A COMPARISON BETWEEN SWIMMING AND JOGGING USING
SELECTED CARDIOVASCULAR EFFICIENCY TESTS

by

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in

Physical Education

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The author would like to express his sincere appreciation for the contributions made to this study by the Physical Education Department and the staff involved.

A special note of thanks is given to Dr. Albert Suvac, Associate Professor in the Education Department, for his help with the computer programming and analysis. Also, a special note of thanks to the typist, Mrs. Dee Strong.

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ABSTRACT

This study was conducted in order to establish which of two activities, swimming or jogging, was most beneficial in improving cardiovascular efficiency.

Eighteen male college students were tested in three groups, two study groups and one control group, over a six-week period of time.

The results obtained by this study were as follows:

(1) Swimming and jogging improved cardiovascular efficiency equally.

(2) Respiration rates were significantly improved in the study groups as compared to improvement in the control group.

(3) Exercise was better than no exercise in improving cardiovascular efficiency.
CHAPTER I
INTRODUCTION

I. Statement of the Problem

A. General Problem - The general problem of this particular research was to compare selected cardiovascular efficiency tests between three study groups: swimming, jogging, and the control group.

B. Specific Problem - Specific problems to be considered were:
   1. To determine if there is a significant improvement in the subject's pulse rate.
   2. To determine if there is a significant improvement in the rhythm and rate of the subject's electrocardiogram.
   3. To determine if there is a significant improvement in the subject's respiration rate.
   4. To conduct all the efficiency determining tests by the use of the E. and M. Physiograph.
   5. To make all the above efficiency determining tests on the three study groups and then to compare the results in an attempt to establish which activity will prove to be more efficient in regards to cardiovascular improvement.

II. Delimitation of the Problem

This study will be delimited to: (1) Spring quarter of the 1968-69 school year; and (2) 18 male college students who will participate as indicated in the following examples: six male
students in the swimming group, six male students in the jogging group, three male students from the swimming class from which the swimming subjects were selected, to serve as a control group in the elimination of one variable, and three students from the tennis class from which the jogging subjects were selected, to serve as a control group in the elimination of one variable.

III. Definitions

A. Jogging - Jogging was conducted by having each subject use a comfortable stride suitable to his own personal preference. The subject took as much time as necessary, within a 60 minute period, to complete ten minutes of actual jogging time.

B. Swimming - Swimming was conducted by having each subject use the American Crawl as prescribed by the American Red Cross in their Instructor's Manual. The subject swam for as long as necessary, within a 60 minute period, to complete ten minutes of actual swimming.

C. Control Groups - One control group of six men was given a pre-test and a post-test. These tests were conducted to eliminate the possible variable that the physical education classes could play on the experimental groups.

D. Rate - Measuring a frequency or speed against a standard.

E. Physiograph - A versatile physiological recording system which can be operated as a single-channel recording device for a single event, or in conjunction with a large selection of accessories to provide simultaneous multi-channel recordings of a complex variety of physiological phenomena.
IV. Justification of the Study

Today there exists a public cry for an increase in ways of achieving personal health. As a result, much pressure is being exerted on the physical educator to provide various exercises, recommendations, and trends to help promote a means to achieve physical fitness as its end results. Many physicians, physical education instructors, coaches, the Federal Government, recreational and physical fitness groups (YMCA, YWCA, and AAHPER) are striving to develop activities that are beneficial to promoting physical fitness. As the minimum wage increases, the availability of facilities also increases. It has previously been proven, by scores of influential individuals, that fitness of the body is one of the keys to healthful living. However, there exists a need for research which will definitely point out which activity is one of the most beneficial in regards to personal health.

"Physical fitness is total body fitness; and, just as health is total and represents physical and mental, likewise physical fitness means total fitness--physical, social, emotional, and mental."\(^1\)

It is hoped that this study will lead an individual to an activity (swimming and/or jogging) that will be proven to be one of the best. By using one of the activities, a physical fitness program most beneficial to the individual will be partially achieved. By no means is this research trying to discredit current physical

fitness programs. It is primarily concerned with taking two excellent physical activities and, through controlled comparison, prove which is most beneficial regarding cardiovascular efficiency.

V. Research Method

A. Testing Procedures - There existed two study groups and one control group, with a total of 18 students participating.

1. In experimental group A, the swimming group, each individual was required to swim a total of ten minutes in a 60 minute period. The entire group was required to use the American Crawl stroke. This activity was conducted two alternate days of the week for a six-week period.

2. In experimental group B, the jogging group, each individual was required to jog a total of ten minutes in a 60 minute period. The entire group was required to use a stride that was comfortable to each individual. This activity was conducted two alternate days of the week for a six-week period.

3. In the control group, the individuals were required to take the selected cardiovascular pre-test at the beginning of the six-week period and a post-test at the end of the six-week period to see if the physical education class had any effect on the readings.

4. The selected cardiovascular tests, pulse rate, electrocardiogram, and respiration rate were given on Fridays of the
alternate even weeks starting on the second week, continuing on the fourth week, and ending on the sixth week of testing. The testing instrument used was the E. and M. Physiograph. The pulse rate was taken on channel one, the electrocardiogram on channel three, and the respiration rate on channel five. Each individual was tested separately. The subject assumed a comfortable supine position on a padded reclining couch. The external electrodes were placed bilaterally on the chest approximately between the interspace of the fifth and sixth rib. The photoelectric pulse pickup was placed on the index finger of the right hand. The physiograph was engaged in such a manner that two frames of 25 centimeters were recorded, the first frame at .5 centimeters per second and the second frame at 2.5 centimeters per second. After the test, the pulse rate, electrocardiogram, and respiration rate from the graph were compared for noticeable improvement.

B. Sampling - The sampling was obtained from 18 volunteer male, Caucasian students from Montana State University. Nine students were selected from the intermediate swimming physical education service class, six for experimental group A and three for the control group. Nine students were selected from the beginning tennis physical education service class, six for the experimental group B and three for the control group. The age groups ranged between 19 and 29. The height factors ranged
from five feet two inches (5'2") to six feet three inches (6'3").

The weight factors ranged from 132 pounds to 193 pounds.

VI. Hypothesis

It was the author's firm belief that the results obtained from this study were one, or a combination of, the following:

(1) swimming proved to be superior in establishing an improved cardiovascular condition during this particular test;
(2) jogging was beneficial, but not as beneficial as swimming during this particular test; and
(3) due to the amount of time and number of subjects involved, the entire study only gave an indication as to which exercise is superior.

VII. Review of Related Literature

Dr. Richard H. Pohndorf, in his article, "Swimming and Fitness", is thoroughly convinced of swimming for fitness. He aptly pointed out that swimming is one activity that holds no age barriers. It is excellent for all people of all ages from all walks of life. Dr. Pohndorf referred to the accessibility of pools as quite easy in any season. The cost of equipment is low and the long term values for any group is greatest when participating in swimming. The weightless effect the water gives to the body has a therapeutic effect on the nervous and circulatory system which is extremely beneficial. The author also pointed out the respiratory rate is reduced considerably, making each inhalation and exhalation greater in volume. The pulse rate slows down while the volume of blood during each stroke of the heart is increased because of the improved
venous return. Swimming is responsible for better blood circulation, better oxygen utilization; and, the greater the amount of blood filling the heart, the more beneficial the exercise is to the individual. He also pointed out that the skin surface blood is driven deeper into the muscles and vital organs, thereby producing optimum conditions for muscle contraction and transportation of blood to and from the vital organs. The author continued to point out that the water resistance produces bodily massage during exercise movements, thus promoting greater circulation. These actions, reactions, and interactions of the various muscles and organs are most favorable for developing circulatory and muscular fitness. Swimming serves as an invigorating tonic by increasing the metabolism, deepening the breathing, stimulating the vital organs, and nourishing the body and the mind. He indicated that research has proven that moderate swimming over a period of many weeks results in favorable cardiovascular changes. The author also pointed out that there exists a strong indication that swimming regularly helps prevent or alleviate asthma, hernias, bursitis, arthritis, etc. Finally, the author believes that swimming is an excellent antidote for fatigue of emotional origin.²

In Dr. Richard T. Mackey's article, "Get in the Swim and Regain Your Vim", he points out the importance of doing an exercise

because you enjoy it and having fitness benefits being the by-product is just as important as having a physically fit body. To force yourself into something not enjoyable is starting with a negative attitude. Dr. Mackey also referred to tests on middle-aged men done by Dr. Thomas K. Cureton. These tests showed that vigorous swimming drills can help lower pulse rates, improve breath-holding ability, improve leg and strength endurance, and reduce body fat. The amount of time spent doing these activities is arbitrary because the time involved will always produce gains that are worthwhile.3

D. G. Barker and N. A. Ponthieux ran an investigation to determine if physical fitness and the ability to swim had any significant correlation. They concluded that physical fitness was directly related to the ability to swim. The authors used 1,335 male subjects. The authors found that there existed a statistical significance between physical fitness and the ability to swim. They were not large, but positive.4

Dr. Pohndorf's article, "Developing and Maintaining Adult Physical Fitness Through Swimming," pointed out values he attributed to swimming as an exercise in establishing and maintaining physical

3Dr. Richard T. Mackey, "Get In the Swim and Regain Your Vim", Fitness for Living, Vol. 2, No. 4, July/August 1968.

fitness. The author showed that the reduction of basal blood serum cholesterol decreased from 240 to 200 mg/ml in females and decreased from 260 to 190 mg/ml in males. He also pointed out the cardiovascular changes as: (1) tremendous improvements in pulse rates, (2) pulse pressures, and (3) diastolic and systolic blood pressures. When commenting on these changes, the author maintained that continuous swimming produces an improved cardiovascular function, provided the swimming is enough and continued over a considerable period of time. The author also pointed out some subjective results referred to him by his subjects. They were: (1) felt better, (2) performed daily work better, and (3) worldly worries diminished after the swimming work out. In two female subjects, both medical subjects, it was a confirmed fact that over fifty percent (50%) of the visible broken surface blood vessels disappeared as a result of the swimming program. The author continued his article by bringing to the attention of his readers that these adults had acquired new skills and they can now utilize them for attaining and improving fitness state. The author concluded his results by stating that adjustment and motivation to swimming as an activity was demonstrated by all.5

In Cureton's article, "The Relative Value of Various Exercise Conditioning Programs to Improve Cardiovascular Status and to Prevent Heart Disease", he aptly pointed out in an indication that the

best method of improving cardiovascular fitness was through endurance programs, such as jogging, swimming, and cycling. Bowerman and Harris indicated that jogging will gradually increase the level of physical fitness.

In John A. Baker's article, "Comparison of Rope Skipping and Jogging as Methods of Improving Cardiovascular Efficiency of College Men", he found that jogging 30 minutes a day for a six-week period of time was significant in improving cardiovascular efficiency. He also found that skipping rope ten minutes a day for a six-week period was significant in improving cardiovascular efficiency. He also stated that rope skipping was as good as jogging and even better in the respect of being less time consuming and more attractive to adults who wanted to increase their cardiovascular efficiency but unable to participate in jogging because of time/facilities factors.

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CHAPTER II
ANALYSIS OF DATA

The data collected during this study was collected and recorded with the use of the E. and M. Physiograph. The location for obtaining the data was The Human Performance Laboratory, Department of Physical Education, Montana State University, Bozeman, Montana.

The entire study was programmed and directed into the Sigma VII Computer at Montana State University. When the experiment was programmed, it was programmed in such a manner that the .05 level of confidence was obtained by the results. This signifies that the results obtained would be identical in 95 out of 100 trials. The following is an analysis of the data of this experiment, as found by the Sigma VII Computer.

In the analysis of data, reference will be made to Groups I, II, and III. Group I will be referring to the swimming experimental group, Group II will be referring to the jogging experimental group, and Group III will be referring to control group, who were involved in an activity class from which Groups I and II were selected.

TABLE I

In Table I, the age of the subjects was held constant while the pulse, electrocardiogram, and respiration rates were the variables.

The pulse rate of the subjects in Groups I and II, the experimental groups, improved in a direct and equal ratio. A ratio of 118.99:118.99. However, neither group surpassed the other as shown on the t1-test (I-II) with the score of 0.00. In Group III, the control group, a higher improve-
ment was shown, but it was not high enough to prove a significant difference at the .05 level of confidence, as illustrated by the $t_{2,3}$-test (I-III, II-III) scores of 0.39.

The heart rate, as measured by the electrocardiogram (ECG), of the subjects in Groups I and II, the experimental groups, improved in a direct and equal ratio. A ratio of 153.60:153.60. However, neither group surpassed the other as shown on the $t_{1}$-test (I-II) with the score of 0.00. In Group III, the control group, a lower improvement was shown, but it was not low enough to prove a significant difference, as illustrated by the $t_{2,3}$-test (I-III, II-III) scores of 1.81.

The respiration rate of the subjects in Groups I and II, the experimental groups, improved significantly in a direct and equal ratio. A ratio of 207.46:207.46. However, neither group surpassed the other as shown on the $t_{1}$-test (I-II) with the score of 0.00. In Group III, the control group, a lower improvement was low enough to prove a significant difference at the .05 level of confidence, as illustrated by the $t_{2,3}$-test (I-III, II-III) scores of 5.15.

**TABLE II**

In Table II, the weight of the subjects was held constant, while the pulse, electrocardiogram, and respiration rates were the variables.

The pulse rate of the subjects in Groups I and II, the experimental groups, improved significantly in a direct and equal ratio. A ratio of 65.66:65.66. However, neither group surpassed the other as shown on the $t_{1}$-test (I-II) with the score of 0.00. In Group III, the control group,
a higher improvement was shown. This higher improvement was high enough to prove a significance of difference at the .05 level of confidence, as illustrated by the $t_{2,3}$-test (I-III, II-III) scores of 2.46.

The heart rate, as measured by the electrocardiogram (ECG), of the subjects in Groups I and II, the experimental groups, improved in a direct and equal ratio. A ratio of 198.85:198.85. However, neither group surpassed the other as shown on the $t_1$-test (I-II) with the score of 0.00. In Group III, the control group, a lower improvement was shown. This lower improvement was low enough to prove a significance of difference at the .05 level of confidence, as illustrated by the $t_{2,3}$-test (I-III, II-III) scores of 4.88.

The respiration rate of the subjects in Groups I and II, the experimental groups, improved significantly in a direct and equal ratio. A ratio of 199.12:199.12. However, neither group surpassed the other as shown by the $t_1$-test (I-II) score of 0.00. In Group III, the control group, a lower improvement was shown. This lower improvement was low enough to prove a significance of difference at the .05 level of confidence, as illustrated by the $t_{2,3}$-test (I-III, II-III) scores of 5.37.

**TABLE III**

In Table III, the height of the subjects was held constant, while the pulse, electrocardiogram, and respiration rates were the variables.

The pulse rate of the subjects in Groups I and II, the experimental groups, improved significantly in a direct and equal ratio. A ratio of 103.11:103.11. However, neither group surpassed the other as shown by
the $t_1$-test (I-II) scores of 0.00. In Group III, the control group, a higher improvement was shown, but was not high enough to prove a significance of difference at the .05 level of confidence, as illustrated by the $t_{2,3}$-test (I-III, II-III) scores of 0.72.

The heart rate, as measured by the electrocardiogram (ECG) of the subjects in Groups I and II, the experimental groups, improved in a direct and equal ratio. A ratio of 158.39:158.39. However, neither group surpassed the other as shown by the $t_1$-test (I-II) score of 0.00. In Group III, the control group, a lower improvement was shown, but it was not low enough to prove a significance of difference, as illustrated by the $t_{2,3}$-test (I-III, II-III) scores of 1.96.

The respiration rate of the subjects in Groups I and II, the experimental groups, improved significantly in a direct and equal ratio. A ratio of 215.12:215.12. However, neither group surpassed the other as shown by the $t_1$-test (I-II) score of 0.00. In Group III, the control group, a lower improvement was shown. This lower improvement was low enough to prove a significance of difference at the .05 level of confidence, as illustrated by the $t_{2,3}$-test (I-III, II-III) scores of 5.55.

It might be appropriate here to point out what scores in the $t$-tests would prove significant. In $t_1$-test, if the score was more than 2.17, then it was significant. In $t_2$-test, if the score was more than 2.20, then it was significant. In $t_3$-test, if the score was more than 2.16, then it was significant.
SUMMARY

In summary, all phases of cardiovascular efficiency improved more noticeably in the experimental groups. However, in Table II, the control group's pulse rate was significantly better. This could be due to an error on the experimenter's procedures. In all three Tables, the respiration rate of the experimental group proved to be significantly better than the control group. In Table II, the heart rate of the experimental groups proved to be significantly better than the control group.

In reference to the hypothesis, some points were accepted, others were of no effect, and some were rejected. The two activities were equal in their ability to improve cardiovascular efficiency. Therefore, swimming was not significantly superior or significantly inferior than jogging. As a result, a null hypothesis was obtained. Jogging proved to be on a par with swimming and a definite asset in improving cardiovascular efficiency. As a result, the hypothesis concerning jogging as subordinate to swimming was rejected while the factor concerning as a good means of improving cardiovascular efficiency was accepted. It was obvious, with the data obtained, that exercise was far better than no exercise at all.

CONCLUSIONS

A careful analysis of data returned from the Sigma VII computer reveals the following significant conclusions:
1. The E. and M. Physiograph is an excellent source for collecting data relating to cardiovascular efficiency tests.

2. The Sigma VII computer is an excellent source for analyzing collected data.

3. When the age of the subjects is held constant, the respiration rate of the experimental groups improved in an equal ratio and was superior to the control group.

4. When the weight of the subjects is held constant, the electrocardiogram and respiration rates of the experimental groups improved in an equal ratio and was superior to the control group.

5. When the weight of the subjects is held constant, the pulse rate of the control group was superior to that of the experimental groups.

6. When the height of the subjects is held constant, the respiration rate of the experimental group was superior to that of the control group.

7. Neither experimental group surpassed the other as shown by the t-test scores of 0.00.

8. Regular physical exercise is better than no physical exercise at all.

RECOMMENDATIONS

The following is the author's recommendations for future similar studies:
1. A more complete introduction between the subjects and the testing procedures and the testing apparatus.
2. The predetermined establishment of a ratio of distance between swimming and jogging holding the time still constant would prove to be quite beneficial.
3. The experiment should be conducted over a prolonged period of time, six weeks was not sufficient to establish good concrete data.
4. A larger sampling of somotypes, age groups, and abilities.
5. Stricter controls on diet and the time of meal consumption of subjects.
6. Stricter controls on the sleeping habits of subjects.
7. Rigid controls over such variables as heat, humidity, extracurricular activities, and actual testing procedures, such as the time of day subjects were tested and the resting period before the mechanical testing period.
LITERATURE CITED
LITERATURE CITED

Periodicals


TABLE I

Adjusted means of the post-test regarding the pulse, electrocardiogram, and respiration when the age is the covariate.

<table>
<thead>
<tr>
<th></th>
<th>GROUP I (N = 5)</th>
<th>GROUP II (N = 7)</th>
<th>GROUP III (N = 6)</th>
<th>t₁ (I - II)</th>
<th>t₂ (I - III)</th>
<th>t₃ (II - III)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pulse Mean</strong></td>
<td>118.99</td>
<td>118.99</td>
<td>130.22</td>
<td>0.00</td>
<td>0.39</td>
<td>0.39</td>
</tr>
<tr>
<td><strong>S.D.</strong></td>
<td>61.34</td>
<td>61.34</td>
<td>16.98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ECG Mean</strong></td>
<td>153.60</td>
<td>153.60</td>
<td>119.89</td>
<td>0.00</td>
<td>1.81</td>
<td>1.81</td>
</tr>
<tr>
<td><strong>S.D.</strong></td>
<td>47.48</td>
<td>47.48</td>
<td>13.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resp. Mean</strong></td>
<td>207.46</td>
<td>207.46</td>
<td>85.60</td>
<td>0.00</td>
<td>5.15</td>
<td>5.15</td>
</tr>
<tr>
<td><strong>S.D.</strong></td>
<td>55.84</td>
<td>55.84</td>
<td>15.46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* S.D. = standard deviation

** ECG = electrocardiogram

*** Resp. = respiration

**** There is a significant difference beyond the .05 level of confidence
### TABLE II

Adjusted means of the post-test regarding the pulse, electrocardiogram, and respiration when the weight is the covariate.

<table>
<thead>
<tr>
<th></th>
<th>GROUP I N = 5</th>
<th>GROUP II N = 7</th>
<th>GROUP III N = 6</th>
<th>t₁ I - II</th>
<th>t₂ I - III</th>
<th>t₃ II - III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse Mean</td>
<td>65.66</td>
<td>65.66</td>
<td>122.13</td>
<td>0.00</td>
<td>2.46</td>
<td>2.46</td>
</tr>
<tr>
<td>S.D.*</td>
<td>47.18</td>
<td>47.18</td>
<td>17.19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ECG</strong> Mean</td>
<td>198.85</td>
<td>198.85</td>
<td>115.88</td>
<td>0.00</td>
<td>4.88</td>
<td>4.88</td>
</tr>
<tr>
<td>S.D.</td>
<td>42.19</td>
<td>42.19</td>
<td>15.37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>***Resp. Mean</td>
<td>199.12</td>
<td>199.12</td>
<td>97.86</td>
<td>0.00</td>
<td>5.37</td>
<td>5.37</td>
</tr>
<tr>
<td>S.D.</td>
<td>43.35</td>
<td>43.35</td>
<td>15.79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* S.D. = standard deviation  
** ECG = electrocardiogram  
*** Resp. = respiration  
**** There is a significant difference beyond the .05 level of confidence
TABLE III

Adjusted means of the post-test regarding the pulse, electrocardiogram, and respiration when the height is the covariate.

<table>
<thead>
<tr>
<th></th>
<th>GROUP I (N = 5)</th>
<th>GROUP II (N = 7)</th>
<th>GROUP III (N = 6)</th>
<th>( t_1 )</th>
<th>( t_2 )</th>
<th>( t_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pulse Mean</strong></td>
<td>103.11</td>
<td>103.11</td>
<td>122.13</td>
<td>0.00</td>
<td>0.72</td>
<td>0.72</td>
</tr>
<tr>
<td>S.D.*</td>
<td>56.59</td>
<td>56.59</td>
<td>16.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ECG Mean</strong></td>
<td>158.39</td>
<td>158.39</td>
<td>122.58</td>
<td>0.00</td>
<td>1.96</td>
<td>1.96</td>
</tr>
<tr>
<td>S.D.**</td>
<td>47.71</td>
<td>47.71</td>
<td>13.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resp. Mean</strong></td>
<td>215.12</td>
<td>215.12</td>
<td>90.37</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.D.***</td>
<td>52.94</td>
<td>52.94</td>
<td>15.10</td>
<td></td>
<td>5.55</td>
<td>5.55</td>
</tr>
</tbody>
</table>

* S.D. = standard deviation

** ECG = electrocardiogram

*** Resp. = respiration

**** There is a significant difference beyond the .05 level of confidence