8-1-1969

A Comparison of Heart Rate Between Two Methods of Survival

Lyall Glen Bennett

A COMPARISON OF HEART RATE BETWEEN TWO METHODS OF SURVIVAL

by

Lyall Glen Bennett

B.S. in Physical Education, University of North Dakota 1968

A Thesis

Submitted to the Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the Degree of

Master of Science

Grand Forks, North Dakota

August
1969

This Thesis submitted by Lyall Glen Bennett in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

John L. Ireland
(Chairman)

W. C. Koenig

Robert G. Gjostad

A. William Johnson
Dean of the Graduate School

Permission

Title A COMPARISON OF HEART RATE BETWEEN TWO METHODS OF SURVIVAL

Department Physical Education

Degree Master of Science

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Date July 30 '69

ACKNOWLEDGMENTS

The writer wishes to acknowledge his appreciation to Dr. John Quaday and Mr. Walter Koenig, Professors in Physical Education at the University of North Dakota, for their guidance, assistance, criticism, and special efforts which helped make this study possible. Appreciation is also extended to Dr. Robert Apostal and Dr. Eldon M. Gade for serving as members of my committee.

A special note of thanks is extended to my wife, Elaine, for her constant encouragement, understanding, faith and help during this past year of graduate work.

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ABSTRACT

The purpose of this study was to determine the difference in mean heart rate, if any between drown-proofing and supine floating.

Heart rate was recorded by the researcher by palpating the radial artery for one-half minute.

One group of ten subjects was used in this study. This group was tested in the spring of 1969. The subjects were tested twice with each session lasting one hour. During each session drown-proofing and supine floating were each administered for one-half hour. The subjects were tested six times during each half hour session.

Comparisons were made between the mean differences for each method of survival for all six recordings. The null hypothesis was assumed in making comparisons at the .05 level. This hypothesis was tested with the "t" technique for the significance of the difference between means derived from correlated scores from small samples.

The conclusions indicated that supine floating required less energy, as determined by pulse rate, than drown-proofing at each of the six five-minute intervals for the ten subjects participating in this study. Results at the end of the first five-minute interval were significant at the .05 level of confidence. Results at all other intervals were significant at the .01 level of confidence.

CHAPTER I

INTRODUCTION

Today there are more people participating in aquatics than in any other period of history. Modern man is now involved in boating, boat racing, fishing, water skiing, and swimming. Now that there are more people involved in aquatics, it is obvious that man must become more aware of modern techniques of drowning prevention that may save his life.

Statement of the Problem

The purpose of this study was to determine whether drown-proofing or supine floating would have greater effect upon heart rate over a prolonged period of time. The writer was also interested in discovering which method was the most comfortable for the subjects.

Need for the Study

The writer believed that there were two reasons which made this study feasible. First, it was believed that there were too many drownings that might be avoided. Secondly, it was believed that the information gained through this study could be used to guide swimming instructors in the selection of what method was the most practical to teach.

Delimitations of the Study

The writer delimited the study to:

1. a volunteer group of university students at the University of North Dakota.

2. swimmers who already had passed or were capable of passing the American Red Cross Advanced Beginners test.

3. an indoor swimming pool with modern heating facilities.

4. Lanoue's method of drown-proofing in its normal execution.

5. the American Red Cross method of supine floating in its normal execution.

Limitations of the Study

The following limitations must be taken into consideration when interpreting the results of this study:

1. No control was exercised over the sleep, diet, daily habits, or emotional or physical make-up of the subjects.

2. The degree of interest on the part of the students may have affected the results in some cases.

3. There was no regulation upon the age of the subjects.

Definition of Terms

Floating.--To rest on the surface of the water without (or with slight) movement.

Supine Floating.--The ability to rest on the surface of the water with the face up, without or with only slight movement.

Tuck Floating.--Floating with knees bent to chest, arms encircling knees, forehead on knees.

Buoyancy.--The ability of the body to float.

Vital Capacity.--The maximum inspiration of air in an individual.

Surface area.--The amount of surface of the body to be in contact with the water.

Specific Gravity.--The ratio of the density of a body as compared to the density of water.

Drown Proofing.--The ability to float in an open tuck floating position with the head of the body under the surface of the water. The head will break the surface of the water periodically to exhale and inhale air. This is caused by the force of dropping the arms to the side or by kicking the legs together in a scissor fashion.

Review of Related Literature

There are very few studies that have been done in aquatics that deal with supine floating or drown-proofing. The areas studied dealt with buoyancy, floating ability, and specific gravity.

Cureton[1] claimed that many swimming instructors believe that if a body has buoyancy it will float. This assumption may be invalid because every object has some buoyancy, but not all objects float in water. The Law of Buoyancy by Archimedes stated: "A body is buoyed up by a force equal to the weight of the volume of the water displaced."[2]

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[1] T. K. Cureton, War Aquatics (Champaign, Ill.: Stipes Publishing Co.), p. 78.

[2] Ibid.

Rork and Hellebrandt[3] based their study on three factors affecting floating ability: (1) specific gravity, (2) buoyancy, (3) equilibrium in the water. The authors stated in the same study that, as early as 1874, Pettigrew expressed the belief that since all humans are lighter than water, everyone can float in this medium if a relaxed supine position is assumed with the arms outstretched and if the breathing remains natural. It was also revealed that Sandon, an English investigator, concluded that floating cannot be achieved in fresh water if the specific gravity of the body is greater than .9875. Hence, since all women have a density less than this, all women can float. Rork and Hellebrandt believed that both Pettigrew and Sandom were wrong because not all women could float in their practical experience. The experiment was performed on a group of 27 adult women, all of whom were expert swimmers. It was found that the primary factor affecting the specific gravity was the quantity of air and gas in the various body cavities. The results also indicated that the relation between adipose tissue and buoyancy is probably less significant in determining the floating ability of an adult than either vital capacity or surface area. The authors also indicated that not all women can float.

A study of the various floating abilities of the male was understaken by Whiting.[4] The study involved the use of 1,040 males

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[3]R. Rork and F. Hellebrandt, "Floating Ability of Women," Research Quarterly, VIII (December, 1937), 19-22.

[4]T. A. Whiting, "Variations in Floating Ability with Age in the Male," Research Quarterly, XXXIV (March, 1963), 84-90.

between the ages of 9 and 24 years. The participants were subjected to the following four tests of flotation:

1. A tuck float.
2. A tuck float during normal respiration.
3. A tuck float during maximal exhalation underwater.
4. A horizontal float on the back.

Whiting's results showed a significant decrease in the proportion of floaters from the age of 13 years and upward. The other age groups tested showed a pronounced peak in both horizontal and tuck floating between the ages of 10 and 13 years. There was an almost complete inability for horizontal floating from the age of 15 years and upward. It was estimated that the acquisition and distribution of high and low density occurred between childhood and maturity.

There was a similar study done on women by Whiting.[5] There were 877 female subjects between the ages of 10 and 18 years of age. They were tested in an indoor pool with a temperature of 78-80° F. The subjects were required to do:

1. a tuck float after a maximum inspiration.
2. a tuck float during the normal respiration.
3. a tuck float after a maximum expiration.
4. horizontal floating on the back.

It was found that superior tuck floating occurred after maximum inhalation and during normal breathing. Superior horizontal floating ability occurred from the age of about 13 years upward as compared with a male of similar age.

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[5]T. A. Whiting, "Variations in Floating Ability with Age in the Female," Research Quarterly, XXXVI (May, 1965), 37.

When considering respiration, it is important to be aware of the effect of the water temperature. Karpovich[6] indicated that swimmers (especially beginning swimmers) experience difficulty when first adjusting to the water. He illustrated the effect a cold shower has on a person. At first there occurs a gasping effect which is caused by the diaphram not working properly. The author concluded that headaches and nose bleeds are due to a disturbance in blood pressure brought about by improper breathing. It was also noted that teaching correct breathing to beginners in swimming would eliminate this problem.

A study was done by E. C. Love and J. C. Mitchem[7] to predict either floating or non-floating buoyancy from certain anthropometric measurements. A secondary purpose of the study was to determine the possibility of the existence of racial differences which affect buoyancy. Seventeen anthropometric measurements were taken employing the technique used in the Iowa Child Welfare Research Station. After the data had been obtained, the participants were asked to do the tuck float. It was discovered that three variables---standing height, vital breathing capacity, and sitting height--were the greatest contributors to the prediction of buoyancy for the white group. From the testing it was discovered that Negro males are anthropometrically different and experience much greater difficulty with buoyancy.

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[6]P. V. Karpovich, "The Effect of Water Temperature on Respiration in Swimming," Research Quarterly, X (October, 1939), 39.

[7]E. C. Love and J. C. Mitchem, "Buoyancy as Predicted by Certain Anthropometric Measurements," Research Quarterly, XXV (March, 1964), 21-28.

A study of the effect water temperature has on aerobics was conducted by Costill.[8] Four members of the Cortland State College swimming team were used as subjects. The participants were to assess the effects of three swimming pool water temperatures (64° F., 77° F., and 90° F.) on metabolic responses during three minutes of experimental work. Heart rates and rectal temperature were recorded after each minute of exercise. It was found the water temperatures did not significantly affect heart rate, rectal temperature or maximal oxygen uptake. There was greater hyperventilation in water at 64° F. than in water at 77° F. temperature.

A study to show the relationship of certain buoyancy measures with specific gravity and body fat in adult males was undertaken by Hovell.[9] All subjects were weighed hydrostatically. Six weighings were recorded for each individual under three different "lung-air" conditions: forced respiration, normal respiration, and forced expiration. The specific gravity was determined from hydrostatic body weight after maximal exhalation. Hovell found that significant, but low positive correlations were obtained between all buoyancy variables. It was also discovered that some adult males are not able to float regardless of air intake.

In the year 1963, F. R. Lanoue[10] published a book on a method of using the body's buoyancy to float submerged below the water.

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[8]D. L. Costill, "Effects of Water Temperature on Aerobic Capacity," Research Quarterly, XXXIX (March, 1968), 67-73.

[9]M. L. Hovell, et al., "Relationship Between Human Buoyancy Measures, Specific Gravity and Estimated Body Fat in Males," Research Quarterly, XXXIII (October, 1962), 400-405.

[10]F. R. Lanoue, Drown-proofing, A New Technique for Water Safety (Englewood Cliffs, N.J.: Prentice Hall, 1963), p. 1-35.

Lanoue claimed that his method did not drain the human body of its energy as much as any other method of floating or resting in the water. The method employed was called drown-proofing. The name given to this technique implied that anyone who used this method with a calm mind would not drown regardless of his ability to swim. Such national swimming societies as the American Red Cross[11] and Canadian Red Cross[12] have accepted Lanoue's method in their instructional programs. Noted national magazines (such as Safety Education,[13] Times Educational Supplement,[14] School Safety,[15] and Good Housekeeping,[16]) have approved and sanctioned drown-proofing as the best method for surviving. During a personal interview with Dr. R. Clayton[17] on August 4, 1968, at the University of North Dakota, the writer discovered that Dr. Clayton's views regarding drown-proofing as the best method available for resting in the water were highly favorable. Dr. Clayton felt that drown-proofing was a superior method of floating and that it

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[11]American Red Cross, Swimming and Water Safety (American Red Cross, 1968).

[12]Canadian Red Cross Society Water Safety Division, "Instructor's Guide and Reference," (I.G.R. Reprint, 1966).

[13]Hutto, B., "Drownproof Yourself," Safety Education, XXXIX (May, 1960), 14.

[14]R. H. Harcourt, "All Children Should be Drown-Proofed," Times Educational Supplement, XLIII (September, 1965), 43.

[15]"Learning to Float," School Safety, II (March, 1967), 16.

[16]"Easy to Learn Survival Floating," Good Housekeeping, June 1962, p. 139.

[17]R. D. Clayton, Private interview held at the University of North Dakota, Grand Forks, North Dakota, August 4, 1968.

would be only a very short time before everyone would be aware of this method.

Summary of Related Literature

From the review of literature, there was considerable evidence that the majority of men and women possess the ability to float.

Studies examined for this research also indicated that children in their early teens have the best buoyancy and therefore could float better than at any other time during their lives. The literature also revealed that women are better floaters than men, that the temperature of the water influences oxygen consumption, and that anthropometric measurements can be used to predict floating ability.

CHAPTER II

METHODOLOGY

Description of Test

The test to be used was constructed by the writer to determine the relative energy cost of supine floating as compared to drown-proofing. The purpose of the test was to measure the heart rate of an individual by palpating the radial artery for thirty seconds in duration. The test was suitable to use because of the simplicity and relative ease in administration.

This test is original in that the design of construction and the purpose was never used before. However, in the literature reviewed there were similar tests that have been constructed to measure heart rate, but the purposes of these tests were not the same. This method of obtaining heart rate is usually relatively short in duration.

Procedure

A reliability study of the test was undertaken by the writer. Spearman's Rank-Difference correlation was used to establish reliability.

The test is valid in that it measured heart rate of an individual over a prolonged period of time. According to Blakiston's "New Gould Medical Dictionary,"[18] pulse is defined as:

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[18] N. L. Hoerr and A. Osal, Blakiston's New Gould Medical Dictionary (New York: McGraw Hill Book Co., Inc.), 1928, p. 988.

> The intermittent change in the shape of an artery due to an increase in the tensions of its walls following the contraction of the heart. The pulse is usually counted at the wrist (radial pulse) but may be taken over any artery that is palpable.

It can be mentioned that, although the test was designed to measure the heart rate of an individual during submaximal working conditions, it could also have measured the increased heart rate due to human emotion. However, it was assumed by the writer that emotions had very little effect.

The objectivity of the test was insured due to the relative ease of obtaining heart rate. Because learning to count pulse rate was relatively simple and only one recorder used, the objectivity of the test was assured.

To further insure the reliability, validity and objectivity, test procedure and administration did not vary from each testing session.

The test was economical in both time and expense due to its simplicity in design. All equipment necessary was provided by the Men's Physical Education Department of the University of North Dakota. The test was feasible for this research because of its simplicity and short test time.

Equipment Used

1. University of North Dakota Pool

    (a) Constructed by Lenci and Englund
    (b) Cost was $93,000
    (c) The pool was provided for the study by the Division of Men's Physical Education at the University of North Dakota.

2. Lafayette Stop Watch

   (a) Manufactured by Lafayette Instrument Company
   (b) Cost was $31
   (c) The stop watch was borrowed from the Division of Men's Physical Education at the University of North Dakota.

3. Timex Watch

   (a) Manufactured by Timex of the United States of America
   (b) Cost was $15
   (c) The watch was purchased by the writer

4. Thermometer

   (a) Manufactured by Precision Thermometer and Instrument Co.
   (b) Cost was $5
   (c) The instrument was borrowed from the Division of Men's Physical Education at the University of North Dakota.

Experimental Method

Because this study was conducted at the University of North Dakota pool, it thus became a laboratory setting.

It was necessary for the experimenter to place controls on who was eligible to be tested and the means by which these subjects were selected. It was decided by the experimenter that all male students enrolled in an intermediate swimming course offered by the Division of Men's Physical Education were eligible to participate. Subjects for the study were selected on a volunteer basis. The experiment consisted of two sessions each lasting one hour in duration. These two sessions were completed within 72 hours of each other. Further, rigid controls were placed on temperature of the water at the pool. This remained constant for both one hour sessions.

The purpose of the testing was to determine the arterial pulse rate for both drown-proofing and supine floating. The scope of this study involved measuring heart rate for all subjects during a 30 minute period for each method of floating and then repeating the procedure within 72 hours. Following the testing procedure the data were collected and evaluated, and the results were analyzed and compared.

The experiment involved a non-probability sample utilizing the single group technique. The sample was composed of 10 male students between the ages of 18-40, registered at the University of North Dakota.

The main assumption of this design was the increased precision of the standard error of estimate resulting from the elimination of intersubject errors.

The design used for this project was appropriate in that it allowed the experimenter to monitor heart rate and to retain control of the experiment by having the subject determining the variability of the energy expenditures by participating in drown-proofing and supine floating.

Test Administration

The test consisted of two one hour sessions each divided into two one-half hour intervals. In the initial half hour of the first session all students were assigned at random to either drown-proofing or supine floating. Then during the next half hour, they completed the other technique. During the second session the process was reversed. In other words, if subject number six started with drown-proofing the first night, he started with supine floating the second night. The subjects during each session were started individually with one minute of time elapsing between them. The maximum number of subjects being tested at any one time was four.

During each half hour session, heart rate was taken at each five minute interval. The heart rate was taken by the researcher at the 4th, 9th, 14th, 19th, 24th, and 29th minutes. Heart rate was taken by the researcher by palpating the right wrist of each subject for 30 seconds. This reading at the end of 30 seconds was then doubled and recorded by the examiner on a scorecard. During the 30 seconds that pulse rate was being taken the subjects were resting.

Statistical Procedure

For purposes of this study, the null hypothesis was assumed in analyzing the difference between the means recorded on the test and retest by this group. This hypothesis asserts that there is no difference between the two mean scores, and that any difference found between the sample means is a chance difference and is accidental and unimportant.[19]

Investigation of possible tests of the null hypothesis indicated that the "t" technique for testing the significance of the difference between means for paired comparisons was suitable. In this test "t" was checked for significance in a "t" table. The value of "t" was proportional to the degrees of freedom (n-1) allowed in determining the relationship between the mean differences.

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[19] Quinn McNemar, Psychological Statistics (New York: John Wiley and Sons, Inc., 1949), p. 225.

For this study, it was decided to retain the null hypothesis at the .05 level of significance at the two-tailed level. The region of rejection for all "t" values stated that the probability associated with their occurrence under the null hypothesis was equal to or less than the .05 level. Thus, a value of "t" of 2.261 or less at the two-tailed level was necessary to reject the null hypothesis.

Complete data and the procedures utilized in the statistical analysis are presented in Appendix C, page 33.

CHAPTER III

ANALYSIS OF DATA

Purpose

The purpose of the testing in this study was to determine whether there was a significant difference in heart rate between drown-proofing and supine floating over a prolonged period of time. The bases for the comparisons were the results of the mean heart rates of ten subjects taken at five-minute intervals over a 30 minute period for both methods of survival.

The data collected and compiled in this study were analyzed on the basis of six separate recordings. The next step in the study was to analyze the data statistically to determine the significance of the differences between the means of the results of the two methods of survival.

Test Results

Table 1, page 17, shows the data computed for drown-proofing and supine floating at the end of five minutes. Mean heart rate for each method, difference between the means and the significance of "t" at the .05 level were included.

TABLE 1

CALCULATED HEART RATE

Group Design	D.P.	S.F.	$\overline{D}$	"t" value
Comparison of mean scores (D.P.-S.F.) Within Groups				
Single	87.5	80.5	7	2.90 significant

The mean heart rate for the ten participants was seven beats higher during drown-proofing than for supine floating at the end of the first five minute interval. The "t" value of 2.90 with nine degrees of freedom was significant at the .05 level. Thus, the null hypothesis was rejected.

Table 2 shows the data computed for drown-proofing and supine floating at the end of ten minutes. Mean heart rate of each method, difference between the means and the significance of "t" at the .05 level were included.

TABLE 2

CALCULATED HEART RATE

Group Design	D.P.	S.F.	$\overline{D}$	"t" value
Comparison of mean scores (D.P.-S.F.) Within Groups				
Single	89.2	81.1	8.1	3.34 significant

The mean heart rate for the ten participants was eight and one-tenth beats higher during drown-proofing than it was for supine floating at the end of the second five-minute interval. The "t" value of 3.34 with nine degrees of freedom was significant at the .05 level. Thus, the null hypothesis was rejected.

Table 3 shows the data computed for drown-proofing and supine floating at the end of fifteen minutes. Mean heart rate of each method, difference between the means, and the significance of "t" at the .05 level were included.

TABLE 3

CALCULATED HEART RATE

Group Design	D.P.	S.F.	$\overline{D}$	"t" value
	Comparison of mean scores (D.P.-S.F.) Within Groups			
Single	90.6	83.6	7	5.33 significant

The mean heart rate for the ten participants was seven heart beats higher during drown-proofing than it was for supine floating at the end of the third five-minute interval. The "t" value of 5.33 with nine degrees of freedom was significant at the .05 level. Thus, the null hypothesis was rejected.

Table 4, page 19, shows the data computed for drown-proofing and supine floating at the end of twenty minutes. Mean heart rate of each method, difference between the means, and the significance of "t" at the .05 level were indicated.

TABLE 4

CALCULATED HEART RATE

Group Design	D.P.	S.F.	$\bar{D}$	"t" value
Comparison of mean scores (D.P.-S.F.) Within Groups				
Single	88.1	84.1	4	3.35 significant

The mean heart rate for the ten participants was four beats higher during drown-proofing than it was for supine floating at the end of the fourth five-minute interval. The "t" value of 3.35 with nine degrees of freedom was significant at the .05 level. Thus, the null hypothesis was rejected.

Table 5 shows the data computed for drown-proofing and supine floating at the end of twenty-five minutes. Mean heart rate for each method, difference between the means, and the significance of "t" at the .05 level were included.

TABLE 5

CALCULATED HEART RATE

Group Design	D.P.	S.F.	$\bar{D}$	"t" value
Comparison of mean scores (D.P.-S.F.) Within Groups				
Single	87.5	81.8	5.7	3.92 significant

The mean heart rate for the ten participants was five and seven tenths beats higher during drown-proofing than it was for supine floating at the end of the fifth five-minute interval. The "t" value of 3.92 with nine degrees of freedom was significant at the .05 level. Thus, the null hypothesis was rejected.

Table 6 shows the data computed for drown-proofing and supine floating at the end of thirty minutes. Mean heart rate of each method, difference between the means, and the significance of "t" at the .05 level were included.

TABLE 6

CALCULATED HEART RATE

Group Design	D.P.	S.F.	$\bar{D}$	"t" value
Comparison of mean scores (D.P.-S.F.) Within Groups				
Single	89.3	82.5	6.8	7.22 significant

The mean heart rate for the ten participants was six and eight tenths beats higher during drown-proofing than it was for supine floating at the end of the sixth five-minute interval. The "t" value of 7.22 with nine degrees of freedom was significant at the .05 level. Thus, the null hypothesis (that there will be no significant difference in heart rate at the thirty minute reading between drown-proofing and supine floating) was rejected.

The mean heart rate for the ten participants was significantly lower for supine floating than it was for drown-proofing at all six five-minute intervals.

CHAPTER IV

DISCUSSION

The writer found while working on this study, that many factors influenced the outcome. After reviewing the literature it was decided that a mixture of men and women as subjects might introduce bias due to the body build of women which allows them to float with great ease. The percentage of non-floaters among women as compared to men is considerably lower. The writer then decided upon using men as the subjects.

The problem then arose as to the level of swimming skill desired for subjects. After much deliberation the writer decided to use those men who, by the American Red Cross standards, would be considered advanced beginners. These subjects were utilized mainly because they would not necessarily have perfected the ability to supine float such as an advanced swimmer may have. This meant that the ability to supine float would be at a minimum. This, then, was comparable to their ability as drown-proofers since only two hours of training in drown-proofing had been included in the beginning swimming course of instruction.

Some subjects complained of discomfort due to feeling cold at the end of the hour. Thirty minutes in water with minimum expenditure of energy may be too long.

Many of the subjects came back for the retest dreading the second hour. There were also complaints of boredom and stiffness of the neck resulting from thirty minutes of either method of survival. There were also complaints of the air temperature being too cold. These could be expected to accompany complaints of body chill due to long periods of immersion with minimum effort. There was little evidence that one method was more discomforting than the other.

Other emotional factors could have affected the subjects' preoccupation during the testing session. For instance, isolated cases of banging on the pool door and insistent ringing of the telephone could have affected the subjects' heart rates. The examiner's method of acknowledging the subject certainly must be considered. Almost invariably, when heart rate was being taken, the individual wanted to know if the rate of the heart was as wanted. The reply at that time, if there was going to be one, had to be unbiased, yet not approving and not disapproving.

When considering the results of this study, the ability of the examiner to record heart rate and any unconscious bias must be considered. The examiner found that, as easy as heart rate can be taken, in the water the degree of difficulty was greater. This was due to the ability of the body to transmit movement, as it was almost impossible for the subject to remain completely still in the water when the examiner was taking his heart rate. For instance, if a subject loosened or tightened his grip on the edge of the pool, this to the examiner could have been recorded as a beat of the heart unconsciously or consciously. This may have happened in the one instance where the individual heart rate for supine floating was higher than that for drown-proofing for subject number five at the ten-minute interval since, at the fifteen-minute interval, the results were reversed again.

Endurance, strength, and coordination seemed to be areas where some of the subjects were weak. This could have been due to the fact that a great many of them did not participate in physical education regularly. These factors might have had an effect on heart rate for drown-proofing.

Scheduling was an important factor in the success of the study. The researcher found that there were many conflicts that could have been avoided if all subjects could have participated during the weekend. Attendance was good. All subjects met individually at the same hour for the second session as they did individually for the first session.

Firm control was established at the beginning of the testing session and this remained throughout.

At this point in the discussion it is important to point out that in almost all swimming programs, supine floating is one of the basic skills first learned. However, this is not the case with drown-proofing. Drown-proofing is a relatively new skill and, in all probability, the subjects used in this test had not had drown-proofing techniques as long as they may have had supine floating. This could have been a factor worthy of consideration when reviewing the results.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine whether there was a significant difference in heart rate between drown-proofing and supine floating, as experienced by ten subjects of advanced beginner level, over a prolonged period of time.

The subjects were obtained from the Men's Division of Physical Education service swimming program. The subjects were not considered good swimmers, but had the ability to pass the American Red Cross beginner test.

Each subject was tested twice and each session lasted for one hour. This one hour was divided into two sessions, during which drown-proofing was experienced by half the group the first half hour while the remainder participated in supine floating. During the second half hour of each session, each group member participated in the activity he had not experienced during the first half hour. At the first meeting the subjects were not aware of what they were expected to do or in what order. The next time the subjects met with the examiner, they were aware beforehand what they would do first. Those who had floated during the first session experienced drown-proofing during the first thirty minutes of the second session and so on.

Analysis of the data statistically to determine the significance of the differences between means of group performances in each method of survival was carried through for each succeeding five-minute interval.

The null hypothesis was assumed and tested for significance with a "t" test designed for testing the significance of difference between means derived from correlated scores of small samples.

Conclusions

The following conclusions drawn from the results of this study seem warranted:

1. Supine floating required less energy, as determined by pulse rate, than drown-proofing at each of the six five-minute intervals for the ten subjects participating in this study.

   a. Results at the end of the first five-minute interval were significant at the .05 level of confidence.

   b. Results at all other intervals were significant at the .01 level of confidence.

Recommendations

It is suggested that in any future study of this nature, the following recommendations may be of value:

1. Similar studies involving greater numbers of swimmers of all skill and age levels should be undertaken to verify the results in terms of specific energy expenditure.

2. Measuring heart rate using a Bio-Telemeter might be more accurate for studies of this type.

3. The writer recommends that, in a further study, the initial test and retest each be given twice under the same conditions to facilitate obtaining more accurate scores for the statistical treatment of the data.

4. A similar study involving women of various levels of skill and age should be undertaken.

APPENDIX A

Form Used for Recording Data

Subject #	Normal Heart Rate	Method	H.R. 5 min.	H.R. 10 min.	H.R. 15 min.	H.R. 20 min.	H.R. 25 min.	H.R. 30 min.
1		SF						
		DP						
2		SF						
		DP						
3		SF						
		DP						
4		SF						
		DP						
5		SF						
		DP						
6		SF						
		DP						
7		SF						
		DP						
8		SF						
		DP						
9		SF						
		DP						
10		SF						
		DP						

H.R. --- Heart Rate

SP --- Supine Floating

DP --- Drown-proofing

APPENDIX B

Difference from Normal Heart Rate for

Drown-proofing and Supine Floating

Subject #	Normal Heart Rate	Method	H.R. 5 min. Diff.	H.R. 10 min. Diff.	H.R. 15 min. Diff.	H.R. 20 min. Diff.	H.R. 25 min. Diff.	H.R. 30 min. Diff.
1	56	SF	18	10	22	22	12	15
		DP	25	15	31	28	20	20
2	66	SF	2	4	9	13	6	2
		DP	2	12	14	16	10	12
3	72	SF	22	14	18	21	17	19
		DP	23	31	26	21	19	28
4	74	SF	11	11	9	13	13	12
		DP	16	14	14	15	16	14
5	67	SF	14	23	23	19	21	21
		DP	22	19	28	21	25	27
6	62	SF	10	12	12	10	10	7
		DP	10	12	13	11	11	12
7	76	SF	10	11	6	8	8	9
		DP	18	14	20	16	14	17
8	68	SF	16	13	13	18	17	15
		DP	17	14	18	19	19	19
9	78	SF	5	8	16	17	13	17
		DP	27	31	29	22	27	27
10	76	SF	2	10	13	5	6	13
		DP	20	15	18	17	19	22

Diff.--Difference between normal and existing heart rate.

APPENDIX C

COMPARISON OF HEART RATE FOR DROWN-PROOFING AND

SUPINE FLOATING AT FIVE MINUTES

	Subject	Drown-Proofing	Supine Floating	Sum of Difference	Difference Squared
	1	81	74	7	49
	2	68	68	0	0
	3	95	94	1	1
	4	90	85	5	25
	5	89	8;	8	64
	6	72	72	0	0
	7	94	86	8	64
	8	85	84	1	1
	9	105	83	22	484
	10	96	78	18	324
TOTAL	n=10 pairs	$\Sigma X_1=875$	$\Sigma X_2=805$	$\Sigma D=70$	$\Sigma D^2=1012$

Mean Score of Drown-Proofing	87.5
Mean Score of Supine Floating	80.5
Sum of Difference	70
Sum of Difference Squared	1012

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED

FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Five Minutes Group Experimental

$N = 10$

$\Sigma D = 70$

$\Sigma D^2 = 1012$

$$"t" = \frac{\Sigma D}{\sqrt{\dfrac{n\Sigma D^2 - (\Sigma D)^2}{n - 1}}} \qquad "t" = \frac{70}{\sqrt{\dfrac{10(1012) - (70)^2}{9}}}$$

$$"t" = \frac{70}{\sqrt{\dfrac{10120 - 4900}{9}}} \qquad "t" = \frac{70}{\sqrt{\dfrac{5220}{9}}}$$

$$"t" = \frac{70}{\sqrt{580}} \qquad "t" = \frac{70}{24.1}$$

$$"t" = 2.90$$

df = n - 1

df = 9

"t" at .05 (two tailed test) level = 2.262

Significant at .05 level

COMPARISON OF HEART RATE FOR DROWN-PROOFING AND

SUPINE FLOATING AT TEN MINUTES

	Subject	Drown-Proofing	Supine Floating	Sum of Difference	Difference Squared
	1	81	66	15	225
	2	78	70	8	64
	3	103	86	17	289
	4	88	85	3	9
	5	96	90	6	36
	6	74	74	0	0
	7	90	87	3	9
	8	82	81	1	1
	9	109	86	23	529
	10	91	86	5	25
TOTAL	n=10 pairs	$\Sigma X_1=892$	$\Sigma X_2=811$	$\Sigma D=81$	$\Sigma D^2=1187$

Mean Score of Drown-Proofing	89.2
Mean Score of Supine Floating	81.1
Sum of the Difference	81
Sum of the Difference Squared	1187

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED

FROM CORRELATED SCORES FROM SMALL SAMPLES

Test ___Ten Minutes___ Group ___Experimental___

N ___10___

D ___81___

D^2 ___1187___

$$"t" = \frac{\Sigma D}{\sqrt{\frac{n\Sigma D^2 - (\Sigma D)^2}{n - 1}}} \qquad "t" = \frac{81}{\sqrt{\frac{10(1187) - (81)^2}{9}}}$$

$$"t" = \frac{81}{\sqrt{\frac{11870 - 6361}{9}}} \qquad "t" = \frac{81}{\sqrt{\frac{5309}{9}}}$$

$$"t" = \frac{81}{\sqrt{589.88}} \qquad "t" = \frac{81}{24.27}$$

$$"t" = 3.34$$

df = n - 1

df = 9

"t" at .05 (two tailed test) level = 2.262

Significant at .05 level

COMPARISON OF HEART RATE FOR DROWN-PROOFING AND

SUPINE FLOATING AT FIFTEEN MINUTES

	Subject	Drown-Proofing	Supine Floating	Sum of Difference	Difference Squared
	1	87	78	9	81
	2	80	75	5	25
	3	98	90	8	64
	4	88	83	5	25
	5	95	90	5	25
	6	75	74	1	1
	7	96	82	14	196
	8	86	81	5	25
	9	107	94	14	196
	10	94	89	5	25
TOTAL	n=10 pairs	$\Sigma X_1=906$	$\Sigma X_2=836$	$\Sigma D=71$	$\Sigma D^2=663$

Mean Score for Drown-Proofing	90.6
Mean Score of Supine Floating	83.6
Sum of the Difference	71
Sum of the Difference Squared	663

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED

FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Fifteen Minutes Group Experimental

N 10

ΣD 71

ΣD^2 663

$$"t" = \frac{\Sigma D}{\sqrt{\frac{n\Sigma D^2 - (\Sigma D)^2}{n - 1}}} \qquad "t" = \frac{71}{\sqrt{\frac{10(663) - (71)}{9}}}$$

$$"t" = \frac{71}{\sqrt{\frac{6630 - 5041}{9}}} \qquad "t" = \frac{71}{\sqrt{\frac{1389}{9}}}$$

$$"t" = \frac{71}{\sqrt{176.55}} \qquad "t" = \frac{71}{13.3}$$

$$"t" = 5.33$$

df = n - 1

df = 9

"t" at .05 (two tailed) level = 2.262

Significant at .05 level

COMPARISON OF HEART RATE FOR DROWN-PROOFING AND

SUPINE FLOATING AT TWENTY MINUTES

Subject	Drown-Proofing	Supine Floating	Sum of Difference	Difference Squared
1	84	78	6	36
2	82	79	3	9
3	93	93	0	0
4	89	87	2	4
5	88	86	2	4
6	73	72	1	1
7	92	84	8	64
8	87	86	1	1
9	100	95	5	25
10	93	81	12	144
TOTAL n=10 pairs	$\Sigma X_1=881$	$\Sigma X_2=841$	$\Sigma D=40$	$\Sigma D^2=288$

Mean Score of Drown-Proofing	88.1
Mean Score of Supine Floating	84.1
Sum of the Difference	40
Sum of the Difference Squared	288

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED

FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Twenty Minutes   Group Experimental

N = 10

ΣD = 40

ΣD^2 = 288

$$"t" = \frac{\Sigma D}{\sqrt{\frac{n\Sigma D^2 - (\Sigma D)^2}{n - 1}}} \qquad "t" = \frac{40}{\sqrt{\frac{10(288) - (40)^2}{9}}}$$

$$"t" = \frac{40}{\sqrt{\frac{2880 - 1600}{9}}} \qquad "t" = \frac{40}{\sqrt{\frac{1280}{9}}}$$

$$"t" = \frac{40}{\sqrt{142.22}} \qquad "t" = \frac{40}{11.92}$$

$$"t" = 3.35$$

df = n - 1

df = 9

"t" at .05 (two tailed) level = 2.262

Significant at .05 level

COMPARISON OF HEART RATE FOR DROWN-PROOFING AND

SUPINE FLOATING AT TWENTY-FIVE MINUTES

Subject	Drown-Proofing	Supine Floating	Sum of Difference	Difference Squared
1	76	68	8	64
2	76	72	4	16
3	91	89	2	4
4	90	87	3	9
5	92	88	4	16
6	73	72	1	1
7	90	84	6	36
8	87	85	2	4
9	105	91	14	196
10	95	82	13	169
TOTAL n=10 pairs	$\Sigma X_1=875$	$\Sigma X_2=818$	$\Sigma D=57$	$\Sigma D^2=515$

Mean Score of Drown-Proofing	87.5
Mean Score of Supine Floating	81.8
Sum of Difference	57
Sum of Difference Squared	515

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED

FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Twenty-Five Minutes   Group Experimental

N = 10

ΣD = 57

ΣD^2 = 515

$$"t" = \frac{\Sigma D}{\sqrt{\frac{n\Sigma D^2 - (\Sigma D)^2}{n - 1}}} \qquad "t" = \frac{57}{\sqrt{\frac{10(515) - (57)^2}{9}}}$$

$$"t" = \frac{57}{\sqrt{\frac{3150 - 3249}{9}}} \qquad "t" = \frac{57}{\sqrt{\frac{1901}{9}}}$$

$$"t" = \frac{57}{\sqrt{211.22}} \qquad "t" = \frac{57}{14.53}$$

$$"t" = 3.92$$

df = n - 1

df = 9

"t" at .05 (two tailed) level = 2.262

Significant at .05 level

COMPARISON OF HEART RATE FOR DROWN-PROOFING AND

SUPINE FLOATING AT THIRTY MINUTES

Subject	Drown-Proofing	Supine Floating	Sum of Difference	Difference Squared
1	76	71	5	25
2	78	68	10	100
3	100	91	9	81
4	88	86	2	4
5	94	88	6	36
6	74	69	5	25
7	93	85	8	64
8	87	83	4	16
9	105	95	10	100
10	98	89	9	81
TOTAL n=10 pairs	$\Sigma X_1=893$	$\Sigma X_2=825$	$\Sigma D=68$	$\Sigma D^2=532$

Mean Score of Drown-Proofing	89.3
Mean Score of Supine Floating	82.3
Sum of the Difference	68
Sum of the Difference Squared	532

THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS DERIVED FROM CORRELATED SCORES FROM SMALL SAMPLES

Test Thirty Minutes   Group Experimental

N 10

ΣD 68

$\Sigma D^2 =$ 532

$$"t" = \frac{\Sigma D}{\sqrt{\frac{n\Sigma D^2 - (\Sigma D)^2}{n - 1}}} \qquad "t" = \frac{68}{\sqrt{\frac{10(532) - (68)^2}{9}}}$$

$$"t" = \frac{68}{\sqrt{\frac{5320 - 4624}{9}}} \qquad "t" = \frac{68}{\sqrt{\frac{696}{9}}}$$

$$"t" = \frac{68}{\sqrt{77.33}} \qquad "t" = \frac{68}{8.8}$$

$$"t" = 7.22$$

df = n - 1

df = 9

"t" at .05 (two tailed) level = 2.262

Significant at .05 level

THE RELIABILITY OF THE HEART RATE RESPONSE TO SUPINE FLOATING

Subject Number	Heart Rate #1	Heart Rate #2	Rank Heart Rate #1	Rank Heart Rate #2	Rank Diff.	D^2
1	76	83	3	3	0	0
2	84	93	4	4	0	0
3	72	73	1	1	0	0
4	75	75	2	2	0	0
					ΣD^2	0

THE RELIABILITY OF THE HEART RATE RESPONSE TO DROWN-PROOFING

Subject Number	Heart Rate #1	Heart Rate #2	Rank Heart Rate #1	Rank Heart Rate #2	Rank Diff.	D^2
1	93	93	3	3	0	0
2	87	87	2	2	0	0
3	104	104	4	4	0	0
4	81	81	1	1	0	0
					ΣD^2	0

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