study was that a short term, closely supervised, strength training program using hydraulic exercises, can significantly increase concentric isokinetic strength in prepubertal boys.

Pfeiffer and Francis (1986) investigated the effects of an isokinetic resistive exercise program on three developmentally different groups of young males. These groups were called prepubescent, pubescent, and postpubescent. Eighty males ranging from eight to 21 years of age participated in this study. Subjects were classified using Tanner's stages of pubescent development. Those at stage one were considered prepubescents, those at stage two through four were considered pubescent, and those at stage five were considered postpubescent. There were 30 prepubescent subjects, 30 pubescent subjects, and 20 postpubescent subjects. The subjects were randomly assigned to experimental or control groups. There were 33 subjects in the experimental group and 31 in the control group who finished the study.

Strength of elbow and knee flexors and extendors were assessed using a Cybex Isokinetic Dynomometer. Anthropo-
metric measures of weight, height, bilateral upper arm and thigh girth were also taken. The experimental group trained three times a week. The control group was asked not to participate in any strength training program for the duration of the study.

The experimental group performed four primary lifts which were, leg extension, leg curl, bench press, and bicep curls. The subjects were required to perform three sets of primary lifts. The first set they performed 50 percent of their maximum weight for 10 repetitions, the second set they did 75 percent and the third set one 100 percent. Five other exercises were designated as ancillary lifts, they were rowing, shoulder shrugs, leg press, sit-ups, and butterflies. The purpose of these lifts were to provide balance to the program and also help keep the participants occupied during each session.

The results of this study showed that the experimental group at all three maturity levels significantly outperformed the control group in all tests. However, of the 16 strength tests given, there were no instances where the pubescent or postpubescent groups significantly gained over the prepubescent group. The prepubescent group gained significantly over the pubescent group in elbow flexion 120 degrees, knee extension at 120 degrees and knee flexion at 30 degrees. These three tests were the only tests where significance between groups was found.
This study indicates that all three maturity level can gain strength as a result of a resistive exercise program. This study also showed that the only three significant differences found, favored the prepubescent group.

Summary

In reviewing the literature, Degutis (1962), found that higher levels of physical maturity were associated with greater strength. Keeney and Kusenitz (1958) and Pitman (1960) found that adolescence can improve strength measures as a result of a weight training program. Studies by Cahill (1985), Sewall and Micheli (1986), Servedio et al., (1986), and Weltman et al., (1986) report that prepubescents who strength train showed significant increases in strength measures over prepubescents who did not strength train. Pfeiffer and Francis (1986), reported that prepubescent, pubescent, and postpubescent groups all showed significant increases in strength as a result of participating in a weight training program.

Legwold (1982), Krogman (1972), Burger (1981), and Corbin (1980) have all stated that there is little chance for the prepubescent to gain in strength measures until the male androgen, testosterone, is developed at puberty. The results of research conducted using weights as a mode of training indicates that prepubescents can gain in strength measures.
it is apparent that additional research needs to be done in this area. This study will compare strength and girth measures of prepubescent and postpubescent males as a function of a weight training program.
Chapter III

Methods and Procedures

This chapter presents the methods and procedures used to conduct this study. Information is be presented in the following order: subject selection, measuring physical maturity, subject grouping, tests, testing procedures, and treatment.

Subject Selection

The population for this study consisted of 125 seventh grade boys at the Brockport Middle School, Brockport, New York. The study was explained to the 125 boys during the week of February 25, 1985 in their physical education class. It was stressed that involvement was on a volunteer basis and in no way should they feel forced to participate. The boys were given a parental permission slip at the close of class on Monday, February 25, or Tuesday, February 26, 1985. Participants were required to return the signed permission slip one week from the date they received them. The permission letter is presented in Appendix A.

Fifty-seven boys responded with slips giving them permission to participate in the study. All 57 boys were asked to stay after school on Monday, March 11, or Tuesday, March 12. They reported on their corresponding physical education class day. Of the 57 boys volunteering,
55 were in attendance for physical maturation testing.

Measuring Physical Maturation

The procedure used in this study for measuring physical maturity was developed and illustrated by Tanner (1962).

Each subject was matched with one of Tanner's stages of physical development.

Stage 1 - Infantile state, increase slightly in size but not in overall appearance. No true pubic hair.

Stage 2 - Scrotum begins to enlarge and there is reddening and changes in texture of the scrotal skin. Slight pubic hair growth, straight or slightly curled hair.

Stage 3 - Penis increases in length and there is a slight increase in breadth. Pubic hair begins to spread and becomes darker and coarser.

Stage 4 - The length and breadth of the penis increases and the glans develop. The scrotum continues to enlarge and scrotal skin becomes darker. Pubic hair is adult in character but covers less area.

Stage 5 - Penis has adult size and shape. Pubic hair spreads to thighs and toward navel. (Tanner, 1962)

All of the boys who attended the sessions for physical maturation testing were tested by the investigator in consultation with the school physician, Dr. Johansten.

Each subject was asked to wait in the locker room with just their gym shorts on. One at a time the investigator called a subject into an office located adjacent to the locker room. Each subject was asked to take off their shorts and underwear so that the investigator could get a true measurement of their weight. With the assistance of a fellow physical education teacher, who recorded height and
weight, each volunteer stepped on the scales with no clothes on. At this time the investigator visually surveyed the participant for physical maturation while at the same time checking their height and weight. The investigator told the recorder the height and weight of each subject. When the subject left the room the investigator recorded the stage of development of each subject. Subjects were not aware that physical maturation was being determined along with their height and weight. Some subjects appeared to feel uneasy, but at no time were they visible to other subjects during the process.

Subject Grouping

All stage one and stage two subjects were placed into a group labeled prepubescent. All who were at stages three, four, or five were placed into a group identified as postpubescent. There were a total of 27 prepubescent and 28 postpubescent boys in the study.

Each member of the prepubescent group was given a number one through 27. Each member of the postpubescent group was given a number one through 28. Using a table of random numbers, 20 participants from each group were chosen to be in the experimental (trained) group. The remaining participants were used in the control (untrained) group. The experimental groups were placed randomly into one of two training subgroups: Monday-Wednesday-Friday (M-W-F) and Tuesday-Thursday-Friday (T-Th-F). These
subgroups reflected training days.

The 55 participants who were tested for physical maturity were then asked to attend pretesting during the week of March 18, 1985. After this testing, each subject was told whether they were in the experimental or control group. Experimental group members were informed of their training days.

Testing Procedures

Girth Measures. Girth measures of the right bicep and chest were taken. Circumference measures were taken with a cloth tape obtained from the Home and Careers Lab at the Brockport Middle School. Circumference was measured to the nearest centimeter. Each measure was taken three times and the median score was recorded to the nearest centimeter.

The right bicep was measured extended, at the maximal girth of the mid-upper arm with the underlying muscles fully contracted.

![Biceps Extended](image)

Figure 3.1 Site of girth measure of the right bicep extended.
The circumference of the chest was measured at the nipple line at mid-tidal volume.

![Chest Diagram](image)

**Figure 3.2 Site of girth measure of the chest.**

**Strength Tests.** Strength tests included the bench press, tricep extension, bicep curls, and seated overhead press.

Each subject's strength was represented by a maximum lift for each strength test. If the first attempt could be lifted easily or more than once, the participant rested for a minimum of five minutes before the load was increased so that only one repetition could be completed. A description of how each lift was performed is presented on pages 29 and 30.

The weight, in pounds, was then recorded on the subject's score sheet.

A sample score sheet is presented in Appendix B.

**Treatment**

The training group, which consisted of 20 pre-
pubescent and 20 postpubescent boys, took part in an eight-week weight training program which began on Monday, March 25, 1985 and concluded on Friday, May 27, 1985. They trained three days a week for 45 minutes each day. They began the first two training sessions of each week with a five minute warm-up which included a one minute jog, stretching, 20 push-ups and 20 sit-ups. After the warm-up they began working with the weight equipment.

Each day the experimental group performed a circuit training workout which consisted of three circuits. Each circuit consisted of eight different exercises and two resting stations. The stations and exercises are listed below together with a description of the instructions given to the subjects.

1. Bench Press (Universal Gym) - Lie flat on the bench with the head close to the machine. Be sure the handles are above the chest and feet should on the floor. Press the weight up and return slowly (see figure 3.3).

2. Sit-ups - Lie flat on the incline board at its' lowest position. Place your instep under the handles to keep your feet in place. Place the buttocks 18 inches from the heels. Fold your hands behind the head and sit up so that both elbows touch the corresponding knee (see Figure 3.4).

3. Leg Press (Universal Gym) - Using the lower foot position pedals, extend your legs so that the knees remain slightly bent. Slowly return to the flexed position. Keep the weight under control (see Figure 3.5).

4. Rest

5. Tricep Extensions (Universal Gym) - Stand straight in front of the bar. Grasp the bar with palms down and hands close together. Bring the bar to shoulder height,
press down and extend your arms. Slowly return the weight to chest height and repeat (see Figure 3.6).

6. Bicep Curls - With a curl bar, assume a comfortable stance with the bar resting on your thighs. Use the overhand grip with your palms pointing out. Slowly flex arms so that bar comes to chest. Always keep the elbows in and the back straight. Lower the bar slowly until it re-touches the thighs (see Figure 3.7).

7. Upright Rowing (Universal Gym) - Adjust the chain and bar so that the bar rests across the thighs at arms length. Slowly pull the bar to the chin, allow the arms to move back to their original position (see Figure 3.8).

8. Rest

9. Seated Overhead Press (Universal Gym) - Sit facing the machine with shoulders almost touching the handles. Place the feet on the rings of the bench. Press the weights upward until the arms are fully extended. Keep your back flat (see Figure 3.9).

10. Chin-Ups (Universal Gym) - Assume a shoulder width grip. Fully extend your body and pull to chin level (see Figure 3.10).

As noted above, all exercises were performed on the Universal Gym except for bicep curls. They were performed using free weights and a curl bar.
Figure 3.5 Leg Press
Figure 3.6 Tricep Extensions

Figure 3.7 Bicep Curls
Figure 3.8 Rowing

Figure 3.9 Chin-ups
Figure 3.10 Military Press
The training group established their starting weights by determining what weight they could lift one time for one maximum contraction for each exercise. They computed 60 percent of their maximum contraction for each exercise and used that weight as the exercise load. A chart (see Appendix C) was provided on the weight room wall so that calculation was expediated. This procedure is in agreement with that recommended by Smith (1984) and Kenney (1984). The maximum contraction for each exercise was attempted at the first session of each week to determine if the load of the workout should be increased.

Members of the training group worked with partners. Each partner had 30 seconds to perform each set before they switched with their partners. Partners were encouraged to give moral support in order to get maximal effort at each station.

On Fridays, both training subgroups worked together. After warm-ups, one training subgroup would complete one set of the workout, while the other subgroup stayed in the gymnasium and performed a pyramid workout of push-ups and sit-ups. They performed a pyramid up to eight and then back to one. The subgroup in the gymnasium would do one push-up and then one sit-up. They would then do two of each, then three, until they reached eight of each. After reaching eight they would then start back down to one. When the training subgroup in the weight room completed
their circuit workout, they would then switch with the subgroup in the gymnasium. If time remained at the end of completing one circuit for each training subgroup, the subjects were allowed to have open gym time as long as they did not participate in any further weight training activities. The subgroup that began in the weight room on one Friday would begin in the gymnasium the next week.

The untrained group was asked not to participate in any weight training activities during the eight-week training period. The trained and untrained groups participated in regular physical education classes during the study.

Each participant in the trained group was required to attend 20 out of 24 training sessions. Those individuals who did not complete 20 sessions were allowed to continue to train but their data was not used in the final analysis.

On Friday, May 27, 1985, all members of the experimental group were posttested using the same procedures as the pre-test. The untrained group was posttested on the following Friday.

There were a total of six participants whose data could not be used in the final analysis. Four were removed from the training prepubescent group and two were removed from the training postpubescent group. In all six cases, they were removed because they did not attend the
minimum required sessions. The mean ages and number of subjects for each group in the study is presented in Table 3.1.

Table 3.1

<table>
<thead>
<tr>
<th>Group</th>
<th>Prepubescent</th>
<th>Postpubescent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (A.I.M)</td>
<td>N (A.I.M)</td>
<td>N (A.I.M)</td>
</tr>
<tr>
<td>Trained</td>
<td>16 157</td>
<td>18 163</td>
<td>34 161</td>
</tr>
<tr>
<td>Untrained</td>
<td>7 157</td>
<td>8 168</td>
<td>15 162</td>
</tr>
<tr>
<td>Total</td>
<td>23 157</td>
<td>26 165</td>
<td>49 161</td>
</tr>
</tbody>
</table>

(A.I.M) = Age In Months
Chapter IV

Data Analysis and Results

In this chapter, descriptive statistics and inferential statistics will be presented. All raw scores for this study were recorded on individual sheets (see appendix C). The raw scores are presented in appendix D.

Descriptive Statistics

The observed means and standard deviations on all pretest scores are presented in Table 4.1.

In every test, postpubescent group scores were higher than the prepubescent group scores.

The observed means, standard deviations and adjusted means for all posttest scores are presented in Table 4.2.

The adjusted mean posttest scores for postpubescent subjects are higher than those of the prepubescent subjects but the differences are not as great as the observed means, as would be expected.

Figure 4.1 graphically illustrates the combined pre and posttest observed mean scores for the trained and untrained groups for all seven test items.
Table 4.1

Observed Means and Standard Deviations for Pretest Scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Prepubescent</th>
<th>Postpubescent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>trained</td>
<td>untrained</td>
</tr>
<tr>
<td>arm girth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>25.13</td>
<td>24.61</td>
</tr>
<tr>
<td>SD</td>
<td>4.52</td>
<td>4.83</td>
</tr>
<tr>
<td>chest girth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>78.28</td>
<td>79.20</td>
</tr>
<tr>
<td>SD</td>
<td>9.76</td>
<td>4.83</td>
</tr>
<tr>
<td>bench press</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>74.38</td>
<td>80.00</td>
</tr>
<tr>
<td>SD</td>
<td>15.48</td>
<td>12.91</td>
</tr>
<tr>
<td>tricep extensions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>43.13</td>
<td>42.86</td>
</tr>
<tr>
<td>SD</td>
<td>10.14</td>
<td>9.51</td>
</tr>
<tr>
<td>curls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>32.81</td>
<td>32.86</td>
</tr>
<tr>
<td>SD</td>
<td>9.99</td>
<td>4.88</td>
</tr>
<tr>
<td>rowing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>36.25</td>
<td>45.71</td>
</tr>
<tr>
<td>SD</td>
<td>9.57</td>
<td>17.18</td>
</tr>
<tr>
<td>military press</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>70.63</td>
<td>68.57</td>
</tr>
<tr>
<td>SD</td>
<td>16.11</td>
<td>14.64</td>
</tr>
</tbody>
</table>
Table 4.2

Observed Means, Standard Deviations and Adjusted Means for Posttest Scores

<table>
<thead>
<tr>
<th>variable</th>
<th>Prepubescent trained</th>
<th>Prepubescent untrained</th>
<th>Postpubescent trained</th>
<th>Postpubescent untrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>arm girth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>25.58</td>
<td>24.49</td>
<td>27.43</td>
<td>28.45</td>
</tr>
<tr>
<td>SD</td>
<td>4.39</td>
<td>1.07</td>
<td>3.97</td>
<td>3.78</td>
</tr>
<tr>
<td>adj mean</td>
<td>26.62</td>
<td>26.03</td>
<td>27.02</td>
<td>26.26</td>
</tr>
<tr>
<td>chest girth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>79.46</td>
<td>79.26</td>
<td>86.65</td>
<td>85.89</td>
</tr>
<tr>
<td>SD</td>
<td>9.31</td>
<td>4.61</td>
<td>7.03</td>
<td>8.51</td>
</tr>
<tr>
<td>adj mean</td>
<td>83.27</td>
<td>82.21</td>
<td>83.40</td>
<td>82.37</td>
</tr>
<tr>
<td>bench press</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>86.35</td>
<td>84.29</td>
<td>118.33</td>
<td>110.00</td>
</tr>
<tr>
<td>SD</td>
<td>17.08</td>
<td>7.87</td>
<td>24.07</td>
<td>11.95</td>
</tr>
<tr>
<td>adj mean</td>
<td>100.16</td>
<td>93.07</td>
<td>107.37</td>
<td>98.27</td>
</tr>
<tr>
<td>tricep extensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>48.75</td>
<td>44.29</td>
<td>65.00</td>
<td>57.50</td>
</tr>
<tr>
<td>SD</td>
<td>14.08</td>
<td>7.87</td>
<td>12.00</td>
<td>8.86</td>
</tr>
<tr>
<td>adj mean</td>
<td>52.73</td>
<td>48.48</td>
<td>61.07</td>
<td>53.25</td>
</tr>
<tr>
<td>curls</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>45.63</td>
<td>34.29</td>
<td>59.44</td>
<td>52.38</td>
</tr>
<tr>
<td>SD</td>
<td>11.53</td>
<td>5.35</td>
<td>13.05</td>
<td>10.25</td>
</tr>
<tr>
<td>adj mean</td>
<td>51.42</td>
<td>40.04</td>
<td>52.78</td>
<td>47.59</td>
</tr>
<tr>
<td>rowing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>50.63</td>
<td>47.14</td>
<td>66.11</td>
<td>63.75</td>
</tr>
<tr>
<td>SD</td>
<td>16.52</td>
<td>16.04</td>
<td>11.45</td>
<td>10.61</td>
</tr>
<tr>
<td>adj mean</td>
<td>60.37</td>
<td>48.94</td>
<td>64.77</td>
<td>53.55</td>
</tr>
<tr>
<td>military press</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td>81.25</td>
<td>72.86</td>
<td>97.78</td>
<td>93.75</td>
</tr>
<tr>
<td>SD</td>
<td>19.62</td>
<td>9.51</td>
<td>18.96</td>
<td>15.96</td>
</tr>
<tr>
<td>adj mean</td>
<td>87.69</td>
<td>81.38</td>
<td>93.77</td>
<td>82.60</td>
</tr>
</tbody>
</table>
Figure 4.1 Trained and Untrained Observed Mean Scores
As shown in figure 4.1, the posttest mean scores for trained subjects are greater than those of the untrained subjects in every case except arm girth, even though the mean pretest scores of the trained group were actually lower.

Figure 4.2 graphically compares the pre and posttest observed mean scores of prepubescent and postpubescent subjects. The lines for all seven graphs show improvement for both prepubescent and postpubescent trained groups. The scores for postpubescent trained subjects are higher than the prepubescent trained subjects, but the rate of improvement for both groups is similar on all test items.
Figure 4.2 A Comparison of Prepubescent and Postpubescent Trained Subjects on Selected Measure of Strength and Girth
Inferential Statistics

To determine whether significant differences existed between trained and untrained subjects and between pre-pubescent and postpubescent subjects, a multivariate analysis of covariance (MANCOVA) was applied to the data. In this analysis, strength and girth posttest scores were analyzed simultaneously and all strength and girth pretest scores served as covariates. By covarying pretest scores, observed differences in posttest scores were thought to be attributable to training rather than initial ability. The MANCOVA summary table is presented in Table 4.3.

Table 4.3
Multivariate F Ratios for Strength and Girth

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>Group</th>
<th>Pubescence</th>
<th>GroupxPubescence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multivariate</td>
<td>7,32</td>
<td>5.85*</td>
<td>1.43</td>
<td>4.43</td>
</tr>
</tbody>
</table>

* = significant at .05

In the multivariate analysis, group, which contrasted trained and untrained subjects, was the only factor significant. The trained group of subjects significantly out-performed the untrained group of subjects. Pubescent status was not a significant factor in the multivariate analysis. The interaction of group and pubescence was also
not significant. To explain the significant multivariate F ratio for group, a univariate analysis was then performed post hoc.

Results of the univariate analysis are presented graphically in Figure 4.3. The adjusted posttest mean scores for group and pubescence are presented using bar graphs. The univariate F ratios and degrees of freedom associated with each analysis are also presented.

Based on the univariate analysis, it was found that group was significant on all seven test items. An examination of the means confirms that in each test, the trained group had significantly higher scores than the untrained group. Pubescence was a significant factor on the bench press and triceps extension tests, even though pubescence was not significant in the multivariate analysis. In these two instances, the postpubescent group made significantly higher scores than the prepubescent group.
Figure 4.3 Adjusted Posttest Mean Scores for Group and Pubescence

**Arm Girth**

- Group: 15.94*
- Pubescence: 3.27
- Group x Pubescence: .26

**Chest Girth**

- Group: 6.59*
- Pubescence: .10
- Group x Pubescence: .00

**Bench Press**

- Group: 11.22*
- Pubescence: 4.71*
- Group x Pubescence: .17

* = significant at .05
\( df = 1.44 \)
Tricep Extension

Bicep Curl

Rowing

Figure 4.3 (continued)
To supplement the covariance analyses presented above, a series of univariate repeated measures analyses was also calculated. Only subjects from the trained group were included in these analyses. The between-subject effect was pubescence and the within-group effect was time. Although it appeared self-evident that without adjustments for initial ability pubescence would most likely be significant and that post-training scores would be higher than pre-training scores (the "time" effect), it was of interest to look more closely at the interaction between these two variables. The results of these analyses are presented in Table 4.4.
Table 4.4

Pubescence and Time F Ratios for Trained Group Only

<table>
<thead>
<tr>
<th></th>
<th>Pubescence</th>
<th>Time</th>
<th>P X T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm Girth</td>
<td>1.35</td>
<td>42.98*</td>
<td>3.75</td>
</tr>
<tr>
<td>Chest Girth</td>
<td>6.51*</td>
<td>13.98*</td>
<td>.42</td>
</tr>
<tr>
<td>Bench Press</td>
<td>18.27*</td>
<td>119.76*</td>
<td>3.38</td>
</tr>
<tr>
<td>Tricep Extension</td>
<td>10.37*</td>
<td>39.66*</td>
<td>4.84*</td>
</tr>
<tr>
<td>Bicep Curl</td>
<td>12.95*</td>
<td>98.53*</td>
<td>.22</td>
</tr>
<tr>
<td>Rowing</td>
<td>12.97*</td>
<td>81.78*</td>
<td>.44</td>
</tr>
<tr>
<td>Military Press</td>
<td>4.98*</td>
<td>79.46*</td>
<td>2.82</td>
</tr>
</tbody>
</table>

* = significant at .05

Data in Table 4.4 indicate that pubescence was significant on six of the seven items and time was significant on all seven. Of more significant interest, the pubescence by time interaction term was significant for only one item, tricep extension. It generally would appear, therefore, that although postpubescent subjects did better than prepubescent, all subjects improved over time and the rates of improvement were comparable.

The results of this study indicate that the trained group, consisting of both pre and postpubescent boys, significantly out-performed the untrained group. Although overall performance generally favored the postpubescent
boys, the performance of both groups improved significantly as a result of training. Pubescent status was not a significant factor on the development of strength and girth measures employed in this study. The lack of significance for pubescent development questions the writings of Legwold (1980), Krogman (1972), Burger (1981), and Corbin (1980). These writers claim that efforts by the prepubescent to accelerate or enhance strength measures are ineffective until the androgenic hormone testosterone, is released at puberty. The results of this study are more consistent with studies done by Dudas (1986), Sewall and Micheli (1985), Servedio et al. (1985), Weltman et al. (1986), and Pfeiffer and Francis (1986).

If hormonal activity is important to the effect that Legwold (1980), Krogman (1972), Burger (1981) and Corbin (1980) have said, it was not substantiated in this study. This study found that pre and postpubescent boys increased strength measures as a result of training.
Chapter V

Summary, Findings, Conclusions, and Recommendations

Summary

This study was designed to compare the effects of weight training on strength and girth measures of pre-pubescent and postpubescent boys.

The study included two groups. The first was a trained group of 34 seventh grade boys participating in an eight-week weight training program. Eighteen of these subjects were postpubescent and 16 subjects were prepubescent. The second group consisted of eight postpubescent subjects and seven prepubescent subjects in an untrained group.

All trained and untrained subjects were administered pretests which included girth measures (right upper-arm and chest girth) and strength tests (bench press, curls, tricep extension, military press, and rowing). The trained subjects participated in an eight-week weight training program. The program consisted of bench press, tricep extensions, military press, bicep curls, rowing, chin-ups and sit-ups. The trained group trained three days a week for 45 minutes each day. The untrained group participated in regular physical education classes. At the conclusion of the eight-week training program, the trained and untrained subjects were posttested using identical procedures as in the pretest.
Data were analyzed using multivariate and univariate procedures. Significance for group, pubescence, and group x pubescence were determined using F ratios obtained from the multivariate analysis. A univariate analysis was performed post hoc to analyze each test item. A univariate repeated measures analyses was also performed on the trained group only.

Findings

The results of this study revealed that trained subjects significantly out-performed untrained subjects and that both prepubescent and postpubescent boys improved their performance. It was found that although overall performance generally favored postpubescent boys, pubescent status was not a significant factor on the development of strength and girth measures. Thus, if pubescent development is a factor on the development of strength and girth measures it was generally not supported by this study. Group x pubescence was not significant suggesting no interaction between training and pubescence occurred.

Conclusions

This study supports the contention that both post-pubescent and prepubescent boys can gain in strength and girth measures as a result of a weight training program.
Recommendations

This investigator makes the following recommendations for future research.

1) Perform a similar study for a longer period of time.

2) Perform a similar study using different age groups to accentuate pubescent differences. For example, use sixth grade boys and eleventh grade boys.

3) Perform a similar study and test for pubescent development at the beginning and end of the study.

4) Perform a similar study and give the untrained group a special treatment other than weight training to help control for the "Hawthorne Effect".
References


Pfeiffer, R.D. & Francis, R.S. (1986). Effects of strength training on muscle development in prepubescent pubescent, and postpubescent boys. The physician and sportsmedicine, 14(9).


Dear Parents:

Your son has volunteered to take part in a study which I will be using to help fulfill the requirements for my Master's Degree in Physical Education.

He will take part in an eight week weight training program. This will be held during our Intramural Activity Period after school. This period runs from 2:00 p.m. until 2:50 p.m. Your son will train three days a week. Two days will be available for him to stay after for other teachers if it becomes necessary.

I will be recording some information on your child which will be necessary for the success of the study. I will record height, weight, and level of physical maturity. All information is confidential and will only be seen by the investigator.

Your son will also be tested for muscle size and strength. He will then take part in the training program and be retested at the end to see how much they improved. It should prove to be a very fun and exciting study for your son.

Please fill out the parent consent form at the end of this letter if you wish to have your son participate in the study. If you have any questions feel free to call me at any time. I will be at my work number between 7:15 a.m. and 3:00 p.m. and at my home phone number anytime after 8:00 p.m.

Thank you very much for your time and cooperation.

Sincerely,

Brian C. Jones

Brockport Middle School
Allen Street
Brockport, N.Y. 14420
Appendix A (cont.)

Parent Consent Form

I give _______________________ permission

Students Name
to participate in the weight training study and understand
that I have the right to withdraw my consent and discontinue
participation at any time.

__________________________
Parents Name Printed

/                             

__________________________
Parents Signature  Date
<table>
<thead>
<tr>
<th>WEEK</th>
<th>THIGH</th>
<th>ARM</th>
<th>CHEST</th>
<th>HEIGHT</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C

60% of Maximum Weight Calculations

\[ \text{MAX} = 60\% \text{ to the nearest 5 pounds} \]

<table>
<thead>
<tr>
<th>Weight</th>
<th>60% of MAX</th>
<th>Weight</th>
<th>60% of MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>5</td>
<td>105</td>
<td>65</td>
</tr>
<tr>
<td>15</td>
<td>10</td>
<td>110</td>
<td>65</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
<td>115</td>
<td>70</td>
</tr>
<tr>
<td>25</td>
<td>15</td>
<td>120</td>
<td>70</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>125</td>
<td>75</td>
</tr>
<tr>
<td>35</td>
<td>20</td>
<td>130</td>
<td>80</td>
</tr>
<tr>
<td>40</td>
<td>25</td>
<td>135</td>
<td>80</td>
</tr>
<tr>
<td>45</td>
<td>25</td>
<td>140</td>
<td>85</td>
</tr>
<tr>
<td>50</td>
<td>30</td>
<td>145</td>
<td>85</td>
</tr>
<tr>
<td>55</td>
<td>35</td>
<td>150</td>
<td>90</td>
</tr>
<tr>
<td>60</td>
<td>35</td>
<td>155</td>
<td>95</td>
</tr>
<tr>
<td>65</td>
<td>40</td>
<td>160</td>
<td>95</td>
</tr>
<tr>
<td>70</td>
<td>40</td>
<td>165</td>
<td>100</td>
</tr>
<tr>
<td>75</td>
<td>45</td>
<td>170</td>
<td>100</td>
</tr>
<tr>
<td>80</td>
<td>50</td>
<td>175</td>
<td>105</td>
</tr>
<tr>
<td>85</td>
<td>50</td>
<td>180</td>
<td>110</td>
</tr>
<tr>
<td>90</td>
<td>55</td>
<td>185</td>
<td>110</td>
</tr>
<tr>
<td>95</td>
<td>60</td>
<td>190</td>
<td>115</td>
</tr>
<tr>
<td>100</td>
<td>60</td>
<td>195</td>
<td>115</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200</td>
<td>120</td>
</tr>
<tr>
<td>Group</td>
<td>ID#</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-----</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pubcat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>height 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>height 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>weight 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>weight 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>arm 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>arm 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chest 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chest 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>leg 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>leg 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bench 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bench 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>leg press 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>leg press 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tricep 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tricep 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>curl 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>curl 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>row 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>row 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mil press 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mil press 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Appendix D**
Appendix E

Commands used to run SPSS-X subprogram MANOVA on the Prime Computer.

1 0 FILE HANDLE BJ.SYS2/PATH = BJ.SYS2
2 0 GET FILE = BJ.SYS2
3 0 IF (PUBRAT LE 2) PUBRAT = 1
4 0 IF (PUBRAT GE 3) PUBRAT = 2
5 0 BREAKDOWN AGE BY GROUP BY PUBRAT
6 0 BREAKDOWN AGE BY PUBRAT BY GROUP
7 0 MANOVA ARM2 BY GROUP(1,2), PUBRAT(1,2) WITH ARM1/
8 0 PRINT = PMEANS(TABLES(GROUP,PUBRAT))/
9 0 MANOVA CHEST2 BY GROUP(1,2), PUBRAT(1,2) WITH CHEST1/
10 0 PRINT = PMEANS (TABLES(GROUP,PUBRAT))/
11 0 MANOVA ARM2,CHEST2,BENCH2,TRICEP2,CURL2,ROW2, MIL2, BY GROUP(1,2), PUBRAT(1,2) WITH ARM1,CHEST1,BENCH1,TRICEP1,CURL1, ROW1,MIL1/
12 0 PRINT = PMEANS (TABLES(GROUP,PUBRAT))/
13 0 PRINT = PMEANS (TABLES(GROUP,PUBRAT) ERROR(W))/
14 0 MANOVA BENCH2 BY GROUP(1,2), PUBRAT(1,2) WITH BENCH1/
15 0 PRINT = PMEANS (TABLES(GROUP,PUBRAT))/
16 0 MANOVA TRICEP2 by GROUP(1,2), PUBRAT(1,2) WITH TRICEP1/
17 0 PRINT = PMEANS (TABLES(GROUP,PUBRAT))/
18 0 MANOVA CURL2 BY GROUP(1,2), PUBRAT(1,2) WITH CURL1/
Appendix E  (cont.)

20 0 PRINT = PMEANS(TABLEs(GROUP,PUBRAT))/
21 0 MANOVA  ROW2 BY GROUP(1,2), PUBRAT(1,2) WITH ROW1/
22 0 PRINT = PMEANS(TABLEs(GROUP,PUBRAT))/
23 0 MANOVA MIL2 BY GROUP(1,2), PUBRAT(1,2) with MIL1/
24 0 PRINT = PMEANS(TABLEs(GROUP,PUBRAT))/
25 0 FINISH
Title of Thesis: A Comparison of the Effects of Weight Training on Strength and Girth Measures of Prepubescent and Postpubescent Boys

Author: Brian C. Jones

Read and Approved by: ____________________________

Date Submitted to the Department of Physical Education and Sport:

Accepted by the Department of Physical Education and Sport, State University of New York, College at Brockport, in partial fulfillment of the requirements for the degree Master of Science in Education (Physical Education).

Date: ____________________________

Chairperson of Department of Physical Education and Sport