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The Establishment of Reliability, Objectivity, and Validity for a Developed Handball Test

Jan B. Olson

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THE ESTABLISHMENT OF RELIABILITY, OBJECTIVITY, AND

VALIDITY FOR A DEVELOPED HANDBALL TEST

by

Jan B. Olson

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This thesis submitted by Jan B. Olson in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

W.C. Koenig
(Chairman)

John L. Quaday

E. Gordon Richardson

A. William Johnson
Dean of the Graduate School

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Title THE ESTABLISHMENT OF RELIABILITY, OBJECTIVITY, AND VALIDITY FOR A DEVELOPED HANDBALL TEST

Department ___ Physical Education

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ABSTRACT

This study was basically concerned with developing a battery of

specific test items that could measure an individual's ability to play

handball. It was this writer's intent to develop a battery of test

items which included several measurements of actual handball skills

and several that measured the general motor ability associated with

playing handball. Furthermore, reliability, objectivity, and validity

were established for the test developed in this study.

The test developed by this writer consisted of a battery of

five individual tests. They include: 30-Second Alternate Hand-Wall

Volley Test, Service Placement Test, Power Test, Handball Shuttle Run

and Six-Minute Run.

Reliability was established for the Developed Test by the test-

retest method. All tests except the 30-Second Alternate Hand Wall Vol-

ley Test were found reliable and acceptable at the .05 level of sig-

nificance.

Objectivity was established by having a different tester admin-

ister the retest for the Developed Handball Test. The results for

objectivity are therefore, the same results obtained for reliability.

The validity of the Developed Handball Test was determined by

comparing the results of the Cornish Handball Test (Published Handball

test with known validity) versus Test One Results of the Developed

Handball Test. The Cornish Handball Test versus Test Two Results of

the Developed Test and the Test One Results of the Developed Test versus the results of a Ladder Tournament were also used. The Test Two REsults of the Developed Test versus the results of the Ladder Tournament were used as well. All comparisons made showed an acceptable amount of validity at the .05 level of significance.

All testing for this study was conducted in the University of North Dakota Fieldhouse. Ten subjects were used and the testing period lasted approximately three weeks.

CHAPTER I

INTRODUCTION

Nature of the Problem

Grading practices in physical education are frequently the subject of much discussion and, at times, the object of considerable criticism. Many of the problems which exist in this area are not readily solved. Grading procedures, for example, may vary with the curriculum, school regulations, availability of equipment, teaching level, educational philosophy of the teacher and a multitude of other factors. Performance, however, is generally considered an important component of any grading plan; in fact, it is quite common for the entire grade to be based upon performance criteria.

Skill tests are available for most motor activities, including handball. As the name skills test would imply, only skills that are directly associated with the activity are measured. Tests must be developed to measure performance in activities. These tests should include not only skills directly relating to the activity, but general motor ability needed to accomplish those skills as well. Reliability, objectivity, and validity must also be established for these performance tests to ensure that they measure effectively that which is to be measured.

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Statement of the Problem

The problem in this study was to develop a battery of specific
test items which measured an individual's ability to play handball. It
was this writer's intent to develop a battery of test items which
included several measurements of actual handball skills and several
that measured the general motor ability associated with playing hand-
ball. Furthermore, objectivity, reliability, and validity were estab-
lished for the test developed in this study.

Need for the Study

There has been a noticeable trend toward the use of more sports
activities in physical education programs in the United States. If
sports skills are emphasized in instructional programs, it seems only
reasonable that these same skills should occupy a prominent position
in the testing programs.

There is a real need for scientific measurement of progress
toward the objectives of the physical education program. Game skills
as an objective have been clear in the minds of physical education
teachers, yet few tests have been devised that actually measure abil-
ity in various sports. This has been a handicap to physical education,
resulting in inaccurate grading. Standard objective tests should be
drawn up in various activities in order to eliminate subjective rat-
ings, which are sometimes inaccurate measurements of ability. Judg-
ment ratings also allow other factors to enter into the picture such
as effort, attitude, interest, and personal prejudices and, therefore,
are not always as accurate as intended.

According to Clarke (1967) skill testing has three major roles to play in physical education: (a) to determine pupil achievement and progress, (b) to classify students by ability levels, and (c) to measure "progress toward educational objectives." In spite of the acknowlledged importance of skill tests, few such tests have been developed in handball.

Physical education is an integral part of the school curriculum. However, because of a lack of an objective grading system in most activities, the physical education teacher is called upon to explain his grading system which is normally quite subjective. Because of this, tests are needed that have economy in both cost and time, are objective, and are also accurate evaluators of skill and general motor ability. Handball is no exception.

Hypothesis

The null-hypothesis for this study is that there would be no difference between the test results of the subjects tested on the Developed Handball Test as compared to the test results attained on the Cornish Handball Skills Test and a ladder tournament.

The research hypothesis for this study is that there would be a relationship between the scores of the subjects on the Developed Handball Test and their handball performance ability.

Limitations of the Study

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

1. size of the handball courts at the University of North Dakota which are considerably smaller than suggested American Amateur Union standards,

2. previous handball experience of subjects could not be controlled,

3. conditions such as the momentary attitudes of the subjects will have affected the results of the study to some extent,

4. previous testing experiences on the part of the subjects were not taken into consideration,

5. the diet, sleep, and daily habits of each individual were not controlled,

6. such factors as heat, light, and humidity will have affected the results of performance on certain test items, especially the Six-Minute Run which was run on the indoor track at the University of North Dakota Fieldhouse.

Delimitations of the Study

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

1. The study was delimited to the male population enrolled in the physical education service program at the University of North Dakota.

2. Standard procedures and equipment were used by the testers during each day of the testing. Testing of each subject for all tests was done approximately at the same time each day.

3. The Cornish Handball Test was administered to subjects during one class period. All subjects were administered the

test items in the same order. The test, as administered, included: Thirty-Second Volley, Front-Wall Placement, Back-Wall Placement, Power-Test, and Placement-Service Test.

4. The test-retest of the Developed Test was administered during a three week period. Only four subjects were tested per hour due to the length of the test. The subjects were administered the Developed Test in the following order for both test and retest: 30-Second Alternate Hand-Wall Volley Test, Power Test, Service Placement Test, Shuttle Run, and Six-Minute Run. The retest for all subjects came two days after the initial test of the Developed Test.

5. The ladder tournament was conducted throughout the semester after initial playing procedures and rules were reviewed. A two week practice period preceded any actual game competition.

Definitions

Cornish Handball Test:--A handball skills test which is validated and includes the following battery of tests: 30-Second Volley, Back Wall Placement, Front Wall Placement, Power Stroke, and Placement Service.

Developed Handball Test:--A handball test developed by this writer including the following battery of tests: 30-Second Alternate Hand-Wall Volley, Power Stroke, Service Placement, Handball Shuttle Run and Six-Minute Run.

Endurance:--The capacity for continuous exertion. Various types of endurance are included such as muscular endurance and cardiovascular endurance.

Ladder Tournament:--A challenge type tournament where participants are ranked linearally according to success or failure in actual game competition.

Measurement:--A method of determining status by comparison with a standard.

Motor Ability or Activity:--The acquisition and development of the abilities which are essential to movement and the subsequent acquisition of motor skills.

Objectivity:--The consistency with which a test can be administered to the same subject by different teachers.

Performance:--A formal exhibition of skill or talent.

Reliability:--The consistency with which a test can be administered by the same tester.

Skills Test:--A test that measures the ability involved in participating in a particular activity.

Validity:--The accuracy with which a test measures what it purports to measure.

Review of Related Literature

Although relatively little is known about handball, its history is indeed interesting. Robert Ripley, the "Believe It or Not" Man, implied that handball is the oldest of all games played with a ball (Phillips, 1937). Homer talked of "the Princess of Corcepa with her maidens, amusing themselves at handball." Also, playing at handball was one of many recreations prohibited by proclamation in the reign of Edward III (Strutt, 1876).

The present form of handball as it is known today is relatively new and very little material has been written about it. To date, there is only one handball skills test that is used to any degree according to the research conducted by this writer. That test is the Cornish Handball Test. However, several other tests have been developed, but due to various factors are not used as a measure of determining or evaluating handball ability. The main reason that some of these recently developed tests have not been published is that they lack either reliability or validity. Without substantial scientific evidence, their ability to accurately measure handball performance is doubtful.

In making up a selected list of books and material on sports, Ranck (1935) wrote, in December, 1934, regarding handball, "For material on this game played in an enclosed room using all six walls, the best place to go is the Spaulding Athletic Library. There are no books on the subject."

The following review of related literature is concerned with several different aspects that should be considered when developing a handball test. First of all, previous handball tests that have been developed is discussed as to their content, significance, and scientific evidence. Secondly, a number of general athletic ability skills tests is discussed as to how they could apply and aid in the evaluation and development of an effective handball test.

The first established handball skills test discussed is the Cornish Handball Test. This test was developed by Clayton Cornish (1949) of Howard College in Birmingham, Alabama. The purposes of this study were: (1) to determine the validity of certain skills

in measuring ability in handball, (2) to select tests that brought about game situations for measurement.

The data presented by Cornish were obtained from six physical education classes at Louisiana State University. One hundred and thirty four students were given the test. These students were schooled in the fundamentals of handball at the beginning, given instructions in the proper manner of stroking the ball and also the basic rules of the game.

Cornish, after much observation and review of literature available on testing in handball, selected the following battery of test items:

1. Thirty-Second Volley,

2. Front-Wall Placement Test,

3. Back-Wall Placement Test,

4. Power Test,

5. Placement-Service Test.

The last four weeks of the class were used to play games with each student playing 23 games. The total number of points scored by each student minus those scored by his opponent were tabulated and these points were used as a criterion for measurement against the five scores of the test battery.

The multiple correlation of the five tests with the total number of plus points on games won was found to be .694. The highest individual correlation with the criterion was the Power Test with .58. The lowest correlation with the criterion was the Back-Wall Placement, with a correlation of .38. The lowest intercorrelations (.26) were

those involving the Service-Placement Test with the Front-Wall Placement Test, and Service-Placement Test with the Back-Wall Placement.

A combination of the 30-Second Volley and the Service Placement Test with the criterion was found to have a correlation of .67.

Cornish (1949) concluded that if only one test item were selected, the Power Test would probably be the best as it has a rather significant correlation with all other tests. The best battery of test items would probably be the Thirty-Second Volley and Service-Placement Tests as they had a .67 correlation with the total number of plus points scored.

Reuter (1967) developed a handball skills test. He used the results of a round robin tournament in the same manner as did Cornish to determine the correlation between the scores on his test and success in actual game competition. The results of his study were favorable.

In the Edgren and Robinson (1937) Handball Test, the following battery of test items was included:

1. Speed Test,

2. Accuracy Test,

3. Volley Test,

4. Service Test,

5. Back-Wall Return.

Although it was fairly accurate measurement of handball skills, some of the skills being measured seemed to overlap.

The authors did not claim that this form of test measures all the factors involved in making a good handball player. They did believe, however, that the technique had some value in measuring the achievement of the individual in his ability to play the game.

Another battery of test items by Clevett was described by Cornish. Clevett's test was designed from the five basic strokes in handball and included:

1. Full-Arm Stroke,

2. Easy-Placement Stroke,

3. Back-Wall Stroke,

4. Service Test,

5. Overhand Stroke.

The front wall and floor were marked off into six equal areas for front wall and nine equal areas for the floor, with numerals denoting the difficulty of hitting the handball into each area.

No validity was established. The test was used for the purpose of measuring the progress of pupils after a course of instruction had been given in handball.

The fourth group of test items was proposed by Friermood (n.d.). His test items were designed to measure ability to perform certain strokes and the ability to serve cross-court into designated areas, such as right into left and left into right. Friermood's test varied from other skill tests listed in that no targets or watches were used and that the scores were based totally on the judgment ratings of the scorers.

Of the first four series of test items discussed, only the Cornish Test has been used extensively. The other three groups of test items mentioned have been used very sparingly. Also, no known attempts to find the validity or reliability of these tests have been made.

Still another method of measuring handball ability was used by Schiff (1938). He had three assistants schooled in the system of checking the success of each player through observation techniques and the ratings by each assistant were then totaled and averaged for each student. His findings were very significant, showing a correlation of .87 when the scores from the calculated observation techniques were compared against the rankings assigned to each player by the three test assistants.

Bancroft (1937) related the following about the physical aspect of handball, "The game calls for strenuous, all-over muscular exercise and great skill and quickness." Means and Jack (1965) added:

> Handball, as played by the skilled, is a fast, rough and energy consuming game. It requires agility, endurance, good conditioning, quick reflexes, and dexterity, all of which help to make it a great body conditioner.

While reviewing the literature, numerous comments such as these appeared. It became apparent that a handball test must be devised that measures more than isolated game skills. General motor ability must also be measured for such a physical game in order to get a complete picture of the handball player's ability. It was assumed by this writer that a number of fitness tests that are used to measure general athletic ability such as the American Association for Health, Physical Education, and Recreation Youth Fitness Test, the Western Motor Ability Test, and the JCR Test could also be applied to a handball test.

The American Association for Health, Physical Education, and Recreation Youth Fitness Test is a battery of seven test items designed to give a measure of physical fitness for both boys and girls. The test items were selected to evaluate specific aspects of physical

status which when taken together, give an over-all picture of one's general fitness.

The test battery includes seven items which can be given in the gymnasium or outdoors. They are: pull-up for judging arm and shoulder girdle strength; sit-ups for judging efficiency of abdominal and hip flexor muscles; shuttle-run for judging speed and change of direction; standing-broad jump for judging explosive power of leg extensors; 50-yard dash for judging speed; softball throw for distance for judging skill and coordination; and the 600 yard run-walk for judging endurance (American Association for Health, Physical Education and Recreation, 1958).

The test item from this battery that was of primary interest was the shuttle-run. A more detailed description by Corbin (1969) of this test includes:

(a) Equipment: Two blocks of wood, 2 inches x 2 inches x 4 inches, and a stopwatch.

(b) Performance: Two parallel lines are marked on the floor 30 feet apart. The blocks of wood are placed behind one of the lines. On the signal "Ready? Go!" the subject runs to the blocks, picks one up, runs back to the starting line, and places the block behind the line. He then runs back and picks up the second block which he carries back across the starting line.

(c) Scoring: The better of two trials is recorded.

The Western Motor Ability Test as described by Van Vliet and Howell (1967) consists of a battery of four test items which includes: agility run, standing broad jump, alternate-hand wall-toss, and

sitting basketball throw. The agility run and alternate-hand wall-toss directly relate to several of the tests in the Developed Handball Test and a brief description of these two test items is as follows:

Agility Run

(a) Equipment: 4 chairs, stopwatch, and 15 foot x 50 foot floor space.

(b) Performance: Run zigzag pattern laid out in fastest possible time.

(c) Scoring: Measurement in total number of seconds needed to complete course.

(d) Reliability controls: The test is taken in rubber-soled shoes. A "ready" warning signal is given prior to the starting signal. Two trials are allowed and the better trial recorded. A short rest of two to three minutes should be allowed between the trials.

Alternate-hand wall-toss

(a) Equipment: Three tennis balls, a stopwatch or timer, and a smooth-surfaced wall (6 feet wide).

(b) Starting position: Stand facing wall, behind a 6 foot restraining line, with ball in right hand. Extra balls are located in a container at the side of right foot.

(c) Performance: On the starting signal, the ball is tossed against the wall with an underhand motion with either hand. The ball must then be caught with the opposite hand that was used for throwing and this hand that catches the ball is then used as the throwing hand.

This alternate movement is repeated as often as possible in 30 seconds.

(d) Scoring: Total number of successful catches with each hand in 30 seconds.

(3) Reliability controls: The ball must be thrown underhand. The ball cannot be trapped against the body. The restraining line cannot be crossed. Two trials are allowed and the better trial recorded.

The JCR Test as described by Phillips (1947) is a three-item test consisting of the vertical jump, chinning with the natural grip, and a 100 yard shuttle-run. The shuttle run covers a ten-yard course ten times. It purports to measure the ability of an individual to perform fundamental motor skills such as jumping, climbing, running, and dodging which involves the basic elements of power, strength, speed, agility, and endurance.

Summary of Review of Related Literature

Objective measurement of certain basic skills plays an important part in determining overall motor ability in a specific activity. The use of well-constructed tests can aid the teacher in recognizing different ability levels, in determining progress, in selecting the best performers, and in recognizing strengths and weaknesses of the participants within the activity. With the increasing popularity of handball as a physical education activity there appears to be a need for the development of a handball test which evaluates general motor ability as well as skills with regard to the play of handball.

CHAPTER II

METHODOLOGY

Preliminary Planning and Group Selection

The data used in this study were obtained from students enrolled
in a section of Handball 102. The course was offered to male students
at the University of North Dakota during the fall semester of 1971 and
met on Tuesdays and Thursdays for 50 minutes.

A total of ten students participated in the study. All ten sub-
jects participated in the Cornish Handball Test, the test-retest of the
Developed Handball Test, and the ladder tournament. The participating
students had varying amounts of handball experience ranging from skilled
players who played on the average of three times a week prior to enroll-
ing in the class to those who had no previous handball experience at all.

Procedure

The Cornish Handball Skills Test was administered according to
the directions and recommendations of "A Study of Measurement of Ability
in Handball" contained in the Research Quarterly (May, 1949). The
Developed Handball Test was administered according to the directions
designed by this writer.

The purpose of this study was explained to all the subjects
before they were administered the Developed Handball Test and the
Cornish Handball Test. All subjects were encouraged to participate

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"to the best of their ability" by being informed before testing that their test scores would assist in determining their final grade in Handball 102. Also, it was added that their cooperation would aid in developing a more suitable Handball test. Occasional vocal encouragement was used by the testers but not to a great extent.

The Developed Handball Test was administered starting on a Tuesday to four subjects. On Thursday of week one another four subjects were tested. On Tuesday of week two the final two students were tested. On Thursday of week two the retest was administered to the same four students who had taken the initial test first. On Tuesday of week three the next four students were tested and on Thursday of week three the final two students completed the testing. All students were tested during the retest in the same order as during the first test. Also, the five test items of the Developed Test were administered in the same order during both the test and retest.

The Cornish Handball Test was administered to the subjects at their convenience after the fall semester was completed. Virtually all testing for the Cornish Test was conducted at approximately the same time of day as the regularly scheduled class during the semester.

Experimental Design

The experimental design used in this study was the single group design. It was selected to obtain the test data because it would not be biased and it would allow for a minimum of time between tests.

Test Administration

The Cornish Handball Skills Test included the following battery of test items:

1. 30-Second Volley,

2. Front-Wall Placement,

3. Back-Wall Placement,

4. Power Stroke,

5. Placement Service.

All five of the tests were administered in the handball courts at the University of North Dakota.

The developed Handball Test included the following battery of test items:

1. Thirty-Second Alternate Hand-Wall Volley,

2. Service Placement,

3. Power Test,

4. Handball Shuttle Run,

5. Six-Minute Run.

The first four tests were administered in the handball courts at the University of North Dakota. The Six-Minute Run was conducted on the indoor track in the University of North Dakota Fieldhouse.

Test Assistants

The Cornish Handball Test, the initial test of the Developed Handball Test, and parts of the ladder tournament were under the direct supervision of this researcher. The retest of the Developed Test and most of the ladder tournament were under the supervision of Mr. Hank Biesoit, a graduate-teaching assistant for the Physical Education Department at the University of North Dakota. Times, measurements, and test scores were recorded by both Mr. Biesoit and this writer.

Directions for Tests

A complete description of the directions for the Cornish Handball Test and the Developed Handball Test are presented in Appendix A, pages 35-43.

Equipment and Supplies

The entire study was extremely economical to administer. No purchase of special equipment was necessary. The equipment used needed no special adjustment or calibration. Administration time was also reasonably economical as all the tests and the ladder tournament were conducted during regularly scheduled class periods. As was mentioned the Cornish Test was administered at a later date.

Basic Assumptions

1. All subjects had equal instruction and explanation of the objectives of all tests.

2. All subjects had an equal opportunity to score on each administered test.

3. The subjects performed on all tests to the best of their ability.

The Setting

The testing was conducted in an operational type setting. All tests, excluding the six-minute run, were conducted in the handball courts used for regular class activities at the University of North Dakota.

The Controls

The controls imposed on the study related to the methods of
administering the test items. For adequate control, the specific
methods involved in handling each test item and the criteria for
scoring on each item were rigidly adhered to. Precise and under-
standable instructions were given to each subject before each test
was given. Further, the testing environment was constantly main-
tained throughout all testing.

Recording of Data

A scorecard was constructed for the Developed Handball Test
by this researcher. A copy of this scorecard is located in Appendix
B, page 44.

Statistical Design

The data from the test-retest were used in determining the
reliability correlation coefficients for the Developed Handball Test.
These reliability correlation coefficients were determined for each
of the five test items of the Developed Test by the use of The Spear-
man Rank-Difference Correlation as designated by Weber and Lamb (1970)
whereby $rho = 1 - \dfrac{6 \, \Sigma (R_x - R_y)^2}{N(N^2 - 1)}$.

Objectivity was gained by using a different tester for the
retest. The results for determining reliability were therefore, also
the results for objectivity.

The data from the Cornish Handball Test, the test-retest and
the ladder tournament were used in determining the validity correlation
coefficients for the Developed Handball Test. The students were ranked

from one through ten on the Cornish Handball Test and the ladder tourna-
ment. The Spearman Rank Correlation Coefficient as designated by Siegel
(1956) whereby $r_s = 1 - \dfrac{6 \sum\limits_{i=i}^{N} di^2}{N^3 - N}$ was then used to determine the validity

correlation coefficients.

Comparisons to obtain this data were made between the Cornish
Handball Test and Test One of the Developed Test, the Cornish Test and
Test Two of the Developed Test, Test One and the ladder tournament, and
Test Two and the ladder tournament.

The validity coefficients computed from these comparisons were
then compared against Table 1 (Siegel, 1956) located on page 21 to
determine at what level of significance the results could be accepted.

The mathematical procedures for obtaining correlation coeffi-
cients for reliability, objectivity, and validity are located in
Appendix C, page 47.

CHAPTER III

ANALYSIS OF THE DATA

The purpose of this study was to design a Handball Test that would measure both skills and general motor ability used in playing handball. The degrees of reliability, objectivity, and validity for the Developed Test were also calculated.

Analysis to Determine Reliability

The results obtained from the test-retest of the five items of the Developed Handball Test were used to calculate the correlation coefficients for the reliability of the Developed Test.

The reliability coefficients were calculated by using the Spearman Rank-Difference Correlation statistical analysis as discussed in Chapter II, page 20. The results were then compared with Table 1 (Barrow and McGee, 1970) and Table 2 (Siegel, 1956). These two tables appear as follows:

TABLE 1

ARBITRARY STANDARDS FOR INTERPRETING CORRELATION COEFFICIENTS*

Coefficients	Validity	Reliability and Objectivity
.95 to 99		excellent
.90 to .94		very good
.85 to .89	excellent	acceptable
.80 to .84	very good	acceptable
.75 to .79	acceptable	poor
.70 to .74	acceptable	poor
.65 to .69	questionable (except for very complex tests)	questionable (except for groups)
.60 to .64	questionable	questionable (except for groups)

*(Barrow & McGee, 1970)

TABLE 2

TABLE OF CRITICAL VALUES OF rs, THE SPEARMAN RANK CORRELATION COEFFICIENT*

| | Significance level (one-tailed test) | |
N	.05	.01
4	1.000	
5	.900	1.000
6	.829	.943
7	.714	.893
8	.643	.833
9	.600	.783
10	.564	.746
12	.506	.712
14	.456	.645
16	.425	.601
18	.399	.564
20	.377	.534
22	.359	.508
24	.343	.485
26	.329	.465
28	.317	.448
30	.306	.432

*(Siegel, 1956)

The following material presents the statistical results for reliability of the five items of the Developed Handball Test.

30-Second Alternate Hand-Wall
Volley Test

The correlation coefficient for reliability was found to be .44. The 30-Second Alternate Hand-Wall Volley Test was therefore not reliable because it did not attain a high enough degree of correlation when compared with the values in Table 1. Further, the value needed to attain a significance level was not reached when compared with the values in Table 2. The null hypothesis for this test item was not accepted at

the .05 level of confidence. This was the only test item that failed to achieve an acceptable degree of reliability.

Service Placement Test

The correlation coefficient for reliability was found to be .80. The Service Placement Test was therefore reliable because it did attain a degree of correlation high enough when compared with the values in Table 1. A significance level was attained at the .01 level when the correlation coefficient of .80 was compared with the values in Table 2. The null hypothesis was accepted at the .05 level.

Power Test

The correlation coefficient for reliability was found to be .99. This was the highest correlation coefficient attained on any of the five test items. The Power Test was reliable because it had a high degree of correlation when compared with the values in Table 1. Table 2 indicated that a correlation coefficient of .99 would be significant at the .01 level. The null hypothesis for the Power Test was accepted at the .05 level.

Shuttle Run

The correlation coefficient for the Shuttle Run was found to be .68. When compared against the values on Table 1 the Shuttle Run was found to be reliable. A correlation coefficient of .68 was accepted at the .05 significance level according to Table 2. Therefore, the null hypothesis was accepted at the .05 level.

Six-Minute Run

The correlation coefficient was found to be .92 for the Six-Minute Run. The Six-Minute Run was therefore reliable according to the values in Table 1. A level of significance of .01 was accepted with the correlation coefficient value of .92. The null hypothesis was accepted at the .05 level for the Six-Minute Run.

Summary of Analysis to Determine
Reliability

All items of the Developed Handball Test were reliable except the 30-Second Alternate Hand-Wall Volley Test. This test item was also the only one for which a significance level of .05 was not obtained. A ranking of the five tests from top to bottom with their respective correlation coefficients would be as follows: (1) Power Test (.99), (2) Six-Minute Run (.92), (3) Service Placement Test (.80), (4) Shuttle Run (.68), (5) 30-Second Alternate Hand-Wall Volley Test (.44).

Analysis to Determine Objectivity

The data obtained from the five test items used to determine reliability were also the same scores used in determining objectivity. Therefore, the results for determining the reliability of the Developed Test were also the results for objectivity. This was made possible in this study when a different tester administered the retest of the Developed Handball Test.

Analysis to Determine Validity

The results obtained from the Cornish Handball Test, a ladder tournament, and the test-retest of the Developed Handball Test were

used to calculate various associated correlation coefficients for validity with regards to the Developed Test.

The validity coefficients were calculated by using the Spearman Rank-Difference Correlation statistical analysis discussed in Chapter II, page 20. The results were then compared with the values in Tables 1 and 2, pages 21 and 22, in the same manner as were the reliability correlation coefficients.

The following five comparisons were used to aid in calculating the validity of the Developed Handball Test:

Comparison of Cornish Handball Test
Results versus Test One Results of
the Developed Test

The correlation coefficient was found to be .73. This comparison had acceptable validity according to the values in Table 1. A .05 level of significance was accepted after the correlation coefficient of .73 was compared to the values in Table 2. The null hypothesis was accepted at the .05 level.

Comparison of Cornish Handball Test
Results versus Test Two Results of
the Developed Test

A .61 correlation coefficient was found in this comparison. This was the lowest of the four comparisons made to determine validity. This correlation coefficient was questionable according to the values in Table 1, page 21. However, according to the values in Table 2, it was acceptable at the .05 significance level. The null hypothesis was accepted at the .05 level.

Comparison of Test One Results of the Developed Handball Test versus the Results of the Ladder Tournament

The correlation coefficient for this comparison was calculated at .72. Table 1 values indicate that this correlation coefficient has acceptable validity. Table 2 values relate that a .05 significance level would be accepted. The null hypothesis was accepted at the .05 level.

Comparison of Test Two Results of the Developed Handball Test versus the Results of the Ladder Tournament

The correlation coefficient was found to be .79. The comparison contained the highest degree of validity of those tested. This comparison had an acceptable amount of validity with regards to the values in Table 1 and was accepted at the .01 level of significance according to the values in Table 2. The null hypothesis for this comparison was accepted at the .05 level.

Summary of Analysis to Determine Validity

All but one of the comparisons indicated an acceptable amount of validity. The exception was the Cornish Handball Test Results versus Test Two Results of the Developed Test and these results for validity were termed questionable because of the correlation coefficient of .61. All comparisons for validity were acceptable at the .05 level of significance.

CHAPTER IV

DISCUSSION

Handball is a game where relatively little research has been completed when compared to other areas within the field of physical education. The tremendous increase of interest in handball is evidenced by the extensive use of handball courts both for leisure play and physical education classes. It could be considered from this standpoint that any research completed with regards to evaluating handball could make a significant contribution to the applied knowledge of physical educators.

Discussion of Tests for Reliability

Three of the five reliability correlation coefficients of the Developed Handball Test were found to be significant at the .01 level of significance. However, there was a significant deviation among these correlation coefficients at the .01 level. The correlation coefficients for reliability for the Power Test, Six-Minute Run, and the Service Placement Test, were .99, .92, and .80 respectively. These correlation coefficients were termed excellent and very good according to Barrow and McGee (1970). The Power Test was designed to measure skill for striking the handball and propelling it for distance. The Six-Minute Run was used to measure cardio-vascular efficiency. The Service Placement Test measured only the subjects' ability to serve the handball into designated areas on the handball court. Speed at which the

handball traveled into these areas was not measured. The Service Place-
ment Test was strictly a test of serving skill.

The Handball Shuttle-Run had a correlation coefficient of .68
which was the fourth best of the test items. The reliability of the
Handball Shuttle-Run was questionable according to Barrow and McGee
(1970). According to Siegel (1956), the correlation coefficient was
acceptable at the .05 level of significance. The Handball Shuttle
Run was used to measure speed and change of direction.

The scores for the test-retest on the Shuttle Run and Six-
Minute Run varied only slightly, which would be a reasonable indica-
tion that the subjects' effort and desire remained constant through-
out all testing as both of these tests were of a strenuous nature.

The lowest reliability correlation coefficient of .44 was
attained on the 30-Second Alternate Hand-Wall Volley Test. Because
of the low reliability correlation coefficient of this test item it
was not acceptable at the .05 level of significance. Cornish (1949)
showed a much better correlation on his 30-Second Volley Test. The
Cornish 30-Second Volley Test however, differed quite significantly
from this writer's test in several important aspects. The subjects
were allowed to strike the ball with either the left or right hand
and if the ball was missed the test administrator handed the subject
another ball on the Cornish Test. In the Developed Handball Test the
subject was required to hit the ball alternately with the left and
right hands and, if the ball was missed, he had to chase it himself
and subsequently put the ball back into play.

The 30-Second Alternate Hand-Wall Volley Test was designed to
test the subject's ability to control the ball using both the left

and right hands which is an essential skill in playing handball. It was
assumed by this writer that with a limited amount of practice on this
30-Second-Alternate Hand-Wall Volley Test prior to testing the corre-
lation coefficient would become significantly higher as was evidenced
by the improvement of scores from Test One to Test Two of the Developed
Test.

All of the following test items except the 30-Second Alternate
Hand-Wall Volley Test would be recommended for a battery of tests
designed to measure ability in playing handball. Several minor changes
in the 30-Second Alternate Hand-Wall Volley Test might make it a worthy
addition to the test battery.

Discussion of Tests for Validity

The validity of the Developed Handball Test was determined by
comparing the results of the Cornish Handball Test versus Test One
Results of the Developed Handball Test. The Cornish Handball Test
versus the Test Two Results of the Developed Test and the Test One
results of the Developed Test versus the results of the Ladder Tourna-
ment were also used as well as the Test Two results of the Developed
Test versus the results of the Ladder Tournament.

The comparison of the Test Two results of the Developed Hand-
ball Test versus the Ladder Tournament results was significant at the
.01 level of confidence because of its .79 correlation coefficient.
It could be assumed from this correlation coefficient that the more
the subjects played or practiced the higher the validity correlation
coefficient became.

The other three comparisons made were all significant at the
.05 level. Correlation coefficients of .73 and .72 respectively

were obtained on the Cornish Handball Test versus Test One results of the Developed Test and Test One results of the Developed Test versus the results of the Ladder Tournament.

A correlation coefficient of .61 on the results of the Cornish Test versus Test Two results of the Developed Test was obtained.

According to Barrow and McGee (1970), all validity correlation coefficients were in the acceptable range except the Cornish Test results versus Test Two results of the Developed Test, which was termed questionable (see Table 1, page 21).

If one comparison were selected for the establishment of validity for the Developed Handball Test this writer would select the Test Two results of the Developed Test versus the results of the Ladder Tournament because it attained the highest validity correlation coefficient of .79 and also because actual game competition was used as a measure for the comparison. This comparison also evaluated most closely what this study intended to measure.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to develop an effective test to measure handball ability more accurately than those already published or unpublished. Furthermore, included in this study would be the establishment of reliability, objectivity, and validity for the Developed Handball Test.

A battery of five test items were selected to form the Developed Handball Test. Each of these five test items were checked for reliability by using the recommended test-retest method. Four of the five test items showed significant results at the .05 level. These four test items along with their calculated reliability correlation coefficients included: Service Placement Test (.80), Power Test (.99), Handball Shuttle Run (.68), and Six-Minute Run (.92). Only the 30-Second Alternate Hand-Wall Volley Test with a correlation coefficient of .44 did not have a satisfactory level of reliability or significance. The Spearman Rank Difference Correlation was used in calculating the reliability correlation coefficients of the test items. The four test items with acceptable levels of significance and reliability correlations were recommended as the battery of test items for the Developed Handball Test.

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Objectivity was established for the Developed Test by having a different tester administer the retest of the Developed Test. Therefore, the results established for reliability are also the results for the test for objectivity.

Validity was established by using the results of the test-retest of the Developed Handball Test, the Cornish Handball Test, and a ladder tournament conducted among the subjects used in all testing. The Cornish Handball Test had been previously validated and was, therefore, used as a criterion in validating the Developed Handball Test.

Several comparisons were made among these test results. A comparison of the Test Two results of the Developed Handball Test versus the results of the ladder tournament was recommended by this writer as the most significant test for validity because of the .79 validity correlation coefficient calculation and also because actual game competition was used as a criterion for evaluation. All comparison results indicated an acceptable amount of validity and were significant at the .05 level of significance.

The Spearman Rank Difference Correlation was used in determining the validity correlation coefficients for the Developed Test.

Conclusions

Within the limitations, delimitations, assumptions, and the interpretation of the statistical data in this study the following conclusions appeared to be noteworthy:

1. All the test items in the Developed Handball Test, with
   the exception of the 30-Second Alternate Hand-Wall

Volley Test, proved to be reliable and objective measures of evaluating handball ability.

2. The Developed Handball Test proved to be a valid measure of evaluating handball ability.

3. From the analysis of the statistical data the following test items would be recommended to constitute the Developed Handball Test: Service Placement Test, Power Test, Handball Shuttle Run, and the Six-Minute Run.

4. The null hypothesis was accepted and the research hypothesis rejected for this study because there was a relationship between the scores of the subjects on the tests and their handball performance ability.

Recommendations

The following recommendations are made with regards to this study:

1. The test items designed for the Developed Handball Test should be administered on a regulation size handball court to see if the reliability, objectivity, and validity calculated would be consistent with the results found in this study.

2. If the results for this study are found to be consistent with those found on a regulation size handball court the tests designed in the Developed Handball Test should be used by physical educators as a measure of evaluating handball ability.

3. The 30-Second Alternate Hand-Wall Volley Test should be administered only to intermediate and skilled handball players.

4. A test item should be developed for beginning handball players that measures handball volleying ability with the non-dominant hand.

APPENDIX A

Test Directions

Directions for Administration of Cornish Handball Test

30-Second Volley Test

A. Equipment

    1. Stopwatch

    2. Handball

    3. Markings (service line)

B. The Test

Standing behind the service line, the subject began by dropping the ball to the floor and stroking it continuously for thirty seconds. The ball must rebound far enough from the wall for the subject to remain behind the service line. The subject could step into the front court to strike a ball that failed to return across the service line, but must return for each succeeding stroke. If the subject missed the ball, the judge handed him another, and the play continued.

C. Scoring

Each time the ball struck the front wall, one point was scored and the total was recorded at the end of thirty seconds.

Front Wall Placement Test

A. Equipment

    1. Handball

    2. Markings on front wall (Figure 1, page 37)

B. The Test

The front wall was divided into areas as shown in Figure 1, page 37. The smaller areas containing the larger numbers were more diffi-cult to obtain than the larger areas containing smaller numbers. The
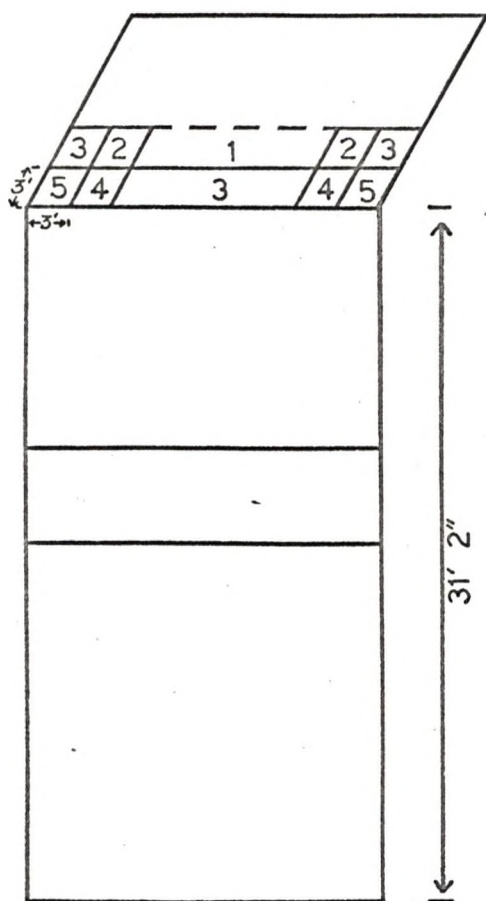
Fig. 1.--Difficulty of
various positions on the
front wall and their values.
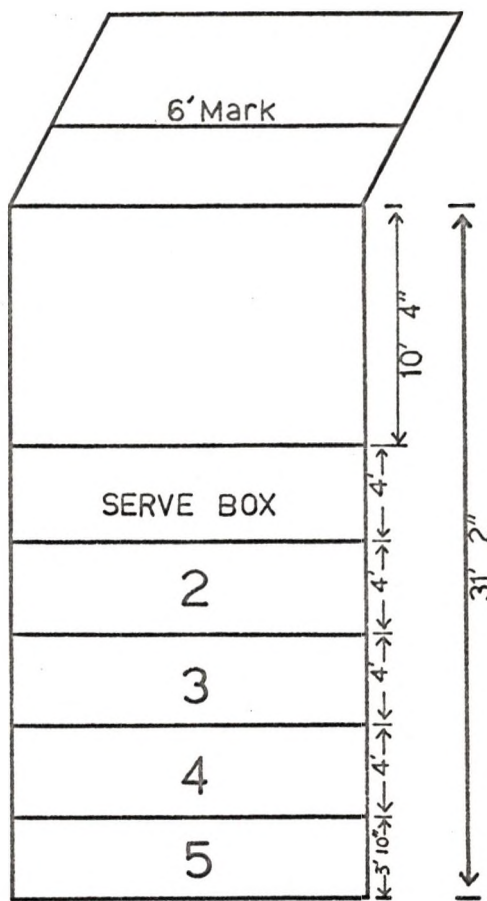
Fig. 2.--Values placed on various
areas of court relative to power in
handball.
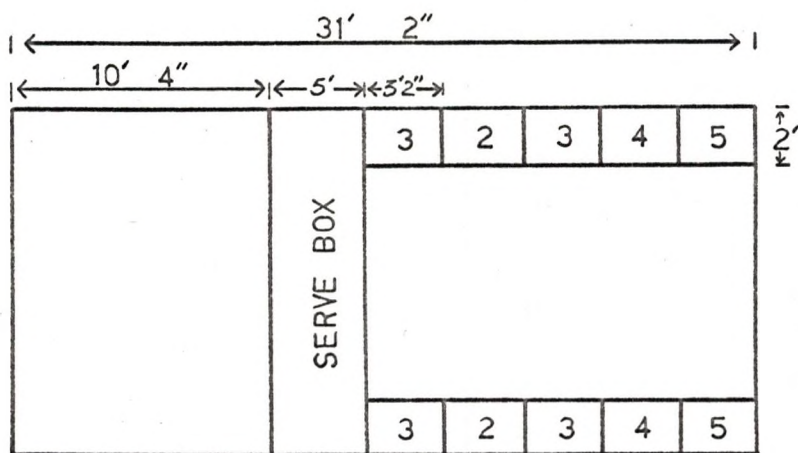
Fig. 3.--Values placed on various areas for
Placement Service Test.

subject, starting from the service line tossed the ball to the front wall below a line drawn six feet above the floor, and struck each rebounded ball, trying to place it in the areas containing the largest numbers. The ball was stroked five times with the right hand and five times with the left hand.

C. Scoring

The total number of points was recorded.

Back Wall Placement Test

A. Equipment

1. Handball

2. Markings on front wall (Same as for Front Wall Placement, Figure 1, page 37).

B. The Test

The same pattern was used as in the front wall placement test. The subject tossed the ball so that it would strike the back wall approximately three feet above the floor. The ball was stroked by the subject who attempted to strike the largest numbers on the wall. Five strokes were made with the right and five were made with the left.

C. Scoring

The total number of points scored was recorded.

Power Test

A. Equipment

1. Handball

2. Markings on the floor (Figure 2, page 37)

B. The Test

Figure 2, page 37, shows the division of the court into five areas, and the values for each. While standing in the service zone, the subject tossed the ball to the front wall, allowing it to bounce before striking it. The ball, after being stroked, must strike the front wall below a line six feet above the floor. Another trial was allowed if the subject stepped into the front court to strike the rebounded ball or the ball struck the wall above the six foot line. Five strokes were made with the left hand and five with the right.

C. Scoring

One point was scored if the ball struck the floor in front of the service line. The total number of points was recorded for the placement of the rebounded ball.

Placement Service Test

A. Equipment

    1. Handball

    2. Markings on the floor (Figure 3, page 37)

B. The Test

The back court was divided into areas as in Figure 3, page 37. The subject was allowed ten serves, five of which must be cross court serves. All serves were with the hand normally used in serving.

C. Scoring

The total score accumulated was recorded (Cornish, 1949).

Developed Handball Test

Test #1: 30-Second Alternate Hand-Wall Volley Test

A. Equipment

    1. Stopwatch

2. Handball

3. Markings on floor (Service line)

B. The Test

Standing behind the service line, the subject will begin by throwing the ball against the wall and stroking it continuously using alternate hands each time the ball rebounds from the front wall for thirty seconds. The ball must rebound far enough from the wall so the subject will remain behind the service line. The subject can step into the front court to strike a ball that does not return across the service line, but the subject must return for each succeeding stroke. If the subject misses the ball he is required to retrieve it himself.

C. Scoring

Each time the ball strikes the front wall, provided it is hit with alternate hands, one point is scored. The total is recorded at the end of thirty seconds.

Test #2: Service Placement Test

A. Equipment

1. Handball

2. Floor markings (Figure 3, page 37)

B. The Test

The back court will be divided into areas as in Figure 3, page 37. The subject will be allowed ten serves, five of which must be two-wall, cross court. All serves will be done with the hand normally used in serving.

C. Scoring

The total score for all ten serves will be recorded. All serves that

are long, short, strike a sidewall past the serving line, or do not cross courts when required to do so will receive zero points.

Test #3: Power Test

A. Equipment

    1. Handball

    2. Markings on floor (Figure 2, page 37)

B. The Test

Figure 2, page 37, shows the division of the court into five areas, and the values for each. While standing in the service zone, the subject will toss the ball to the front wall, allowing it to bounce before striking it. The ball after being stroked must strike the front wall below a line 6 feet above the floor and land in one of the designated areas as shown in Figure 2, page 37. Another trial will be allowed if the subject steps into the front court while striking the ball or the ball is struck against the wall above the six foot line. Five strokes will be made with the left hand and five with the right.

C. Scoring

Points will be scored only if the ball lands in the four point zones in back of the server's box. The total number of points will be recorded for the placement of the rebounded ball.

Test #4: Handball Shuttle Run

A. Equipment

    1. Stopwatch

    2. Floor markings (Figure 4, page 44)

    3. Coffee Can

4. Four handballs

5. Handball gloves on subjects

B. The Test

The subject will start in the square in the center of the servers box facing the left corner of the front wall. The subject will run forward to the left corner of the front wall which is marked #1 on Figure 4, page 44. At this point the subject will pick up the handball that has been placed in the corner. Subject will then run forward to the back corner of the left court marked #2 again picking up the handball that has been placed there. The subject will then run forward to the starting box and place the two handballs picked up in the coffee can that is located in the starting box. The subject will then run forward to the right front corner marked #3, again picking up a handball. The subject will then run forward to the back right hand corner marked #4 and again pick up a handball. The subject will then run forward to the starting box and place the other two handballs in the coffee can. Subject will then remain in the box for 20 seconds (at which time the four handballs will be placed in the four corners by test administrator). After the 20 second rest period the subject will repeat the test only moving to the four corners backwards. Upon completion of the backward movement the subject will receive a 20 second rest period and then move through the course (same as before) only laterally. Upon completion of the lateral movement the test is complete.

C. Scoring

A stopwatch will be used and the total time for the three movements will be recorded as one score.

Test #5:   6-Minute Run

A.   Equipment

    1.   Indoor track located in the UND Fieldhouse

    2.   Stopwatch

B.   The Test

Subjects will run for 6 minutes on indoor track.

C.   Scoring

The laps of the subjects will be recorded. Laps will be counted to the nearest .25 or one-quarter of each lap.
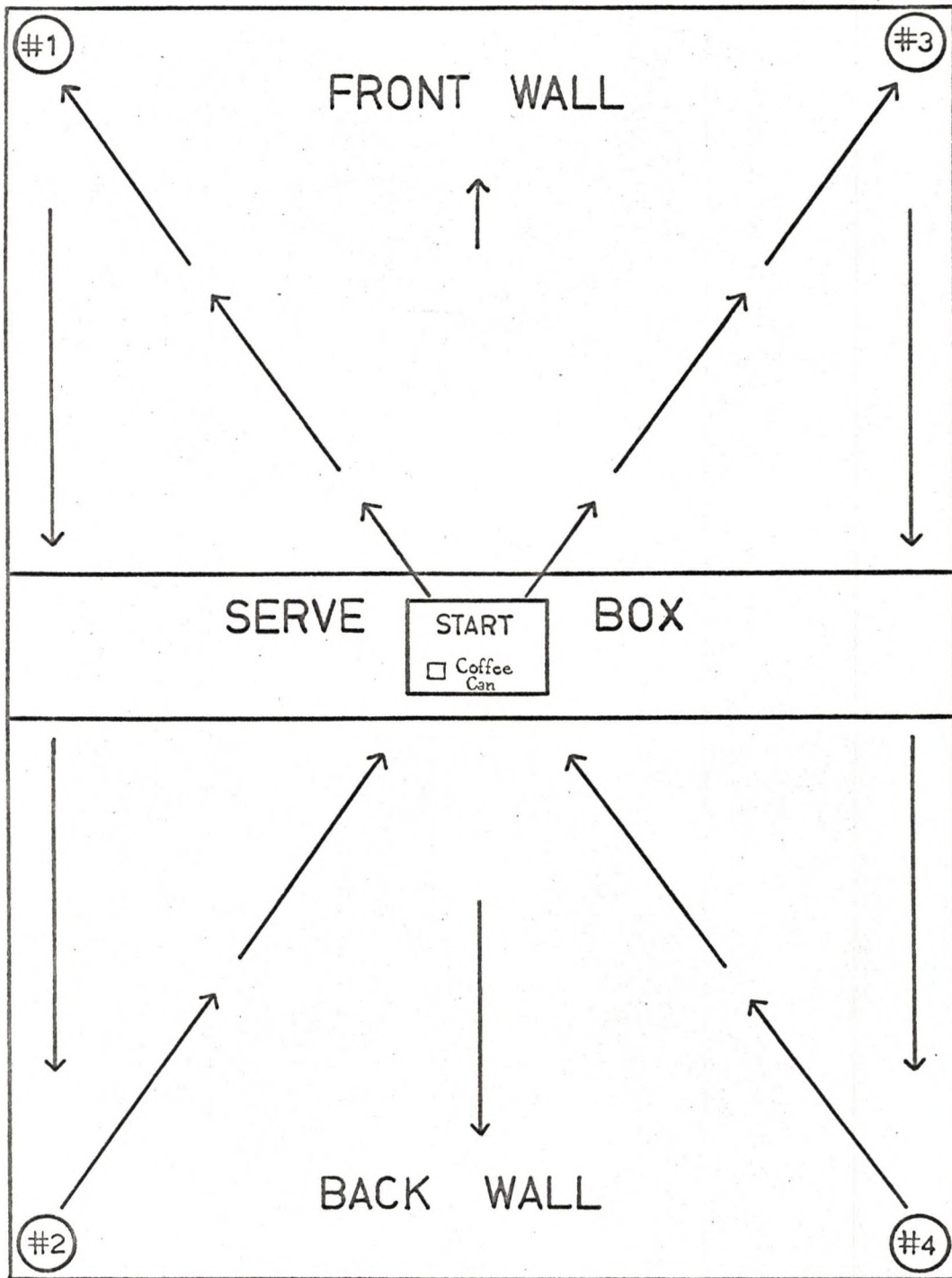
Fig. 4.--Diagram for Handball Shuttle Run

APPENDIX B

Scorecard

Developed Handball Test

NAME OF STUDENT _____ _____
                           Last   First

DATE OF TEST _____ _____ _____
                  Day   Month   Year

AGE _____ DATE OF BIRTH _____ _____ _____
        Years   Day   Month   Year

CLASS (CIRCLE)   Fr.   Soph.   Jr.   Sr.

Back of Scorecard for Developed Test

STUDENT's NAME _____

Test No.	Test Name	Test Score or Trial Score										Test Score
1.	30-Second Volley	Total # Volley's:										
2.	Service Test	Trial	1	2	3	4	5	6CC	7CC	8CC	9CC	10CC	
			0	0	0	0	0	0	0	0	0	0	
			2	2	2	2	2	2	2	2	2	2	
			3	3	3	3	3	3	3	3	3	3	
			4	4	4	4	4	4	4	4	4	4	
			5	5	5	5	5	5	5	5	5	5	
			1R	2R	3R	4R	5R	6L	7L	8L	9L	10L	
3.	Power Test		0	0	0	0	0	0	0	0	0	0	
			2	2	2	2	2	2	2	2	2	2	
			3	3	3	3	3	3	3	3	3	3	
			4	4	4	4	4	4	4	4	4	4	
			5	5	5	5	5	5	5	5	5	5	
4.	Shuttle Run	Total Time:											
5.	1 Mile	Total Time:											

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APPENDIX C

TABLE 3

TEST AND RETEST OF 30-SECOND ALTERNATE HAND-WALL VOLLEY TEST--
COMPARISON OF TEST I AND II

Subject	Initial Test (T_1)	Retest (T_2)	R_x	R_y	$R_x - R_y$	$(R_x-R_y)^2$
1	7	11	10	9.5	.5	.25
2	16	16	2.5	8	-5.5	30.25
3	14	23	4.5	1.5	3.0	9.00
4	13	20	6.5	4	2.5	6.25
5	14	19	4.5	5	-0.5	.25
6	13	21	6.5	3	-3.5	12.25
7	18	18	1	6.5	-5.5	30.25
8	12	18	8	6.5	1.5	2.25
9	9	11	9	9.5	-0.5	.25
10	16	23	2.5	1.5	1.0	1.00
						$\Sigma D^2 = 92.00$

T = Test Number
D = Difference
D^2 = Difference Squared
ΣD^2 = Sum of Difference Squared

The Correlation Rank Difference Between Test I and II:

Test = 30-Second Alternate Hand-Wall Volley Test

N = 10
D^2 = 92.00
rho = Spearman Rank-Difference Correlation

$$rho = 1 - \frac{6 \Sigma (R_x - R_y)^2}{N(N^2 - 1)} = 1 - \frac{6(92.00)}{10(100-1)} =$$

$$1 - \frac{552}{990} = 1 - .56 = rho = .44$$

Not significant at .05 level.

TABLE 4

TEST AND RETEST OF SERVICE PLACEMENT TEST COMPARISON OF TEST I AND TEST II

Subject	Initial Test (T_1)	Retest (T_2)	R_x	R_y	$R_x - R_y$	$(R_x-R_y)^2$
1	9	12	9.5	8.5	1	1
2	19	12	4.5	8.5	-4.0	16.00
3	27	28	1	1	0	0
4	18	19	6	5	1	1
5	17	18	7	6	1	1
6	22	25	3	2	1	1
7	19	20	4.5	3.5	1	1
8	9	16	9.5	7	2.5	6.25
9	11	11	8	10	2.0	4.00
10	23	20	2	3.5	1.5	2.25
						ΣD^2 = 33.50

T = Test Number
D = Difference
D^2 = Difference Squared
ΣD^2 = Sum of Difference Squared

The Correlation Rank Difference Between Test I and II:

Test = Service Placement Test

N = 10
ΣD^2 = 33.50

rho= Spearman Rank Difference Correlation

$$rho = 1 - \frac{6 \, \Sigma (R_x - R_y)^2}{N(N^2 - 1)} = 1 - \frac{6(\, 33.50)}{10(100-1)}$$

$$1 - \frac{201}{990} = 1 - .20 \quad rho = .80$$

Significant at .05 level.

TABLE 5

TEST AND RETEST OF POWER TEST COMPARISON OF TEST I AND II

Subject	Initial Test (T_1)	Retest (T_2)	R_x	R_y	$R_x - R_y$	$(R_x-R_y)^2$
1	10	12	10	10	0	0
2	19	16	7.5	8	.5	.25
3	22	25	6	5.5	.5	.25
4	26	25	4.5	5.5	1.0	1.0
5	19	21	7.5	7	.5	.25
6	26	27	4.5	4	.5	.25
7	31	31	1	1	0	0
8	28	30	2	2	0	0
9	17	15	9	9	0	0
10	27	29	3	3	0	0
						$\Sigma D^2 = 2.00$

T = Test Number
D = Difference
D^2 = Difference Squared
ΣD^2 = Sum of Difference Squared

The Correlation Rank Difference Between Test I and II:

Test = Power Test

$N = 10$
$\Sigma D^2 = 2.00$

rho = Spearman Rank Difference Correlation

$$rho = 1 - \frac{6\ \Sigma(R_x - R_y)^2}{N(N^2 - 1)} = 1 - \frac{6(2.00)}{10(100-1)} =$$

$$1 - \frac{12}{990} = 1 - .01 = rho = .99$$

Significant at .05 level.

TABLE 6

TEST AND RETEST OF HANDBALL SHUTTLE RUN COMPARISON OF TEST I AND II

Subject	Initial Test (T_1)	Retest (T_2)	R_x	R_y	$R_x - R_y$	$(R_x - R_y)^2$
1	42	41	6.5	5.5	1	1
2	37	35.5	1	2	-1	1
3	38.5	38.5	3.5	4	-0.5	.25
4	43.5	41	8	5.5	2.5	6.25
5	44	42.5	9.5	7	2.5	6.25
6	38.5	35	3.5	1	2.5	6.25
7	42	46	6.5	10	-3.5	12.25
8	44	43.5	9.5	8	1.5	2.25
9	41	44	5	9	4.0	16.00
10	37.5	37.5	2	3	-1.0	1.00
						$\Sigma D^2 = 52.75$

T = Test Number
D = Difference
D^2 = Difference Squared
ΣD^2 = Sum of Difference Squared

The Correlation Rank Difference Between Test I and II:

Test = Shuttle Run

$$N = 10$$
$$\Sigma D^2 = 52.75$$

rho = Spearman Rank Difference Correlation

$$rho = 1 - \frac{6 \ \Sigma (R_x - R_y)^2}{N(N^2 - 1)} = 1 - \frac{6(52.75)}{10(100-1)} =$$

$$1 - \frac{316.50}{990} = 1 - .32 = rho = .68$$

Significant at .05 level.

TABLE 7

TEST AND RETEST OF 6 MINUTE RUN COMPARISON OF TEST I AND II

Subject	Initial Test (T_1)	Retest (T_2)	R_x	R_y	$R_x - R_y$	$(R_x-R_y)^2$
1	10.00	10.25	5.5	5.5	0	0
2	11.25	11.25	3	3	0	0
3	11.50	11.50	1.5	1.5	0	0
4	9.50	9.00	9	8.5	.5	.25
5	8.75	8.50	10	10	0	0
6	11.50	11.00	1.5	4	2.5	6.25
7	9.75	9.00	7.5	8.5	1	1
8	10.00	10.25	5.5	5.5	0	0
9	9.75	9.25	7.5	7	.5	.25
10	11.00	11.50	4	1.5	2.5	6.25
						$\Sigma D^2 = 14.00$

T = Test Number
D = Difference
D^2 = Difference Squared
ΣD^2 = Sum of Difference Squared

The Correlation Rank Difference Between Test I and II:

Test = 6 Minute Run

$$N = 10$$
$$\Sigma D^2 = 14.00$$

rho = Spearman Rank Difference Correlation

$$rho = 1 - \frac{6 \Sigma (R_x - R_y)^2}{N(N^2 - 1)} = 1 - \frac{6(14.00)}{10(100-1)}$$

$$1 - \frac{84}{990} = 1 - .08 = rho = .92$$

Significant at .05 level.

TABLE 8

RANKING FOR CORNISH HANDBALL TEST

Subject	30 Sec Volley	Front Wall Placement	Back Wall Placement	Power Test	Placement Service	Total	Rank
1	10	5.5	9.5	9	6	40	9
2	1.5	2	9.5	3	3	19	3
3	6	5.5	7.5	7	4	30	6.5
4	4.5	8.5	1	2	8	24	4
5	9	7	7.5	6	5	34.5	8
6	4.5	2	4	8	9	27.5	5
7	3	4	6	1	2	16	2
8	7	8.5	2.5	5	7	30	6.5
9	8	10	5	10	10	43	10
10	1.5	2	2.5	4	1	11	1

TABLE 9

RANKING FOR TEST (TEST #1) OF DEVELOPED HANDBALL TEST

Subject	30 Sec Volley	Service Placement	Power Test	Shuttle Run	6 min Run	Total	Rank
1	10	9.5	10	6.5	5.5	41.5	10
2	2.5	4.5	9	1	3	20	4
3	4.5	1	6	3.5	1	16.5	2
4	6.5	6	4.5	8	9	34	6
5	4.5	7	7	9.5	10	38	9
6	6.5	3	4.5	3.5	1.5	19	3
7	1	4.5	1	6.5	7.5	20.5	5
8	8	9.5	2	9.5	5.5	34.5	7
9	9	8	8	5	7.5	37.5	8
10	2.5	2	3	2	4	13.5	1

TABLE 10

RANKING FOR RETEST (TEST #2) OF DEVELOPED HANDBALL TEST

Subject	30 Sec Volley	Service Placement	Power Test	Shuttle Run	6 min Run	Total	Rank
1	9.5	8.5	10	5.5	5.5	39	9
2	8	8.5	8	2	3	29.5	6.5
3	1.5	1	5.5	4	1.5	13.5	2
4	4	5	5.5	5.5	8.5	28.5	5
5	5	6	7	7	10	35	8
6	3	2	4	1	4	14	3
7	6.5	3.5	1	10	8.5	29.5	6.5
8	6.5	7	2	8	5.5	29	4
9	9.5	10	9	9	7	44.5	10
10	1.5	3.5	3	3	1.5	12.5	1

TABLE 11

COMPARISON OF CORNISH HANDBALL TEST VS. (TEST #1) OF DEVELOPED
HANDBALL TEST

Subject	Cornish Test Rank	Developed Test (Test #1) Rank	d_i	d_i^2
1	9.0	10.0	-1.0	1.0
2	3.0	4.0	-1.0	1.0
3	6.5	2.0	4.5	20.25
4	4.0	6.0	2.0	4.0
5	8.0	9.0	1.0	1.0
6	5.0	3.0	2.0	4.0
7	2.0	5.0	-3.0	9.0
8	6.5	7.0	- .5	.25
9	10.0	8.0	2.0	4.0
10	1.0	1.0	0	0
				$\Sigma d_i^2 = 44.50$

d_i = Difference
d_i^2 = Difference squared
Σd_i^2 = Sum of Difference squared

N = 10
Σd_i^2 = 44.50

$$r_s = 1 - \frac{6 \sum_{i=1}^{N} d_i^2}{N^3 - N}$$

$$r_s = 1 - \frac{6\,(44.50)}{(10)^3 - 10}$$

$$r_s = 1 - \frac{267}{990}$$

$$r_s = 1 - .27$$

$$r_s = .73$$

Significant at .05 level.

TABLE 12

COMPARISON OF CORNISH HANDBALL TEST VS. (TEST #2) OF DEVELOPED HANDBALL TEST

Subject	Test Rank	Developed Test (Test #2) Rank	d_i	d_i^2
1	9.0	9.0	0	0
2	3.0	6.5	-3.5	12.25
3	6.5	2.0	4.5	20.25
4	4.0	5.0	-1.0	1.0
5	8.0	8.0	0	0
6	5.0	3.0	2.0	4
7	2.0	6.5	-4.5	20.25
8	6.5	4.0	2.5	6.25
9	10.0	10.0	0	0
10	1.0	1.0	0	0
				$\Sigma d_i^2 = \overline{64.00}$

d_i = Difference
d_i^2 = Difference squared
Σd_i^2 = Sum of difference squared
N = 10
Σd_i^2 = 64.00

$$r_s = 1 - \frac{6 \sum_{i=1}^{N} d_i^2}{N^3 - N}$$

$$r_s = 1 - \frac{6(64.0)}{(10)^3 - 10}$$

$$r_s = 1 - \frac{384}{990}$$

$$r_s = 1 - .39$$

$$r_s = .61$$

Significant at .05 level.

TABLE 13

COMPARISON OF (TEST #1) OF DEVELOPED HANDBALL TEST VS.
LADDER TOURNAMENT

Subject	Developed (Test #1) Rank	Ladder Tourn Rank	di	di^2
1	10.0	10.0	0	0
2	4.0	7.0	-3.0	9.0
3	2.0	5.0	-3.0	9.0
4	6.0	6.0	0	0
5	9.0	8.0	1.0	1.0
6	3.0	4.0	-1.0	1.0
7	5.0	2.0	3.0	9.0
8	7.0	3.0	4.0	16.0
9	8.0	9.0	-1.0	1.0
10	1.0	1.0	0	0
				$\Sigma di^2 = 46.00$

di = Difference
di^2 = Difference squared
Σdi^2 = Sum of Difference squared

N = 10
Σdi^2 = 46.00

$$rs = 1 - \frac{6 \sum_{i=1}^{N} di^2}{N^3 - N}$$

$$rs = 1 - \frac{6(46.00)}{(10)^3 - 10}$$

$$rs = 1 - \frac{276}{990}$$

$$rs = 1 - .28$$

$$rs = .72$$

Significant at .05 level.

TABLE 14

COMPARISON OF (TEST #2) OF DEVELOPED HANDBALL TEST VS.
LADDER TOURNAMENT

Subject	Developed (Test #2) Rank	Ladder Tourn Rank	di	di^2
1	9.0	10.0	-1.0	1.0
2	6.5	7.0	- .5	.25
3	2.0	5.0	-3.0	9.0
4	5.0	6.0	-1.0	1.0
5	8.0	8.0	0	0
6	3.0	4.0	1.0	1.0
7	6.5	2.0	4.5	20.25
8	4.0	3.0	1.0	1.0
9	10.0	9.0	1.0	1.0
10	1.0	1.0	9	0
				$\Sigma di^2 = 34.50$

di = Difference
di^2 = Difference squared
Σdi^2 = Sum of difference squared

N = 10
Σdi^2 = 34.50

$$rs = 1 - \frac{6 \sum_{i=1}^{N} di^2}{N^3 - N}$$

$$rs = 1 - \frac{6(34.50)}{(10)^3 - 10}$$

$$rs = 1 - \frac{207}{990}$$

$$rs = 1 - .21$$

$$rs = .79$$

Significant at .05 level.

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