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The primary purpose of this study was to investigate the influence of lightweight plastic balls on teaching the overhead volley in volleyball. An additional purpose of this study was to investigate the relationships between the following: (a) grip strength and finger strength, (b) grip strength and volley ability, and (c) finger strength and volley ability.

For this study one class consisted of beginning volleyball players divided into two groups. There were nineteen subjects in the experimental group, while the control group had eighteen subjects. The experimental group used lightweight plastic balls and the control group used regulation volleyballs. The only skill measured for this study was the overhead volley. The experimental period lasted four days.

There was a slight degree of relationship found between the wall volley and grip strength. There was a moderate degree of relationship between finger strength and grip strength and between finger strength and the wall volley.

There was a significant difference between pre- and post-tests on wall volley in the group using regulation volleyballs. There was no change for the group using the lightweight plastic balls. There was no difference between the groups in grip strength after the experimental period. There was no difference in the scores between the groups on the wall volley test.

A STUDY TO INVESTIGATE THE EFFECTIVENESS OF
USING A LIGHTWEIGHT PLASTIC BALL IN
TEACHING THE OVERHEAD VOLLEY
IN VOLLEYBALL

by

Alice Adams

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the Faculty of the Graduate School at
The University of North Carolina at Greensboro
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Approved by

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CHAPTER I

INTRODUCTION

Currently, the game of volleyball is 75 years old and is still gaining in popularity. Volleyball has appeal to individuals of varied backgrounds and experiences. "Volleyball is an ideal sport for intramural programs and is probably the best co-recreational sport available at present." (13:450) Volleyball courts are appearing almost everywhere, from backyards, to parks, playgrounds, beaches, and schools. Countless numbers of people play the game on a recreational basis every day. Recreational departments, schools and businesses have included volleyball in their activity programs. The armed forces have also found volleyball to be a favorite activity among their members.

Inclusion of volleyball for women in the 1964 Olympics could be regarded as a high point in the development of the game. Even though this level of competition was available in the Pan American Games, inclusion in the Olympics seemed to point to its universal appeal.

Although there are several skills which one must develop in playing volleyball, the overhead volley is perhaps one of the most strategic skills. The spike is a spectacular play when executed correctly. However, it is totally impossible to achieve a spike without a well-placed set pass. In most cases it is the overhead pass which is used to set the ball to the spiker.

"Ball handling accounts for approximately one-half to two-thirds of both offense and defense play in volleyball."

(38:43) Based on this finding there should be little doubt as to the basic need of a well-executed overhead volley. Since a great part of play is dependent upon the player's ability to handle the ball well, practice of the ball handling skills is essential. One of the most important elements in the game is proficiency in the basic skills.

Occasionally students express a reluctance toward hitting the ball. They feel they may hurt their fingers in this process. Use of the lightweight plastic ball might aid in reducing the reluctance of hitting the ball.

Another advantage in the use of lightweight plastic balls is in relation to the financial considerations. If the use of such a ball does not hinder performance when changing to the regulation balls, more balls could be made available for practice with the same amount of money.

The increased number of balls would allow more practice time per student per class. Hopefully, this increased practice time would, in turn, result in greater proficiency. With the additional lightweight plastic balls available for practice, each student will have to wait for a shorter period of time before it is her turn to practice. This factor, therefore, makes the use of the lightweight plastic ball more appealing providing it does not inhibit performance with the regulation volleyballs.

Once the basic overhead volley is mastered, it can pave the way to many hours of enjoyable volleyball. For those interested in the competitive aspect, it may lead to a program of competitive volleyball participation.

The primary purpose of this study was to investigate the influence of lightweight plastic balls on volleyball performance. The subjects were college students who had completed a course in volleyball. An additional purpose of this study was to determine the relationship between the subjects' age, height, weight, and finger strength, and their volleyball performance. The following table shows the results of the study.

Definition of Terms

The following terms have been defined for purposes of this study:

Overhead volley. The overhead volley is a type of volleyball in which the ball is struck in a level plane, the fingers are slightly spread, and the thumb and index finger are used to strike the ball. The ball is struck in a level plane, the fingers are slightly spread, and the thumb and index finger are used to strike the ball. The ball is struck in a level plane, the fingers are slightly spread, and the thumb and index finger are used to strike the ball.

In reviewing the literature, it was found that the following factors were related to volleyball performance: age, height, weight, and finger strength. The results of this study are presented in the following table.

Lightweight plastic balls. The ball used in this study was a plastic ball with a diameter of 10 inches and a weight of 1/2 lb. The ball was used in the study to determine the influence of ball weight on volleyball performance.

CHAPTER II

STATEMENT OF PROBLEM

The primary purpose of this study was to investigate the influence of lightweight plastic balls on teaching the overhead volley in volleyball. An additional purpose of this study was to investigate the relationships between the following: (a) grip strength and finger strength, (b) grip strength and volley ability, and (c) finger strength and volley ability.

Definition of Terms

The following terms have been defined for purposes of this study:

Overhead volley. The overhead volley is that skill used when the ball is chest level or higher, the fingers are slightly flexed, and the thumb and forefingers of opposite hands are close to each other forming a triangle.

In reviewing the literature, it was found that the following terms were used to describe the overhead volley: overhead set, overhead pass, set pass, set volley, overhead pass, and the chest volley or pass.

Lightweight plastic ball. The ball used in this study was a plastic ball which weighed approximately 6.4 ounces, and was 27 3/4 inches in circumference. A regulation volleyball weighs

approximately 8 ounces and is between 26 and 27 inches in circumference. The lightweight plastic ball was purchased in a drugstore which carried children's toys.

REVIEW OF LITERATURE

Since volleyball was first introduced by 1895, many changes have taken place in the playing field. As with all sports which are popular and exciting, volleyball has had to have facilities not only on the recreational level, but on the competitive level as well. Due to its popularity, volleyball and other forms of volleyball have attempted to develop the better which are essential to try to better the playing field.

This chapter has been divided into three sections to cover the organization of the information, according to the particular subject areas. The sections are: (1) the purchased volley, (2) the volleyball and its equipment, and (3) skills tests.

The Purchased Volley

Recent and obsolete volleyball equipment is covered in this section. Volleyball is one of the most popular sports in the history of volleyball. (1) This section covers the history of volleyball which pointed to the development of the volleyball game. (2) The development of the purchased volley, (3) the volleyball.

As the volleyball equipment has changed, the volleyball is called by different names. The volleyball is frequently called volleyball. The volleyball is frequently called volleyball.

CHAPTER III

REVIEW OF LITERATURE

Since volleyball was first introduced in 1895, many changes have taken place in the playing style. As with all games which are popular and exciting, volleyball has come to be a favorite not only on the recreational level, but on the competitive level as well. Due to its popularity, teachers and coaches of volleyball have attempted to analyze the skills which are essential to try to better the playing style.

This chapter has been divided into three sections in order to organize the information according to the literature reviewed in the particular subject areas. The subject areas included are: (a) the overhead volley, (b) grip strength and finger strength, and (c) skills tests.

The Overhead Volley

Meyer and Schwartz stated that quite frequently the overhead volley is one of the most neglected skills in the teaching of volleyball. (12) This was only one of the many references which pointed to the importance which should be placed upon the perfection of the overhead volley. (2, 3, 6, 10, 12, 20)

As was stated under definition of terms, the overhead volley is called by various names, the pass being one of the most frequently used terms. "The fundamental technique involved in

volleyball is the overhead (chest) pass which is used when the ball is chest level or higher." (3:438) This statement by Barnes et al. seemed to emphasize the importance placed upon the development of the overhead volley.

Stanley placed a great deal of importance upon the perfection of the overhead volley, and suggested that many hours of practice be spent developing this skill. (19) Trotter, apparently feeling strongly about this point, stated, ". . . no good offensive play can result without a sound beginning in a good pass." (21:21)

Singer conducted a study in which he taught four basic volleyball skills. The order in which the skills were presented were varied from group to group. He concluded that, while the order of presentation of skills was not apparently important, practice in the basic skills was important. The overhead pass was one of the basic skills.

Although students enjoy playing the game, the teaching of volleyball should be such that skill development is both interesting and enjoyable to the students. Johnson wrote that students will tolerate the postponement of a game if the skills are motivational. According to Gouwens and Miller, if individual skills are practiced in situations which are as gamelike as possible, student interest may be kept due to proper motivation. Skill situations should be made more difficult as the students' proficiency increases. (33)

Accuracy is a much desired element of the overhead volley. McCue pointed to this idea in stating, "a pass or set-up should be

high enough and controlled to allow one's teammate to position herself for an effective play." (11:362)

Neglect in learning the basics may limit the level to which one might progress. Anthony gave support to this in the statement, "the 'overhead pass'. . . is one of the most distinctive actions in the game of volleyball, and unless it is learnt (sic) correctly the level of skill will remain low." (2:14)

A statement made by Ward in relation to the United States Olympic Team's weaknesses was quite interesting. "The basic weaknesses of the United States Team was lack of control with the two-hand 'bump', lack of ball control using the two hand pass, and weak blocking." (1:127) It was inferred that if the United States team was able to develop those skills more fully, it would have a greater chance for success in the future Olympic Games. (1)

According to Schaafsma the future of volleyball is bright, and perhaps even more so than many individuals currently expect. (1) Schaafsma stated, "the trend has been away from resisting and toward learning, evidenced by the number of summer session workshops scheduling volleyball and the number of participants attending these workshops." (1:126) It was emphasized that this increased interest in learning the skills of volleyball will help to increase the quality of play.

Although volleyball may be considered to be going through a period of transition into a game commonly called power volleyball, Thigpen maintained that the overhead volley has perhaps taken on even greater importance. (20)

In the game of power volleyball, the fisting skills have taken on more importance than in the past. However, according to Scates and Ward,

The overhead pass is a much more controlled technique because the player has contact with the ball with the fingers of both hands, has the ball between his eyes and his intended target and can put the ball exactly where he wants it with much more consistency. (15:14)

Strategy is an important aspect of volleyball and is usually developed after the basic skills are mastered. One of the plays used in effective strategy is the spike. A key factor to a well-executed spike is a well-placed set pass. Baley has stated, "since a good set-up is prerequisite to a good spike, students should spend considerable time in practice on the set-up." (24:57)

The overhead volley is used not only to receive the serve, but also as a means by which to begin the offensive patterns of play. (1) The ability to perform this overhead volley takes many hours of practice, and in no way comes about automatically. (6) According to Egstrom and Schaafsma, "for the novice volleyball player, receiving the serve and passing it (overhead) is one of the most difficult skills to master." (6:8)

At this point it would seem that there could be no doubt as to the importance of the overhead volley in volleyball. The literature would seem to support the idea that the overhead volley is one of the basic building blocks, perhaps the very foundation of the game.

The reviewed literature did not reveal any references to support using lightweight equipment. This might be a result of the fact that use of this type of equipment is a rather new idea in teaching.

Relationship of Grip Strength and Finger Strength to Volleyball

While reviewing the literature there was limited research to lend support to the concept of a need for strong fingers, and grip strength in relation to volleying ability.

There are several types of body strength which can be measured. Odeneal and Wilson stated, "volleyball brings into use all the large muscle groups, requires natural body movements, and demands speed, coordination, and strength for a good game." (14:1) Although they did not state the specific type of strength needed, they did point out that strength was one of the factors involved in playing volleyball.

In studies which utilized the measurement of grip strength several factors were reported. Everett and Sills stated that, ". . . grip strength has been used as a measure of 'physical fitness', physiological growth, and hand dominance." (30:161) Students enrolled in volleyball classes were used as subjects, although the findings may not have been directly related to playing ability.

Conflicting results were found in studies in which grip strength was the key factor. This was clearly shown by one study done by Wessel and Nelson and another study by Owens. Wessel and Nelson found that grip strength was related to grades in

physical education classes, (45) while Owens found no significant relationship between strength and grades. (41)

In another study which was conducted by Lamp, using Junior High School subjects, grip strength was used as the strength measurement. Both the right and the left hands were measured, and then the scores from each hand were added to determine the final scores. "Positive correlations were found between volleyball playing ability (of both boys and girls) and the factors: age, height, weight, and strength." (35:189)

Limited information was available concerning finger strength and volleyball ability. The following statement was made by Anthony, ". . . strong fingers will make the volley action better." (2:60) Although this seemed to be a logical statement since the ball should rebound from the fingertips, Anthony did not include any research to substantiate his view.

Volleyball Skills Tests

Since it was the primary purpose of this study to determine the volleying ability of the subjects, a valid and reliable measure of the overhead volley was necessary. Of the many skills tests available, each varied slightly from the others.

Investigation of the literature related to skills testing in volleyball revealed several volley tests to be available for use. Some were developed as a volley test alone, while others were developed as a part of a test battery.

The major area of variation with the wall volley tests is in relation to the use of a restraining line. Some authorities

also thought that the height of the individual being tested might be influential in scoring.

Mohr and Haverstick experimented by varying the distance of the restraining line while using the Russell-Lange volley test. They found best results were possible when a seven-foot restraining line was used. This experimentation was carried out using college age women as subjects. (39)

West conducted an investigation of wall volley tests, and made the following statement: "If the test is a true measure, height should not be influential." (50:4) If this is correct, then the taller individual would have no advantage in performance on the wall volley test. In relation to skills tests, West also said, ". . . three trials seem to be sufficient in number to produce reliability for most age and skill groups. Trials exceeding thirty seconds in length are extremely fatiguing for most women players. . . ." (47:37)

The Russell-Lange volley test was originally designed for use with junior high school students. (42) The norms for the test were also developed on the scores achieved by the junior high school students.

Brady developed a skills test in volleyball for men. He developed it on the premise that, ". . . men's volleyball may roughly be divided into three skills: serving, general ball handling upon receipt of the serve and the setup volleys, and a third general skill of spiking and of blocking." (25:15) Although this was developed for college men it did point to the importance of measuring the volleying ability of the players.

Clifton developed a volley test after some experimentation with the restraining line. Use was made of both the five foot and seven foot restraining line. (28) The more recent tests using no restraining line were deemed more acceptable for this study.

French and Cooper developed their own test battery. (31) In using this test the negative aspect is in the extra time required to administer the battery if the objective is to measure the overhead volley alone.

The Cunningham-Garrison High Wall Volley test was also reviewed as one of the tests currently available. The test was developed for use with college women in the general physical education program. The subjects used to develop the test were college freshmen and sophomores in the general physical education instructional program. (29)

The criteria used to validate the Cunningham-Garrison High Wall Volley test were: (a) judges ratings, and (b) comparison with a previously validated test. The test used for comparison was the Liba and Stauff Volleyball Pass Test. (36)

CHAPTER IV

PROCEDURE

The primary purpose of this study was to investigate the influence of lightweight plastic balls on teaching the overhead volley in volleyball. An additional purpose of this study was to investigate the relationships between the following: (a) grip strength and finger strength, (b) grip strength and volley ability, and (c) finger strength and volley ability.

Selection of the Plastic Ball

The ball used in this study was a plastic ball which weighed 182 grams (approximately 6.4 ounces) and was 27 3/4 inches in circumference. A regulation volleyball weighs approximately 8 ounces and is between 26 and 27 inches in circumference. The plastic ball was purchased in a drugstore which carried children's toys. The balls came in a variety of colors and markings. The ball used for this study was a light red color with clear specks. This ball was selected because it did not seem to produce any type of distorted visual effect while in flight as did some of the more brightly colored balls. The price of each ball was approximately sixty-nine cents.

Selection of Subjects

The subjects of the study were thirty-seven women students enrolled in a physical education volleyball class at The University

of North Carolina at Greensboro. The study was conducted during the fall semester of 1969.

The class met two times a week for thirty-five minutes each meeting. During each class meeting, thirty minutes were devoted to activity. An explanation of the study was given during the first class meeting. Any questions by the students were answered in order to insure complete understanding of the study. The cooperation of the students was requested in order to obtain the best possible results. The investigator concluded that the students did extend their full cooperation.

Selection of the Skill Test

It was essential to the study to find a test which measured overhead volleying ability for college women. An investigation of the wall volley tests currently available was made prior to the selection of the Cunningham-Garrison Wall Volley test.

There were two factors which influenced the selection of the Wall Volley Test. The factors were: (a) the subjects were college women, and (b) the test was developed specifically to measure the overhead volley.

The reliability and validity coefficients were considered to be high enough to meet an acceptable standard. The reported reliability coefficient for the test was .87 and the validity coefficient was .72. (29)

The test was not recommended by Cunningham and Garrison to be used as a sole means of testing overall volleyball ability.

However, it did receive their recommendation as a measure of the overhead volleying ability of the players.

Selection of Grip Strength and Finger Strength Instruments

Since it was one of the purposes of this study to measure the relationship which existed between grip strength and finger strength with the overhead volley, a means to measure these strengths was required.

The grip strength dynamometer used to measure grip strength was the type which can be used to measure push-pull strength as well. This grip strength dynamometer is sometimes called a manometer. The Cable Tensiometer was used to measure finger strength.

Pre-Tests

Pre-tests were administered prior to the experimental period. The areas tested were wall volley, grip strength, and finger strength.

Wall volley test. During the second class meeting the Cunningham-Garrison High Wall Volley test was administered to all class members. Each student received an individual score card and printed her name on the top. A regulation volleyball was used during the administration of the test. The class divided itself into four groups for this testing period.

All required markings for the test were placed on the wall in the gymnasium prior to the testing time. The test was given in accordance with the regulations set forth by Cunningham and Garrison. (29)

Class members provided the required assistance in the test administration. As one student took the test, the next in line counted the number of legal volleys into the target area. At the end of each thirty-second trial the total number of legal hits was recorded on the students' score card.

The writer served as the timer for the test. After the two thirty-second trials were completed for each student, the total number of legal hits was recorded on the student's card. The scores were checked by the writer for possible errors and saved for comparison with the post-test scores.

The test was explained completely and any questions answered before the students began. The entire class was tested in one class period. A copy of the test, the score card, and the raw scores can be found in the Appendix.

Grip strength. A measure of grip strength was made using a manometer, more commonly called a grip strength dynamometer. The grip strength of both the right and left hands was taken in the two testing periods following the wall volley test. Each student was tested individually, and the scores were recorded in pounds on the student's individual score card. The testing was done in Rosenthal Gymnasium of The University of North Carolina at Greensboro. A complete explanation of the procedure was given the students before they began. An explanation of the procedure used to measure grip strength and the raw scores of the tests can be found in the Appendix.

Finger strength. The fingers of both hands were tested for flexion and extension using the Cable Tensiometer. The thumbs were tested for abduction and adduction. The testing of finger strength was done during the two class periods following the Wall Volley Test. Finger strength was recorded in pounds on the student's score card.

Each student was tested individually in Rosenthal Gymnasium testing laboratory. A complete explanation of the procedure used and the raw scores of the tests can be found in the Appendix.

Assignment of Groups

A method of random selection was used in placing the subjects in their respective groups. The score cards were dealt out alternately, the first being the experimental group, the second the control group. The same procedure was used for the remainder of the cards until all students were assigned to one of the two groups. There were nineteen subjects in the experimental group and eighteen in the control group.

The experimental group did not use the regulation volleyballs throughout the entire experimental period. Students were asked to be prompt so that full use of limited class time could be made. The students were most cooperative in complying with this request.

Class Instruction

Class instruction on the overhead volley began during the fifth class period. The first session was used for a general

orientation, the second class was used to administer the Wall Volley Test, while the third and fourth were used for finger strength and grip strength testing.

Both the experimental and the control groups attended class together receiving equal time and identical instruction in the overhead volley. The control group used regulation volleyballs, while the experimental group used lightweight plastic balls. Beginning with the fifth class meeting the students worked within their designated groups.

The only skill measured for this study was the overhead volley. Skill practices and games using only the overhead volley were used during the experimental period. Four class periods were devoted to practice of the overhead volley. The sequence of lessons taught during the experimental period can be found in the Appendix.

Post-Tests

Post-tests were administered after the experimental period. The two tests administered at that time were for the wall volley and the finger strength.

Wall volley test. The students received their original score card for the post-test period. Identical testing procedures were used in the post-test period as were used in the pre-test.

Grip strength. Identical procedures were used in the post-test as in the pre-test.

Finger strength. An arbitrary decision was made to eliminate the testing of finger strength at the end of the experimental period.

Statistical Treatment

Correlations using the Pearson Product-Moment Raw Score formula were calculated to determine the relationship between the following: (a) finger strength-grip strength, (b) finger strength-wall volley, and (c) grip strength-wall volley. Correlations were determined for the pre-test scores and for grip strength-wall volley in the post-test trials.

The Fisher "t" test of significance of differences of correlated means was used to determine the within-group variation in scores on the wall volley and grip strength.

An analysis of covariance was calculated to determine between-group differences on the measurements recorded in both testing situations. Analysis of covariance was used to eliminate any possible differences which might have existed between the groups prior to the experimental period. The formulas used in the above calculations can be found in the chapter on statistical analysis.

CHAPTER V

ANALYSIS AND INTERPRETATION OF DATA

The purpose of this study was to investigate the influence of lightweight plastic balls on teaching the overhead volley in volleyball. An additional purpose of this study was to investigate the relationships between the following: (a) grip strength and finger strength, (b) grip strength and volley ability, and (c) finger strength and volley ability.

Correlations

In order to determine the relationship among the various factors in this study the correlation technique was used. Since the sample was small, the Pearson Product-Moment Raw Score Formula was used to calculate the correlation coefficients. The formula used was as follows:

$$r = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2] [N \sum Y^2 - (\sum Y)^2]}}$$

This formula was selected because it allows each score to maintain its individual identity, as opposed to a method which would require the grouping of scores.

Three correlation coefficients were determined in the pre-test situation: (a) finger strength-grip strength, $r = .52$,

(b) finger strength-wall volley, $r = .46$, and (c) grip strength-wall volley, $r = .38$. The correlation coefficient for grip strength-wall volley in the post-test was $.33$. (See Table I)

The correlation coefficients were statistically significant at the 5 per cent level. Those variables which showed the greatest degree of relationship were finger strength and grip strength.

Within Group Differences

The scores obtained on the pre-test and the post-test were compared to measure within-group differences. The Fisher "t" test for significance of difference for small groups with correlated means was used. The formula was as follows:

$$t = \frac{M d}{\sqrt{\frac{\sum d^2}{N (N-1)}}$$

In order to determine the "t" the mean and standard deviation were calculated. The following method was used to calculate the mean and the standard deviation.

Mean. For grip strength the scores from both the right and left hands were averaged to obtain one score for the test for each individual. Each of these scores was then used to determine the average score of the whole group.

For finger strength the total number of pounds of all fingers was added for each hand. This resulted in two scores:

TABLE I

CORRELATION COEFFICIENTS

Variable	Pre- test	Post test
Wall volley- finger strength	.46*	
Grip strength- finger strength	.52*	
Grip strength- wall volley	.38*	.33*

*Significant at the 5 per cent level. (7:315)

one each for the right and the left hands. These two scores were added and divided by ten to get an average score for each subject. These average scores were then used to determine the average of the whole group.

For the wall volley the two trials for each individual were added to obtain one total score. This total score for each individual was then used to determine the average score for each group.

Standard deviation. The standard deviation was calculated using the raw score formula as follows:

$$\sigma = \frac{1}{N} \sqrt{N \sum X^2 - (\sum X)^2}$$

The "t" test for significance of difference computed for grip strength for the experimental group before and after the experimental period was 2.05. This was not significant at the 5 per cent level since the "t" needed was 2.131. The "t" for grip strength for the control group before and after the experimental period was .74. The "t" for the wall volley for the experimental group before and after the experimental period was 1.52. The "t" for the wall volley for the control group before and after the experimental period was 3.29 which was significant at the 5 per cent level. (See Table II)

There was a statistically significant within-group difference for the control group calculated among the mean scores on the wall volley. This difference was based upon the scores from

TABLE II

FISHERS "t" TEST FOR SIGNIFICANCE OF
DIFFERENCE WITHIN GROUPS

	N	M	S.D.	"t"
Grip strength				
Experimental	19			
Pre		62.15	12.11	
Post		65.44	10.82	2.05
Control	18			
Pre		63.55	9.33	
Post		64.86	10.21	.74
Wall volley				
Experimental	19			
Pre		15.05	10.86	
Post		18.42	9.99	1.52
Control	18			
Pre		14.05	10.44	
Post		18.44	11.99	3.29*

*Significant at the 5 per cent level. (7:308)

the pre-test and the post-test trials. The experimental group did not show a significant difference between pre-test and post-test scores.

As a result of these data it appeared that the group using the regulation volleyballs did improve on the wall volley test with concentrated practice of the overhead volley. Equal practice time was given to both the experimental and the control group, however, the experimental group did not show any improvement.

Between Group Differences

The between-group differences were calculated using the covariance statistical technique. This technique was used in order to equalize any differences which might have existed between the groups prior to the experimental period.

When the analysis of covariance was calculated to determine if there was a difference between groups in grip strength scores on the post-test, the resulting F was .28. Calculation to determine if there was a difference between groups using the wall volley scores of both groups resulted in an F of .10. (See Table III)

The results of the analysis of covariance indicated that there was not a significant difference in performance between the groups in relation to the grip strength scores. It may, therefore, be stated that a period of four days of volley practice was not enough to change the grip strength of either group.

In the analysis of covariance for the difference in wall volley scores, neither group scored significantly better than

TABLE III
 ANALYSIS OF COVARIANCE FOR DIFFERENCES BETWEEN
 GROUPS IN GRIP STRENGTH AND WALL VOLLEY

	df	SSx	SSy	SSxy	SSx.y	MSx.y	F
<u>Grip strength</u>							
Source of variation							
Among means	1	18.06	3.18	7.58	19.57	19.57	.28
Within groups	34	4355.47	4096.35	2715.55	2403.26	70.68	
<u>Wall volley</u>							
Source of variation							
Among means	1	9.18	.01	.22	6.18	6.18	.10
Within groups	34	4185.9	4478.14	3215.14	2071.56	59.34	

the other. This was possibly caused by the short length of the experimental period. It can also be noted that even though there was a within-group difference in the wall volley scores for the control group, it did not seem to be enough to cause a difference between groups.

The purpose of this study was to investigate the influence of light-weight plastic balls on teaching the overhead volley in volleyball. An additional purpose of this study was to determine the relationships between the following: (a) grip strength and drop strength, (b) grip strength and volley ability, and (c) finger strength and volley ability.

The test used to measure the high volley was described by Goodenough and Jackson. Measurement was made in both the control and experimental groups during the test.

The subjects for the study were thirty-seven women students enrolled in the physical education department at the University of Illinois at Urbana-Champaign. The study was conducted during the fall semester of 1968. The subjects were divided into two groups: an experimental group and a control group. The subjects were not informed of the purpose of the study.

The purpose of this study was to determine the effect of light-weight plastic balls on teaching the overhead volley in volleyball. The study included four class periods, during which time the experimental group used light-weight plastic balls and the control group used regulation volleyballs. Both groups were given the same instruction and practice time.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND
RECOMMENDATIONS FOR
FURTHER STUDY

The purpose of this study was to investigate the influence of lightweight plastic balls on teaching the overhead volley in volleyball. An additional purpose of this study was to investigate the relationships between the following: (a) grip strength and finger strength, (b) grip strength and volley ability, and (c) finger strength and volley ability.

The test used to measure the high volley was developed by Cunningham and Garrison. Measurements were recorded in both the pre-test and the post-test situations using this test.

The subjects for the study were thirty-seven women students enrolled at The University of North Carolina at Greensboro in a physical education volleyball class. The study was conducted during the fall semester of 1969. The subjects were asked to be prompt so that full use of limited class time could be made. The subjects were most cooperative in complying with this request.

For purposes of this study the class was randomly divided into the experimental group and the control group. The study involved four class periods, during which time the experimental group used lightweight plastic balls and the control group used regulation volleyballs. Both groups met at the same time receiving equal instruction and practice time.

Conclusions

As a result of the analysis of the data involved in this study the following conclusions were drawn:

1. There was a moderate degree of relationship between finger strength and grip strength.
2. There was a slight relationship between the wall volley and grip strength.
3. There was a moderate degree of relationship between finger strength and wall volley.
4. There was a significant difference in the scores on the wall volley for the group using regulation volleyballs.
5. There was no difference in the scores on the wall volley test for the group using the lightweight plastic balls.
6. There was no difference between the groups in grip strength scores after the experimental period.
7. There was no difference between the groups in the wall volley scores at the end of four days of practice.

Recommendations for Further Study

The writer would suggest that additional study be done using the lightweight plastic balls as a standard practice in teaching volleyball. The experimental period could be longer and additional skills might also be included. Additional testing periods would be recommended during the longer experimental period. It is also recommended that if possible larger numbers of subjects be used.

It is recommended that correlations be calculated between the individual fingers and grip strength. If a significant relationship could be found it might be possible to measure just one or two fingers rather than all ten.

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DESCRIPTION OF TESTS
FOR MEASUREMENT

FINGER FLEXION

Starting position

- a. Subject sitting in arm-chair; feet on floor; feet are resting comfortably on thigh.
- b. Forearm and hand on table; subject's right hand resting on writing board; subject's left hand on table for support.
- c. Line of metacarpal-phalangeal joints at edge of writing board; subject's forearm is at 90 degrees.

Attachments

- a. Finger strap placed around first phalanx of finger.
- b. Pulling assembly attached to end of strap on front leg of chair; subject's hand is pulled "back into" straight line with forearm when testing.

Precautions

- a. Forearm parallel to floor and elbow flexed by tracing.

FINGER EXTENSION

Starting position

- a. Subject sitting in arm-chair; feet on floor; feet are resting comfortably on thigh.
- b. Shoulder on side of table; subject's right hand resting on writing board; subject's left hand on table for support; line of metacarpal-phalangeal joints at edge of writing board; subject's forearm is at 90 degrees.

Attachments

- a. Finger strap placed around first phalanx of finger.
- b. Pulling assembly attached to end of strap on front leg of subject.

Precautions

- a. Forearm parallel to floor and elbow flexed by tracing.
- b. Forearm should not be extended by pulling on it.

APPENDIX

DIRECTIONS FOR FINGER
STRENGTH MEASUREMENT *

FINGER FLEXION

Starting position

- a. Subject sitting in arm-rest chair; feet on floor; free arm resting comfortably on thigh.
- b. Forearm and hand on side tested supinated and resting on writing board; towel placed under arm and hand for comfort.
- c. Line of metacarpal-phalangeal joints at edge of writing board; finger being tested extended beyond 180 degrees.

Attachments

- a. Finger strap placed around first phalanx of finger.
- b. Pulling assembly attached to hook on front leg of chair; adjust so that forefinger "pulls into" straight line with forearm when testing.

Precautions

- a. Prevent palmar flexion and elbow flexion by bracing.

FINGER EXTENSION

Starting position

- a. Subject sitting in straight chair; feet on floor; free arm resting comfortably on thigh.
- b. Shoulder on side tested in 180 degrees extension and adduction; forearm and hand pronated lying flat on arm rest of another chair; forefinger just off edge of arm rest, flexed to 80 degrees.

Attachments

- a. Finger strap placed around first phalanx of forefinger.
- b. Pulling assembly attached to wall at rear of subject.

Precautions

- a. Prevent wrist dorsal flexion and elbow flexion by bracing.
- b. Prevent thumb from interfering by extending it.

*(5:11)

DIRECTIONS FOR FINGER
STRENGTH MEASUREMENT *

THUMB ADDUCTION

Starting position

- a. Subject sitting in arm-rest chair; feet on floor; free arm resting comfortably on thigh.
- b. Forearm on side tested in mid-prone-supine position; thumb adducted to maximum; fingers extended.

Attachments

- a. Finger strap placed around interphalangeal joint of thumb.
- b. Pulling assembly attached to wall at rear of subject, directly in line of pull.

Precautions

- a. Prevent abduction and elevation of shoulder.
- b. Keep wrist and fingers fully extended by bracing.

THUMB ABDUCTION

Starting Position

- a. Subject sitting in arm-rest chair; feet on floor; free arm resting comfortably on thigh.
- b. Forearm on side tested in mid-prone-supine position; side of hand resting on writing board far enough forward to allow thumb attachment; fingers extended; thumb extended to be in line with forefinger at height of pull (place pad under wrist for comfort).

Attachments

- a. Finger strap around phalanx of thumb.
- b. Pulling assembly attached to chair-leg hook.

Precautions

- a. Prevent abduction and elevation of shoulder.
- b. Keep fingers and wrist fully extended by bracing.

* (5:12)

DIRECTIONS FOR GRIP STRENGTH MEASUREMENT

The grip strength dynamometer was handed to the subject so that the dial was facing the palm.

The curved part of the dynamometer was put in the hand toward the fingers.

The student was instructed to squeeze the dynamometer as hard as possible and then hand it back to the tester.

Each student was given only one chance, unless they dropped the dynamometer while squeezing it.

ADMINISTRATION PROCEDURES FOR THE
CUNNINGHAM-GARRISON HIGH WALL VOLLEY TEST

- EQUIPMENT:** Official leather volleyball, properly inflated; flat, unobstructed wall space 9 feet wide and 15 feet high; stopwatch.
- MARKINGS:** A target area formed by three lines consisting of a horizontal line 3 feet long and 10 feet from the floor with vertical lines 3 feet long (at each end of the horizontal line) extending upward at right angles to the horizontal line.
- TEST:** The test consists of two 30 second trials. The player stands anywhere in front of the target (no restraining line). With the signal "ready, go" she uses any type of toss or hit to send the ball into the target area on or above the 10 foot line and on or between the two vertical lines or their extensions. When the ball returns she volleys it repeatedly into the target area. Only one contact of the ball is allowed on each volley. If the player loses control of the ball, she recovers it and starts again as before. She may not use the sequence "toss, volley, catch; toss, volley, catch" but must make an attempt to perform a repeated volley. Following the first trial the player rests while the other members of her group take their first trial. A second trial is given as before.
- SCORING:** One point is scored each time the ball hits in the target area or on the lines bounding it (including imaginary extensions of the vertical lines), following a legal volley of a ball rebounding from the wall. The toss or hit to start the ball does not count. If the player loses control of the ball scoring continues with the next legal hit.

(29:487-488.)

SCORE CARD

CUNNINGHAM-GARRISON HIGH WALL VOLLEY TEST

NAME	GROUP
Last, First	_____

DATE	DATE
Trial 1	Trial 1
Trial 2	Trial 2
_____	_____
Total	Total

RAW SCORES FOR
FINGER STRENGTH
IN POUNDS

		Right					Left				
1.	flex	13	10	9	8	2	20	9	19	5	5
	ext	10	10	10	8	5	13	10	10	8	5
2.	flex	5	17	15	6	5	9	6	15	6	9
	ext	17	10	17	8	8	10	9	17	10	6
3.	flex	5	15	18	10	6	15	10	10	10	9
	ext	10	15	10	10	8	15	10	13	10	8
4.	flex	13	10	9	8	2	6	6	9	6	5
	ext	10	8	10	9	2	8	6	9	6	5
5.	flex	5	8	8	5	0	6	6	5	2	2
	ext	10	8	9	9	0	9	10	8	9	2
6.	flex	5	8	8	6	2	6	5	9	6	5
	ext	9	6	8	5	2	10	9	10	8	2
7.	flex	9	6	10	9	2	13	8	9	8	5
	ext	13	10	10	10	8	10	9	10	10	5
8.	flex	17	10	15	8	6	13	17	13	10	10
	ext	15	9	20	10	10	10	9	10	8	6
9.	flex	5	2	8	6	2	8	6	5	5	2
	ext	6	8	8	8	5	5	2	5	2	2
10.	flex	10	10	8	5	6	5	8	2	0	2
	ext	6	9	10	8	9	8	9	10	8	8
11.	flex	5	8	5	0	0	2	2	0	2	2
	ext	8	10	13	6	2	0	0	8	8	0
12.	flex	5	10	9	6	2	10	9	8	5	5
	ext	13	13	13	15	9	22	25	24	13	8
13.	flex	5	10	13	9	6	10	8	6	9	6
	ext	13	13	17	9	2	10	10	10	10	2
14.	flex	5	6	8	8	5	2	8	6	8	2
	ext	6	6	9	6	2	5	5	6	8	2
15.	flex	5	6	8	5	2	2	5	6	5	2
	ext	5	9	9	8	0	6	8	6	5	5
16.	flex	8	2	2	2	2	10	5	2	2	2
	ext	10	9	10	10	6	10	10	10	10	5

RAW SCORES FOR FINGER STRENGTH (continued)

		Right					Left				
17.	flex	10	10	18	10	2	10	10	18	8	2
	ext	18	25	24	10	10	19	18	19	10	10
18.	flex	10	8	9	5	5	6	10	10	10	9
	ext	19	20	18	13	10	13	9	6	9	8
19.	flex	5	8	8	8	2	6	6	9	6	2
	ext	10	8	10	6	5	6	10	9	8	6
20.	flex	6	5	5	6	2	8	6	8	5	0
	ext	18	10	10	15	8	18	10	10	10	5
21.	flex	13	10	9	8	5	13	10	10	9	5
	ext	8	8	10	10	8	9	10	8	9	5
22.	flex	10	6	5	5	2	5	6	6	5	2
	ext	10	10	10	9	9	9	8	9	10	6
23.	flex	15	10	10	8	5	8	9	15	10	10
	ext	13	6	8	6	9	10	6	9	5	2
24.	flex	10	9	10	9	6	18	8	9	5	5
	ext	18	10	10	10	5	17	13	15	10	5
25.	flex	5	6	8	8	5	10	5	8	6	0
	ext	10	10	10	2	6	13	2	10	5	2
26.	flex	10	18	10	5	5	5	8	6	8	9
	ext	18	6	9	8	5	10	6	8	5	2
27.	flex	8	5	5	2	0	10	6	9	6	
	ext	13	10	17	8	8	10	6	8	9	5
28.	flex	10	8	6	5	2	10	8	5	2	2
	ext	15	10	10	6	5	15	10	9	5	5
29.	flex	5	8	10	5	2	5	9	10	6	5
	ext	9	6	9	6	5	6	6	8	8	2
30.	flex	5	6	6	5	5	6	8	5	2	2
	ext	9	6	8	9	2	10	6	9	5	2
31.	flex	2	8	10	5	5	5	6	5	0	0
	ext	9	10	8	5	2	5	8	8	6	0
32.	flex	9	6	5	2	2	6	6	8	5	5
	ext	8	10	5	5	2	10	8	5	5	2
33.	flex	5	6	5	6	2	10	6	9	8	5
	ext	9	10	2	8	2	8	5	6	5	2

RAW SCORES FOR FINGER STRENGTH (continued)

		Right					Left				
34.	flex	4	9	9	8	5	6	6	9	8	2
	ext	10	8	8	6	0	13	10	10	10	5
35.	flex	8	8	9	8	2	9	2	5	5	5
	ext	17	10	10	6	5	10	8	8	5	0
36.	flex	8	6	8	5	5	9	8	6	10	5
	ext	10	10	9	8	5	10	15	8	10	2
37.	flex	9	8	10	8	5	10	10	9	9	5
	ext	20	15	10	9	8	17	10	10	9	6

RAW SCORES FOR
GRIP STRENGTH SCORES
IN POUNDS

PRE TEST		POST TEST	
Right	Left	Right	Left
78	70	68	62
72	40	62	60
70	64	64	82
50	60	50	62
64	60	62	60
75	82	90	88
78	60	84	75
62	64	56	50
62	44	90	60
44	42	52	40
36	32	64	62
66	70	90	70
77	50	75	64
50	60	68	60
76	78	80	72
76	73	70	50
62	52	60	50
62	56	68	55
64	58	70	70
60	52	52	40
70	60	74	68
74	60	74	60
66	70	60	58
72	60	60	58
70	64	64	64
84	62	90	60
52	48	58	58
54	38	60	40
70	60	82	74
72	64	60	54
80	78	92	60
48	35	56	40
70	68	72	74
80	76	84	76
55	50	62	54
47	54	60	58
76	70	88	78

RAW SCORES FOR THE
WALL VOLLEY

PRE-TEST	POST-TEST
10	11
15	8
20	32
4	5
8	18
8	14
21	39
12	19
21	15
5	23
4	15
10	8
19	23
17	10
4	24
35	27
45	34
24	27
4	1
10	12
2	4
12	11
10	18
19	26
21	19
6	10
21	15
29	45
10	14
2	15
11	16
8	14
4	5
11	20
7	10
45	53
22	18

SEQUENCE OF LESSONS

September 18

General Orientation

September 23

Cunningham-Garrison
Volley Test

September 25

Finger Strength-Grip

September 30

Finger Strength-Grip

October 2

Divide into Groups
Begin overhead volley drills

October 7

Drills on overhead volley

October 9

Continue drills overhead volley

October 14

Finish overhead volley
Drills and game with the
overhead volley only

October 16

Post-test overhead volley
Grip-strength