The Velocity of the Baseball Batting Swing as Affected by the Addition of a Select Resistance Exercise of a Traditional Pre-season Weight Training Program

Harold George Wertich

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THE VELOCITY OF THE BASEBALL BATTING SWING AS AFFECTED BY THE ADDITION OF A SELECT RESISTANCE EXERCISE TO A TRADITIONAL PRE-SEASON WEIGHT TRAINING PROGRAM

BY

HAROLD GEORGE WERTICH, JR.

A thesis submitted in partial fulfillment of the requirements for the degree Master of Science, Major in Physical Education, South Dakota State University 1967

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THE VELOCITY OF THE BASEBALL BATTING SWING AS AFFECTED BY THE
ADDITION OF A SELECT RESISTANCE EXERCISE TO A TRADITIONAL
PRE-SEASON WEIGHT TRAINING PROGRAM

This thesis is approved as a creditable and independent
investigation by a candidate for the degree, Master of Science, and
is acceptable as meeting the thesis requirements for this degree, but
without implying that the conclusions reached by the candidate are
necessarily the conclusions of the major department.
THE VELOCITY OF THE BASEBALL BATTING SWING AS AFFECTED
BY THE ADDITION OF A SELECT RESISTANCE EXERCISE TO A
TRADITIONAL PRE-SEASON WEIGHT TRAINING PROGRAM
Abstract

HAROLD GEORGE WERTICH, JR.

Under the supervision of Associate Professor Ervin Huether

The purpose of this investigation was to determine the effects
of two types of resistance-training programs on the velocity of the base­
ball batting swing. A sub-problem of the study was to determine the
effect on the velocity of the batting swing of using a weighted bat
immediately prior to batting.

The following procedure was employed: thirty freshman baseball
candidates at South Dakota State University were selected as subjects
and were placed in two groups equated by the measure of the velocity of
the baseball batting swing. The subjects in the two experimental groups
(Traditional Weight Training Group and Resistance Training Group) partic­
ipated in a six-week training program. The exercise program was
determined by the varsity baseball coach and the writer (wrist curl, two-
arm curl, bench press, bent-over lateral raise, one-half squats, and sit-
ups with weight, with an additional specific resistance exercise for the
Resistance Group).

To obtain data for this investigation an initial and a final
test for the velocity of the baseball batting swing were administered to
the subjects. A second final test was administered in conjunction with
the sub-problem of this study, The experimental groups met three times per week. The training program began February 6, 1967, and terminated on March 17, 1967.

As a result of the findings obtained from this investigation, the following conclusions appear warranted: that either a traditional weight training program or a similar program with the addition of one specific resistance exercise will increase the velocity of the baseball batting swing; that neither method seems to be significantly better than the other; and that swinging a weighted bat immediately prior to batting does not significantly affect the velocity of the baseball batting swing.
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CHAPTER I

INTRODUCTION

An effective early season training program for baseball is often difficult to organize in the upper midwest due to inclement weather conditions. Unfavorable spring weather conditions are usually present in this area, and as a result baseball squads are fortunate if they are able to take part in active baseball practice prior to the start of competition. Wickstrom\(^1\) states that hitting is affected more than any other baseball skill by this problem. Many high school and college baseball teams have space available for pitchers to throw and to prepare themselves for the coming season, but few schools have adequate facilities to prepare their hitters for competition. Due to the short baseball season and the lack of adequate indoor practice areas, baseball coaches have searched for means of conditioning their hitters before outdoor practice begins.

\(^1\)Ralph Wickstrom, "Weight Training for Baseball," Scholastic Coach March, 1960, p. 36

Need for the Study

Weight training has been used for years by many baseball coaches as a program for pre-season conditioning. However, these programs have been designed for over-all strength development rather than for actually preparing a batter for the skill of hitting a baseball. Strength development programs have not concentrated on
conditioning the exact muscle groups involved in the skill of swinging a baseball bat. According to Clarke,\textsuperscript{2} there is increased evidence supporting the theory of high neuromotor specificity. It seems logical to assume that isotonic resistance exercise would better prepare a hitter if applied through the range-of-motion of the subsequent activity, in this case, the hitter's swing.

Since there has been limited research in this area, the writer felt that it would be of value to baseball coaches to determine if a training program could produce greater benefits for hitters using the "law of specificity" as opposed to a traditional weight training program in the preparation of hitters for the outdoor season.

Statement of the Problem

The purpose of this study was to determine the effects of two types of resistance-training programs on the velocity of the baseball batting swing. A sub-problem of the study was to determine the effect on the velocity of the batting swing of using a weighted bat immediately prior to batting.

Delimitations

1. This study was limited to selected freshman baseball candidates at South Dakota State University who did not participate in other intercollegiate sports at the time this study was being completed.
2. The training program was conducted from February 6, 1967 to March 15, 1967.

3. Eighteen training periods were utilized during the six-week training program.

4. There was no attempt to control diet, rest, or other general living habits of the subjects.

5. Motivation was not considered as a factor.

6. Maturation of the individuals tested was not taken into consideration.

Definition of Terms

1. *Velocity of the baseball batting swing*: The total time involved between reacting to a stimulus and, from a prescribed batting stance, swinging a baseball bat through a termination switch.

2. *Hale Reaction-Performance Timer*: An electronic machine designed to accurately measure an individual's reaction and/or performance.

3. *Stimulus*: A signal to start a given action. In this investigation the stimulus was visual (a flash of light) and was used in conjunction with the Hale Reaction-Performance Timer.

4. *Traditional Group*: Those subjects who performed only the six weight training exercises.

5. *Resistance Group*: Those subjects who performed the additional resistance exercise along with the six weight training exercises.
6. **Exer-Genie:** The commercial resistance device used to create the force for the Resistance Group to swing their bats through using the correct range of motion.

7. **Weighted Bat:** A leaded regulation bat of varying weight used for warm-up purposes prior to competitive hitting. In this study, the weighted bat weighed 57 ounces.
CHAPTER II
REVIEW OF RELATED STUDIES

Introduction

A search of the literature revealed limited completed research concerning baseball. Of those studies which did relate to baseball, few were concerned specifically with batting or the speed of the batter's swing. Related studies concerning strength and speed, strength and hitting, and strength development are reported in this chapter.

Report of Pertinent Findings

Zorbas and Karpovich\(^3\) studied the effect of weight training upon the contractile speed of muscles of the arm and of the shoulder girdle. Subjects used were 600 male college students. The subjects were divided into groups of 300 each. One group was comprised of weight trainers who had participated in weight training for a minimum of six months. The second group had no experience in weight training. Results indicated that the weight trainers had faster rotary arm movements than the non-lifters. The difference was statistically significant at the .01 level of significance.

Massey\textsuperscript{4} and co-authors state that anyone wishing to increase

\textsuperscript{4}Benjamin H. Massey, Harold W. Freeman, Frank R. Manson, and Janet A. Wessel, The Kinesiology of Weight Lifting, p. 58.

the speed of some movement should use conditioning exercises for the muscle involved and use maximal speed when practicing the movement desired.

Masley\textsuperscript{5} and co-authors studied the effects of training on


strength, speed, and coordination. The study included an experimental group taking six weeks of beginning weight training, and two control groups: a volleyball class and a sports lecture class. The weight training group when compared to the control classes increased in speed, as measured by rotary arm movement, and strength to a greater degree.

Homola states,\textsuperscript{6} "It has been established that an increase in


strength produces an increase in speed. But I doubt that the full value of the strength increase can be utilized if it isn't developed in conjunction with the skill it's to support.

Jensen\textsuperscript{7} states, "The coach and athlete should keep in mind the

\textsuperscript{7}Clayne R. Jensen, "The Significance of Strength in Athletic Performance," Coach and Athlete, Dec., 1965, p. 23.
fact that strength is basic to all vigorous motor performances which require maximum effort and, therefore, in many cases increased strength will result in improved performance."

According to Hooks,⁸ "When an individual's strength is noticeably increased there is a definite improvement in his ability."

Experiments conducted by Hooks have shown a very high correlation between strength and success in hitting.

Stallings⁹ has written concerning weight training and strength for baseball players:

All baseball men will agree that a degree of physical strength is necessary to be able to play the game with some skill. Weight training offers the best answer for the young ballplayer not blessed with it.

Williams¹⁰ states that to be a better hitter one must "Develop strong, quick hands and wrists which whip the bat through the ball at the instant of impact."

Goldenberg¹¹ has written concerning muscles and movement:

⁸Gene Hooks, Application of Weight Training to Athletics, pp. 117-118.


¹⁰Ted Williams, "How to be a Better Hitter," Scholastic Coach, April, 1956, p. 9.

The muscles are solely responsible for every movement of our body. It is the only tissue with this specialized function. Movement is determined by the manner in which these muscles have been developed. The more powerful the muscles, the easier the work. It's the contraction and relaxation of muscle groups that enable us to perform properly.

Training with weights will give you that extra power or strength when it's needed, and it will also enable you to train harder and longer without getting tired as quickly.

According to Wickstrom, the development of strength requires

\[\text{Wickstrom, op. cit. p. 36.}\]

the high-resistance, low-repetition system.

\[\text{Homola states, "Exercise against resistance, whether}\]

\[\text{isometric or isotonic, can activate more muscle fibers than can simple}\]

\[\text{gravity-resistance isotonics done in high repetitions, thus increasing}\]

\[\text{muscle size and building more strength."}\]

\[\text{Breen conducted an extensive cinematographical study while}\]

\[\text{James L. Breen, "What Makes a Good Hitter?" Journal of Health,}\]

\[\text{Physical Education, and Recreation, April, 1967, pp. 36-39.}\]

serving as research director for the Chicago Cub Baseball Club. Breen filmed major league hitters and conducted time and motion studies on these hitters. The objectives of this study were to discover the major factors affecting performance and to estimate their relative importance. The author found that there were five characteristics
which distinguish the superior hitter in the major leagues from the average hitter. One of these characteristics which the superior hitter possessed was greater bat speed.

Summary

The literature reviewed reveals a strong indication that increased strength is a valuable asset in the improvement of performance and also in the increasing of speed. The research cited also indicates that increased strength is better utilized when developed specifically with the muscles involved in a skill.
CHAPTER III
PROCEDURE FOR OBTAINING DATA

Introduction

The procedure used for selecting subjects, the instruments used for obtaining data, and the training programs are described in this chapter.

Subjects

The subjects for this study were candidates for the 1967 freshman baseball squad at South Dakota State University. In January, from a squad of 54 candidates, the varsity baseball coach and the writer selected 30 candidates to participate in the study. The selection was based on the candidate's potential ability for playing college baseball as judged by the varsity baseball coach and the writer after observing the total squad for two weeks. Twenty-six subjects completed the training program. Four subjects decided not to participate in freshman baseball after the training sessions were in progress.

Instruments for Obtaining Information

On February 3, 1967, each of the 30 subjects was given the initial test to determine the velocity of his baseball batting swing. The training program commenced on February 6, 1967, and continued through March 17, 1967. On March 20, 1967, each subject was given a final test to again determine the velocity of his baseball batting swing.
On March 21, 1967, the subjects were given an additional final test in conjunction with the sub-problem of this study.

**Velocity of the Baseball Batting Swing**

The velocity of the baseball batting swing was the measure utilized in this study. The Hale Reaction-Performance Timer (Figure 1) was used to measure the total time elapsed for the subject to swing a baseball bat, from the time the stimulus was given to bat contact with the termination switch. The stimulus was a flash of light which was controlled by the investigator and placed in front of the subject. The visual stimulus started the performance timer on the Hale Reaction-Performance Timer. A termination switch was mounted on top of a batting tee (Figure 2) and placed at the point where a pitched ball would normally be hit. Contact with the termination switch stopped the performance timer. The times were recorded to the nearest hundredth of a second.

Subjects were allowed to swing a baseball bat several times as a warm-up. Each subject was allowed to swing through the target (termination switch) until he could hit it consistently. Each subject was then given three consecutive trials. An additional trial was given for each "miss." The subject used a prescribed batting stance and started his swing when the stimulus was initiated.

Following the six-week training program the test for the velocity of the baseball batting swing was again administered. The same procedures of the initial test were used for the final test. The second final test, for the sub-problem, was also administered in the
Figure 1. Hale Reaction-Performance Timer
Figure 2. Termination Switch
same manner as the initial test. However, before being tested for the velocity of the baseball batting swing this time, each subject swung a weighted bat five times. The weighted bat weighed 57 ounces.

**Training Programs**

The training programs used in this study were conducted on a six-week, three sessions-per-week basis. Each of the sessions was conducted in conjunction with indoor baseball practice, which consisted of throwing, fielding and hitting. Stallings\textsuperscript{15} states that an athlete will have to make special compensations for his added strength unless he performs the skills while taking part in a weight training program. Wickstrom\textsuperscript{16} states that if players are able to practice throwing, catching, and batting along with weight training, they can easily make any minor adjustments in technique because of increased strength.

The 30 subjects were divided into two groups which were equated using the initial test of the velocity of the baseball batting swing as the criterion. The two groups were randomly assigned to one of the experimental training programs using the track pill box method. Group designations were the Traditional Weight Training Group and the Resistance Training Group. Hereafter these groups will be referred to as the Traditional Group and the Resistance Group.
The traditional weight training program, as determined by the varsity baseball coach, consisted of six exercises. They were the wrist curl, two arm curls, sit-ups with weight, one-half squats, bent-over lateral raise, and bench press. (See Appendix A for description of weight training program).

The resistance training program was exactly the same as the traditional weight training program with the addition of the use of the law of specificity. A commercial resistance exercise device (the Exer-Genie) was utilized for the addition of the law of specificity to the resistance program. Each subject in the Resistance Group swung the bat attached to the resistance device 15 times each training session (Figure 3). The resistance device was so set (17 notches) that the subjects could swing the bat in near normal batting swing. This procedure was followed to involve neuromotor specificity. The subjects in the Resistance Group were instructed to pull on the resistance device as fast as the device would allow with the set resistance. This attempt by the subjects to pull as hard as possible on each successive swing constituted a form of the overload principle. The overload was a progressively increased effort against a fixed resistance.

The practice portion of each training session consisted of throwing, fielding, and hitting. Each subject in both groups was allowed exactly the same number of swings in the batting cage during each session.
Figure 3. Resistance Swinging Apparatus
CHAPTER IV
ANALYSIS OF DATA

Introduction

The procedure used for analyzing data, the statistical methods employed, and the treatment of the data are described in this chapter.

Scoring of Data

The raw scores obtained from the measure of the velocity of the baseball batting swing, timed in hundredths of a second, required no conversion in this study. For each testing session the subjects were given three trials, and the best of these trials was used as the raw score in this study.

Analysis of Data

The analysis of data for this investigation dealt statistically with the mean difference between the Resistance Group and the Traditional Group. The mean difference between the initial and final tests within the Resistance Group, within the Traditional Group, and between the Resistance and Traditional groups was tested for significance at the five percent level of significance by application of the t test. The t ratios that were statistically significant at or beyond the five percent level of significance necessitated a rejection of the null hypothesis.
For comparison between the Resistance and Traditional groups, 24 degrees of freedom were present, and the null hypothesis was rejected if the obtained $t$ ratio was equal to or greater than 2.06. For comparison within the Resistance Group or the Traditional Group, 12 degrees of freedom were present and the null hypothesis was rejected if the obtained $t$ ratio was equal to or greater than 2.18.

The investigator employed the statistical procedures as suggested by Garrett\textsuperscript{17} to determine the $t$ ratio.

\textsuperscript{17}Henry E. Garrett, \textit{Statistics in Psychology and Education}, pp. 212-240.

Findings Between Resistance and Traditional Groups

Table 1 shows the summary of the $t$ tests for the difference between means for the Traditional Group and the Resistance Group after the six-week training program.

While the mean times for both the Traditional and Resistance groups improved from the initial tests to the final test, the statistical analysis employed indicated that there was no statistically significant difference. The null hypothesis was accepted.
Table I
Summary of t Test for Difference between Means for Traditional and Resistance Groups

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Difference</th>
<th>df</th>
<th>t ratio</th>
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<tbody>
<tr>
<td>Traditional</td>
<td>.469</td>
<td>.017</td>
<td>24</td>
<td>.77*</td>
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<tr>
<td>Resistance</td>
<td>.452</td>
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</table>

*No statistical significance at five percent level of significance.

Findings Within Resistance Group

Table II shows the summary of t tests for the difference between means within the Resistance Group.

Table II
Summary of t Test for Difference between Means within Resistance Group

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>df</th>
<th>t ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference</td>
<td>.045</td>
<td>12</td>
<td>4.76**</td>
</tr>
</tbody>
</table>

**Statistical significance at five percent and one percent levels of significance.
The mean difference within the Resistance Group was .045 seconds. The $t$ ratio of 4.76 was statistically significant beyond the one percent level of significance. The null hypothesis was rejected.

**Findings Within Traditional Group**

Table III shows the summary of $t$ tests for the difference between means within the Traditional Group.

**Table III**

<table>
<thead>
<tr>
<th>Mean Difference</th>
<th>df</th>
<th>$t$ ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>.026</td>
<td>12</td>
<td>2.01*</td>
</tr>
</tbody>
</table>

*No statistical significance at five percent level of significance.

The mean difference within the Traditional Group was .026 seconds. The $t$ ratio of 2.01 was not statistically significant at the five percent level of significance. The null hypothesis was accepted.
Findings Within Resistance Group for Sub-Problem

Table IV shows the summary of the t tests for the difference between means within the Resistance Group.

The mean difference within the Resistance Group was .0085 seconds. The t ratio of 1.03 was not statistically significant at the five percent level of significance. The null hypothesis was accepted.

Table IV

Summary of t Test for Difference between Means within Resistance Group for Sub-Problem

<table>
<thead>
<tr>
<th>Mean Difference</th>
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</thead>
<tbody>
<tr>
<td>.0085</td>
<td>12</td>
<td>1.03*</td>
</tr>
</tbody>
</table>

*No statistical significance at five percent level of significance.

Findings Within Traditional Group for Sub-Problem

Table V shows the summary of the t tests for the difference between means within the Traditional Group.

The mean difference within the Traditional Group was .0108 seconds. The t ratio of 1.37 was not statistically significant at the five percent level of significance. The null hypothesis was accepted.
Table V
Summary of t Test for Difference between Means within Traditional Group for Sub-Problem

<table>
<thead>
<tr>
<th>Mean Difference</th>
<th>df</th>
<th>t ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>.0108</td>
<td>12</td>
</tr>
</tbody>
</table>

*No statistical significance at five percent level of significance.

Summary of Findings

Between Resistance and Traditional Groups

The Resistance Group and the Traditional Group both improved their velocity of the baseball batting swing; however, the t test indicated that there was no statistically significant difference in the means at the five percent level of significance for the velocity of the baseball batting swing.

Within Resistance Group

The t test indicated a statistically significant difference beyond the one percent level of significance for the velocity of the baseball batting swing within the Resistance Group.
Within Traditional Group

The t test indicated no statistically significant difference at the five percent level of significance for the velocity of the baseball batting swing within the Traditional Group.

Within Resistance Group for Sub-Problem

The t test revealed no statistically significant difference for the velocity of the baseball batting swing in relation to the subproblem of this study within the Resistance Group.

Within Traditional Group for Sub-Problem

The t test revealed no statistically significant difference for the velocity of the baseball batting swing in relation to the subproblem of this study within the Traditional Group.

Discussion of Findings

The findings of this study appear to indicate the following:

Both types of resistance training programs appeared to be effective methods for improving the velocity of the baseball batting swing. However, from the statistical results obtained, neither program appeared to be a more effective method of training.

The swinging of a weighted bat immediately prior to batting had no significant effect on the velocity of the baseball batting swing. In light of this finding, the investigator is of the opinion that swinging a weighted bat immediately prior to batting is only traditional and psychological.
CHAPTER V

SUMMARY

Problem

The purpose of this study was to determine the effects of two types of resistance-training programs on the velocity of the baseball batting swing. A sub-problem of the study was to determine the effect on the velocity of the batting swing of using a weighted bat immediately prior to batting.

Data

The subjects were 30 college freshman who were candidates for the 1967 freshman baseball squad, and were selected from a total of 54 candidates. The 30 subjects were divided into two groups which were equated by a test for the velocity of the baseball batting swing. These equated groups were designated by use of the track pill box method as the Resistance and Traditional Groups.

Both groups completed 18 training sessions in a six-week period. The Traditional Group participated in a weight training program which consisted of six exercises. The Resistance Group completed the same weight training program as the Traditional Group with the addition of one specific resistance exercise completed through the range-of-motion of the baseball batting swing.

The test measuring the velocity of the baseball batting swing was administered prior to and after the six-week weight training program.
In conjunction with the sub-problem of this study the velocity test was administered the day following the post-test.

The data collected and recorded were statistically treated to determine the effects of two types of resistance-training programs on the velocity of the baseball batting swing. The mean difference between the Resistance and Traditional groups and the mean difference within each group was treated statistically with the \(t\) test. Also, the mean difference within each group for the sub-problem of the study was treated statistically with the \(t\) test.

**Findings**

**Between Resistance and Traditional Groups**

In the test for the velocity of the baseball batting swing, the mean time for the Resistance Group decreased; the mean time for the Traditional Group also decreased. The difference between the means of the two groups was not statistically significant at the five percent level of significance. A mean loss seemed to indicate an increase in the velocity of the baseball batting swing.

**Within Resistance Group**

In the test for the velocity of the baseball batting swing, the mean time for the Resistance Group decreased. The difference between the mean on the initial and final test was statistically significant beyond the one percent level of significance. A mean loss seemed to indicate an increase in the velocity of the baseball batting swing.
Within Traditional Group

In the test for the velocity of the baseball batting swing, the mean time for the Traditional Group decreased. The difference between the mean on the initial and final test, was not statistically significant at the five percent level. A mean loss seemed to indicate an increase in the velocity of the baseball batting swing.

Within Resistance Group for Sub-Problem (Weighted Bat)

In the test for the velocity of the baseball batting swing for the sub-problem of the study, the mean time for the Resistance Group decreased. The difference between the mean on the final and sub-final test was not statistically significant at the five percent level of significance. A mean loss seemed to indicate an increase in the velocity of the baseball batting swing.

Within Traditional Group for Sub-Problem (Weighted Bat)

In the test for the velocity of the baseball batting swing for the sub-problem of the study, the mean time for the Traditional Group decreased. The difference between the mean on the final and sub-final test was not statistically significant at the five percent level of significance. A mean loss seemed to indicate an increase in the velocity of the baseball batting swing.

Conclusions

The findings of this study appear to indicate the following conclusions:
1. The method of resistance-training employed by the Resistance Group in this study appeared to be an effective method of increasing the velocity of the baseball batting swing. There was a significant improvement within this group at the one percent level of significance.

2. In approaching statistical significance within the group, the traditional weight training program also appeared to be an effective method of increasing the velocity of the baseball batting swing.

3. Swinging a weighted bat immediately prior to batting appeared to have no significant effect on the velocity of the baseball batting swing.

Recommendations for Further Study

The following are the investigator's recommendations for possible future study in the area of weight training and hitting in baseball:

1. That a similar study be undertaken involving a longer training period.

2. That a similar study be undertaken involving a control group.

3. That a similar study be undertaken using a training program involving weight training exercises and one training program using the law of specificity, rather than a combination of the two training programs.

4. That a similar study be undertaken using a lighter resistance from the commercial resistance device.
5. That a similar study be undertaken involving a measure of the subject's strength measured specifically with the skill of hitting.
REFERENCES CITED


APPENDIX A
DESCRIPTION OF WEIGHT TRAINING PROGRAM

The system of strength development utilized in this study was heavy weights and low repetitions. Each subject was instructed to determine his own starting weights. When a subject could perform five repetitions in one set of a particular exercise he was instructed to increase the amount of weight for that exercise. Each exercise was completed in three sets at each training session.

Wrist Curl

Position: Sitting on chair, feet on floor shoulder-width apart, back of forearms resting on thighs, wrists one inch beyond knees, bar grasped with reverse grip.

Exercise: Raise bar upward and inward as far as possible with curling motion. Forearms remain in contact with thighs during entire movement.

Sit-ups with Weight

Position: Supine on inclined board with weight held behind head.

Exercise: Curl trunk upward and forward and touch knees with elbows. First set with no weight; second set with five pounds; third set with ten pounds.

Bench Press

Position: Supine on bench, feet on floor, barbell held with wide grip at chest.

Exercise: Extend arms and push bar vertically and then lower bar. Repeat.
APPENDIX A (continued)

One-half Squats

Position: Standing with feet shoulder-width apart, bar resting across top of shoulders and back part of neck, hands holding bar with wide grip.

Exercise: Keeping back straight and head up, go into squat position with angle formed at knees 90 degrees and then return to starting position.

Bent-over Lateral Raise

Position: Standing with feet shoulder-width apart, trunk horizontal, arms extended downward, and hands grasping dumbbells with palms facing inward.

Exercise: Keeping arms straight, raise dumbbells sideward to position slightly higher than shoulders and return to starting position.

Two Arm Curl

Position: Standing with feet shoulder-width apart, holding barbell with wide grip and forearms horizontal.

Exercise: Raise barbell upward and inward with curling motion and return to starting position.
APPENDIX B

RAW SCORES
(Hundredths of seconds)

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<th>Sub-Final</th>
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\[ \bar{x} = 0.497 \quad \bar{x} = 0.452 \quad \bar{x} = 0.443 \]

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\[ \bar{x} = 0.495 \quad \bar{x} = 0.470 \quad \bar{x} = 0.459 \]