A COMPARISON BETWEEN SEX AND BUOYANCY OF PREPUBERTY CAUCASIAN CHILDREN

A THESIS

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CHAPTER I

ORIENTATION TO THE STUDY

Introduction

Experimental research concerning the floating ability of the human body has been carried out by comparatively few investigators. In general, results have been specific to either the adult population or to the separate sexes. Investigations concerning the floating ability of males and females have indicated that growth development and different body measurements are factors that affect buoyancy. Previous studies have indicated that there is a greater differentiation between the male and female bodies after than before puberty. However, investigators who have conducted studies on the buoyancy of children have not dealt specifically or directly with the prepuberty child. Also, no study involving a comparison of the floating ability of the prepuberty males and prepuberty females was found.

Learning to float is one of the very first skills to be mastered by beginning swimmers. Most of today's swimming authorities suggest that the tuck float be taught to beginners because it builds up their confidence in water and it facilitates their learning of the more difficult floats, such as the

prone, the back, and the vertical floats. In addition, the tuck float can be used as a test for buoyancy.[1] The only studies found in which the tuck float was used to determine buoyancy were those conducted by H.T.A. Whiting, and John C. Mitchem and Elizabeth A. Lane.[2]

Thousands of people drown each year. Because of this recognized hazard and the increasing popularity of swimming, which in turn has lead to an increase in the availability of swimming instructors, people are learning to swim at an earlier age. For this reason, more research involving and pertaining to the young seems needed.

The investigator found no study that focused specifically on differences between sex and buoyancy involving prepuberty children. It was the aim of this study to add to the available literature concerning these factors.

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[1]Irene A. Clayton, Howard C. Leibee, Lloyd L. Messersmith, and Don Cash Seaton, Physical Education Handbook (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969), p. 319.

[2]H.T.A. Whiting's use of the tuck float is explained in "Variations in Floating Ability With Age in the Female," Research Quarterly, XXXVI (May, 1965), pp. 216-218 and "Variations in Floating Ability With Age in the Male," Research Quarterly, XXXIV (March, 1963), pp. 84-90. John C. Mitchem's and Elizabeth Lane's use of the tuck float is explained in "Buoyancy as Predicted by Certain Anthropometric Measurements," Research Quarterly, XXXV (March, 1964), pp. 21-28 and "Buoyancy of College Women as Predicted by Certain Anthropometric Measures," Research Quarterly, XXXIX (December, 1968), pp. 1032-1036.

Statement of the Problem

The investigation involved forty-six Caucasian females and forty-three Caucasian males between the ages of ten and thirteen years who had not yet reached puberty. The specific problem was to determine differences, if any, between sex and buoyancy at this age level and at this stage of development. The subjects were volunteers. They were members of the swim clubs at the University of Virginia in Charlottesville, Graves' Mountain Lodge in Syria, and the Young Men's Christian Association in Charlottesville. The tuck float was used to test buoyancy. The test was conducted during the period from August, 1974, to January, 1975. Conclusions were drawn concerning differences between sex and buoyancy.

Definitions and/or Explanations of Terms

For the purpose of clarification, the following definitions and/or explanations of terms were established for use throughout the present study:

1. Buoyancy: Buoyancy was defined as the ability to float in a tuck position with lungs fully inflated.
2. Tuck Float: Whiting's definition of a tuck float was used in this study: the floating position in which the

subject has knees bent to chest, arms encircling knees, and forehead on knees.[1]

3. Swimmer: A swimmer was defined as a child who could propel himself or herself fifteen feet in water while in a prone position with face immersed.

4. Prepuberty: Prepuberty was defined as the period of growth prior to that in which the gonads or sex glands attain normal adult function. The prepuberty male was defined as the male who lacks the secondary sex characteristic of hair growth in the axillae and on the face and pubes. The prepuberty female was defined as the female who has not begun menstruation.[2]

Purpose of the Study

The purpose of the study was to determine whether or not prepuberty Caucasian males were more or less buoyant than prepuberty Caucasian females while performing a tuck float.

The following null hypothesis was tested: There is no significant difference between sex and buoyancy of prepuberty Caucasian children.

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[1]H.T.A. Whiting, "Variations in Floating Ability With Age in the Male," Research Quarterly, XXXIV (March, 1963), p. 84.

[2]Diana C. Kimber, et, al. Anatomy and Physiology (New York: The Macmillan Company, 1968), p. 703.

Limitations of the Study

The present study was subject to the following limitations:

1. Forty-six Caucasian females and forty-three Caucasian males between the ages of ten and thirteen years who lived in the state of Virginia and who were members of the swim clubs at the University of Virginia, Graves' Mountain Lodge, and the Charlottesville Young Men's Christian Association.
2. The validity, reliability, and objectivity of the instrument used to measure buoyancy.
3. The cooperation and participation of the subjects who were volunteers.
4. The cooperation of the parents who agreed to allow their children to act as subjects.

Organization of the Remaining Chapters

Chapter II presents a review of literature that was found pertinent to this study. In Chapter III the methods and procedures utilized in the investigation are explained, while an analysis of the data and the results derived therefrom are presented in Chapter IV. Chapter V, the last chapter, includes a summary, the findings and the conclusions, and recommendations for future study which were drawn.

CHAPTER II

RELATED LITERATURE

An examination of previous studies disclosed that the present study did not duplicate any known investigation. A review of literature which was deemed related to the present investigation and was of benefit to its development is presented in this chapter.

Mitchem and Lane[1] conducted a study of sixty-nine white male students and fifty-two Negro students, seventeen to twenty-seven years of age, who were enrolled in the physical education service programs of Northern Illinois University at De Kalb, Illinois. The purpose was to predict buoyancy, as either floating or nonfloating, from seventeen anthropometric measurements and four ratios.

Seventeen anthropometric measurements were taken following the technique of the University of Iowa Child Research Station. The measurements included standing and sitting height; chest, shoulder, hip, and knee width; chest depth and circumference; arm and upper leg girth; arm, chest,

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[1]Elizabeth C. Lane and John C. Mitchem, "Buoyancy as Predicted by Certain Anthropometric Measurements," Research Quarterly, XXXV (March, 1964), pp. 21-28.

abdominal, back and suprailiac fat; breathing capacity; and weight. The technique for taking the measurements was standardized.

The following instruments were used to obtain the data for the study:

1. The Lange Skinfold caliper was used for fat measurements.
2. A Wet Spirometer was used for breathing capacity measurements.
3. A chest and shoulder caliper was used for anthropometric widths measurements.
4. A Broca plane was used for height measurements.
5. A steel anthropometric tape was used for girth measurements.

The four ratios computed were: (a) chest circumference divided by standing height; (b) weight divided by standing height; (c) sitting height divided by standing height; and (d) body surface area as measured by the Dubois and Dubois formula.

In order to standardize the procedure for determining buoyancy, all subjects were given the following directions:

> Place your hands on the front of your thigh; take a deep breath and bend forward, placing your face in the water. Slide your hands down your legs and bend your knees until you have encircled your legs with your arms, chest touching your thighs and hands holding your ankles. Maintain this position until you count to twenty.[1]

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[1]Ibid., p. 23.

The buoyancy test was performed in chest-deep water. The subject was rated a floater if his back rose to the surface of the water and as a nonfloater if he sank.

The data were analyzed in three separate classifications: a white group consisting of sixty-three floaters and six nonfloaters, a Negro group which contained seventeen floaters and thirty-five nonfloaters, and a total group in which the white and Negro group data were combined. Means and standard deviations were computed for the measurements, and the four ratios were computed for all of the subjects.

A discriminate analysis was used to predict floating or nonfloating as a dichotomous variable from twenty-one different, continuous variables. The "F" test was employed to determine the level of significance of the three discriminate equations used in the study. Each of the equations was found to be significant beyond the one percent level. Percentage contribution for each of the variables in the equation were also computed.

Three variables--standing height, breathing capacity, and sitting height--were found to be the greatest contributorsto the prediction of buoyancy for the white group. For the Negro group, chest depth was the greatest contributor. Eight variables--standing height, knee width, chest circumference, arm girth, upper leg girth, breathing capacity, back

fat, and sitting height--contributed four to eleven percent to the prediction.

Results of this study indicated that a significant number of Negro males are anthropometrically different and experience much greater difficulty with buoyancy than white males. The investigators concluded that new methods of teaching swimming, not utilizing buoyancy as an intrinsic step, should be investigated as methods for teaching classes involving Negro males.

Mitchem and Lane[1] conducted a second study related to buoyancy. The subjects included seventy-four Caucasian and eighty-one Negro women from Central State College, Wilberforce, Ohio, and Northern Illinois University, Decalb, Illinois. The purpose of the study was to predict buoyancy, as either floating or nonfloating, from certain anthropometric measurements and also to determine the possibility of racial difference which may affect buoyancy.

Seventeen anthropometric measurements were taken following the technique of the University of Iowa Child Welfare Research Station. The measurements were standing and sitting height; chest, shoulder, hip, and knee width;

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[1]Elizabeth C. Lane and John C. Mitchem, "Buoyancy of College Women as Predicted by Certain Anthropometric Measures," Research Quarterly, XXXIX (December, 1968), pp. 103201036.

chest depth and circumference; arm and upper leg girth; arm, chest, abdominal, back and superiliac fat; breathing capacity; and weight. All measurements were recorded in the metric system. Four ratios were computed: (a) chest circumference divided by standing height; (b) weight divided by standing height; (c) sitting height divided by standing height; and (d) body surface was measured by the DuBois and DuBois formula. A procedure was standardized for determining the buoyancy of the subjects rated as floaters or nonfloaters. The procedure was the same as that described in the previously noted study by these authors.

The data in the study were analyzed in two separate classifications: a Negro group consisted of seventy-two floaters and nine nonfloaters; and a Caucasian group in which all seventy-four of the subjects were floaters. Means and standard deviations were computed for the seventeen anthropometric measurements and the four ratios that were computed for all of the subjects.

A discriminant equation to predict buoyancy as a dichotomy, floating or nonfloating, from seventeen anthropometric measurements was computed for the Negro group. By employing the "F" test, the equation was found to be not significant at the .05 level. Percentage contribution for each of the variables was also computed.

Six variables--sitting height, breathing capacity, chest depth, chest circumference, chest fat, and abdominal fat--were found to be the greatest contributors to the prediction of buoyancy. It was concluded that the fact that a discriminant equation could be computed for the Negro group indicates the possible need for additional research in this area.

Whiting[1] conducted a study of 1,040 males between the ages of nine and twenty-four years to determine the variation in floating ability with age in the male. All of the 1,040 males were subjected to the following four tests of flotation.

> Test 1. Tuck float after a maximum inspiration. Standing in the shallow end of the pool with water up to his waist, the performer was required to make a maximum inspiration, hold his breath and adopt the tuck float position . . . and to hold the position to a count of ten.
> Test 2. Tuck float during normal inspiration. The test was similar to test 1, but instead of a maximum inspiration, the tuck float was performed during normal respiration: i.e., without a forced inspiration, but with the breath held.
> Test 3. Tuck float after a maximum expiration. To attain, the performer adopted the tuck float position with his lungs inflated (the degree of inflation unimportant) and as soon as his head was under water, exhaled to a maximum and remained in the tuck position to a count of ten.
> Test 4. Horizontal floating on the back. The performer was required to adopt a horizontal floating position on the back during normal respiration (i.e. breathing without forced inspiration or expiration), with arms sideways horizontal, palms

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[1] H.T.A. Whiting, "Variations in Floating Ability With Age in the Female," Research Quarterly, XXXIV (March, 1963), pp. 84-90.

> upwards, legs straight (but relaxed) and together, feet adopting a natural position, head in line with the body . . . height, to sink their shoulders under water, and to gently adopt a horizontal floating position on the back as described.

All members of the group were swimmers. All of the tests were performed in an indoor heated swimming pool. The specific gravity of the chlorinated water at the temperature used (79^{o}-84^{o} F) differed insignificantly. All the subjects performed in the nude.

Results of the study indicated that there is a marked decrease in the percentage of floaters from the age of thirteen years onwards; there is a pronounced peak in both horizontal and tuck floating ability between the ages of ten and thirteen years; there is almost complete incapacity for horizontal floating from about fifteen years onwards; and there are few sinkers between the ages of fourteen and eighteen years. The tuck float with maximum inspiration yielded the best result at all age levels.

Whiting[1] conducted a study of 877 females between the ages of ten and eighteen years to determine the variations in floating ability with age in the females. The tests were conducted in an indoor heated swimming pool. The specific gravity of the chlorinated water at the temperature used

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[1]H.T.A. Whiting, "Variations in Floating Ability With Age in the Female," Research Quarterly, XXXVI (May, 1965), pp. 216-218.

(78^{o}-80^{o} F) differed insignificantly. The subjects wore swimming costumes and caps. The 877 females were subjected to the same four tests of flotation used in Whiting's previous study, "Floating Ability With Age in the Male."

Comparisons were made between this study and Whiting's previous study with male students. The female showed superior floating ability over the males in the tuck float position with normal respiration over the age range of ten to eighteen years. The result was the same when comparing the horizontal floating ability of male and female between the ages of ten to thirteen years.

The overall result of the four flotation tests indicate:

1. Superior tuck floating after maximum inhalation and normal respiration of the female and superior horizontal floating of the female from about thirteen years onwards as compared with the male of a similar age.
2. Peaks in horizontal floating ability of the female between the ages of ten to thirteen years and fifteen to seventeen years with corresponding decreases on horizontal floating ability between the ages of thirteen and fifteen years and from seventeen years onwards.
3. The presence of only one sinker occurring in the age range from fourteen to fifteen years.

Burdeshaw[1] conducted a study of thirteen Negro and white college women on beginning swimming performance, motor ability, buoyancy, and body measurements. A secondary objective was to determine if previous instruction and initial ability affected the learning rate of the Negro and white college women in beginning swimming.

The subjects were assigned to one of four classes for eight weeks of instruction. The Scott Motor Ability Test and measurements of height, weight, sitting height, leg strength, shoulder width, hip width, and breathing capacity were used as preliminary tests. Buoyancy was measured by hydrostatic weighing. The Fox Power Test was used to measure terminal achievement. The fifty-seven women who ranged in age from seventeen to twenty years, were screened for participation in the study through an interview, a questionnaire on previous instruction in swimming, and a test of initial skill. The criterion of a nonswimmer was an individual's inability to propel the body fifteen feet in a prone position with the face immersed.

The study was conducted over a ten week period with one week of preliminary testing, eight weeks of instruction,

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[1]Dorothy Burdeshaw, "Aquisition of Elementary Swimming Skills by Negro and White College Women," Research Quarterly, XXXIX (December, 1968), pp. 873-879.

and one week of terminal test. The subjects were assigned to one of four classes for instruction. There were two forty-five minute classes each week. Variables held constant were content, method of instruction, water temperature, scheduled time of class, size of class, and time spent in class. Each subject agreed to engage in no outside practice. A subject's failure to participate in class required her to attend a subsequent session in which material that she had missed was presented.

Single classification analysis of variance and multiple discriminant analysis were the statistical procedures utilized in the study. The .01 level of significance was chosen. The "F" test for comparison of variances was applied where significant results were indicated.

The results of the investigation were as follows:

1. There were no significant differences in the mean scores for breath capacity, height, weight, and achievement on the front crawl.
2. The Negro group was significantly superior on the Scott Motor Ability Test.
3. The white group proved to be significantly more buoyant.
4. There were significant differences in the mean scores for sitting height, leg strength, shoulder width, and hip width.

5. The white group was significantly superior in the performance of the sidestroke and elementary backstroke.
6. A slower learning rate of the Negro group was detected in the back float, combined backstroke, sidestroke, treading water, dive and level to backstroke, combined deep water skills, prone kick glide, back kick glide, combined front stroke, turn from front to back, and the standing dive followed by leveling to front crawl.

The investigator concluded that the difference in swimming performance between these groups was influenced by the factor of buoyancy. The difference between the groups was apparent only in those skills demanding or aided by buoyancy.

Burdeshaw suggested that special techniques for the nonbuoyant are needed to facilitate learning. Also, the utilization of gliding strokes should be postponed until body balance in continuous propulsive skills is a reality.

Hellebrandt and Rork[1] conducted a study of twenty-seven young adult women, all of whom were expert swimmers, to redetermine the floating ability of women and to explain why some assume a more horizontal position in water than others.

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[1]Frances A. Hellebrandt and Rozelle Rork, "Floating Ability of Women," Research Quarterly, IV (December, 1937), pp. 19-27.

The experiment was performed in an indoor fresh water swimming pool. The average temperature of the water was 26^{o}-25^{o} C. The specific gravity of the water was 99^{o}. Three factors affecting floating ability were taken into consideration: (a) the specific gravity of the body, (b) its buoyancy, and (c) its equilibrium in water. Buoyancy and equilibrium in water were studied in three horizontal floating positions: (a) back floating position with full extension of the arms, the limbs resting naturally at the sides of the body; (b) back floating position with complete flexion at the shoulder joints bringing the arms to a comfortable posture elongated above the head; and (c) back floating position with the arms elongated above the head and with an additional wrist flexion carrying the hands out of water. The buoyancy test was done with maximal inspiration.

The method for obtaining the specific gravity of the body was based on Archimedes' Principle. Buoyancy in each of the three floating positions was measured by fastening rope loops connected to a spring scale around each ankle. The legs were lifted to the surface of the water, and the force needed to maintain this position was determined. Buoyancy was equal to the weight of the body minus the extra force necessary to support the legs. Equilibrium was established by locating the center of gravity and the center of buoyancy. This was

accomplished by having each subject assume a recumbent posture on the platform of a tilting board with the feet pressed firmly against a foot rest and the arms placed in each of the floating positions to be analyzed. The suspended board was balanced by moving the counter-weighted adjustable platform, and the height of the center of weight from the soles of the feet was directly read in the plane of the fulcrum. In order to attain stability in water, it was necessary for the clockwise rotating torque to equal the counterclockwise one. Once the location of the center of gravity, the buoyancy, and the added force required to maintain the desired positions was known, the horizontal distance between the center of buoyancy and the center of gravity could be calculated and the center of buoyancy determined, according to these investigations.

It was concluded that all subjects floated most horizontally with shoulder and wrist joint flexion; next best with the arms above the head and the hands in the water; and least horizontally when the arms rested at the sides of the body. It was also concluded that floating ability is greatest when all three attributes are simultaneously present.

The result of the study justified the following conclusions:

1. Not all women can float in fresh water.
2. Anyone with a specific gravity of less than one and a body configuration which displaces enough water to equal its own weight can float.
3. If the voluntary air in the lungs is increased, the specific gravity of the body is lowered and the floating ability is improved.
4. The angle of flotation may be decreased by shortening the rotating torque.
5. The angle of flotation depends upon the distance between the centers of buoyancy and weight.[1]

Karpovich[2] analyzed physical and physiological factors which condition correct breathing in swimming and diving: the physical factors of water temperature, water pressure, effect of water pressure upon exhalation, water pressure against the nose and the mouth, and body buoyancy and respiration; the physiological factors of excess respiratory work done in swimming, excess energy used on respiration in swimming, efficiency of the extra respiratory work in water, the interference of the arm on leg action with respiration, the rate and depth of respiration, effect of the length of inhalation upon its depth, breathing through the mouth and nose, the voluntary control of respiration, and respiratory types. Karpovich discussed breathing on the start and breathing in the crawl stroke, backstroke, breastroke, and

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[1]Ibid., p. 22.

[2]Peter V. Karpovich, "Respiration in Swimming and Diving," Research Quarterly, X (October, 1939), pp. 9-14.

overarm sidestroke. Also discussed were breathing during distance diving, depth diving, and helmet diving.

As a result of his research, Karpovich found that water temperature has a great influence upon respiration. Cold water causes a temporary arrest of respiration on the inspiratory phase. Swimming in cold water will cause a gasping type of respiration at first which will gradually become slower and more regular. The desirable water temperature range is 80^{o} F for the beginner and 72^{o} for competitors.

It was concluded that the presence of water pressure demands a greater respiratory effort as well as a greater expiratory effort. Also, water pressure against the nose and mouth inhibits respiration.

When investigating body buoyancy and respiration, Karpovich found that inhalation increases body buoyancy while exhalation decreases body buoyancy. He also found that when all parts of the body are in water, buoyancy is the greatest. When some parts of the body are lifted out of water, buoyancy decreases. As a result of these findings it was suggested that one should inhale before body buoyancy is least and exhale when it is greatest.

A summary of Karpovich's analysis of the physical and physiological factors which condition breathing in swimming and diving is presented in the following statements.

1. Teaching correct breathing in swimming is an essential part of instruction.
2. Water pressure is transmitted upon the internal organs to the extent of forty to seventy per cent in the chest and forty to eighty per cent in the abdomen.
3. Excess energy used in respiration in swimming for each 1000 cc of air inhaled is 2.77 to 5.97 Kg-m.
4. Mechanical efficiency of the extra respiratory work in water varies from 8 to 22.6 per cent.
5. Headaches and nose bleeds in beginners are due to a disturbance in blood pressure brought about by improper breathing.
6. Respiratory movements interfere with propulsive movements and tend to decrease the speed of swimming.
7. A general rule applied to respiration in swimming: Inhale before the body buoyancy is the least and exhale when it is the greatest.
8. Depth of a breath in swimming varies from 476 to 3851 cc.
9. Very rapid inhaling may become inefficient for a proper lung ventilation.
10. In most of the swimming strokes, exhaling should be done through the nose and inhaling through the mouth. Backstroke may be an exception.
11. People predisposed or affected by sinusitis should avoid exhaling through the nose under water.
12. Japanese women divers can go to a depth of 98.5 feet without any apparatus except a pair of goggles and a weight.
13. The claim that stunt divers may prolong the duration of submersions by means of inhalation of air regurgitated from the stomach under water seems to be open to doubt.
14. Without the aid of compressed air, submersion to a depth of only 4.25 feet may preclude any possibility of breathing through a tube leading to the surface of water.
15. In helmet diving, "ducking" the helmet should be avoided because it may result in caisson sickness.[1]

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[1]Ibid., p. 13.

Costell[1] conducted a study of four members of the Cortland State College swimming team to assess the effect of three swimming pool water temperatures (64°, 77°, and 90° F) on metabolic responses during three minutes of maximal work. Estimates of total body fat of the subjects were made by skinfold measurements and calculated using Consolazio's technique. The percentage of body weight composed of fat ranged from 7.0 to 12.1. A swimming ergometer was used to regulate the severity of the exercise. The collection of exhaled air during the third minute of exercise was made with the open circuit method using a Douglas bag. A Haldane-Henderson-Bailey gas analyzer was used to analyze the exhaled gas. Heart rates, which were recorded during rest and at the end of each minute of exercise were recorded by a Sanborn Viso-Cardiette electrocardiograph. A YSI Tele-Thermometer and general purpose probe were utilized to measure the rectal temperatures of the subjects during rest and at the end of each minute of exercise. Maximal oxygen uptake was determined by the first three tests, after which there were two testing sessions in each water temperature.

During the testing, the subjects were fitted around the waist with a belt attached to wires connected to a cable.

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[1]David L. Costell, "Effects of Water Temperature on Aerobic Working Capacity," Research Quarterly, XXXIX (March, 1968), pp. 67-73.

The cable ran over two pulleys which were attached to a weighted resistance. The subject assumed a prone position on the surface of the water while holding a flutter board. When the exercise period began, the swimmer was required to flutter kick hard enough to maintain an elevated weighted object at a height of from ten to fifteen inches. Each exercise session was made progressively more difficult by increasing the weight. The reliability coefficient for the testing was found to be +0.971.

The first three tests were executed in water ranging from 77.0° to 78.3° F. The fourth and fifth tests were administered in water ranging from 63.5° to 65.8° F. The sixth and seventh tests were conducted in water ranging from 89.7° to 90.1° F. In order to detect any changes in physical conditioning which might have evolved because of the testing sessions, a final test was made.

Determination of the reliability coefficients and "t" ratios between the initial and final maximal oxygen uptake values were used in identifying variation in response to the 77° F water. The "t" test was used to determine any significant difference which may have existed among the mean rectal temperature changes which occurred during the exercise sessions in the different water temperatures.

The results indicated that there was no significant difference among heart rates during maximal exercise in 64°, 77°, or 90° F water. The results showed that the swimmers' aerobic working capacities were not significantly affected by the three water temperatures. There was no significant difference in the rate of increase of rectal temperature at the end of three minutes of exercise in 64°, 77°, or 90° F water. Finally, the results of the study indicated that there was greater hyperventilation in water at 64° F than in water at 77° F.

When interpreting the findings of the study, the investigator suggested that even though one's aerobic working capacity is not significantly affected by the three different water temperatures, one must assume that over long distances and longer periods of exercise in water 64° F one's energy requirements might be increased because of the increased work imposed by hyperventilation. The investigator also suggested that consideration should be given to the psychological problem caused by exposing swimmers to water at either 64° or 90° F.

Summary

A review of the literature indicated that the present study did not duplicate any previous investigation.

The investigator found no study that focussed specifically on the difference between sex and buoyancy involving the young.

Reviews of pertinent studies and articles concerned with the floating ability of males and females were presented in this chapter. Mitchem and Lane conducted two studies in order to predict buoyancy from seventeen anthropometric measurements and four ratios. One study involved Caucasian and Negro females, while the other involved Caucasian and Negro males. Whiting conducted two studies, involving females and males separately, in order to determine the variation in floating ability with age.

Burdeshaw compared Caucasian and Negro college women on beginning swimming performance, motor ability, buoyancy, and body measurements. She also investigated the effects which previous instruction and initial ability have on the learning rate of women in beginning swimming.

While redetermining the floating ability of women, Hellebrandt and Rork studied and tested three factors--specific gravity, buoyancy, and equilibrium--which affect floating ability. Karpovich analyzed physical and physiological factors which condition correct breathing in swimming and diving. Costell assessed the effect of three swimming pool temperatures on metabolic responses during three minutes of maximal work.

In Chapter III, which follows, the methods and procedures which were used in the presently reported study are described.

CHAPTER III

METHODS AND PROCEDURES

The general purpose of the present study was to determine whether or not prepuberty Caucasian males are more or less buoyant than prepuberty Caucasian females while performing a tuck float. The following null hypothesis was tested: There is no significant difference between sex and buoyancy of prepuberty Caucasian children. The study was limited to prepuberty Caucasian males and females between the ages of ten and thirteen years.

The present chapter describes the methods and procedures used in pursuing the problem. Included are preliminary procedures, selection and description of the test, and preparation of the final written report.

The data utilized in the study were secured from both human and documentary sources. The human subjects included eighty-nine Caucasiam children between the ages of ten and thirteen years who were classified as swimmers.

Documentary sources included books, periodicals, pamphlets, bulletins, and tests related to all aspects of

the study. Theses, dissertations, and other unpublished materials pertinent to the investigation were also used.

Preliminary Procedures

The investigator studied data from all available documentary and human sources. This information was used in the formation of the tentative outline.

Permission to conduct the study was secured from the managers and/or proprietors of the three swim clubs at the University of Virginia, Graves' Mountain Lodge, and the Charlottesville Young Men's Christian Association, all in Virginia.

The outline of the proposed study was developed by the investigator and approved by the members of the thesis committee. On November 21, 1974, the completed tentative outline of the thesis was presented in a Graduate Seminar in the College of Health, Physical Education, and Recreation. In accordance with suggestions made by the thesis committee, the outline was revised. A Prospectus of the approved study was then filed in the office of the Dean of Graduate Studies at the Texas Woman's University.

Selection and Description of the Subjects

The subjects included in this study were forty-six Caucasian females and forty-three Caucasian males. All were

volunteers and members of the swim clubs at the University of Virginia in Charlottesville, Graves' Mountain Lodge in Syria, and the Young Men's Christian Association in Charlottesville. Each participant met the following criteria:

1. Each subject must be between the ages of ten and thirteen years.
2. Each subject must be classified as a swimmer.
3. Each subject must be Caucasian.
4. Each subject must be prepuberty.

Only Caucasians were chosen as subjects for the following reason. The related literature indicated that the acquisition of elementary swimming skills is more difficult for Negroes than for Caucasians and that Negroes have less buoyancy than Caucasians.[1] Since the present study focused specifically on differences between sex and buoyancy of children, it was decided not to add another variable; therefore, only Caucasian subjects were chosen.

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[1]Elizabeth C. Lane and John C. Mitchem, "Buoyancy as Predicted by Certain Anthropometric Measurements," Research Quarterly, XXXV (March, 1964), pp. 21-28; Elizabeth C. Lane and John C. Mitchem, "Buoyancy of College Women as Predicted by Certain Anthropometric Measures," Research Quarterly, "Acquisition of Elementary Swimming Skills by Negro and White College Women," Research Quarterly, XXXIX (December, 1968), pp. 873-879.

Young people who have entered the adolescent period of growth usually experience weight gain, increase in body measurements, and other bodily changes. Humans tend to show a high capacity to float between the ages of ten and thirteen years, and a decrease in floating ability after the age of thirteen.[1] For these two reasons prepuberty children between the ages of ten and thirteen years were used as subjects for the present study.

No subject who was not classified as a "swimmer" was included. Since the object was to investigate performers' ability to perform a tuck float, it was deemed desirable to eliminate fear as a contaminating factor. A preliminary test, therefore, was given to all subjects to determine whether or not they were swimmers. Each potential subject was asked to propel himself or herself fifteen feet in water while in a prone position with face immersed. This test did not require a high level of physical skill, yet was deemed adequate in length and physical requirement to determine that the individual was not afraid of water and could progress in water. Those who succeeded were classified as "swimmers."

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[1]H.T.A. Whiting, "Variations in Floating Ability With Age in the Female," Research Quarterly, XXXVI (May, 1965), pp. 216-218.

Letters were sent to parents whose children met the criteria of being Caucasian, between ten and thirteen years of age, and classified as a swimmer. The purposes were to explain the reasons for the study, to secure the parents' permission to use their child as a subject, and to obtain information concerning the physical growth development of the child. An example of the letter may be found on pages 43 and 44 in the Appendix. In cases where the letter was not returned, the parent or parents were contacted by telephone to secure the necessary information and permission.

The subjects were chosen on the basis of the criteria established. Each subject was then given the buoyancy test.

Selection and Description of the Test

All available tests of buoyancy were identified and studied thoroughly. It was decided that the test chosen must meet the following criteria:

1. It must be simple to administer.
2. It must be easy to perform.
3. No support movements must be necessary.

On the basis of these established criteria, the tuck float was selected to test buoyancy.

It was necessary for the test to be simple, easy to perform, and need no support movements in order to assure that buoyancy, not physical strength or ability, was being

tested. The fact that the tuck float with maximum inspiration is a highly successful method of floating and that it is used widely by modern swimming instructors in beginning swimming lessons had a great influence on the investigator's selection of this buoyancy test.

The verbal instructions given to the subjects during the test were standardized. The instructions were as follows:

> Place your hands on front of your thighs; take a deep breath and bend forward, placing your face in the water. Slide your hands down your legs and bend your knees until you have encircled your legs with your arms, chest touching your thighs and hands holding your ankles.

Each subject was tested individually in waist-deep water. Each was given the instructions and asked to maintain the tuck float with maximum inspiration for a count of ten in order to give sufficient time for the final position of the body to be observed. A pilot study proved that a count longer than ten was not needed in order to observe the buoyancy; a longer time usually just tired the subject. The observer, who was beside each subject in the water, signalled the end of the count and the test by a light tap on the individual's back. The subject was rated as a floater if any portion of the body (usually the back) rose to the surface of the water. The subject was rated as a nonfloater if he or she sank; that is, if no portion of the body rose to the water's surface.

The swimmers all wore light-weight swimming costumes. Two indoor heated swimming pools and one outdoor swimming pool were utilized for conducting the buoyancy test. The specific gravity of the chlorinated water at the temperature used (77^{o} - 85^{o} F) did not differ significantly.

Prior to the actual testing, the subjects were acquainted with the testing procedures. Practice time was allotted to each of the performers. All of the subjects could execute the tuck float correctly. The nervous factor did not seem to be present in any case.

Each testing period was conducted between the hours of 4:00 P.M. and 5:30 P.M. The selection of this time of day was based on the established criteria: subjects should not perform immediately after meals; and subjects should be tested when they were readily available.

Data sheets were devised in order to record the necessary information about the subjects and their buoyancy. Areas recorded consisted of subject number, age, sex, and floating classification. The date, water temperature, chlorination, and time were also recorded for each testing period. An example of the data sheets devised for this study is presented on page 42 in the Appendix. The findings of the study are presented in Chapter IV.

CHAPTER IV

ANALYSIS OF DATA AND RESULTS

Introduction

The specific problem of the study was to determine whether or not prepuberty Caucasian males are more or less buoyant than prepuberty Caucasian females. The following null hypothesis was tested: There is no significant difference between sex and buoyancy of prepuberty Caucasian children.

Data were collected from forty-six females and forty-three males between the ages of ten and thirteen years. The tuck float was used to test buoyancy. Analysis of the data provided information regarding the difference between sex and buoyancy.

Presentation of Data

Illustration 1, presented on page 35, shows the tuck float position which the subjects were asked to maintain for a count of ten with maximum inspiration. The subjects were asked to stand in waist-deep water, then place their hands on front of their thighs, take a deep breath and bend forward, placing their faces in the water. Next they were to slide their hands down their legs and bend their knees until

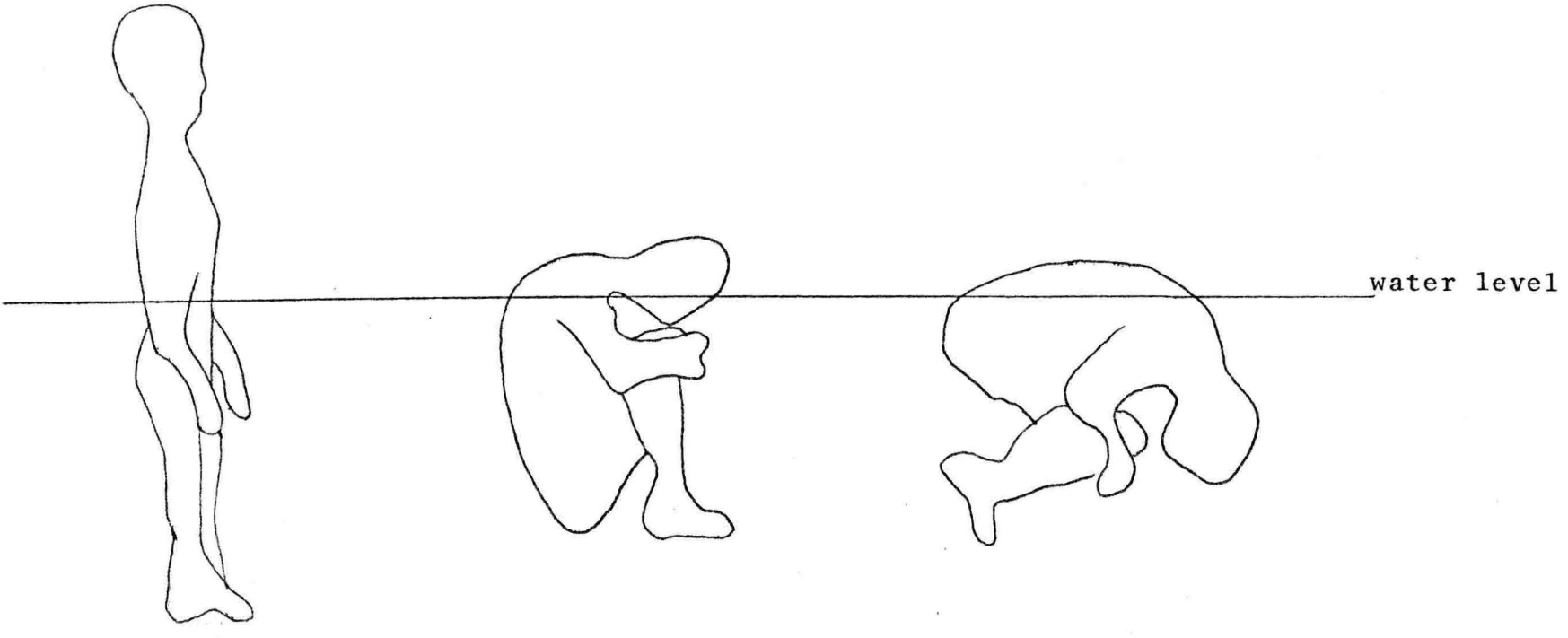

Illustration 1 -- Example of the basic body positions taken in order to execute the tuck float.

they had encircled their legs with their arms, chest touching their thighs and hands holding their ankles.

Table 1, presented below, illustrates the number of males and females tested and the number of floaters and non-floaters in each group. No subject had to be excluded from the study because of inability to perform the tuck float. Two were eliminated because it was determined that they had reached puberty.

TABLE 1

NUMBER OF MALES AND FEMALES TESTED AND THE NUMBER OF FLOATERS AND NONFLOATERS IN EACH GROUP

Males		Females	
Number of subjects . . .	43	Number of subjects . .	46
Number of floaters . . .	43	Number of floaters . .	45
Number of nonfloaters .	0	Number of nonfloaters	1

The results of the buoyancy test indicated an almost 100 per cent ability to float in both sexes at this age level.

The samples of the male and female proportions were extreme. Therefore a "t" test of proportions was used to treat the data statistically.

The proportion of floaters for the male population was 1.00; while the proportion of the female population

proved to be .98. The standard error of the difference was based on the proportions in the two groups combined. The standard error of the difference between the two populations was .0211, indicating that the samples closely represent the whole populations.

Once the standard error of difference was found, the test of significance was computed. It showed a result of .95, a figure not significant at the .05 level. Results of the investigation therefore indicate that there is no significant difference between sex and buoyancy among prepuberty Caucasian children between the ages of ten and thirteen years.

With respect to the tuck float with maximum inspiration, the high rate of floating ability found among the children in the age groups of ten, eleven, twelve, and thirteen years in both males and females coincides with that found among the subjects between the ages of ten and thirteen years in H.T.A. Whiting's studies on floating ability of humans with respect to age.

Chapter V contains a discussion of the results relative to the purposes of the present study, conclusions, and recommendations for further studies.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of the study was to determine whether or not prepuberty Caucasian males are more or less buoyant than prepuberty Caucasian females. The specific problem was to determine differences, if any, between sex and buoyancy at this age level and at this stage of development.

Experimental research concerning the floating ability of the human body has been conducted by comparatively few investigators. In general, results have been specific to the adult population and to the separate sexes. Investigations have indicated that growth development and different body measurements are factors that affect buoyancy. However, no study was found in which the floating ability of prepuberty males and prepuberty females was compared. Modern authorities point out that the tuck float builds up the beginner's confidence, facilitates the learning of more difficult skills, and provides a good method for testing buoyancy. Few investigators, however, have used the tuck float as a means of testing buoyancy.

The purpose of the proposed study was to determine whether or not prepuberty Caucasian males are more or less buoyant than prepuberty Caucasian females. The following null hypothesis was tested: There is no significant difference between sex and buoyancy of prepuberty Caucasian children.

Data were collected on forty-six prepuberty Caucasian females and forty-three prepuberty Caucasian males between the ages of ten and thirteen years who were members of three different swim clubs in the state of Virginia.

A review of literature was made which included pertinent studies and current books related to buoyancy. Mitchem and Lane conducted two studies involving a total of 276 Caucasians and Negroes in order to predict buoyancy from seventeen anthropometric measurements and four ratios. One study dealt specifically with female Caucasians and Negroes, while the other dealt specifically with male Caucasians and Negroes.

Whiting conducted two different studies in order to determine the age variation in floating ability in the male and in the female. One study involved 1,040 males, while the other involved 877 females.

Burdeshaw conducted a study of thirteen Negro and forty-four white nonswimmers to compare Negro and white college women on beginning swimming performance, motor

ability, buoyancy, and body measurements. A secondary purpose was to determine if previous instruction and initial ability affected learning rates of beginning swimmers.

Hellebrandt and Rork conducted a study to determine the floating ability of twenty-seven young adult women and to explain why some assume a more horizontal position than others. Karpovich analyzed physical and phsyiological factors which condition current breathing in swimming and diving. Costell studied four members of the Cortland State College swimming team to assess the effect of three swimming pool water temperatures on metabolic responses during three minutes of maximal work.

In the present study, eighty-nine prepuberty Caucasian males and females were given a buoyancy test to determine whether or not prepuberty Caucasian females are more or less buoyant than prepuberty Caucasian males. The tuck float was used to test buoyancy.

Findings of the Study

The purpose of the proposed study was to determine whether or not prepuberty Caucasian females are more or less buoyant than prepuberty Caucasian males. The tuck float with maximum inspiration was used as the measure of buoyancy. The data revealed the following:

1. A high percentage of floaters was found among prepuberty Caucasian males between the ages of ten and thirteen years.
2. A high percentage of floaters was found among prepuberty Caucasian females between the ages of ten and thirteen years.
3. No significant difference was found between the floating ability of Caucasian males and females at this age level while using the tuck float.

Conclusion to the Study

Based upon the findings of the study, the investigator concluded that there is no significant difference between sex and buoyancy among prepuberty Caucasian children between the ages of ten and thirteen years.

Recommendations for Future Studies

The following recommendations are suggested for additional investigations:

1. Determine the relationship between sex and buoyancy of prepuberty Negro children.
2. Determine the extent of buoyancy in Caucasian males and females and/or Negro males and females.

APPENDIX A

DATA SHEET

Date: _____
Time: _____
Water Temperature: _____
Chlorination: _____

Subject	Age	Sex	Floater	Non-floater*
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

*A check mark was placed in either the floater or non-floater column to denote the subject's floating classification

APPENDIX B

LETTERS SENT TO PARENTS FOR CONSENT TO USE THEIR CHILD AS A SUBJECT FOR THE STUDY AND FOR INFORMATION CONCERNING THE PHYSICAL DEVELOPMENT OF THE CHILD

Dear Parents:

I am in the process of studying the relationship between sex and buoyancy among young, prepuberty Caucasian children between the ages of 10 and 13 years. I am attempting to find the relationship, if any, between males and females and buoyancy. The tuck float will be used to test buoyancy.

The test will be simple. The subjects will be asked to perform a tuck float while in waist-deep water. Each subject will attempt to hold this position for a count of ten. The testing will be conducted during the regularly scheduled hours of the winter swim program on January 24, 1975.

For the purpose of the study, prepuberty will be defined as the period of growth prior to that in which the gonads or sex glands attain normal adult function. The prepuberty male will be defined as the male who lacks the secondary sex characteristic of hair growth in the axillae and on the face and pubes. The prepuberty female will be defined as the female who has not begun menstruation.

I am asking selected parents from the YMCA Winter Swim Program in Charlottesville, Virginia for permission to use their child as a subject for this study and to indicate whether their child is prepuberty or puberty.

At no time will your child's name be mentioned during the study. All children will be referred to as Subject #1, Subject #2, etc. All necessary precautions for the safety of the children will be taken. Lifeguards will be present throughout the testing period.

Thank you for your cooperation.

Betty Sue Camper
Master of Arts Candidate
College of Health, Physical Education, and Recreation
Texas Woman's University
Home phone: 1-703-923-4592 (Syria, Virginia)

We, the parents of_____ give permission for our child to assist in the above mentioned study on February 24, 1975.

Our child is puberty/prepuberty (circle one).

Signature_____

Home phone_____

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