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A Measurement of Differences in Motor Fitness Performances According to Primary Grade Levels

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A MEASUREMENT OF DIFFERENCES IN MOTOR FITNESS PERFORMANCES ACCORDING TO PRIMARY GRADE LEVELS

by
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A Measurement of Differences in Motor Fitness Performances According to Primary Grade Levels

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The University of North Dakota, 1974

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The research hypothesis states that children of primary grade school level (K-2), when tested in four areas of motor fitness (agility, speed in running, leg power and balance), will differ in performance scores according to grade; the upper grade will indicate the superior performance.

There were three main objectives of this research project. The first objective was to establish reliability on six motor fitness test items. These test items were: the sprint (measure of speed), the zig zag run (measure of agility), the standing broad jump (measure of leg power), the one legged stand (measure of static balance), and the stair climb (measure of agility, speed, and balance).

The second objective was to analyze the results and report the findings related to the grade of the subject (excluding the zig zag run).

The third objective was to analyze the results and report the findings related to the sex of the subjects (excluding the zig zag run).

Although not a primary objective, the investigator did compare each motor fitness test item to the other (excluding the zig zag run).

The subjects were pupils in kindergarten, first grade and second grade at Holy Family Elementary School; this is a parochial school. There were twenty-seven pupils in each of the first grade and second grade classes; there were twenty-four pupils in the kindergarten class.

High reliability correlation coefficients were established on all of the motor fitness test items. The coefficients ranged from a low of 0.851 to a high of 0.965.

A multiple linear regression analysis was used in treated the data. The results indicated a significant difference between grades in five of the motor fitness test items. The results further indicated that the boys were significantly superior in their performances in the standing broad jump.

This Thesis submitted by William Lee Predovich 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.

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Department Health, Physical Education and Recreation

Degree Master of Science

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ABSTRACT

The research hypothesis states that children of primary grade school level (K-2), when tested in four areas of motor fitness (agility, speed in running, leg power and balance), will differ in performance scores according to grade; the upper grade will indicate the superior performance.

There were three main objectives of this research project. The first objective was to establish reliability on six motor fitness test items. These test items were: the sprint (measure of speed), the zig zag run (measure of agility), the standing broad jump (measure of leg power), the one legged stand (measure of static balance), and the stair climb (measure of agility, speed, and balance).

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Although not a primary objective, the investigator did compare each motor fitness test item to the other (excluding the zig zag run).

The subjects were pupils in kindergarten, first grade and second grade at Holy Family Elementary School; this is a parochial school. There were twenty-seven pupils in each of the first grade and second

grade classes; there were twenty-four pupils in the kindergarten class.

High reliability correlation coefficients were established on all of the motor fitness test items. The coefficients ranged from a low of 0.851 to a high of 0.965.

A multiple linear regression analysis was used in treating the data. The results indicated a significant difference between grades in five of the motor fitness test items. The results further indicated that the boys were significantly superior in their performances in the standing broad jump.

CHAPTER I

INTRODUCTION

It has taken man thousands of years to develop the ability to learn to read and to write, but now nearly every primary-age child with an educational opportunity can read and can write; some children know how to read by the age of four. Today, the average man has a reserve of knowledge which surpasses that of any other generation.

Likewise, in the area of physical development, the average man is bigger, stronger and possesses more physical skills than any previous generation. The present generation of athletes have surpassed practically every record set by prior generations of athletes. Faster times in the dashes and distances continually appear along with men pole vaulting over seventeen feet, and putting the shot over seventy feet.

The improvement in so many types of physical performance is due to man's ability to communicate and pass on his experience to succeeding generations (1). Through man's ability to record and communicate, prior trial and error methods have been eliminated, resulting in the improvement of man's performance and efficiency. Human growth has increased because of man's application of knowledge of health and nutrition.

A skilled movement is one in which a predetermined objective is

accomplished with maximum efficiency and the minimum out lay of energy. A skillful movement does not just happen. There has to be conscious effort and purposeful practice on the part of the performer for a period of time if he is to accomplish a movement in a skillful way.

There are many factors that affect the rate at which a child develops and the level at which he is able to perform motor fitness tasks. Practice affects the skill level of an individual along with the individual's maturity level. Progress may be extremely slow in teaching a child a complex task where no primary skill achievement exists. A readiness factor enters in also. A child must be at the proper maturity level (physically, mentally and neurologically) in order for practice of a particular skill to be effective. In the learning of complex skills, practice is more effective at the point of maturation, not before, but also, not long after the period of biological readiness. The practice of motor skills should affect the motor performance of the individual along with his maturation level and his willingness to learn.

During his early years, a child is most receptive to play activities. Knowing this, teachers often neglect the teaching of motor skills necessary for participation in physical education programs. Many elementary school children are neurologically capable of performing complex motor skills; rules and equipment must be adjusted to suit the physical and mental level of the child, but these changes do not detract from the value of the activity. By the age of ten, most children have the neuromuscular potential to master the skills required in practically

any physical education course offered at the college level (2). This does not necessarily mean that the child could pass the course since he probably lacks the necessary strength and size, but he does have the potential of mastering the neuromuscular skills.

The teacher of physical education is fortunate to have so many activities available from which to make choices. But first, one must evaluate the students' physical aptitudes, limitations and needs so as to determine activities which are most appropriate. Hopefully, this research project will aid in the process of evaluating primary children's physical aptitudes and limitations. This research project will provide Holy Family Elementary School with the foundation for future motor fitness testing of their pupils. The components of motor fitness which will be analyzed are agility, speed in running, leg power and balance.

Hypothesis

The research hypothesis states that children of primary grade school level (K-2), when tested in four areas of motor fitness (agility, speed in running, leg power and balance), will differ in performance scores according to grade; the upper grade will indicate the superior performance.

Need for the Study

Researchers in the academic field are attempting to teach mathematics, physics, chemistry, the languages, etc., at the elementary school level on the premise that these children have the ability to learn such

complex subjects. The academic trend is to do more research with the younger student and to challenge his capabilities. There is a definite need to do the same with a child's physical and motor capabilities.

Components such as agility, speed in running, leg power and balance are strategic for participation in motor activities. Agility and skill in footwork are essential for successful participation in handball, tennis, basketball, etc. General body coordination and balance are needed for the learning of precise movements in dance, gymnastics, diving, etc. Speed in running is essential in practically every team sport and very seldom is it considered a hinderance in any activity. Powerful legs are considered an aid in the long jump, high jump, basketball, etc.

It is helpful if the teacher at the elementary level is able to evaluate a child's performance in these components; this would be a logical first step to meeting the activity needs of the child. A program for successful participation in those areas where the performance may be deficient can then be prescribed.

The activity of an individual throughout his elementary school days will, to a great extent, determine his readiness for a wide variety of activities or for a few specific sports at the junior high school level. Activity tends to promote readiness for further activity. Developing basic motor components, such as agility, speed in running, balance and leg power is of prime concern to the physical educator. If these components are developed, it becomes a distinct advantage to the

child in these activities in which these components are a part.

Wickstrom (3) noted that it is helpful to know the immature motor patterns of a child because it will assist in setting expectations for skill development, and it will help in evaluating progress. He stated that immature motor patterns are evident at every age level even through motor patterns ought to be achieved during childhood. According to Wickstrom an immature motor pattern is synonomous to poor form.

Research has been done at the high school, junior high school, and upper elementary school levels, but little in the primary grades. There is a need to observe the motor performance of these children and to establish norms from which to evaluate performance. More research in the primary age group is necessary.

Definition of Terms

Agility. The quality of being able to move quickly and easily while changing directions (4).

Balance. Stability produced by even distribution of weight on each side of a vertical axis (4).

Coordination. The quality of being able to perform body movements in a smooth, accurate and purposeful way (4).

Dynamic Balance. That which enables an individual to maintain balance during movement (5).

Motor Ability. The efficiency with which a motor skill is performed (6).

Motor Capacity. The innate capacity or potential to perform a

motor skill (6).

Motor Educability. The degree of ease with which a new skill can be learned (6).

Motor Fitness. Composed of the components agility, speed, power, coordination and balance (5).

Motor Learning. The improvement in performance of a motor skill resulting from practice (7).

Motor Performance. The assessment of immediate skill level (7).

Physical Fitness. It is composed of the elements of strength, muscular endurance, cardio-respiratory endurance and flexibility (5).

Power. It expresses the amount of work done per unit of time (4).

Speed. The quality of being able to move swiftly (4).

Static Balance. That which enables an individual to hold a stationary position (5).

Delimitations and Limitations

The research project was delimited in the following ways:

1. The subjects were the kindergarten, first and second grade boys and girls at Holy Family Elementary School.

2. Only those subjects who were present on the day of testing were included in the results.

3. No make-up tests were given.

4. The subjects wore shirts, slacks and tennis shoes.

5. It was delimited to the motor fitness skills used in the test--zig zag run for agility, one legged stand for static balance, balance beam

walk for dynamic balance, the sprint for speed and the standing broad jump for leg power.

6. The test was delimited to the results on the two trials or the results on the two best trials if a third trial was allowed.

The study was limited in many different ways because of its nature:

1. Because of the enrollment of the school, the sample was small--twenty-seven second grade children, twenty-seven first grade children and twenty-four kindergarten children.

2. There was an unequal number of boys and girls in each grade--second grade, seventeen boys and ten girls; first grade, eighteen boys and nine girls; kindergarten, thirteen boys and eleven girls.

3. Because of inclement weather, the testing was restricted to the gymnasium.

4. The gymnasium floor was tile, as a result occasional slipping occurred which resulted in another trial.

5. Because of the dimensions of the gymnasium, a sprint distance of fifteen yards was required.

6. The study was limited to the motor capacity and motor educability of each child.

Review of Related Literature

Frank L. Smoll (8) examined the influence of physical growth and muscular strength upon motor performance. He reported that the combination of height and weight used separately are factors of little consequence in

accounting for individual differences in performance in the broad jump and the dashes for boys and girls in similar age brackets. Strong boys and girls are somewhat better performers in both the standing broad jump and the dashes, but it appears that strength is of greater consequence in the performance of girls than boys. He further concluded that the performance in the broad jump can be more accurately predicted in adolescence from physical growth, muscular strength and motor performance in the dash. He finally noted that the performance of the boys was more accurately predicted in adolescence than the performance of the girls.

Gearhart (9) noted that motor ability develops in an irregular pattern rather than as a constant and consistent process. Blackington (10) reported that it was not possible to predict motor ability on the basis of a height-weight classification, but it was an advantage being tall where motor ability was concerned.

Bailey (11) stated in a longitudinal study that as the boys advanced in age the means of all tests increased particularly in the areas of power, agility and speed.

According to Margie Rosann Hanson (12), elementary school age children in grade one through grade six are consistent enough in the performances on sit ups, standing broad jump, balance and other motor performance tests to be compared on a group basis. She added that boys and girls were consistent enough in the broad jump to use the results for individual diagnosis. Also, girls tended to be slightly less consistent than the boys in their performance on motor tests. Hanson (12)

further stated that boys were generally superior to girls in motor performances with the exception of balance and rope-skipping; often boys were superior in motor performance to girls who were one to two grade levels above the boys. She concluded that, generally boys and girls of one level were superior in motor performance to the boys and girls in the grade level below them. Finally, she stated that one could not predict performance on one motor fitness test by the score on another test and that a negligible relationship was produced in comparing age to motor performance.

In a comparison of performance of kindergarten children in the take off phase of the standing broad jump, Lolas Halverson (13) concluded that: (1) there was no significant difference in sex according to jumping ability, and (2) there was little evidence that six months difference in age made any marked difference in jumping performance.

Smith and Hoffman (14, 15) found that boys were superior to girls of compatible ages in balance. They noted that girls generally have the lower center of gravity but normally this was not enough to offset the greater strength factor which is in favor of the boys. It was noted that the boys would normally have the lower center of gravity in the inverted position.

While the ability to balance may be inherited to a certain degree, Espenshade (16) indicated that balance (dynamic) can be increased to a significant degree through practice. She further concluded that balance improved with an increase in chronological age.

Bachman (17) tested 320 subjects between the ages of six and twenty-six for general motor ability. He formed the following conclusions: (1) there were no sex differences on balance tests between the ages of six and twenty-six; (2) the rate of learning in large muscle skills is independent of age and sex over the range of six and twenty-six years of age; and (3) motor learning progresses in accordance with an exponential law of diminishing effectiveness of practice.

Gutteridge (18) compared the motor development of children ages three to seven. Very rapid development was seen between the ages of four and seven in hopping, skipping, galloping and throwing. At age seven nearly all of the children were rated as proficient in each of these activities. It was indicated that gross motor movement and coordination develop especially fast during this period.

Seils (19) investigated the motor development of children in grades one, two and three. The boys and girls involved in the testing were compared according to grade level and age on a variety of motor ability tests which included running, balance, agility, jumping, throwing and striking. Generally, there was a gradual increase in performance in each of the components from grades one to three. However, a few exceptions were noted: girls did not exhibit a significant improvement between grades one and two; and grade three scores were always higher than those of grade two. It was further concluded that the relationship of physical size and age to performance was low.

In a number of studies concerning sex differences in motor perfor-

mance, a variety of conclusions have been formed. Bontz (20) found that elementary school girls were superior in fine movement activities; however, boys were superior in gross motor activities. Bayley (21) found that there was little difference between boys and girls in motor ability. Garry (22) reported that the motor ability of boys and girls is similar until adolescence.

It has been concluded that boys were faster than girls in ages five to ten (23, 24). It was further indicated that there was a gradual increase in speed of boys and girls from ages five to ten years old. Finally, it was observed that there was a steady increase in distance jumped in the standing broad jump by both boys and girls from ages five to ten. However, the girls exceeded the boys in the broad jump at the age of ten, but at all other ages the boys exceeded the girls.

A longitudinal study by Jordan (25) revealed a moderate degree of consistency in the standing broad jump and sixty yard shuttle run for boys from ages seven through twelve years of age. There was a low inter-age correlation in the ten foot run. As the subjects advanced in age, their means generally increased on all tests, although greater gains occurred for the strength tests than for the motor measures.

The Medford Study (26) indicated a steady increase in mean performance in the standing broad jump for boys ages seven to twelve years of age. Generally, the best jumper in an age could jump twice as far as the poorest jumper in the same age group.

Hindmarch (27) found that eight year old boys who had greater

gross strength had better motor ability scores than boys of lesser gross strength.

Wickstrom (3) reported that a summary of studies of motor performances of elementary school children showed a consistent year to year improvement in running speed for both boys and girls ages five to eleven years old. He noted that boys tend to have an edge over girls, but at ages five, six and seven the performances are quite similar.

In analysis of the running pattern of grade school girls, Dittmer (28) reported that with each successive year there was an increase in running speed.

Jack Keogh (29) summarized the results of eleven studies done over a thirty-five year period that contained data on the performance of elementary school children in the standing broad jump. Variations in the mean performances were reported, but Keogh (29) concluded that there was a consistent linear improvement at successive ages and grade levels. There was no great performance difference between boys and girls until age eight, whereafter, the boys were better performers.

Summary of Related Literature

Studies which were concerned with motor fitness and physical fitness (6, 30, 31) have indicated a difference of opinion in their definitions of the two. Those elements that have been commonly included in the definitions of physical fitness are strength and endurance--both muscular and cardio-respiratory. Those elements that have been commonly included in the definitions of motor fitness are agility, speed, power and balance.

Flexibility and endurance shift between the two depending upon the author.

It appears that most researchers agree that there is a consistent improvement of motor skill performance at successive ages and grade levels. Such a unanimous agreement does not exist in a comparison of sexes in the performers of motor skills. At the elementary level many researchers have found no significant differences in performance according to the performer's sex. Some researchers agreed that boys perform better on most motor skill tests, but the girls have an edge in balance and some agility tests such as rope jumping. Others have found that, generally, boys are the superior performers but at certain ages girls have been superior.

Within an age group, there appears to be a wide range of motor fitness test scores. On some motor skill tests the best performer has doubled the score of the poorest performer.

Elementary school children, including the primary grades, have shown enough consistency in test scores to allow for group and intergroup comparisons.

CHAPTER II

METHODOLOGY

The research was based on observing and statistically treating the results of a motor fitness test established by the investigator. The test was designed to measure performances in agility, power, speed, static balance and dynamic balance. These components were considered because they were the ones most frequently used in the different definitions of motor fitness.

There are many different tests available to measure these motor fitness items. The manner for this study was to choose those test items available that measured the components desired and to choose those that were capable of being applied to the subjects of this age. The test items chosen were the fifteen yard sprint, the stair climb, the zig zag run, the standing broad jump, the one legged stand and the balance beam walk. For a test item description see Appendix A.

The majority of motor fitness tests have been applied to subjects ten years of age (or fourth grade) through college age. Also, norms and reliability coefficients for most test items have been established for those over ten years of age. Very little research has been done in establishing reliability coefficients on motor fitness items for

those children in kindergarten, first and second grade. Therefore, for each of the test items reliability was determined.

The researcher assumed that the subjects would be consistent enough to show high reliability coefficients (0.80 or above). Because of the grade level of the subjects, it was further assumed that there would not be any significant difference in performance scores according to sex. The results were analyzed and statistically treated to confirm or deny these assumptions.

Because many of the test items were unfamiliar to the subjects, it was decided that the first testing day would be a practice session. This would provide each subject the opportunity to observe a demonstration of the task and to participate in the task exactly as he would on the actual test date. Hopefully, this would provide the subject with the opportunity to become familiar with each test item and eliminate as much motor learning as possible between trials on the actual testing day. During the practice test and the actual test, the subjects wore a shirt, slacks and tennis shoes.

The test for reliability was performed in the following manner for each of the test items: the subject was given directions (the same directions as those given during the practice session). Then, the testor demonstrated the proper method of performing the task. This demonstration was followed by the subjects performing two trials. A third trial was allowed if: (1) the subject thought he could do better, (2) the subject slipped or slowed down before crossing the finish line,

(3) the subject hesitated or ran the wrong route and (4) the testor thought the subject did not exhibit his best performance. Trial one score (result) was then compared to trial two score (result) to determine reliability. If three trials were given then the best two trial results were compared to determine reliability. No more than three trials were allowed and two trials were required.

There were two investigators for each test item; one established the subject's score while the other recorded the score. The same testors were used for both the practice session and the final session. Therefore, objectivity was satisfied.

Face validity was accepted on all the test items. The most common test for leg power has been the vertical jump and the standing broad jump. The standing broad jump was chosen as the test item to measure leg power because it appeared to be much easier to administer to subjects of this age. The standing broad jump has been used in a number of research studies as a measure of leg power (11, 12, 13, 23, 25, 32). Although the standing broad jump has been attacked as a strict measure of leg power because of the action of the arms and the trunk, it has been an acceptable measure.

There have been many different tests devised primarily for the measure of agility. One of these is the zig zag run (2, 23). The zig zag run does not exclusively measure agility since factors such as speed and coordination are also included, but it has been an acceptable measure.

There have been many different tests designed to measure static

balance, but one of the best to measure and to accomodate the subjects of this age category is the one legged stand (2, 16). Walking along a balance beam has been considered to be an appropriate measure of dynamic balance (2, 16, 32).

The sprint or the dash has been the common testing device in measuring speed in running (3, 8, 11, 32). Although the distances generally vary between thirty and fifty yards; the sprint distance for this project was limited to fifteen yards.

The other skill item administered was the stair climb. The subject climbed up and down four steps three times. The primary purpose for including this item was to correlate it with the other test items.

Each grade was divided into four groups; the groups were numbered I, II, III, IV. For the first and second grade children, there were three groups with seven subjects and one group with six subjects. The kindergarten was divided into four equal groups of six. The four second grade groups were tested on all the items first, then the first grade groups were tested, and finally, the four kindergarten groups were tested.

There were four testing stations. Station I was the fifteen yard sprint and the stair climb; Station II, the zig zag run; Station III, the standing broad jump; and Station IV, the one legged stand and the balance beam walk.

Group I started at Station I, Group II at Station II, etc. After the groups had finished at their respective stations, the four groups rotated clockwise as indicated in Figure 1. At Station I, the group

members were tested on the fifteen yard sprint and then, they were tested on the stair climb. At Station IV, the group members were tested on the one legged stand and then, they were tested on the balance beam walk.

Because of the difficulty they had during the practice session, the kindergarten children were not tested in the zig zag run. Therefore, the zig zag run was statistically analyzed and treated for reliability, but it was not statistically analyzed or treated regarding sex, grade or the other motor fitness items.

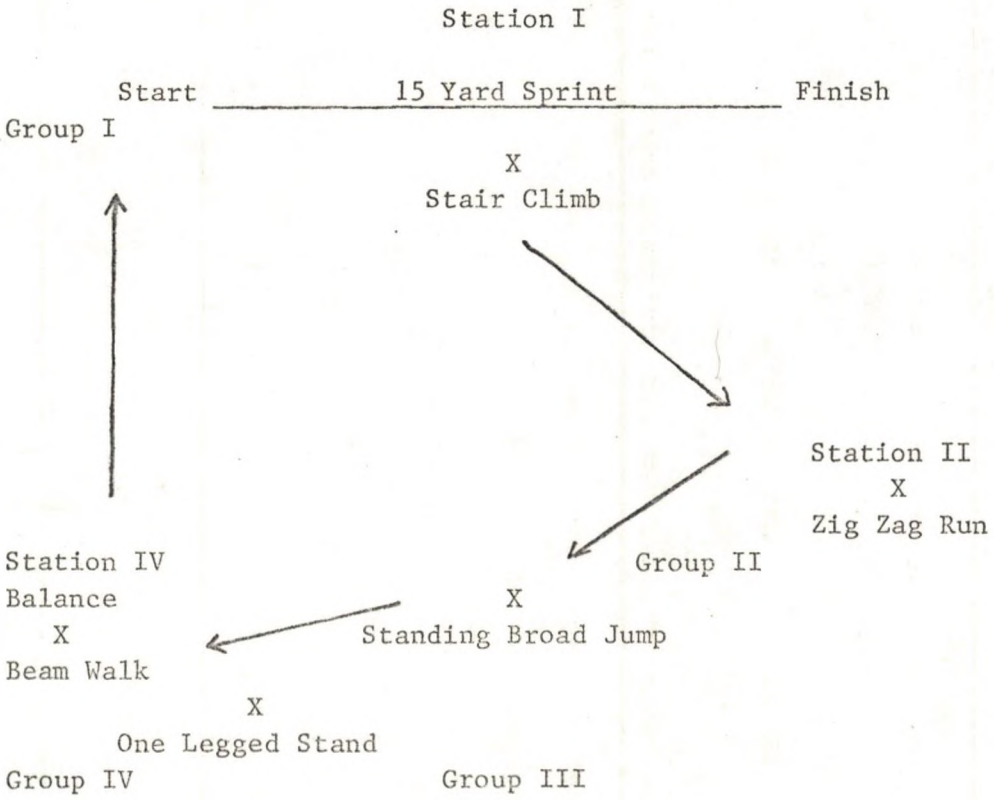

Fig. 1. Layout of the Holy Family Gymnasium and the Testing Stations (arrows indicate the rotation of the groups).

Summary

Trial one was compared to trial two in testing for reliability. If three trials were administered, the best two trials were compared for reliability purposes. This was the procedure on all of the test items.

The data were compiled and programmed for the Fortran IV computer which performed a multiple linear regression analysis on the data. All results were tabulated and analyzed from this computer print out. The level of significance was accepted at the 0.05 level. The calculated F values were compared to those found in a book of tables (34) to determine any significance.

CHAPTER III

RESULTS

The children in kindergarten, first and second grades at Holy Family Elementary School were administered a practice test. Two days later, the same instructions were given and the children were administered the same test as in the practice session. Two trials were required. The first was compared to the second for determining the reliability coefficient. In certain cases a third trial was allowed, if so, the best two scores were compared for reliability purposes.

The null hypotheses were as follows:

1. The kindergarten, first grade and second grade students are not consistent enough in motor fitness performance to establish high reliability.

2. There is no significant difference in performance scores according to the grade of the subject.

3. There is no significant difference in performance scores according to the sex of the subject.

The alternate hypotheses were as follows:

1. The kindergarten, first grade and second grade are consistent enough to establish high reliability.

2. There is a significant difference in performance scores according to the grade of the subject.

3. There is a significant difference in performance scores according to the sex of the subject.

The data were compiled and processed into the Fortran IV computer. A pre-established program at the University of North Dakota was called upon to statistically perform a multiple linear regression analysis on the data. There were six different motor fitness tasks which were analyzed: (1) the sprint, (2) the zig zag run, (3) the standing broad jump, (4) the one legged stand, (5) the balance beam walk and (6) the stair climb. Each one of the tasks was analyzed for reliability, then each one (the zig zag run excluded) was compared for significant differences in performance according to sex and then according to grade. Finally, each task (excluding the zig zag run) was compared to each other to observe the relationship between them.

All six test items had a high reliability coefficient. The reliability correlation coefficients were as follows: the sprint 0.896, the zig zag run 0.924, the standing broad jump 0.958, the one legged stand 0.914, the balance beam walk 0.851 and the stair climb 0.965.

The five motor fitness tests were statistically analyzed according to grade and sex. The average of the two trial scores was used in this analysis. Each of the five tests was significant according to grade at the 0.05 level of significance. At two degrees of freedom in the numerator and sixty degrees of freedom in the denominator the F

value of significance is 3.15.

The F value for each of the five test items was: the sprint 10.46, the standing broad jump 9.54, the one legged stand 13.23, the balance beam walk 12.20 and the stair climb 13.86 (Table 1).

TABLE 1

F-VALUE CALCULATIONS FOR SIGNIFICANCE

Test Item	Variable	df	ss	ms	F Value
Sprint	grade	2	2.49	1.24	10.46
	sex	1	0.16	0.16	1.33
Broad Jump	grade	2	993.78	496.89	9.53
	sex	1	291.31	291.31	5.59
One Legged	grade	2	1964.70	982.35	13.23
Stand	sex	1	50.27	50.27	0.68
Balance Beam	grade	2	73.10	36.55	12.20
Walk	sex	1	53.84	53.84	3.25
Stair	grade	2	58.27	29.14	13.86
Climb	sex	1	3.93	3.93	1.87

The standing broad jump was significant at the 0.05 level of significance according to sex. The F value at one degree of freedom for the numerator and sixty degrees of freedom in the denominator at the 0.05 level of significance is 4.00. The standing broad jump had an F value of 5.59, therefore it was significant (Table 1). In the standing broad jump the boys had a higher mean score at each grade level (Table 2) with the greatest difference of 5.53 inches at the kindergarten. The boys had a 2.75 and 3.72 inch advantage in the first and second grade, respectively.

The range of scores became less in the upper grade levels. The

TABLE 2

THE MEAN SCORES OF PERFORMANCES

Test Item	Grade	Mean	Mean (boys)	Mean (girls)
Sprint	K	3.82	3.79	3.85
	1	3.63	3.61	3.66
	2	3.37	3.31	3.48
Zig Zag Run	K	-	-	-
	1	19.10	19.09	19.12
	2	19.16	18.82	19.75
Standing Broad Jump	K	40.76	43.30	37.77
	1	45.22	46.14	43.39
	2	49.94	51.32	47.60
One Legged Stand	K	15.45	11.50	20.05
	1	24.48	24.55	24.33
	2	27.33	28.44	25.45
Balance Beam Walk	K	6.06	5.61	6.59
	1	8.31	7.91	9.11
	2	11.96	10.88	13.80
Stair Climb	K	11.17	10.96	11.42
	1	10.48	10.30	10.84
	2	9.06	8.91	9.31

second grade had a lower range of scores on each of the six motor fitness test items as well as the kindergarten having the highest (Table 3).

When correlating the motor fitness items to each other (excluding the zig zag run), it was determined that a fairly high positive correlation existed (0.72) between the sprint and the stair climb (table 4). There was an inverse correlation between the sprint and the standing broad jump (-0.73) and the standing broad jump and the stair climb (-0.61). These correlations are a result of inverse scores.

TABLE 3

RANGE OF SCORES ON THE SIX TEST ITEMS

Test Item	Grade	Low Score	High Score	Range
Sprint	2	3.0	4.2	1.2
	1	3.1	4.6	1.5
	K	3.0	4.8	1.8
Zig Zag Run	2	15.8	23.0	7.2
	1	15.7	25.3	9.6
	K	-	-	-
Standing Broad Jump	2	37	61	24
	1	24	58	34
	K	24	59	35
One Legged Stand	2	4	30	26
	1	2	30	28
	K	1	30	29
Balance Beam Walk	2	2	14	12
	1	1	14	13
	K	1	14	13
Stair Climb	2	6.7	10.6	3.9
	1	7.0	14.2	7.2
	K	7.9	16.8	8.9

TABLE 4

CORRELATIONS BETWEEN MOTOR FITNESS ITEMS

	Sprint	Standing Broad Jump	One Legged Stand	Balance Beam Walk	Stair Climb
Sprint	1.00	-0.73	-0.59	-0.46	0.72
Standing Broad Jump	-0.73	1.00	0.40	0.45	-0.61
One Legged Stand	-0.59	0.40	1.00	0.57	-0.50
Balance Beam Walk	-0.46	0.45	0.57	1.00	-0.59
Stair Climb	0.72	-0.61	-0.50	-0.59	1.00

CHAPTER IV

DISCUSSION

This research project had three main objectives. The first objective was to establish reliability on the six motor fitness test items of this research project. The second objective was to analyze the results and report any findings related to the grade of the subjects. The third was to analyze the data and report any findings related to the sex of the subjects. These three objectives were satisfied and a discussion of those results will follow along with any other findings that may have arisen out of the course of this investigation.

The reliability correlation coefficients were high as indicated in Chapter III. This may have been partly a result of the practice session, the allowing of a third trial or the adapting of the test to the age of the subjects.

In analyzing the data and statistically treating it for any effects that the grade level may have upon the performance, significant differences were found in the five motor fitness test items. The zig zag run was excluded from this part of the study. The results showed that the students' performances in the upper grades were significantly superior on the five motor fitness test items (Table 1). The results of this

study seem to confirm Seils (19) observation that performance gradually increased from grades one to three.

Using the means as a basis of comparison, the boys were superior, although not significantly superior in their performances, in all test items except the balance tests (Table 2). The standing broad jump was the only test where the boys did significantly better in their performance. The boys' performance was significantly better at the 0.05 level of significance. The computed F value in the standing broad jump in regards to sex was 5.59. The F value from a table of the F distribution (34) at one degree of freedom (numerator) and sixty degrees of freedom (denominator) was 4.00. The boys' means were superior to the girls' at each grade level in the sprint, stair climb and the zig zag run.

The girls had somewhat of a better mean performance score in the balance tests, especially in the balance beam walk. In the first and second grade, the girls widened the difference between their performance and the boys' performance in the balance beam walk. The girls held a margin of 0.98 of a foot, 1.20 feet and 2.92 feet over the boys in kindergarten, first grade and second grade, respectively. The kindergarten girls nearly doubled the mean performance score of the boys in the same grade in the one legged stand. The girls had a mean of 20.05 seconds while the boys maintained a mean of 11.58 seconds. In the first grade, the boys' performance increased considerably and they held a slight edge (0.22 of a second) over the girls. In the second grade the

the boys held an edge of 2.99 seconds over the girls.

The table of F values (33) indicates that a F value of 4.00 or better is needed for significance at the 0.05 level to be significant. The computed F value in the balance beam test in regards to sex was 3.25 which was not significant.

Hanson (12) noted that boys were slightly superior in some motor components but that girls seem to hold the edge in balance. The results of this research project seems to confirm her observation.

In evaluating the range of scores, the investigator found that within each test item the kindergarten had the highest range of scores and the second grade had the lowest range (Table 3). In two motor fitness test items (the sprint and the zig zag run), two girls had superior performances. A kindergarten girl equalled the best performance score of any of the first or second graders in the fifteen yard sprint (3.0 seconds). A first grade girl had the best performance score in the zig zag run (15.7 seconds).

In observing the relationships between the motor fitness items, there was a fairly high negative correlation between the sprint and the standing broad jump (-0.73). The sprint had a positive correlation with the stair climb (0.72). It is not known which of the motor fitness components are a part of the stair climb, but the investigator is of the opinion that speed, agility and balance have some part in this test item. Also, the stair climb correlated with the standing broad jump and the balance beam walk -0.61 and -0.59, respectively.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Research in motor fitness components has been done at the high school, junior high school and upper elementary school levels. The investigator noticed in observing research in the area of motor fitness that primary grade children are invariably omitted from most studies. Generally, those studies that have been done are concerned with subjects in the fourth grade (age ten) up through the college level. The academic trend has been to do more research with the younger student and challenge his capabilities.

The investigator was interested in observing the performances of children in the primary grade level at Holy Family Elementary School in Grand Forks, North Dakota. The sample consisted of twenty-seven second grade children (seventeen boys and ten girls), twenty-seven first grade children (eighteen boys and nine girls), and twenty-four kindergarten children (thirteen boys and eleven girls). The subjects were tested in the Holy Family gymnasium.

Six motor fitness test items were adapted to fit the grade level of the subjects. The tests were designed to measure speed in running, agility, leg power, static balance and dynamic balance. The six motor

fitness tests (Appendix A) were the fifteen yard sprint (speed), the zig zag run (agility), the standing broad jump (leg power), the one legged stand (static balance), the balance beam walk (dynamic balance) and the stair climb. The stair climb was inserted by the investigator because of an interest in observing its results with the results of the other five tests.

All six motor fitness tests were administered to the subjects with the exception of the zig zag run. A practice test was given to the subjects two days prior to the administering of the actual test. From this practice test the investigator felt that the zig zag run was somewhat too difficult for the kindergarten children and it was eliminated as a test for agility in the kindergarten. The practice test was designed such that the subjects could become familiar with the test items which hopefully, would eliminate any confusion on the part of the subjects during the actual testing.

Two trials were required by each subject on each test item. A third was given if: the subject felt he could do better, the subject slipped or slowed down before crossing the finish line, the subject hesitated or performed the task improperly or the testor thought the subject did not exhibit his best performance. No more than three trials were allowed. If a subject performed three trials, the two best performances were used.

The data were compiled, analyzed and statistically treated. Face validity was accepted on all test items. The same testors were used

throughout the test, therefore, objectivity was satisfied. The two trials were compared to establish reliability coefficients for each test item.

The main objectives of the study was to establish reliability and compare results of the performances in regards to grade and in regards to sex.

The null hypotheses were: (1) the kindergarten, first grade and second grade students are not consistent enough in motor fitness performance to establish high reliability, (2) there is no significant difference in performance scores according to the grade of the subject and (3) there is no significant difference in performance scores according to the sex of the subject.

The alternate hypotheses were: (1) the kindergarten, first grade and second grade students are consistent enough to establish high reliability, (2) there is a significant difference in performance scores according to the grade of the subject and (3) there is a significant difference in performance scores according to the sex of the subject.

Conclusions

The investigator rejects the first null hypothesis and accepts the first alternate hypothesis. The high reliability correlation coefficients are representative of the consistent performance of subjects of this grade level. The study indicates that if the test is adapted to the particular grade level, the subjects' performances are consistent enough to exhibit high reliability.

Also, the second null hypothesis is rejected and the second alternate hypothesis is accepted. The computed F value scores on the five motor fitness test items (zig zag run excluded) overwhelmingly indicates that there was significant differences in performances according to the grade. Pupils in the upper grade were consistently superior to pupils in the lower grade in performances on five motor fitness test items.

Finally, the third null hypothesis is accepted and the alternate hypothesis is rejected for the sprint, balance beam walk, one legged stand and the stair climb. The boys did perform significantly better than the girls in the standing broad jump which indicated more leg power in the boys at this school in grades K-2.

Recommendations

After investigating this research project, the investigator would suggest to those interested in further research in this area the following recommendations:

1. A practice session using simple and clear directions is beneficial in that the children appear to be more confident in their performance.

2. A practice session is recommended because it prepares the investigator in what to expect from the subjects he is testing.

3. In the practice session it is helpful not only to explain test procedures orally but also to have the testors demonstrate the proper procedures.

4. Because the zig zag run appeared to be too difficult for the kindergarten child it is suggested by this investigator that an easier agility run be incorporated for this grade level and below.

5. The investigator found it was important to give continual encouragement as the subject performed to prevent an inferior performance.

6. Many of the subjects were afraid to perform, therefore, it is important for the testor to speak in a friendly way.

7. During a discussion with one of the first grade teachers, it was indicated that a relationship seemed to exist between a poor performance in the balance beam test and the child's reading level. It may be beneficial to do research in this area.

APPENDIX A

Test Item Description

Fifteen Yard Sprint

Purpose: To measure running speed

Equipment: stop watch

Description: The subjects were shown the starting line and the finish line which were measured to be exactly fifteen yards apart and marked with white tape. The subjects were told as a group and individually when it was their turn to get in a standing, ready to run position. The starter then said to them, "When I say, 'ready, go,' you run as fast as you can to the mat against the wall without slowing down, okay?" The starter then gave the "ready, go" signal. The testor started the time on the movement of the subject and stopped it when he or she crossed the finish line. Each subject ran two trials and where necessary, a third trial was run. If there were three trials the best two were compared for reliability. The subject's score was the time to the nearest tenth of a second.

Zig Zag Run

Purpose: To measure agility

Equipment: six pylons, stop watch

Description: The testor demonstrated the method of running the agility courses as illustrated below (Figure 2). The subjects were told as a group and individually when it was their turn to run to get in a standing, ready to run position. The started then said, "When I say, 'ready, go,' you must run the same way that I showed you, going twice around the course as fast as possible, okay?" The starter then said, "ready, go." The time started on the first movement of the subject and was stopped when the subject went around the course twice. His score was the time to the nearest tenth of a second. The same process was repeated on the second trial. If the subject slipped, hesitated, or if he thought he could do better, he was allowed to run again. If there were three trials the best two were compared for reliability.

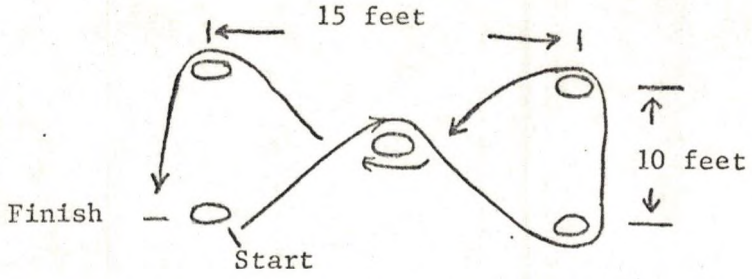

Fig. 2. Zig Zag Run--Route and Dimensions.

Standing Broad Jump

Purpose: To measure explosive power of the legs

Equipment: mat--with tape attached (numbered in inches) to easily indicate distance jumped

Description: The subject was told to begin with the toes of both feet directly behind the restraining line and with his or her body in a crouched position with both arms extended backwards. Then, he was told to swing his arms forward while he jumped forward as far as possible. Both feet must leave the mat simultaneously. Measurements were taken in inches from the back of the restraining line to the point on the mat which is contacted by the body part nearest to the starting line after the subject landed. When it was his turn, each subject was asked to go when he was ready to jump. The subject performed two trials. If a subject had three trials, the best two were used for the reliability test. His score was the distance jumped in inches.

One Legged Stand

Purpose: To measure static balance

Equipment: stop watch

Description: The subject was to pick either foot up and touch the sole of that foot to the knee of the other leg; the other foot was to remain stationary with the floor. While he was doing this, he could maintain his balance by holding onto the testor. When he was ready, he informed the testor and then he put his hands on his hips. The stop watch was started when his hands were on his hips.

The time was stopped when his supporting foot moved from the spot originally taken or when the other foot touched the floor (whichever occurred first). An upper limit of thirty seconds was allowed. A minimum of two trials were given and when there were three trials the best two out of three were used for reliability purposes. His score was the time to the nearest second.

Fig. 3. The Static Balance Position.

Balance Beam Walk

Purpose: To measure dynamic balance

Equipment: balance beam--two inches wide, four inches high, and nine feet long

Description: The subject begins by standing at the end of the balance beam designated by the starting line with his toes of his lead foot behind the starting line. When he was ready, the subject was supposed to walk the balance beam by placing his back foot ahead of the front foot. Both feet must be placed straight forward and cannot be toed in or out. The subject was to walk down past the end line designated by a strip of tape, turn around and return to the starting position. The last place where the subject was able to hold his balance to the nearest foot becomes the score. The maximum score was fourteen. The subject was allowed a minimum of two trials. When three were used, the best two out of three trials were used for reliability purposes. The subject could be assisted onto the balance beam, but once he was ready, no help could be given.

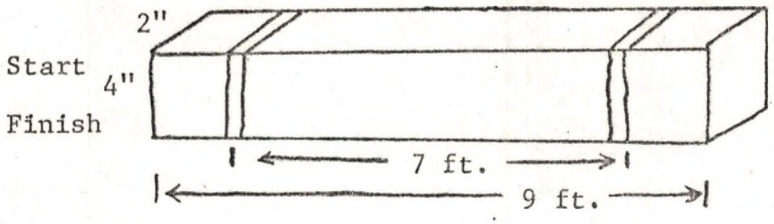

Fig. 4. Balance Beam and Dimensions.

Stair Climb

Purpose: To correlate with the other test items

Equipment: stairs with four steps, stop watch

Description: The subject stands facing the stairs. He was instructed to go up one side and come down the same side three times. He had to hit each step and if a step was skipped he was asked to run it again. He was asked to do the climb as quickly as possible. He was given a "ready, go" command and the watch began on the subject's movement and stopped when his foot reached the floor after he had gone up and down three times. His score was the time to the nearest tenth of a second.

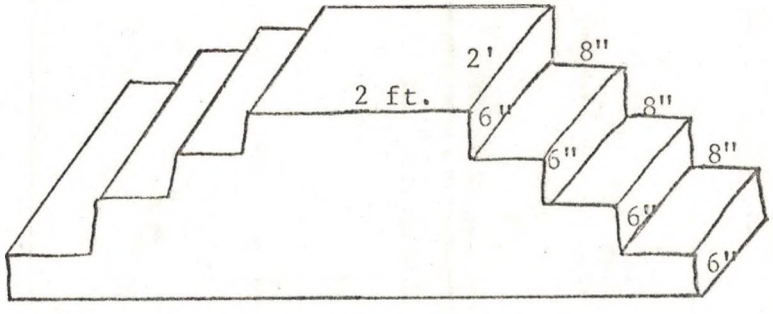

Fig. 5. The Stair Climb and Dimensions.

APPENDIX B

Raw Scores

TABLE 5

SECOND GRADE RAW SCORES

Subject	Sex	Sprint		Zig Zag Run		Broad Jump		One Legged Stand		Beam Walk		Stair Climb	
A	b	3.2	3.0	18.0	17.2	60	61	30	30	14	14	9.3	9.1
B	b	3.5	3.8	21.4	20.8	46	51	30	30	7	14	10.4	10.4
C	b	3.4	3.4	19.3	19.6	43	43	16	26	2	3	9.2	9.2
D	b	3.2	3.2	18.6	16.6	58	60	30	30	14	14	9.0	8.6
E	b	3.2	3.2	18.3	17.6	54	57	30	30	14	14	8.8	8.8
F	b	3.2	3.3	18.0	19.3	52	53	30	30	14	14	7.7	7.7
G	b	3.6	3.2	21.0	21.4	48	44	22	30	14	14	10.6	10.3
H	b	3.0	3.0	16.9	18.1	49	50	30	30	14	14	6.8	6.7
I	b	3.0	3.0	18.9	17.4	60	60	30	30	2	7	8.6	8.1
J	b	3.2	3.4	18.0	18.8	54	50	30	30	10	10	10.1	9.1
K	b	3.0	3.0	17.8	19.3	56	57	30	30	14	14	8.1	7.9
L	b	3.5	3.2	21.6	20.0	37	40	29	30	7	6	10.2	9.9
M	b	4.2	4.0	20.7	20.6	43	40	30	30	8	7	9.9	9.5
N	b	3.5	3.6	18.4	18.7	42	41	18	16	3	7	9.3	9.9
O	b	3.6	3.4	19.5	20.4	48	48	30	30	11	14	9.9	9.6
P	b	3.1	3.3	16.1	15.8	59	60	30	30	14	14	8.0	8.0
Q	g	3.2	3.0	19.7	18.7	38	36	30	30	14	14	9.5	8.9
R	g	3.6	3.5	21.0	21.6	48	44	30	30	14	13	10.0	10.0
S	g	3.4	3.6	20.7	21.2	38	43	30	30	14	14	11.2	10.1
T	g	3.4	3.4	21.6	21.7	49	50	30	30	14	14	9.4	9.3
U	g	3.8	4.0	17.8	16.7	53	49	6	4	14	14	8.2	8.4
V	g	3.6	3.6	19.5	18.7	40	42	25	25	14	14	9.5	10.4
W	g	3.6	3.4	17.8	17.5	44	48	30	30	14	14	7.8	8.4

TABLE 5--Continued

Subject	Sex	Sprint		Zig Zag Run		Broad Jump		One Legged Stand		Beam Walk		Stair Climb	
X	g	3.1	3.3	23.0	22.6	56	57	30	30	14	14	9.4	8.9
Y	g	3.6	3.5	20.2	19.6	61	62	17	21	14	14	9.7	9.6
Z	g	3.6	3.4	17.8	17.7	49	45	30	21	14	14	9.0	8.6
AA	b	3.2	3.0	18.0	17.6	60	61	30	30	14	14	7.5	7.0

TABLE 6

FIRST GRADE RAW SCORES

Subject	Sex	Sprint		Zig Zag Run		Broad Jump		One Legged Stand		Beam Walk		Stair Climb	
A	b	3.4	3.3	17.4	17.7	58	56	30	30	14	14	9.0	8.8
B	b	3.2	3.2	19.2	20.5	48	50	30	18	9	2	10.8	10.8
C	b	3.1	3.2	19.2	19.0	54	52	30	30	3	5	10.0	9.4
D	g	3.6	3.6	19.8	20.0	37	38	30	30	12	10	10.0	10.4
E	b	3.6	3.9	17.9	17.6	41	42	30	30	11	7	10.4	10.1
F	g	3.6	3.6	19.6	19.7	44	45	30	30	1	6	10.3	10.4
G	g	3.6	3.9	17.5	17.0	49	48	30	30	14	14	11.0	10.4
H	g	3.8	3.5	22.0	21.3	46	44	15	3	9	14	11.6	11.0
I	b	3.6	3.4	17.0	16.6	50	51	30	30	14	10	10.0	10.0
J	b	3.5	3.3	19.2	19.4	49	48	30	30	14	14	8.8	9.0
K	b	3.6	3.4	18.4	18.4	50	50	30	30	14	14	11.5	10.8
L	b	3.7	3.7	18.3	18.5	52	52	20	30	3	4	12.0	13.0
M	g	3.4	3.6	16.9	17.4	46	46	30	28	7	6	10.4	10.4
N	b	4.0	3.9	19.1	18.8	24	31	30	22	5	14	10.8	10.2
O	g	3.7	3.6	15.7	16.0	48	52	30	30	14	14	9.4	9.2
P	b	4.4	4.6	21.9	22.0	34	34	2	2	1	3	14.0	14.2
Q	b	3.7	3.6	18.0	17.9	43	46	30	30	5	7	10.4	10.2
R	g	3.6	3.9	22.1	21.8	36	38	5	5	4	1	12.8	12.8
S	b	3.5	3.6	20.7	20.2	41	42	30	30	3	3	9.8	10.4
T	g	3.9	3.9	20.9	20.5	38	35	30	30	3	7	10.5	11.4
U	b	3.4	3.4	18.3	8.0	45	48	12	20	4	4	9.5	8.6
V	b	3.8	3.9	24.5	25.3	36	36	30	30	14	14	12.0	11.2
W	b	3.2	3.1	16.8	16.9	54	54	19	30	14	14	7.1	7.0

TABLE 6--Continued

Subject	Sex	Sprint		Zig Zag Run		Broad Jump		One Legged Stand		Beam Walk		Stair Climb	
X	g	3.4	3.6	18.3	17.8	45	46	30	22	14	14	11.5	11.8
Y	b	3.7	3.9	20.2	20.4	48	46	28	30	7	10	9.5	9.2
Z	b	3.5	3.6	17.5	18.3	48	50	9	12	3	4	9.8	9.4
AA	b	4.0	3.9	18.9	19.2	48	50	16	14	2	2	11.6	12.0

TABLE 7

KINDERGARTEN RAW SCORES

Subject	Sex	Sprint		Zig Zag Run	Broad Jump		One Legged Stand		Beam Walk		Stair Climb	
A	b	3.3	3.4	-	59	59	22	30	6	5	12.8	12.0
B	b	3.5	3.8	-	36	38	3	5	7	10	12.1	12.3
C	b	4.0	3.8	-	46	49	3	7	7	4	11.4	11.0
D	b	4.0	4.0	-	36	36	1	5	2	1	12.1	12.5
E	b	3.8	3.8	-	41	40	7	10	2	1	11.2	11.1
F	b	3.8	4.0	-	36	36	8	12	1	2	11.3	12.2
G	b	3.8	3.9	-	39	41	3	10	7	2	9.5	10.0
H	b	4.8	5.0	-	30	30	4	3	3	1	14.4	14.8
I	b	3.6	3.8	-	46	49	2	3	3	7	10.7	10.7
J	b	4.0	3.6	-	44	46	11	22	7	5	9.5	9.5
K	b	3.2	3.2	-	52	53	30	26	12	14	8.0	7.9
L	b	3.8	3.8	-	44	48	9	5	2	7	10.5	10.1
M	b	3.4	3.6	-	44	48	30	30	14	14	8.8	8.7
N	g	4.8	4.8	-	26	24	12	10	2	3	11.5	12.2
O	g	4.2	4.8	-	34	31	9	15	12	9	11.0	11.4
P	g	3.8	4.0	-	38	40	30	30	12	7	13.4	12.5
Q	g	3.8	3.6	-	38	40	2	5	4	2	10.2	10.4
R	g	4.4	4.6	-	32	32	4	7	3	5	16.5	16.8
S	g	3.6	3.8	-	40	36	30	30	14	14	10.5	10.5
T	g	3.2	3.4	-	46	47	30	30	7	7	9.7	9.5
U	g	3.7	3.6	-	38	44	12	2	2	3	11.1	10.7
V	g	3.0	3.1	-	50	49	30	30	8	14	9.6	9.7
W	g	3.6	3.6	-	36	39	30	30	2	4	10.9	11.0
X	g	3.8	3.6	-	35	36	30	30	4	7	11.1	11.2

REFERENCES

1. Lawther, John D. The Learning of Physical Skills. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1968, pp. 1-2.

2. Hunsicker, Paul. "What Research Says to the Teacher: Physical Fitness." United States Department of Health, Education, and Welfare, 1969, pp. 3-4.

3. Wickstrom, Ralph. Fundamental Motor Patterns. Philadelphia: Lea Febiger, 1970, p. 9.

4. Allee, John Gage. Webster's Dictionary. Ottenheimer, Inc., 1969.

5. Johnson, Barry L., and Nelson, Jack K. Practical Measurements for Evaluation in Physical Education. Minneapolis: Burgess Publishing Company, 1969.

6. McCollum, Robert H., and McCorkle, Richard B. Measurement and Evaluation: A Lab Manual. Boston: Allyn and Bacon, Inc., 1971, p. 71.

7. Carron, Albert V. Laboratory Experiments in Motor Learning. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1971, pp. 1-68.

8. Smoll, Frank L. "The Influence of Physical Growth and Muscular Strength Upon Motor Performance: Within and Between Year Observations." M. S. Thesis, University of Wisconsin, Madison, 1966.

9. Gearhart, Everett Earl. "An Evaluation of Performance in Selected Physical Ability Tests by Elementary School Boys Classified on the Basis of Wetzes Grid Developmental Levels." M. S. Thesis, University of Washington, Seattle, 1963.

10. Blackington, Marion. "The Value of a Height Weight Classification Plan as a Predictor of Motor Ability of College Women." Thesis (Ed. D.), University of Utah, Salt Lake City, 1928.

11. Bailey, Don Charles. "Longitudinal Analysis of Strength, and Motor Development of Boys Ages 12-17." Thesis (Ed. E.), University of Oregon, Eugene, 1968.

12. Hanson, Margie Rosann. "Motor Performance Testing of Elementary School Age Children." Thesis (Ph. D.), University of Washington, Seattle, 1965.

13. Halverson, Lolas Elizabeth. "A Comparison of Performance of Kindergarten Children in the Take-Off Phase of the Standing Broad Jump." Ph. D. Thesis, University of Wisconsin, Madison, 1958.

14. Smith, Jean A. "Relation of Certain Physical Traits and Abilities to Motor Learning in Elementary School Children." Research Quarterly (May, 1956), 27:228.

15. Hoffman, Virginia. "Relation of Selected Traits and Abilities to Motor Learning." Doctor's Dissertation, Indiana University, 1965.

16. Espenshade, Anna. "Dynamic Balance in Adolescent Boys." Research Quarterly (October, 1953), 24:270.

17. Bachman, John C. "Motor Learning and Performance as Related to Age and Sex in Two Measures of Balance Coordination." Research Quarterly (May, 1961), 21:123-137.

18. Gutteridge, Mary. "A Study of Motor Abilities of Young Children." Archives of Psychology (1939), 34:244.

19. Oxendine, Joseph B. Psychology of Motor Learning. New York: Meredith Corporation, 1968, pp. 135-171.

20. Bontz, Emily Jean. "An Analysis of Concepts Basic to Curriculum Construction in Physical Education in the Upper Elementary School." Thesis, University of Iowa, Iowa City, 1948.

21. Bayley, Nancy. Studies in the Development of Young Children. Berkeley, California: University of California Press, 1940.

22. Garry, Ralph. Guidance Techniques for Elementary Teachers. Columbus, Ohio: C. E. Merrill Books, 1963.

23. Johnson, Warren Russell. Science and Medicine of Exercise and Sports. New York: Harper and Row, 1960.

24. Barrow, Harold Marion, and McGee, Rosemary. A Practical Approach to Measurement in Physical Education. Philadelphia: Lea Febiger, 1964.

25. Jordan, David. "Longitudinal Analysis of Strength and Motor Development of Boys Ages 7-12 Years of Age." Ph. D. Dissertation, University of Oregon, Eugene, 1966.

26. Clarke, H. Harrison. "Contributions and Implications of the Medford, Oregon, Boy's Growth Study." Research Project, University of Oregon, Eugene, 1968, p. 8.

27. Hindmarch, Robert G. "Significance of Physique, Maturational, Body, Size, Strength, Motor Ability and Reaction Time Characteristics

of Eight Year Old Boys." Dissertation (Ed. D.), University of Oregon, Eugene, 1962.

28. Dittmer, Joann. "A Kinematic Analysis of the Development of the Running Pattern of Grade School Girls and Certain Factors Which Distinguish Good From Poor Performance at the Observed Ages." Unpublished Master's Thesis, University of Wisconsin, 1962.

29. Keogh, Jack. "Motor Performance of Elementary School Children." Los Angeles: Department of Physical Education, University of California, 1965.

30. Cureton, Thomas Kirk, Jr. Physical Fitness of Champion Athletes. Urbana: University of Illinois Press, 1951.

31. Clarke, H. Harrison. Application of Measurement to Health and Physical Education. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1967, pp. 202-203.

32. "Intensification of the Learning Process, A Series of Reports Designed for Classroom Use, Report Number 3, Gross Motor Performance Scale." Bucks County Public Schools, An ESEA Title III Project, February, 1970.

33. Williams, John D. Regression Analysis in Educational Research. New York: MS Information Company, 1974, pp. 151-152.