1964

The Effects of Supplementary Isometric Exercises With Swimming and Golf on Selected Physiological Factors of College Women.

Mary Louise Life
Louisiana State University and Agricultural & Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_disstheses

Recommended Citation

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Historical Dissertations and Theses by an authorized administrator of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.
LIFE, Mary Louise, 1925—
THE EFFECTS OF SUPPLEMENTARY
ISOMETRIC EXERCISES WITH SWIMMING
AND GOLF ON SELECTED PHYSIOLOGICAL
FACTORS OF COLLEGE WOMEN.

Louisiana State University, Ph.D., 1964
Education, physical
University Microfilms, Inc., Ann Arbor, Michigan
THE EFFECTS OF SUPPLEMENTARY ISOMETRIC EXERCISES WITH SWIMMING AND GOLF ON SELECTED PHYSIOLOGICAL FACTORS OF COLLEGE WOMEN

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

The Department of Health, Physical and Recreation Education

by

Mary Louise Life
B.S., Louisiana Polytechnic Institute, 1945
M.S., Louisiana State University, 1955
May, 1964
-ACKNOWLEDGMENT

The author expresses her sincere appreciation to Dr. Jack K. Nelson for his guidance and assistance during the time of this study.

Further appreciation is acknowledged to Dr. Barton R. Farthing for his assistance in the statistical analysis of the data, to the students who participated in the study, and to the other persons who assisted the author in the many phases of this study.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>ACKNOWLEDGMENT</th>
<th>ii</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF TABLES</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ix</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>x</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>PAGE</td>
</tr>
<tr>
<td>I. STATEMENT OF THE PROBLEM</td>
<td>1</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Purpose of the Study</td>
<td>2</td>
</tr>
<tr>
<td>Need for the Study</td>
<td>3</td>
</tr>
<tr>
<td>Limitations of the Study</td>
<td>4</td>
</tr>
<tr>
<td>Definitions of Terms</td>
<td>4</td>
</tr>
<tr>
<td>II. REVIEW OF RELATED LITERATURE</td>
<td>6</td>
</tr>
<tr>
<td>Literature Concerning the Contributions of Various Sports Activities to Physical Fitness</td>
<td>6</td>
</tr>
<tr>
<td>Literature Concerning the Effects of Isometric Exercise Programs on Strength Development and Cardiovascular Condition</td>
<td>12</td>
</tr>
<tr>
<td>Literature Concerning Cardiovascular Efficiency</td>
<td>20</td>
</tr>
<tr>
<td>Summary of Reviewed Literature</td>
<td>24</td>
</tr>
<tr>
<td>III. PROCEDURE FOR THE STUDY</td>
<td>26</td>
</tr>
</tbody>
</table>

iii
<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects</td>
<td>26</td>
</tr>
<tr>
<td>Subjects</td>
<td>26</td>
</tr>
<tr>
<td>Groups</td>
<td>26</td>
</tr>
<tr>
<td>Program of Activities</td>
<td>27</td>
</tr>
<tr>
<td>Swimming Classes</td>
<td>27</td>
</tr>
<tr>
<td>Golf Classes</td>
<td>29</td>
</tr>
<tr>
<td>Isometric Exercise Program</td>
<td>29</td>
</tr>
<tr>
<td>Procedure for Testing</td>
<td>32</td>
</tr>
<tr>
<td>Roger's Physical Fitness Index Test</td>
<td>32</td>
</tr>
<tr>
<td>Cardiovascular Efficiency Test for Girls and*</td>
<td>33</td>
</tr>
<tr>
<td>Women</td>
<td>33</td>
</tr>
<tr>
<td>Statistical Analysis</td>
<td>35</td>
</tr>
<tr>
<td>IV. ANALYSIS AND PRESENTATION OF THE DATA</td>
<td>36</td>
</tr>
<tr>
<td>Analysis of Mean Differences</td>
<td>36</td>
</tr>
<tr>
<td>Roger's Physical Fitness Index Test</td>
<td>36</td>
</tr>
<tr>
<td>Cardiovascular Efficiency Test</td>
<td>39</td>
</tr>
<tr>
<td>Analysis of Covariance</td>
<td>40</td>
</tr>
<tr>
<td>Roger's Physical Fitness Index Test</td>
<td>40</td>
</tr>
<tr>
<td>Arm Strength</td>
<td>42</td>
</tr>
<tr>
<td>Leg Lift</td>
<td>44</td>
</tr>
<tr>
<td>Physical Fitness Index</td>
<td>46</td>
</tr>
<tr>
<td>Cardiovascular Efficiency Test</td>
<td>46</td>
</tr>
</tbody>
</table>
Analysis of Strength Gains for Isometric Groups ........................................ 48

V. SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS 51

Summary ......................................................... 51
Findings ......................................................... 52

Differences Between Initial and Final Test

Means .......................................................... 52
Physical Fitness Index .................................... 52
Cardiovascular Efficiency ............................. 52

Items of Roger's Physical Fitness Index Test ........................................ 53

Comparison of Programs of Activity ............. 53
Physical Fitness Index .................................... 53
Cardiovascular Efficiency ............................. 53

Items of Roger's Physical Fitness Index Test ........................................ 54

Strength Gains of the Isometric Groups .......... 54

Discussion of Findings ................................... 54

Conclusions ..................................................... 56

Recommendations ........................................... 57

SELECTED BIBLIOGRAPHY ........................................ 59

APPENDIX .......................................................... 65
# APPENDIX

<table>
<thead>
<tr>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. General Instructions for the Isometric Exercise</td>
<td></td>
</tr>
<tr>
<td>Program with the Iso-belt</td>
<td>66</td>
</tr>
<tr>
<td>B. Exercise 1—Elbow Flexors</td>
<td>67</td>
</tr>
<tr>
<td>C. Exercise 2—Arm Adductors</td>
<td>68</td>
</tr>
<tr>
<td>D. Exercise 3—Arm Abductors</td>
<td>69</td>
</tr>
<tr>
<td>E. Exercise 4—Scapula Adductors</td>
<td>70</td>
</tr>
<tr>
<td>F. Exercise 5—Shoulder Shrug</td>
<td>71</td>
</tr>
<tr>
<td>G. Exercise 6—Neck Extensors</td>
<td>72</td>
</tr>
<tr>
<td>H. Exercise 7—Knee Abductors</td>
<td>73</td>
</tr>
<tr>
<td>I. Exercise 8—Knee Abductors (Alternate Method)</td>
<td>74</td>
</tr>
<tr>
<td>J. Exercise 9—Knee Adductors</td>
<td>75</td>
</tr>
<tr>
<td>K. Exercise 10—Dead Lift</td>
<td>76</td>
</tr>
<tr>
<td>L. Exercise 11—Abdominal Contraction</td>
<td>77</td>
</tr>
<tr>
<td>M. Iso-belt and Spring-scale Measuring Device</td>
<td>78</td>
</tr>
<tr>
<td>N. Table for Conversion of Pulse Rates to Cardiovascular Efficiency Scores</td>
<td></td>
</tr>
<tr>
<td>for Those Completing the Three-minute Step Test</td>
<td>79</td>
</tr>
<tr>
<td>VITA</td>
<td>80</td>
</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Differences Between Means of Initial and Final Scores for the Four Groups of College Women Participating in a Varied Program of Activities on the Roger's Physical Fitness Index Test and the Cardiovascular Efficiency Test</td>
<td>37</td>
</tr>
<tr>
<td>II. Analysis of Covariance for Roger's Physical Fitness Index Test and Cardiovascular Efficiency Test</td>
<td>41</td>
</tr>
<tr>
<td>III. F-ratios of Orthogonal Comparisons for Arm Strength as Measured by the Roger's Physical Fitness Index Test for Four Groups of College Women Participating in a Varied Program of Activities</td>
<td>43</td>
</tr>
<tr>
<td>IV. F-ratios of Orthogonal Comparisons for Leg Strength as Measured in the Roger's Physical Fitness Index Test for Four Groups of College Women Participating in a Varied Program of Activities</td>
<td>45</td>
</tr>
<tr>
<td>V. F-ratios of Orthogonal Comparisons for the Physical Fitness Index for Four Groups of College Women Participating in a Varied Program of Activities</td>
<td>47</td>
</tr>
</tbody>
</table>

vii
LIST OF TABLES (continued)

TABLE | PAGE
--- | ---
VI. F-ratios of Orthogonal Comparisons for the Cardiovascular Efficiency Test for Four Groups of College Women Participating in a Varied Program of Activities | 49
VII. Difference Between Means of Initial and Final Spring-scale Measures for College Women Participating in an Isometric Exercise Program in Addition to Intermediate Swimming or Beginning Golf | 50
LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pattern for Orthogonal Comparisons</td>
<td>42</td>
</tr>
</tbody>
</table>
ABSTRACT

The purpose of this study was to study the effects of supplementary isometric exercises with swimming and golf on muscular strength, physical fitness and cardiovascular efficiency of college women.

For the study, ninety-six college women enrolled in physical education basic skills classes composed four groups—Group I participated in intermediate swimming and an isometric exercise program; Group II participated in beginning golf and an isometric exercise program; Group III participated in intermediate swimming with no supplementary exercises; and Group IV participated in beginning golf with no supplementary exercises.

At the beginning and at the end of an eight-week period, subjects were tested on the Roger's Physical Fitness Index Test and the Cardiovascular Efficiency Test for Girls and Women. Subjects in the isometric exercise program were also given strength tests with a spring-scale device.

The t-test was used to determine the significance of the difference between initial and final means on all tests. Analysis of covariance was employed in treating the data to compare effects of the four different programs of activity.

Findings in the study were as follows:

1. All groups showed significant improvement in Physical
Fitness Index.

2. Cardiovascular efficiency was improved significantly by groups participating in swimming and isometric exercises, golf and isometric exercises, and swimming without isometric exercises.

3. All groups showed significant increase in pull-ups, arm strength, leg lift, and lung capacity. Push-up scores were improved by groups participating in swimming and isometric exercises, golf and isometric exercises, and in golf only. No group showed significant changes in grip strength. Back lift scores were increased by subjects participating in golf without isometric exercises.

4. Comparison of the four programs of activity resulted in two significant interactions which indicated that swimming and isometric exercises combined were favored over golf and isometrics combined and that golf alone was more effective than swimming alone in improving the Physical Fitness Index and leg strength.

5. In comparing programs in development of cardiovascular efficiency, isometric exercise programs were found to be significantly superior to non-isometric programs, and swimming programs were superior to golf programs.
6. Differences between groups were not significant in pull-ups, push-ups, grip strength, back lift and lung capacity. Comparisons in arm strength indicated that isometric exercise programs were significantly superior to non-isometric exercise programs.

7. Subjects participating in isometric exercises showed highly significant strength gains in tests with the spring-scale measuring device.

The following conclusions resulted from this study:

1. Physical fitness of college women as measured by the Roger's Physical Fitness Index Test can be improved by participation in intermediate swimming, beginning golf, and a combination of either of these activities and an isometric exercise program.

2. There was no difference in the effectiveness of intermediate swimming and beginning golf in improvement of physical fitness of college women as measured by the Roger's Physical Fitness Index Test.

3. Addition of an isometric exercise program to intermediate swimming and beginning golf did not increase the effectiveness of these activities in improvement of physical fitness of college women.

4. Intermediate swimming improves the cardiovascular efficiency of college women, whereas beginning golf
as taught in this program does not.

5. Intermediate swimming with supplementary isometric exercises and beginning golf with supplementary isometric exercises improve cardiovascular efficiency of college women.

6. The addition of isometric exercises to the intermediate swimming and beginning golf activities develops arm strength as measured by the Roger's Physical Fitness Index Test more effectively than mere participation in the activities without supplementary exercises.
CHAPTER I

STATEMENT OF THE PROBLEM

I. INTRODUCTION

Physical educators subscribe to the belief that physical development is one of the foremost objectives of a physical education program. This is generally interpreted to mean, in part, the development of a state of physical fitness or vigor in the person engaging in a program of physical activity.

Physical fitness, a major part of total fitness, has been given many definitions and is considered to include a number of elements. Scott and French defined fitness as follows:

The fit person is one who is free of limiting and debilitating ailments, and who has the stamina and skill to do the day's work, and who has sufficient reserve energy not only to meet emergencies but to provide a zest for leisure time living.¹

Larson² listed the elements comprising physical fitness as resistance to disease, muscular strength, circulatory-respiratory function, nutritional status, body build, flexibility, and motor skills.


This investigation was concerned with two of these elements, muscular strength and the circulatory-respiratory function or cardiovascular efficiency. Claims have been made or implied that participation in the usual college physical education class will contribute to the development of strength and cardiovascular efficiency. Some research studies support this belief, while some do not. In other research studies activities have been shown to contribute in varying degrees to these aspects of development.

It is the opinion of some physical educators that exercise programs should supplement participation in sports skill activity. Various types of conditioning programs such as traditional conditioning exercises, weight training, and isometric exercise programs have been studied by a number of investigators in an effort to determine the effects of these programs on the development of physical fitness.

II. PURPOSE OF THE STUDY

It was the purpose of this study to study the effects of supplementary isometric exercises with swimming and golf on muscular strength and physical fitness as measured by the Roger's Physical Fitness Index Test\(^3\) and on cardiovascular efficiency as

measured by the Cardiovascular Efficiency Test for Girls and Women.

III. NEED FOR THE STUDY

It is important that the physical educator know the contributions of the activities which are made available to students in a physical education program. Conflicting results have been reported of studies conducted to determine the effects of various sports activities on the development of physical fitness. Two of these activities, intermediate swimming and beginning golf, were selected by the author for further study. This investigation provided the opportunity to study and compare the effect of these two activities on the physical fitness of college women.

Although there has been considerable research done lately on the values of isometric exercises, very few studies have been reported which have involved college women. As isometric exercise is a relatively new field of concern, it is important that all aspects of isometrics be studied in order to determine its value. It was felt that the results of this study would contribute more information on isometrics as it affects women and would be beneficial.

to physical educators in organizing programs concerned with development of physical fitness in college women.

IV. LIMITATIONS OF THE STUDY

The study was limited to a period of eight weeks. It was conducted in Louisiana during the summer months and performance was possibly influenced by weather conditions of high temperatures.

Subjects were asked not to participate in strenuous activities outside of class, but it was impossible to actually control any such participation.

V. DEFINITIONS OF TERMS

For this study the following definitions of terms were used:

Cardiovascular efficiency is the ability of the heart and circulatory system to adjust to the stress of activity.\(^5\)

Isometric contraction is the development of tension without a shortening of muscle fiber.\(^6\)

Isometric exercise is an exercise in which a static muscle

---

\(^5\)Ibid., p. 191.

\(^6\)Lawrence E. Morehouse and A. T. Miller, Jr., *Physiology of Exercise* (St. Louis: The C. V. Mosby Co., 1959), p. 27.
contraction is held for a designated length of time. 7

Muscular strength is the maximum tension a muscle can apply in a single contraction. 8

Physical Fitness Index is the score derived from comparing an achieved Strength Index with a norm based upon the individual's sex, weight and age. A Physical Fitness Index of 100 is considered average. 9

Strength Index is the gross score obtained from lung capacity and the following six strength tests: right grip, left grip, back lift, leg lift, pull-ups, and push-ups (the latter two combined in a formula provide a strength score). 10

8 Ibid.
9 Mathews, loc. cit., 58.
10 Ibid.
CHAPTER II

REVIEW OF RELATED LITERATURE

A review of the literature revealed that there have not been any studies of this exact nature reported. The related studies investigating the relative contributions of various sports activities to physical fitness, the effects of isometric exercise programs on strength development and cardiovascular condition, and the measurement of cardiovascular efficiency will be presented in this chapter.

I. LITERATURE CONCERNING THE CONTRIBUTIONS OF VARIOUS SPORTS ACTIVITIES TO PHYSICAL FITNESS

In this section the writer has attempted to focus particularly on studies dealing with the contributions of swimming and golf, the sports activities studied in this investigation. Some of the reviewed studies employed a rating technique for evaluation; others were experimental in design.

An extensive evaluation of physical education activities was found in a report made by the Committee on Curriculum Research of the College Physical Education Association in 1930. The activities were rated by experts in terms of their contribution to

physical, intellectual, social, safety, and recreational aspects of development. Swimming was given the maximum rating of ten for its contribution to physical development. Golf was given a rating of six.

Polansky\(^2\) evaluated activities for college men by means of judges' ratings. Using a rating of zero to ten, the judges rated swimming 7.5 and golf 5.0 in strength development. In development of cardiovascular endurance, swimming was rated 8.5 and golf 4.0.

In an evaluation of activities for girls in secondary schools Smith\(^3\) used judges' ratings. Ratings on a ten point basis show swimming rated 9.5 in muscular strength development and 9.0 in cardiovascular-respiratory efficiency development. Golf was given a rating of 6.0 for strength development and 3.5 for cardiovascular-respiratory efficiency.

Broer\(^4\) stated that there has not been enough research done to determine the relative contributions of all the activities in


\(^4\)Marion Broer, "For Physical Fitness Vary Your Program," Journal of Health, Physical Education and Recreation, XXVII (September, 1956), pp. 16-19.
developing physical fitness. She reported that in studies conducted with male students, findings have shown that swimming contributes to the development of endurance, but not to the development of strength.

Landiss used the Army Air Force Physical Fitness Test and the Larson Test of Motor Ability to investigate the effect of eight activities—wrestling, conditioning, tennis, volleyball, weight training, boxing, tumbling—gymnastics, and swimming. All seven of the other activities investigated in the study were found to be superior to swimming in development of physical fitness and motor ability.

Studies in which women students participated showed varying results. Bennett used a battery of tests to find the relative contributions of modern dance, folk dance, basketball, and swimming to certain motor abilities in college women. The battery consisted of the Burpee test for agility and coordination, right grip strength for general strength, a 30-second sit-up test for abdominal strength, trunk flexion for flexibility, an obstacle race

---


for speed, the standing broad jump for leg strength and power, the basketball throw for distance for arm and shoulder strength, Bass Leap test for balance, Brouha Step Test for endurance and/or organic fitness, and Scott's Motor Ability Battery for general motor ability. Swimming was found to be the most effective activity in the development of agility, coordination, strength, flexibility, and speed. She found gains in grip and abdominal strength but no gains in leg and shoulder strength as a result of a swimming program.

Smalley and Smalley\(^7\) studied the effects of swimming, folk dance, badminton, dance fundamentals, volleyball, hockey, fencing, basketball, archery, and tennis. Endurance was tested by Glassow's modification of the Burpee test. Arm and shoulder girdle strength was measured by means of a push-pull attachment on a grip dynamometer. Of the ten activities swimming ranked highest for contribution to endurance, but was ninth in development of arm and shoulder girdle strength.

Mohr\(^8\) used the following battery in a study of certain aspects of physical fitness of college women: a chair-stepping


test to measure endurance, sit-ups to measure abdominal strength, pulls on a spring scale to measure arm strength, push-ups to measure arm and shoulder girdle strength, a bouncing test to measure foot strength, and a modification of Scott's obstacle run to measure agility. She found that swimming contributed significantly to the development of arm strength, abdominal strength, foot strength and agility, but that it did not significantly improve arm and shoulder girdle strength. She did not find a significant difference among the contributions of swimming, recreational games, team sports, and dance.

Carter studied the effects of beginning badminton, beginning bowling, beginning swimming, beginning fencing, basketball, body conditioning, international folk dance, and general basic physical education on certain elements of physical fitness of college women. These elements and the test for measuring each were as follows: flexibility, Through-the-stick; arm and shoulder girdle strength and endurance, pull-ups and push-ups; abdominal strength and endurance, curl-ups; endurance, squat thrusts; and agility, the Illinois Agility Run. All activities contributed toward improvement of some of the elements of physical fitness measured in this study. Swimming was found to show significant improvement at the

---

.05 level of confidence in abdominal strength and endurance. However, improvement in the scores in the total physical battery was not significant for the swimming group.

In an investigation of selected physical education activities on cardiovascular efficiency as measured by the Tuttle Pulse Ratio Test, Lucille Lee<sup>10</sup> did not find any measurable effects. Badminton, tennis, Danish gymnastics, modern dance, and swimming were studied. Although it was not statistically significant, greater improvement was made in swimming than in other activities.

Mary C. Lee<sup>11</sup> used the AAHPER Youth Fitness Test to study the effects of an orientation class in physical education on the physical fitness of freshman college women. The course included fundamentals of movement, body mechanics, swimming, safety, health knowledge and practices, team and individual sports, and fundamental rhythms. After completing the one semester course, the subjects showed a mean improvement in the fitness test battery scores at the .01 level of confidence.


11. LITERATURE CONCERNING THE EFFECTS OF ISOMETRIC EXERCISE PROGRAMS ON STRENGTH DEVELOPMENT AND CARDIOVASCULAR CONDITION

In a review of studies involving progressive resistance exercises, Rasch\textsuperscript{12} reported that students at Springfield College in 1929 and 1930 conducted a series of studies which showed that it was possible to increase strength by the use of short static contractions. Subsequent studies were conducted, but little attention was given to the question of strength development through this process until Hettinger and Muller\textsuperscript{13} published results of their experiments in 1953. These authors reported that a single two-thirds maximum isometric effort for six seconds once a day resulted in a weekly gain of five percent above the initial strength although increases in duration, frequency, or amount of effort did not result in faster or greater improvement.

Numerous studies in the area of isometric exercise have been reported during the past ten years. Investigators have


experimented with various types of isometric programs and with
different muscle groups. The results of these studies have sometimes
been conflicting.

Meadows\textsuperscript{14} studied the effect of isometric and isotonic
muscle contraction training on speed and force of offensive
football charge and static and dynamic strength. Strength tests
measured right and left grip, back lift, leg lift, chins, dips and
the vertical jump. He reported that a greater effect on chins was
made by the isotonic exercise, but the difference was not statistical-
ly significant. No significant difference was revealed by the two
methods in dips, right or left grip strength, or leg or back lift.
Isometric exercises were significantly more effective in the
vertical jump tests. The isometric program produced significant
gains in leg lift and back lift strength.

In a study reported by Mathews and Kruse\textsuperscript{15} isometric
exercises of the elbow flexor muscle groups produced significant
gains. Improvement was greater in the isometric exercise group
than in a group using isotonic exercises.

\textsuperscript{14}Paul E. Meadows, "The Effect of Isotonic and Isometric
Muscle Contraction Training on Speed, Force, and Strength," (micro-carded Ph.D. dissertation, University of Illinois, Urbana,

\textsuperscript{15}Donald K. Mathews and Robert Kruse, "The Effect of
Isometric and Isotonic Exercises on Elbow Flexor Muscle Groups,
Dennison, Howell, and Morford\textsuperscript{16} conducted a study to determine the effects of isometric and isotonic exercise programs. They reported significant gains in the Arm Strength Index following both programs, but found no significant difference between gains of the two groups.

Peterson\textsuperscript{17} reported results of a study in which he utilized both male and female subjects. The muscle groups investigated were right elbow flexors and right knee extensors. Subjects were assigned to four groups.

Group I, consisting of five females and five males, trained the right elbow flexors and right knee extensors in thirty-six sessions with one maximum isometric contraction per session. No significant increase in strength was indicated.

Group II, consisting of four females and six males, trained the same muscle groups with ten maximum isometric contractions per session for thirty-six sessions. Significant improvement was shown by males, but not by the females.

Group III, consisting of four females and two males, trained


right elbow flexors with ten eccentric contractions per session for thirty-six sessions. No increase in strength was found.

Group IV, consisting of four females and four males, trained for fifteen minutes on an ergocycle on twenty occasions. Significant strength increase resulted.

A Control Group of seven females and six males showed no change in strength.

In a study to determine the effect of static contractions on the strength development in high school boys, Wolber and Sills\textsuperscript{18} reported significant gains after an eight-week exercise program. The experimental group performed exercises that were selected to develop muscle strength measured by a battery of tests consisting of the leg lift, back lift, grip strength, and the Sargent Jump. Contractions were held for six seconds once a day, five days a week. Significant differences in favor of the experimental group over the control group were found in leg lift, back lift, and grip strength scores.

Wickstrom\textsuperscript{19} studied graduate physical education students, twenty men and six women, to determine the effect of isometric

\textsuperscript{18}Charles P. Wolbers and Frank D. Sills, "Development of Strength in High School Boys by Static Muscle Contractions," The Research Quarterly, XLVII (December, 1956), p. 446.

contraction on grip strength. Subjects exercised five days per week, exerting maximum effort on a tensiometer for two seconds grip with each hand. Measurements of grip strength were made at the beginning of the experiment, after three weeks, and at the end of six weeks. Women students showed a loss of strength in both hands at three weeks and six weeks. Men subjects showed a loss of strength in both hands after three weeks and in the left hand after six weeks, but showed a gain in right grip strength after six weeks.

Barham studied gains in extensor strength of the legs and back of three groups of college men in order to compare the effect of one maximum isometric contraction with the effect of three maximum isometric contractions per day. A control group participated in tennis class only. Subjects in one experimental group participated in tennis or golf class and performed one maximum isometric contraction per day on a specially constructed testing apparatus. Subjects in the second experimental group participated in tennis or golf class and performed three maximum isometric contractions per day. Results of this study indicated that muscle strength can be increased through isometric exercise and that there was no significant difference in the amount of

strength developed through one maximum isometric contraction and the amount of strength developed through three maximum isometric contractions per day.

Other investigations have been made to study various aspects of isometric contraction exercise programs as means of developing muscular strength. Studies reviewed included comparisons of isometric and isotonic exercise programs, comparisons of the length of time muscles were held in contraction, comparisons of the degree of contraction, comparison of the number of repetitions per exercise session, and of the frequency of exercise sessions. In these studies significant strength gains resulting from isometric exercises were reported by Rasch and Morehouse, Darcus and Salter, Salter, Barham, and Rarick and Larsen.

---


Alost\textsuperscript{26} reported the effects of an isometric exercise program on cardiovascular development of college men. Subjects were grouped according to initial Harvard Step Test scores and frequency of training sessions. Two training programs were used: a one-minute run and a series of isometric exercises. Results of the investigation showed no significant differences in the effectiveness of the two training programs. The subjects of below average initial condition tended to gain more than the above average subjects. As frequency of practice sessions increased, improvement in cardiovascular condition increased.

Three studies were reviewed in which all the subjects were women. Lietuvietis\textsuperscript{27} studied the effects of isometric and isotonic exercises on the front and back flutter kick and scissor kick. She used college women students in senior life saving and intermediate swimming classes as subjects. The isometric and isotonic exercises both produced strength gains significant at the .02 level of confidence in hip flexor and hip extensor muscle groups. There were no significant differences between the groups. Swimming kick


\textsuperscript{27}Kaija Lietuvietis, "The Effect of Isotonic and Isometric Leg Exercises on Selected Swimming Kicks," (unpublished Master's thesis, State University of Iowa, Iowa City, 1958), p. 35.
time scores were not improved by either of the exercise programs which were used.

Carr\textsuperscript{28} investigated the effects of isometric contraction and progressive body conditioning exercises on physical fitness and badminton achievement of college women. The aspects of physical fitness measured were endurance, flexibility, agility, arm and shoulder-girdle strength and abdominal strength. Tests used to measure these elements were squat-thrusts, toe-touch test, the Illinois Agility Run, pull-ups and curl-ups. Badminton skills were tested with the Miller Wall Volley Test and a badminton short serve test. The Beginning Badminton Written Examination by Fox was used to determine badminton knowledge.

Subjects were divided into three groups. Group A participated in fifteen minutes of progressive body conditioning exercises and in badminton class activity for the remaining twenty-two minutes per period. Group B participated in a five-minute isometric exercise program and in badminton class activity for the remaining thirty-two minutes per period. Group C participated only in badminton class activity for the entire thirty-seven minute period. Ten class periods of instruction were held between the pre-test and

post-test sessions. On total physical fitness battery scores each group made gains significant at the .01 level of confidence. No significant difference between groups was shown on pre-test or post-test scores. Improvement on the Miller Wall Volley test and Badminton Written Examination scores was significant at the .01 level of confidence for all groups. Only Group C showed significant gain on the short serve test.

Although the purpose of an investigation conducted by Day29 is not directly related to the present study, the study was reviewed because the subjects were college women and performed one of the isometric exercises used in the present study. Day studied the effects of isometric contraction of the abdominal muscles on reduction of the waistline of women. An experimental group performed six six-second contractions of the abdominal and gluteus muscles each day for a six-week training period. An average reduction of 1.24 inches in the subjects' waistlines was reported.

III. LITERATURE CONCERNING CARDIOVASCULAR EFFICIENCY

In reporting the development of the Harvard Step Test,

Brouha\textsuperscript{30} stated that the test measured general capacity of the body, in particular the cardiovascular system, to adapt itself to hard work and to recover from what it has done. In the test a subject stepped up and down on a twenty-inch platform thirty times a minute. The subject continued stepping as long as he could up to a maximum of five minutes. The pulse was counted from 1 to $1\frac{1}{2}$, 2 to $2\frac{1}{2}$, and 3 to $3\frac{1}{2}$ minutes after the subject finished the test. The score was computed by the formula:

$$\text{Index} = \frac{\text{Duration of exercise in seconds} \times 100}{2 \times \text{sum of pulse counts in recovery}}$$

The test was considered to be valuable in showing the different levels of fitness among the men and in indicating the effect of training between pre-test and post-test.

Clarke\textsuperscript{31} used the Brouha modification of the Harvard Step Test as a Functional Physical Fitness Test for college women. In this test an eighteen-inch bench was used and the exercise was continued for four minutes. The remainder of the administration of the test was the same as the Harvard Step Test. A Line Chart for Calculating Physical Fitness Index was used.

The test was administered three times to college women.


Physical Fitness scores for 296 women, who were tested in the first week in October, ranged from eighteen to ninety-one. The average score was 47.35. Twenty-two per cent or sixty-six subjects finished the four-minute test. After six weeks the test was repeated with 321 subjects who had participated in physical education programs. The range of scores was eighteen to ninety-nine; the average score was 56.7. Thirty-four per cent or 110 subjects finished the four-minute test.

Only 250 of the total number who were tested took both the initial test and the re-test. These subjects had participated in the activities for two 45-minute periods per week for the six weeks between the two tests. The original score was maintained or increased by 205 of the group who were re-tested. The highest increases in Physical Fitness scores were noted in swimming students. The other activities in order of their effectiveness were field hockey, crew, tennis, dance, volleyball and archery.

In March, 302 were tested, and scores ranged from 22 to 104. The average score was sixty, and forty-eight per cent finished the test.

Another modification of the Harvard Step Test was used by Sloan\(^3\) to determine the effect of training on physical fitness of college women. The only change in the test in this study was

the height of the bench used for stepping. It was eighteen inches high. Subjects were given the test at the beginning of the academic year and after four and nine months. A group of third year students specializing in physical education were participating in $6\frac{1}{2}$ hours of gymnastics, dancing, and games each week. Two other groups took part in gymnastics forty minutes each week, and a control group had no physical education activity.

After four months the group specializing in physical education showed highly significant improvement ($P < 0.001$). This improvement was maintained to the nine-month testing but without more significant improvement. No other group improved significantly at four or nine months. One of the groups participating forty minutes per week showed significant difference in gain over the control group at four months and maintained the difference in the last test.

An investigation of the effects of two training programs on selected cardio-respiratory variables of college women was conducted by King.$^{33}$ Variables studied were pulse rate, respiration rate, respiration amplitude, minute volume of respiration and oxygen consumption. Subjects participated in running or bicycle riding programs. The training periods were five days per week for four

---

weeks. Distances for runners and riders were the same and increased from one mile the first week to 1½ miles the fourth week. Pulse rate was determined by the Brouha Modification of the Harvard Step Test, and the Collins 13.5 Liter Respirometer was used to measure the other variables.

No significant difference was reported between initial and final sitting pulse rate of the bicyclers; significant difference at the .05 level of confidence was found for the runners. Both runners and bicyclers showed a significant improvement at the .01 level of confidence on step-test scores. The difference between the two training programs on step-test scores was not statistically significant. Significant improvement was reported for both training programs in all variables studied.

IV. SUMMARY OF REVIEWED LITERATURE

The literature concerning the contributions of various activities to the development of physical fitness shows conflicting evidence of the value of swimming and golf. Those studies in which ratings of judges were used showed swimming to have consistently high ratings while golf had medium and low ratings. There was no concensus in the experimental studies as to the effects of these two activities on certain elements of physical fitness. Some investigators reported significant gains in strength of various muscle groups and in endurance while others reported contradictory findings.
A review of the literature concerning isometric exercise programs revealed that most of the studies have been conducted with male subjects. There was agreement among the majority of the investigations reported that isometric exercises do result in improvement in strength. There has not been agreement concerning the superiority of one method of training, isometric or isotonic, over the other. In three studies utilizing women as subjects, conflicting results were found. Of the two studies measuring only strength development, one study showed no increase in strength as a result of the isometric program while the other study revealed significant improvement in strength as a result of isometrics. A third investigation indicated that an isometric exercise program produced significant improvement in physical fitness test scores.

One investigator studied the effect of an isometric exercise program on cardiovascular development. The results of the study showed the isometric program to be as beneficial as a training program consisting of a one-minute run in improving cardiovascular function.

Authors reported in studies reviewed that cardiovascular condition can be changed as a result of activity.
CHAPTER III

PROCEDURE FOR THE STUDY

This study was conducted during the first eight weeks of the 1963 summer session at Louisiana State University.

1. SUBJECTS

Subjects

Subjects in the study were women students enrolled in beginning golf and intermediate swimming classes which are a part of the required Basic Skills Classes of the Department of Health, Physical and Recreation Education at the University. At the first class meeting the nature of the study was explained to the prospective subjects. Each student was asked to report to the investigator any reason for which she felt she should be eliminated from the study. All subjects had previously filed medical examination reports with the university hospital service and were approved for a regular physical education program.

The original number of students participating in the study was 108. In order to equalize the group numbers for statistical purposes, the author eliminated twelve subjects by random selection. The final number in each of four groups was twenty-four.

Groups

The subjects were grouped as follows:
Group I participated in the regular activities of an intermediate swimming class with an added isometric exercise program of approximately two and one-half minutes at the beginning of each class period.

Group II participated in the regular activities of a beginning golf class along with an isometric exercise program of approximately two and one-half minutes at the end of each class period.

Group III participated only in the regular activities of an intermediate swimming class.

Group IV participated only in the regular activities of a beginning golf class.

II. PROGRAM OF ACTIVITIES

Subjects attended class and participated in the activities of their respective groups five days per week. Actual participation time in class was approximately thirty minutes per day. Participation in the golf, swimming, and isometric activities began during the second week of the summer session and continued through the eighth week.

Swimming Classes

Students in four intermediate swimming classes participated in the study. Two of these classes comprised Group I; the other two were in Group III. One class from Group I was taught by one
instructor. The other class in Group I and the two classes of Group III were taught by another instructor. Activities and instruction in the classes were uniform and consistent. Subjects were given instruction in the following strokes: crawl, side stroke, elementary back stroke, back crawl, breast stroke, inverted breast stroke, trudgen, double trudgen, trudgen crawl, and over-arm side stroke. In addition a small amount of basic instruction was given in diving. Class periods were devoted primarily to instruction and practice for improvement of swimming strokes. Students were expected to develop good swimming form and the endurance to swim increasingly longer periods or distances during the course.

The usual class period consisted of approximately five minutes for warm-up, ten minutes for group instruction and practice, and fifteen minutes for supervised individual or group practice. During the warm-up period students were required to do such activities as bobbing, finning, sculling, kicking, or swimming laps. The ten-minute instruction period consisted of demonstration, explanation and practice of the activity being taught or reviewed that day. In the fifteen minutes for supervised practice, students worked on the prescribed activity for the day or on a stroke or other skill in which practice was needed. The instructor gave individual instruction or assistance to students in this part of the period.
Golf Classes

Four golf classes participated in the study. The two classes of Group II were taught by one instructor; another instructor taught the two classes comprising Group IV. Activities and instruction were consistent in these classes. Students were given instruction in the fundamentals of golf using the woods and irons and regular golf balls. The golf classes were conducted on an outdoor practice field in good weather. During inclement weather periods, practice took place in an indoor range equipped with nylon golf driving cages. The students used the No. 3 wood, and Nos. 3, 5, and 9 irons. Class activity consisted of hitting and walking to retrieve thirty to forty balls per period. In addition to class activity each student was required to play three 9-hole rounds of golf during the summer session.

Isometric Exercise Program

The exercise program consisted of exercises for strengthening various muscle groups of the body and are described and illustrated in Appendices B-L, pages 67-77. They were performed with the Iso-belt, pictured in Appendix M, page 78.

One class period was used as an introductory lesson to the isometric exercise program. The uses and values of such a program were explained to the subjects. Exercises with the Iso-belt were performed by the subjects as each exercise was demonstrated and its purposes explained. Subjects were given the opportunity to ask
questions regarding the isometric exercise program or the study being done.

After the initial meeting subjects participated in the exercise program as class groups. The author conducted the isometric exercise program each day. The swimming classes performed the exercises at the beginning of the class period. The golf students did the exercises at the end of the class period. This plan was established for ease of administration of the exercise program. The author felt that it was better to work with smaller groups in the exercise program. In addition, it was better to work with swimmers before they went into the pool and were not wet. One golf instructor requested that the subjects in golf groups be allowed to perform the exercises after golf class so that the hands would not be tired for the class activity.

The exercise program was conducted in a section of the women's dressing room. Benches were provided for the subjects to sit on during the exercise period. Each student was provided with an Iso-Belt. The author stood before the group, announced the exercise to be performed and gave a verbal count for ten seconds for each of the eleven exercises. By the count of four, the subject was expected to reach a maximum contraction. This contraction was held until the count of ten and then relaxed. One contraction was performed for each exercise each day. Frequently, the purpose of each exercise was reviewed, and subjects were constantly reminded of the proper method of performing the exercises.
Periodic checks were made on strength gains of the subjects participating in the isometric exercise program. This procedure was used as a motivational device as isometric exercise programs have been shown to be more effective when the subject knows what progress is being made. This also gave each subject and the investigator a check as to correct procedures on the exercises.

The equipment used for this testing was made of three spring scales taped together and attached to a nylon belt. The belt was of the same length as the Iso-belt. The instrument had been used in a previous study, and the reliability of it had been checked by suspending weights of varying sizes from it. The true weight of the weights did not register on the scale, but it was found to be consistent in that the same reading was achieved each time a particular weight was attached to the spring scale. Due to the fact that the scale reading was not in exact pounds, readings were recorded only as scale units. Readings were taken from only one of the scales and from the same scale each time. A picture of the device is found in Appendix M, page 78.

Six of the exercises were used for the testing: Exercise 1, right and left arms, elbow flexors; Exercise 2, arm adductors; Exercise 3, arm abductors; Exercise 4, scapula adductors; and Exercise 7, knee abductors. Subjects were tested on these exercises the first, third, and seventh weeks of the exercise program.
III. PROCEDURE FOR TESTING

The tests used in this study were the Roger's Physical Fitness Index Test and the Cardiovascular Efficiency Test for Girls and Women. The initial tests were administered during the second week of the summer session. Re-tests were administered during the eighth week. In each testing the Roger's test was given one day and the Cardiovascular Efficiency test was given the next day. Students who were absent on the day a test was administered were given the test within the next two class meetings.

Roger's Physical Fitness Index Test

The items included in the Roger's Physical Fitness Index Test were pull-ups, push-ups, right and left grip, back lift, leg lift, and lung capacity.

The investigator was assisted by a group of six testers in the administration of the Roger's test. Copies of the testing procedures were made and distributed to the testers. Procedures were explained and practiced in order to develop proficiency in the testing. The testers then administered the tests to a group of students prior to the study to perfect their testing techniques.

The tests were given in the women's gymnasium. Each subject was given a score card as she entered the gymnasium. The Roger's tests were set up at separate stations around the gymnasium. Each test was explained and administered individually to the subject.
Her score was recorded by the examiner. The subject was not required to follow any pattern in moving through the tests except that each was asked not to take the pull-up and push-up tests following one another. In the event that the examiner felt the reading was inaccurate or that incorrect procedure resulted, the subject was asked to rest and then repeat the test, so that the best effort could be achieved.

Cardiovascular Efficiency Test for Girls and Women

The test consisted of continuous stepping up and down on an 18-inch high bench twenty-four times per minute for three minutes. Students who completed the three-minute test, rested one minute. Following the completion of the one-minute rest, a thirty-second pulse count was made. Subjects who stopped prior to the three-minute period were allowed a minute to rest after stopping. Pulse was then counted for thirty seconds. Participation time and pulse counts were recorded and used in a formula to determine the subject's score on the test.

One trained assistant helped the investigator with the administration of the test. In this test subjects worked in groups of three. During each administration of the test eight subjects were tested. One subject from each group was taking the test, one was responsible for the time, and one counted the pulse. Prior to the testing practices were taken until the investigator was confident the students were able to count the pulse accurately.
Two students practiced counting the pulse of the third member of the group until their counts were in agreement.

A blackboard was placed before the group. On this board time had been pre-recorded in 5-second intervals for a three-minute period. A time-keeper watched the stop watch and checked off the 5-second intervals on the board. The timer for each group had a card with markings identical to those on the board. When a subject stopped before the end of the test, the timer for that subject circled the corresponding interval which was last checked on the board. At the end of the one-minute rest period, the timer advised the pulse counter to begin counting the pulse, timed the 30-second counting period, and advised the counter when it was time to stop counting. The counter recorded the pulse count on the card. If the subject finished the test, the three-minute interval was circled on the card so that each subject's card showed a time and pulse count.

The author gave verbal signals to start and stop the test and to help subjects maintain the cadence. A metronome was used to set the time of the cadence.

In the event that the students of a group felt a possible mistake in timing or counting had been made, the subject was given a re-test within the next two class periods.

Scores for subjects who failed to finish the three-minute test were computed by the formula:

\[
\text{Score} = \frac{\text{No. of seconds of stepping}}{30 \text{ second recovery pulse}} \times 100 \times 5.6
\]
For those subjects who completed the three-minute test, a conversion table was used to determine the score. Standards set in the table were as follows: Excellent, 71 and above; Very Good, 60-70; Good, 49-59; Fair, 39-48; Poor, 28-38; and Very Poor, 0-27. The conversion table is shown in Appendix N, page 79.

IV. STATISTICAL ANALYSIS

The data were analyzed to determine the difference in scores on the initial and final tests. These analyses were made by the t-test of the significance of the difference between means for individual groups on the initial and final scores of the items of the Roger's test, the initial and final Physical Fitness Index, and the initial and final scores on the Cardiovascular Efficiency test.

In order to determine if there were significant differences in improvement among the four groups, analysis of covariance was used. Orthogonal comparisons were made to find the effect of the isometric program versus no isometric program, golf versus swimming, and interactions between isometric exercise, swimming, and golf.

The results of strength testing with the spring-scale device were analyzed using the t-test to determine if significant improvements were made in strength between the initial and final trials.
CHAPTER IV

ANALYSIS AND PRESENTATION OF THE DATA

I. ANALYSIS OF MEAN DIFFERENCES

The data were analyzed to determine the difference between the means for each of the four groups on the initial and final scores for the Roger's Physical Fitness Index Test and the Cardiovascular Efficiency Test. The t-test was used to determine the significance of the difference in means. Results of these analyses for the four groups on each of the tests are shown in Table I, pages 37 and 38.

Roger's Physical Fitness Index Test

All groups did not show significant gains on each test. In pull-ups each group showed gains significant at the .01 level. Push-ups were increased significantly at the .01 level for Group I, the swimmers who also performed isometric exercises. Group II, the golfers performing isometric exercises, and Group IV, those participating in golf with no isometric exercises, increased the number of push-ups performed significantly at the .05 level of probability. Group III, the subjects participating in swimming only, showed no significant improvement in push-ups.

All four groups showed significant arm strength improvement at the .01 level of probability.
TABLE I
DIFFERENCES BETWEEN MEANS OF INITIAL AND FINAL SCORES FOR
THE FOUR GROUPS OF COLLEGE WOMEN PARTICIPATING IN A
VARIED PROGRAM OF ACTIVITIES ON THE ROGER'S
PHYSICAL FITNESS INDEX TEST AND THE
CARDIOVASCULAR EFFICIENCY TEST

<table>
<thead>
<tr>
<th>Item and Group</th>
<th>Initial Mean</th>
<th>Final Mean</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull-ups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>21.7</td>
<td>31.7</td>
<td>5.26</td>
<td>.01</td>
</tr>
<tr>
<td>II</td>
<td>18.7</td>
<td>28.8</td>
<td>5.32</td>
<td>.01</td>
</tr>
<tr>
<td>III</td>
<td>25.9</td>
<td>32.9</td>
<td>3.68</td>
<td>.01</td>
</tr>
<tr>
<td>IV</td>
<td>25.6</td>
<td>32.4</td>
<td>3.58</td>
<td>.01</td>
</tr>
<tr>
<td>Push-ups</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>3.3</td>
<td>6.0</td>
<td>5.67</td>
<td>.01</td>
</tr>
<tr>
<td>II</td>
<td>1.9</td>
<td>3.0</td>
<td>2.39</td>
<td>.05</td>
</tr>
<tr>
<td>III</td>
<td>.8</td>
<td>1.5</td>
<td>1.52</td>
<td>---</td>
</tr>
<tr>
<td>IV</td>
<td>1.7</td>
<td>2.7</td>
<td>2.17</td>
<td>.05</td>
</tr>
<tr>
<td>Arm Strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>406.0</td>
<td>640.4</td>
<td>7.81</td>
<td>.01</td>
</tr>
<tr>
<td>II</td>
<td>343.4</td>
<td>551.1</td>
<td>6.92</td>
<td>.01</td>
</tr>
<tr>
<td>III</td>
<td>454.4</td>
<td>595.2</td>
<td>4.67</td>
<td>.01</td>
</tr>
<tr>
<td>IV</td>
<td>414.5</td>
<td>541.5</td>
<td>4.23</td>
<td>.01</td>
</tr>
<tr>
<td>Grip (right + left)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>118.3</td>
<td>121.3</td>
<td>1.02</td>
<td>---</td>
</tr>
<tr>
<td>II</td>
<td>115.8</td>
<td>115.5</td>
<td>.10</td>
<td>---</td>
</tr>
<tr>
<td>III</td>
<td>108.4</td>
<td>114.3</td>
<td>2.01</td>
<td>---</td>
</tr>
<tr>
<td>IV</td>
<td>106.0</td>
<td>110.8</td>
<td>1.64</td>
<td>---</td>
</tr>
</tbody>
</table>

Group I: Intermediate swimming and isometric exercises
Group II: Beginning golf and isometric exercises
Group III: Intermediate swimming
Group IV: Beginning golf
Number in each group was 24

\[ t_{.01} = 2.807 \quad t_{.05} = 2.069 \]
TABLE I (continued)

<table>
<thead>
<tr>
<th>Item and Group</th>
<th>Initial Mean</th>
<th>Final Mean</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back Lift</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>236.7</td>
<td>239.6</td>
<td>.48</td>
<td>---</td>
</tr>
<tr>
<td>II</td>
<td>229.8</td>
<td>235.6</td>
<td>.95</td>
<td>---</td>
</tr>
<tr>
<td>III</td>
<td>228.8</td>
<td>240.0</td>
<td>1.84</td>
<td>---</td>
</tr>
<tr>
<td>IV</td>
<td>226.3</td>
<td>242.5</td>
<td>2.66</td>
<td>.05</td>
</tr>
<tr>
<td>Leg Lift</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>527.5</td>
<td>742.5</td>
<td>6.54</td>
<td>.01</td>
</tr>
<tr>
<td>II</td>
<td>607.5</td>
<td>720.4</td>
<td>4.34</td>
<td>.01</td>
</tr>
<tr>
<td>III</td>
<td>655.4</td>
<td>712.5</td>
<td>2.20</td>
<td>.05</td>
</tr>
<tr>
<td>IV</td>
<td>556.9</td>
<td>720.0</td>
<td>6.27</td>
<td>.01</td>
</tr>
<tr>
<td>Lung Capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>175.1</td>
<td>182.9</td>
<td>2.39</td>
<td>.05</td>
</tr>
<tr>
<td>II</td>
<td>162.5</td>
<td>173.6</td>
<td>3.41</td>
<td>.01</td>
</tr>
<tr>
<td>III</td>
<td>175.6</td>
<td>191.3</td>
<td>4.82</td>
<td>.01</td>
</tr>
<tr>
<td>IV</td>
<td>170.9</td>
<td>186.0</td>
<td>4.63</td>
<td>.01</td>
</tr>
<tr>
<td>Physical Fitness Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>103.0</td>
<td>128.4</td>
<td>8.25</td>
<td>.01</td>
</tr>
<tr>
<td>II</td>
<td>94.2</td>
<td>113.5</td>
<td>6.27</td>
<td>.01</td>
</tr>
<tr>
<td>III</td>
<td>107.4</td>
<td>120.7</td>
<td>4.32</td>
<td>.01</td>
</tr>
<tr>
<td>IV</td>
<td>110.5</td>
<td>130.2</td>
<td>6.40</td>
<td>.01</td>
</tr>
<tr>
<td>Cardiovascular Efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>43.8</td>
<td>47.3</td>
<td>2.69</td>
<td>.05</td>
</tr>
<tr>
<td>II</td>
<td>41.4</td>
<td>45.4</td>
<td>3.08</td>
<td>.01</td>
</tr>
<tr>
<td>III</td>
<td>40.2</td>
<td>44.6</td>
<td>3.39</td>
<td>.01</td>
</tr>
<tr>
<td>IV</td>
<td>41.8</td>
<td>41.0</td>
<td>6.61</td>
<td>---</td>
</tr>
</tbody>
</table>

Group I  Intermediate swimming and isometric exercises
Group II Beginning golf and isometric exercises
Group III Intermediate swimming
Group IV Beginning golf
Number in each group was 24

\[ t_{.01}=2.807 \quad t_{.05}=2.069 \]
No significant improvement was made in grip strength by any group. Group II, subjects participating in golf and isometric exercises, showed a loss in grip strength, but it was not statistically significant. Only Group IV, those participating in golf only, showed significant improvement on the back lift test. This improvement was beyond the .05 level.

On the leg lift Group I, those taking swimming and isometric exercises, Group II, those taking golf and isometric exercises, and Group IV, those taking only golf, increased scores significantly at the .01 level. Group III, subjects taking swimming only, showed strength increase at the .05 level on the leg lift test.

Significant increase in lung capacity was at the .01 level for Group II, golf and isometric exercise, Group III, swimming only, and Group IV, golf only. Group I, swimming and isometric exercise, showed significant increase at the .05 level.

All groups showed significant improvement in the Physical Fitness Index at the .01 level of probability.

Cardiovascular Efficiency Test

Scores on this test were improved significantly at the .01 level of probability by Group II, those taking golf and isometric exercises, and Group III, those taking swimming only. Group I, the swimming and isometric exercise subjects, improved at the .05 level of probability. A lower mean score was shown by Group IV,
subjects participating in golf only, on the final test, but it was not statistically significant.

II: ANALYSIS OF COVARIANCE

Analysis of covariance was used to determine if there were significant differences in the final scores among the four groups on each of the tests. This method allows for correlation between initial and final scores, and final means are corrected for any differences that may have existed in the initial means in the tests. Analyses were made of the scores of the Roger's Physical Fitness Index Test items and of the Cardiovascular Efficiency Test. The results of the analyses are shown in Table II. In order to be significant, an F-ratio of .71 was required at the .05 level of probability and of 4.01 at the .01 level.

Roger's Physical Fitness Index Test

Analyses of the items in the Roger's Physical Fitness Index Test battery resulted in F-ratios that indicated significant differences between groups only in arm strength and leg lift strength. As shown in Table II, the F-ratio for arm strength was 3.37 and for leg lift strength was 2.88. These ratios were significant at the .05 level of probability. The F-ratio of 2.61 for the Physical Fitness Index approached significance at the .05 level of probability.
<table>
<thead>
<tr>
<th>Item</th>
<th>Source of Variation</th>
<th>df</th>
<th>Mean Squares</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull-ups Total</td>
<td>94</td>
<td></td>
<td>51</td>
<td>.80</td>
<td></td>
</tr>
<tr>
<td>Among Groups</td>
<td>3</td>
<td></td>
<td>51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td></td>
<td>64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Push-ups Total</td>
<td>94</td>
<td></td>
<td>1.07</td>
<td>.25</td>
<td></td>
</tr>
<tr>
<td>Among Groups</td>
<td>3</td>
<td></td>
<td>1.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td></td>
<td>4.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm Strength</td>
<td>Total</td>
<td>94</td>
<td>69578</td>
<td>3.37</td>
<td>.05</td>
</tr>
<tr>
<td>Among Groups</td>
<td>3</td>
<td></td>
<td>69578</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td></td>
<td>20645</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grip</td>
<td>Total</td>
<td>94</td>
<td>85</td>
<td>.53</td>
<td></td>
</tr>
<tr>
<td>Among Groups</td>
<td>3</td>
<td></td>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td></td>
<td>160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back Lift Total</td>
<td>94</td>
<td></td>
<td>499</td>
<td>.72</td>
<td></td>
</tr>
<tr>
<td>Among Groups</td>
<td>3</td>
<td></td>
<td>499</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td></td>
<td>696</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg Lift Total</td>
<td>94</td>
<td></td>
<td>32352</td>
<td>2.88</td>
<td>.05</td>
</tr>
<tr>
<td>Among Groups</td>
<td>3</td>
<td></td>
<td>32352</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td></td>
<td>11230</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung Capacity</td>
<td>Total</td>
<td>94</td>
<td>350</td>
<td>1.40</td>
<td></td>
</tr>
<tr>
<td>Among Groups</td>
<td>3</td>
<td></td>
<td>350</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td></td>
<td>250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Fitness Index</td>
<td>Total</td>
<td>94</td>
<td>559</td>
<td>2.61</td>
<td></td>
</tr>
<tr>
<td>Among Groups</td>
<td>3</td>
<td></td>
<td>559</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td></td>
<td>214</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiovascular Efficiency</td>
<td>Total</td>
<td>94</td>
<td>138</td>
<td>5.11</td>
<td>.01</td>
</tr>
<tr>
<td>Among Groups</td>
<td>3</td>
<td></td>
<td>138</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>91</td>
<td></td>
<td>27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ F_{.01} = 4.01 \quad F_{.05} = 2.71 \]
For those test items which produced significant F-ratios, further study of the data was made by means of orthogonal comparisons, as shown in Figure 1. In these comparisons an F-ratio of 3.95 was required for significance at the .05 level of probability and of 6.92 at the .01 level of probability.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
<th>Group IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison 1</td>
<td>-1</td>
<td>-1</td>
<td>+1</td>
<td>+1</td>
</tr>
<tr>
<td>Comparison 2</td>
<td>+1</td>
<td>-1</td>
<td>+1</td>
<td>-1</td>
</tr>
<tr>
<td>Comparison 3</td>
<td>-1</td>
<td>+1</td>
<td>+1</td>
<td>-1</td>
</tr>
</tbody>
</table>

FIGURE 1
PATTERN FOR ORTHOGONAL COMPARISONS

Arm strength. Comparisons of performances in arm strength are shown in Table III. The first comparison, between the isometric groups and non-isometric groups, revealed an F-ratio of 9.70, which was significant beyond the .01 level of probability. The average of the final arm strength means of the isometric groups (I and II) was 629, and of the non-isometric groups (III and IV) was 536. This indicates a significantly greater improvement in the isometric groups than in the non-isometric groups. In comparing swimming groups (I and III) with golf groups (II and IV), the resulting F-ratio of 3.51 was not significant. The comparison to determine
For those test items which produced significant F-ratios, further study of the data was made by means of orthogonal comparisons, as shown in Figure 1. In these comparisons an F-ratio of 3.95 was required for significance at the .05 level of probability and of 6.92 at the .01 level of probability.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
<th>Group IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison 1</td>
<td>-1</td>
<td>-1</td>
<td>+1</td>
<td>+1</td>
</tr>
<tr>
<td>Comparison 2</td>
<td>+1</td>
<td>-1</td>
<td>+1</td>
<td>-1</td>
</tr>
<tr>
<td>Comparison 3</td>
<td>-1</td>
<td>+1</td>
<td>+1</td>
<td>-1</td>
</tr>
</tbody>
</table>

**FIGURE 1**

**PATTERN FOR ORTHOGONAL COMPARISONS**

**Arm strength.** Comparisons of performances in arm strength are shown in Table III. The first comparison, between the isometric groups and non-isometric groups, revealed an F-ratio of 9.70, which was significant beyond the .01 level of probability. The average of the final arm strength means of the isometric groups (I and II) was 629, and of the non-isometric groups (III and IV) was 536. This indicates a significantly greater improvement in the isometric groups than in the non-isometric groups. In comparing swimming groups (I and III) with golf groups (II and IV), the resulting F-ratio of 3.51 was not significant. The comparison to determine
### TABLE III

F-RATIOS OF ORTHOGONAL COMPARISONS FOR ARM STRENGTH AS MEASURED BY THE ROGER'S PHYSICAL FITNESS INDEX TEST FOR FOUR GROUPS OF COLLEGE WOMEN PARTICIPATING IN A VARIED PROGRAM OF ACTIVITIES

<table>
<thead>
<tr>
<th>Comparison</th>
<th>F-ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Isometric groups vs. Non-isometric groups</td>
<td>9.70</td>
<td>.01</td>
</tr>
<tr>
<td>2 Swimming groups vs. Golf groups</td>
<td>3.51</td>
<td>---</td>
</tr>
<tr>
<td>3 Interaction of swimming and golf with and without isometric exercises</td>
<td>.003</td>
<td>---</td>
</tr>
</tbody>
</table>

**Corrected Final Means**

<table>
<thead>
<tr>
<th>Group</th>
<th>Activity Details</th>
<th>Mean</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>(swimming and isometric)</td>
<td>639</td>
<td>24</td>
</tr>
<tr>
<td>II</td>
<td>(golf and isometric)</td>
<td>618</td>
<td>24</td>
</tr>
<tr>
<td>III</td>
<td>(swimming)</td>
<td>541</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>(golf)</td>
<td>530</td>
<td></td>
</tr>
</tbody>
</table>

F .01 = 6.92  
F .05 = 3.95  

N = 24 per group
interaction, Comparison 3, resulted in an F-ratio of .003 which was not significant.

Leg lift. In Table II, page 41, it was shown that the F-ratio for leg lift strength was 2.88, which reached significance at the .05 level of probability. Orthogonal comparisons in Table IV reveal an F-ratio of 1.40 for the comparison between isometric and non-isometric groups. This was not significant, nor was there any significant difference between swimming and golf groups as indicated by an F-ratio of .30. The only significant comparison was in the interaction which shows an F-ratio of 6.98, significant at the .01 level.

Interaction is measured by the difference between two differences or by the failure of the two differences to be the same. In order to study this interaction, between swimming and golf with and without isometric exercises, the difference between differences in means was computed. The difference between means of Group I, swimming and isometrics, and Group III, golf and isometrics, was 45; the difference between means of Groups III and IV, swimming and golf without isometric exercises, was -72. The difference between these two differences was 117. This indicates that swimming and isometric exercises are a better combination than golf and isometric exercises in developing leg lift strength and that golf alone contributes more to this development than does swimming alone.
TABLE IV

F-RATIOS OF ORTHOGONAL COMPARISONS FOR LEG STRENGTH AS MEASURED IN THE ROGER'S PHYSICAL FITNESS INDEX TEST FOR FOUR GROUPS OF COLLEGE WOMEN PARTICIPATING IN A VARIED PROGRAM OF ACTIVITIES

<table>
<thead>
<tr>
<th>Comparison</th>
<th>F-ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Isometric groups vs. Non-isometric groups</td>
<td>1.40</td>
<td>---</td>
</tr>
<tr>
<td>2  Swimming groups vs. Golf groups</td>
<td>.30</td>
<td>---</td>
</tr>
<tr>
<td>3  Interaction of swimming and golf with and without isometric exercises</td>
<td>6.98</td>
<td>.01</td>
</tr>
</tbody>
</table>

Corrected Final Means

<table>
<thead>
<tr>
<th>Group</th>
<th>Activity</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Swimming and isometric</td>
<td>759</td>
</tr>
<tr>
<td>II</td>
<td>Golf and isometric</td>
<td>714</td>
</tr>
<tr>
<td>III</td>
<td>Swimming</td>
<td>675</td>
</tr>
<tr>
<td>IV</td>
<td>Golf</td>
<td>747</td>
</tr>
</tbody>
</table>

N = 24 per group

F .01 = 6.92  F .05 = 3.95
Physical Fitness Index. As shown in Table II, page 41, analysis of the Physical Fitness Index revealed an F-ratio of 2.61 which approached significance at the .05 level of probability. Since this ratio approached significance, further study of the data was made. The comparisons are shown in Table V.

The first comparison, to determine the difference between the isometric and non-isometric groups, resulted in an F-ratio of 2.19 which was not significant. The comparison to determine the difference between the effects of swimming and golf showed an F-ratio of .005 which also was not significant. The third comparison, which tested the interaction between swimming and golf with and without isometric exercises, resulted in an F-ratio of 5.51 which was significant beyond the .05 level of probability.

In analyzing this comparison, the difference between the means of Group I (swimming and isometric) and Group II (golf and isometric) was 7. The difference between the means of Group III (swimming) and Group IV (golf) was -6. The difference between these differences was 13. This indicates that a combination of swimming and isometric exercises was better than a combination of golf and isometric exercises, and that golf alone was better than swimming alone for improvement of the Physical Fitness Index.

Cardiovascular Efficiency Test

Analysis of covariance for the Cardiovascular Efficiency Test scores, Table II, page 41, revealed an F-ratio of 5.11,
**TABLE V**

F-RATIOS OF ORTHOGONAL COMPARISONS FOR THE PHYSICAL FITNESS INDEX FOR FOUR GROUPS OF COLLEGE WOMEN PARTICIPATING IN A VARIED PROGRAM OF ACTIVITIES

<table>
<thead>
<tr>
<th>Comparison</th>
<th>F-ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Isometric groups vs. Non-isometric groups</td>
<td>2.19</td>
<td>---</td>
</tr>
<tr>
<td>2 Swimming groups vs. Golf groups</td>
<td>.01</td>
<td>---</td>
</tr>
<tr>
<td>3 Interaction of swimming and golf with and without isometric exercises</td>
<td>5.51</td>
<td>.05</td>
</tr>
</tbody>
</table>

**Corrected Final Means**

<table>
<thead>
<tr>
<th>Group</th>
<th>Activity Description</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>(swimming and isometric)</td>
<td>129</td>
</tr>
<tr>
<td>II</td>
<td>(golf and isometric)</td>
<td>122</td>
</tr>
<tr>
<td>III</td>
<td>(swimming)</td>
<td>118</td>
</tr>
<tr>
<td>IV</td>
<td>(golf)</td>
<td>124</td>
</tr>
</tbody>
</table>

N = 24 per group

F .01 = 6.92  
F .05 = 3.95
significant at the .01 level of probability. In Table VI, orthogonal comparisons showed two significant F-ratios. In comparing the isometric groups to the non-isometric groups, an F-ratio of 6.41 was obtained. This was significant beyond the .05 level of probability and was in favor of the isometric groups. The average of means for Groups I and II, swimming and isometric and golf and isometric, was 45.93 and for Groups III and IV, swimming only and golf only, was 43.23. Significance at the .05 level was found in the comparison of the swimming and golf groups with an F-ratio of 5.67. This difference was in favor of the swimming groups whose average of the means was 45.85 as compared to an average of the means of 43.31 for the golf groups. An F-ratio of 3.07 for comparison three, interaction between the groups, was not significant.

III. ANALYSIS OF STRENGTH GAINS
FOR ISOMETRIC GROUPS

As stated in Chapter III, strength measures were taken periodically with a spring-scale device to provide motivation to exert to the maximum in the isometric exercises and also to determine whether any gain in strength occurred in the positions exercised during the study. The means of the initial and final strength scale readings of the groups using isometric exercises, Group I, swimming and isometric exercises, and Group II, golf and isometric exercises,
TABLE VI

F-RATIOS OF ORTHOGONAL COMPARISONS FOR THE CARDIOVASCULAR EFFICIENCY TEST FOR FOUR GROUPS OF COLLEGE WOMEN PARTICIPATING IN A VARIOUS PROGRAM OF ACTIVITIES

<table>
<thead>
<tr>
<th>Comparison</th>
<th>F-ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Isometric groups vs. Non-isometric groups</td>
<td>6.41</td>
<td>.05</td>
</tr>
<tr>
<td>2 Swimming groups vs. Golf groups</td>
<td>5.67</td>
<td>.05</td>
</tr>
<tr>
<td>3 Interaction of swimming and golf with and without isometric exercises</td>
<td>3.07</td>
<td>---</td>
</tr>
</tbody>
</table>

Corrected Final Means

<table>
<thead>
<tr>
<th>Group</th>
<th>Activity</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>(swimming and isometric)</td>
<td>46.24</td>
</tr>
<tr>
<td>Group II</td>
<td>(golf and isometric)</td>
<td>45.61</td>
</tr>
<tr>
<td>Group III</td>
<td>(swimming)</td>
<td>45.45</td>
</tr>
<tr>
<td>Group IV</td>
<td>(golf)</td>
<td>41.00</td>
</tr>
</tbody>
</table>

N = 24 per group

F .01 = 6.92  F .05 = 3.95
were computed, and the $t$-test was used to test the significance of the difference. This is shown in Table VII. The observed difference of 12.33 scale units resulted in a $t$-ratio of 14.01, which was highly significant beyond the .01 level of probability.

<table>
<thead>
<tr>
<th>Initial Mean</th>
<th>Final Mean</th>
<th>$t$</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.92</td>
<td>54.25</td>
<td>14.01</td>
<td>.01</td>
</tr>
</tbody>
</table>
CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

It was the purpose of this study to study the effects of supplementary isometric exercises with swimming and golf on muscular strength, physical fitness, and cardiovascular efficiency of college women.

Subjects for the study were ninety-six women students at Louisiana State University, Baton Rouge, Louisiana. The subjects were divided into four groups: (1) Group I, participated in intermediate swimming and an isometric exercise program; (2) Group II, participated in beginning golf and an isometric exercise program; (3) Group III, participated in intermediate swimming with no supplementary exercises and (4) Group IV, participated in beginning golf with no supplementary exercises.

At the beginning of the experiment all subjects were tested on the Roger's Physical Fitness Index Test and the Cardiovascular Efficiency Test for Girls and Women. Subjects in the isometric exercise program were also given strength tests with a spring-scale device. At the end of an eight-week period the subjects were measured again on all tests.

The t-test was used to determine the significance of the
difference between initial and final means on the Roger's Physical Fitness Index Test items, the Physical Fitness Index, and the Cardiovascular Efficiency Test. An analysis of covariance was employed to treat the data to compare the effects of the four different programs on strength, physical fitness, and cardiovascular efficiency. The t-test was used to compare initial and final means of strength scores for the isometric groups tested with the spring-scale.

II. FINDINGS

The findings obtained in this study revealed differences between initial and final test means, comparisons of programs of activity, and strength gains of the isometric groups.

Differences Between Initial and Final Test Means

Physical Fitness Index. All groups showed significant improvement in the Physical Fitness Index.

Cardiovascular Efficiency. Cardiovascular efficiency was improved significantly in the group which participated in swimming and isometric exercises, the group which participated in golf and isometric exercises, and the group which participated only in swimming. The group participating in golf without isometric exercises had a lower mean score on the final than on the initial test.
Items of Roger's Physical Fitness Index Test. Scores were improved significantly by all groups on the pull-ups, arm strength, leg lift, and lung capacity. Push-up scores were improved significantly by three groups: those participating in swimming and isometric exercises, in golf and isometric exercises, and in golf only. No group showed significant differences in grip strength. Those participating in golf and isometric exercises showed a loss in grip strength. Back lift scores were increased significantly by only one group, the subjects participating in golf without isometric exercises.

Comparison of Programs of Activity

Physical Fitness Index. The only significant difference found in comparison of groups on the Physical Fitness Index was in the interaction comparing the effects of swimming and golf with and without isometric exercises. In this it was revealed that the swimming and isometric exercises combination produced better results than golf and isometric exercises. Without isometric exercises, golf was more effective than swimming.

Cardiovascular Efficiency. In comparing programs in the development of cardiovascular efficiency, the isometric exercise programs were found to be significantly superior to non-isometric exercise programs. Swimming programs produced significantly higher improvement than the golf programs.
Items of Roger's Physical Fitness Index Test. Differences between groups were not significant in pull-ups, push-ups, grip strength, back lift, and lung capacity. In arm strength comparisons showed the isometric exercise groups significantly superior to the non-isometric groups. On the leg lift test the only significant comparison was in the interaction of swimming and golf with and without isometric exercises. This showed swimming and isometric exercises to be better than golf and isometric exercises and golf alone better than swimming alone.

Strength Gains of the Isometric Groups

Highly significant gains in strength of the subjects taking isometric exercises were revealed by results of tests with the spring-scale measuring device.

Discussion of Findings

It is possible that certain uncontrolled factors contributed to the increase in test scores. Some gain could be due to the education factor in that students improved their scores because they were familiar with the tests. The subjects in the isometric exercise program may have been more highly motivated to try harder during the re-test because of the extra attention given them during the study, and it is conceivable that merely the additional exercises may have made them more conscious of strength development.

The theory that grip strength does not change much is
supported by the fact that no group mean was significantly changed in this study. There is reason to question the finding that subjects participating in golf and the isometric exercise program decreased in grip strength even though it was not statistically significant. It would seem that gripping the golf club alone would cause some strengthening of the grip and that the additional isometric exercises which involved gripping the Iso-belt would also result in an increase.

The interactions which were indicated by comparisons made between groups in the Physical Fitness Index and leg lift showed the combination of swimming and isometric exercises favored over a combination of golf and isometric exercises. However, golf alone produced more increase than did swimming alone. This might be interpreted to indicate that the golf activity and the isometric exercises contributed to the same development and that swimming produced other development.

There has been a theory suggested concerning isometric exercises that a one-second maximum isometric contraction per day is sufficient to increase strength. Perhaps in the golf swing a person is approaching this maximum effort for a short period of time. This would account for there being no difference in groups in strength tests other than in arm strength.

The contraction for each exercise in this study was held for six seconds as an endurance factor. This might account for the
fact that the subjects in golf without the isometric exercises did not improve on the final cardiovascular test.

It is a general belief that swimming contributes more to cardiovascular development than does golf. The results of this study tend to support this belief. The fact that isometric exercises can produce significant increases in this development has been questioned. This study indicated that a program of isometric exercises combined with regular intermediate swimming and beginning golf class activity is preferable to the swimming and golf class activity alone. This would suggest that isometric exercises are effective in increasing the cardiovascular efficiency of college women.

III. CONCLUSIONS

The following conclusions resulted from this study:

1. Physical fitness of college women as measured by the Roger's Physical Fitness Index Test can be improved by participation in intermediate swimming, beginning golf, and a combination of either of these activities and an isometric exercise program.

2. There was no difference in the effectiveness of intermediate swimming and beginning golf in improvement of physical fitness of college women as measured by the Roger's Physical Fitness Index Test.
3. The addition of an isometric exercise program to regular activities of intermediate swimming and beginning golf did not increase the effectiveness of these activities in the improvement of physical fitness of college women.

4. Intermediate swimming improves the cardiovascular efficiency of college women, whereas beginning golf as taught in this program does not.

5. Intermediate swimming with supplementary isometric exercises and beginning golf with supplementary isometric exercises improve the cardiovascular efficiency of college women.

6. The addition of isometric exercises to the intermediate swimming and beginning golf activities develops arm strength as measured by the Roger's Physical Fitness Index Test more effectively than mere participation in the activities without supplementary exercises.

IV. RECOMMENDATIONS

In light of the findings of this study, the author recommends for further research:

1. A study in which subjects would participate in no activity but would be administered two trials of the Roger's Physical Fitness Index test to study the education factor
involved in testing.

2. An investigation in which consideration is given to the high and low Physical Fitness Indices to study the effect of initial condition on improvement of physical fitness in college women.

3. An investigation in which improvement of certain aspects of physical fitness are studied with subjects participating only in isometric exercise in order to study the effect of the isometric exercise program alone.

4. A study which would investigate the effects of other activities of a college physical education basic skills program for women combined with and/or compared to an isometric exercise program similar to the one used in this experiment.
SELECTED BIBLIOGRAPHY
SELECTED BIBLIOGRAPHY

A. BOOKS


B. PERIODICALS


Rasch, Philip J. "Progressive Resistance Exercise: Isotonic and Isometric: A Review," The Journal of the Association for Physical and Mental Rehabilitation, XV (March-April, 1961),


C. ESSAYS AND ARTICLES IN COLLECTIONS


D. UNPUBLISHED MATERIALS


APPENDIX A

GENERAL INSTRUCTIONS FOR THE ISOMETRIC EXERCISE PROGRAM

WITH THE ISO-BELT*

Each exercise should last for approximately ten seconds. The first three or four seconds should be used to gradually increase the pull until the desired effort is reached. This pull is then held for the remainder of the ten seconds.

Maximum effort should not be attempted by a person just starting the exercise program. A gradual increase in pull should result as the individual continues the program. Pain is an indication that the individual is exerting too much force, and she should reduce the force immediately. If pain continues to accompany any exercise, that exercise should be discontinued temporarily.

There is no set order in which all the exercises should be done.**

*Iso-belt designed and manufactured by Francis A. Drury, Baton Rouge, Louisiana.

**"Isometric Contraction Exercises With Iso-belt," instruction booklet accompanying the Iso-belt.
EXERCISE 1—ELBOW FLEXORS

The subject places the right foot on the wooden block and holds the belt in the right hand, palm facing up. An upward force is exerted by flexing the elbow. A downward force is exerted on the block by the foot to keep it on the floor. Exercise is repeated with left foot and hand.
EXERCISE 2—ARM ADDUCTORS

The subject doubles the Iso-belt and holds a double loop in each hand. Holding the arms about chest high, she attempts to put the right hand in front of the left shoulder and the left hand in front of the left shoulder. Arm positions are then reversed and the exercise is repeated.
EXERCISE 3—ARM ABDUCTORS

The subject loops the belt around the wrists and holds the hands about head high in front of the body. She attempts to move the hands away from the mid-line of the body.
EXERCISE 4--SCAPULA ADDUCTORS

The subject doubles the belt and holds a double loop in each hand. Holding the arms about shoulder height, she attempts to pull the hands away from the mid-line.
EXERCISE 5—SHOULDER SHRUG

The subject places the belt under the bench with a loop of the belt in each hand. Keeping the elbows straight, she exerts a force upward by shrugging the shoulders.
The subject holds a loop of the belt in each hand and puts the belt behind the head. She pushes backward with the head and pulls forward with the hands.
APPENDIX H

EXERCISE 7—KNEE ABDUCTORS

The subject loops the belt around both knees and attempts to move the knees away from the mid-line of the body.
EXERCISE 8—KNEE ABDUCTORS (ALTERNATE METHOD)

In the alternate method without the belt, the subject leans forward and places her hands on the outside of the knees. She attempts to move the knees away from the mid-line of the body.
EXERCISE 9—KNEE ADDUCTORS

The subject leans forward and places her forearm between her knees with the elbow against the inside of one knee and the palm of the hand against the inside of the other knee. She attempts to move the knees toward the mid-line of the body.
EXERCISE 10—DEAD LIFT

The subject stands with both feet on the wooden block. She bends the knees slightly, grasps the loop of the belt between and at the level of the knees, and pulls upward, keeping the arms straight. The angle of the back with the floor should be about 60 degrees.
EXERCISE 11—ABDOMINAL CONTRACTION

The subject stands and pulls in the abdominal wall as far as possible.
APPENDIX M

ISO-BELT AND SPRING-SCALE MEASURING DEVICE

Top of picture: the Iso-belt used for the exercises.

Bottom of picture: the spring-scale device used for providing motivation and periodic measurement of strength for subjects participating in the isometric exercise program.
APPENDIX N

TABLE FOR CONVERSION OF PULSE RATES TO CARDIOVASCULAR EFFICIENCY SCORES FOR THOSE COMPLETING THE THREE-MINUTE STEP TEST*

<table>
<thead>
<tr>
<th>Standard</th>
<th>Score</th>
<th>30 sec. pulse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>96 and above</td>
<td>32 and below</td>
</tr>
<tr>
<td></td>
<td>91-95</td>
<td>34-35</td>
</tr>
<tr>
<td></td>
<td>86-90</td>
<td>36-37</td>
</tr>
<tr>
<td></td>
<td>81-85</td>
<td>38-39</td>
</tr>
<tr>
<td></td>
<td>76-80</td>
<td>40-42</td>
</tr>
<tr>
<td></td>
<td>71-75</td>
<td>43-45</td>
</tr>
<tr>
<td>Very Good</td>
<td>66-70</td>
<td>46-49</td>
</tr>
<tr>
<td></td>
<td>60-65</td>
<td>50-54</td>
</tr>
<tr>
<td>Good</td>
<td>55-59</td>
<td>55-58</td>
</tr>
<tr>
<td></td>
<td>49-54</td>
<td>59-65</td>
</tr>
<tr>
<td>Fair</td>
<td>44-48</td>
<td>67-73</td>
</tr>
<tr>
<td></td>
<td>39-43</td>
<td>74-83</td>
</tr>
<tr>
<td>Poor</td>
<td>33-38</td>
<td>84-98</td>
</tr>
<tr>
<td></td>
<td>28-32</td>
<td>99-116</td>
</tr>
<tr>
<td>Very Poor</td>
<td>0-27</td>
<td>117-120</td>
</tr>
</tbody>
</table>

VITA

The author was born in Minden, Louisiana on July 24, 1925. She received her elementary and high school education at Minden High School, graduating from there in 1942.

She received a Bachelor of Science degree in Physical Education from Louisiana Polytechnic Institute in Ruston, Louisiana in 1945. The Master of Science degree with a major in Physical Education and a minor in Health Education was awarded by Louisiana State University in 1955.

The Doctor of Philosophy degree with a major in Physical Education and a minor in Education was obtained from Louisiana State University in May, 1964.

The author was employed by the Port Arthur Independent, School District as teacher of physical education from 1945-1955. Since 1955 she has been a member of the faculty of the Department of Health, Physical and Recreation Education at Louisiana State University.
EXAMINATION AND THESIS REPORT

Candidate: Mary Louise Life

Major Field: Physical Education

Title of Thesis: The Effects of Supplementary Isometric Exercises with Swimming and Golf on Selected Physiological Factors of College Women

Approved:

[Signatures]

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

[Names]

Date of Examination:

April 28, 1964