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A Study of the Relationship of Selected Measures of muscular, Agility, Power and Speed to Team Success in Highschool Football

Roy Hokkanen

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A STUDY OF THE RELATIONSHIP OF SELECTED MEASURES
OF MUSCULAR STRENGTH, AGILITY, POWER
AND SPEED TO TEAM SUCCESS
IN HIGH SCHOOL FOOTBALL

By

Roy Hokkanen

A Research Study
Submitted to the Faculty
of the
Graduate School
of the
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for the Degree of
Master of Education

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1961

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CHAPTER I

INTRODUCTION

The Problem

The problem of this study was to determine the relation of selected measures of physical and motor development to team success in high school football. This study also hopes to add to the knowledge of the relationship of the selected measures of muscular strength, agility, explosive power, and speed of football teams to their success in the football season.

Sub-Problems

The sub-problems of this study were to find the average results of various functional measurements and to correlate them with success.

The sub-problems:

1. Find the average team muscular strength.
2. Find the average team explosive power.
3. Find the average team agility.
4. Find the average team speed.
5. Correlate the average team muscular strength with success.
6. Correlate the average team explosive power with success.
7. Correlate the average team agility with success.
8. Correlate the average team speed with success.

Need For The Study

While there are several excellent tests of general athletic ability and many more tests of achievement in specific sports based on the skills involved therein, there is a limited group of raw measures used as

predictors of ability as they pertain to success in specific sports. The results of this study may indicate some essential information which can be used to develop educationally sound physical education and athletic programs.

This study may also emphasize certain physical weaknesses and strengths among the schools participating, thereby adding to the theory that football will contribute somewhat to the development of the physical fitness of its participants.

Sigerseth,¹ at the University of Oregon in 1944, in an attempt to isolate and identify fundamental factors that underlie motor fitness, found, in addition to the general factor of athletic or motor ability, three group factors that appeared to underlie motor fitness. They were identified as: (1) a strength factor of the upper body including the shoulder girdle and arms, (2) a strength factor of the lower body which includes the pelvic girdle and the legs, and (3) a factor involving speed of application of power.

Anderson² found power to be an important element in athletic success, and that there were greater differences in power between athletic groups than with others.

DiGiovanna³ indicated in his study "The Relation of Selected

¹Peter Sigerseth, "An Attempt to Isolate and Identify Fundamental Factors That Underlie Motor Fitness," Eugene, Ore.: Unpublished Ed. Thesis, 1944.

²Roy Anderson, "Physical Power Relationships," Unpublished M. S. Thesis, Physical Education, University of New Mexico, 1949.

³Vincent DiGiovanna, "The Relation of Structural and Functional Measures to Success in College Athletics," Research Quarterly, May, 1943, p. 199.

Structural and Functional Measures to Success in College Athletics," that factors of body structure, muscular strength, and explosive power are associated with athletic success, however, more studies are needed in these areas.

Limitations of the Study

This study does not purport to reach conclusions that would be acceptable by football predicting standards in every locality. Various factors such as playing experience, personality and emotional qualities, the intelligence and comprehensive capabilities of the youths involved, and the capabilities of the coaching staffs influence athletic performance to the large degree.

Permission to conduct the testing procedure was obtained from the administrators and coaches of the participating schools. The tests were administered to the varsity high school players from the participating schools in the Tri-County Football Conference in Northwestern Minnesota during the 1960 competitive season.

The test was limited only to those boys considered by their coaches as varsity players. This was an attempt to limit the number of young players so as not to affect the team averages too drastically on the various items. The number of varsity players on each squad may have affected certain team averages, as the larger schools may have had more actual varsity players participating than smaller schools.

The final limitation of this study is that its conclusions are drawn from physical tests only. There are no measures of the players' knowledge of the game itself, such as rules and regulations, and the resulting reactions of boys to certain game situations.

Weather conditions during the games were not considered, neither were the education, experience and background of the coaches and their assistants.

Definitions

The following terms have been defined to eliminate confusion and misunderstanding as to the actual terminology used.

Functional measures. - Functional measures are interpreted in terms of measured muscular strength, agility, explosive power, and speed.

Varsity players. - Varsity players are players who have won a letter in a previous season as determined by their school regulations on playing time accumulated throughout the season. Players who played regularly during and up to the time the test was given were considered varsity players.

Explosive power. - Explosive power is the effect of speed on the rate of doing work as suggested by the mechanical principle that power equals force times velocity. $P = F \times V$. It will be determined by using the vertical jump; height by jumping and reaching minus the standard height.

Muscular strength. - Muscular strength is the ability of the major muscle groups to overcome resistance as measured by the number of pull-ups.

Agility. - Agility is the ability to make a rapid change of direction in bodily movements as measured by the burpee or squat thrust.

Speed. - Speed is the ability to move rapidly from one spot to another. This will be determined by timing the members of each team in the fifty-yard dash on the football field without pads.

Organic (Physical) Development. - Organic development is defined as muscular strength acquired by exercise.

Neuromuscular or Motor Development. - Neuromuscular development is defined as skill and muscular coordination as measured by the Burpee or squat thrust.

Success. - The term success refers to the standing the team has in the conference at the end of the football season, with the team or teams with the best percentage of games won at the top of the standings and the team or teams with the least victories at the bottom of the standings.

Overload. - An overload is any exercise that exceeds in intensity or duration the demands regularly made on the organism.

CHAPTER II

REVIEW OF RELATED LITERATURE

The benefits derived from sports, and football specifically have been contested and debated for a long time, but only recently have studies and investigations been made substantiating claims that any tangible benefits are developed through participation. Among the many benefits gained from playing football, for instance, is the development of muscular strength and coordination, agility and power, and a strong healthy body.

Certain studies by coaches and physical education teachers were investigated in the area of the forces of muscular strength, agility, explosive power and speed, and their relation of physical conditioning.

Massey¹ defines good physical condition as that, within the limits of one's innate capacity, the body is functioning efficiently. In terms of athletics, this means that the skeletal muscles are strong and their action well-coordinated; they can be called upon to work at relatively high intensities over reasonably long periods of time. The well-conditioned body evidences the following characteristics: strength, agility, power, speed, endurance and muscular coordination. The physically trained person is far superior in work output to his relatively unconditioned counterpart.

¹Benjamin Massey, Ph. D. F.A.C.S.M. University of Maryland, "The Kinesiology of Weight Lifting," Brown and Co.: 1959, p. 158.

Massey¹ further relates that one of the purposes of any program of athletics should be improvement of general physical efficiency. Tests of strength, endurance, power and agility give some indication of one's status with respect to overall muscular efficiency. There are many tests recommended for measuring muscular efficiency, but the items selected in this study generally reflect those included in many of the physical fitness tests of today. The pull-ups, push-ups, sit-ups, Burpee, and vertical jump, cover the major segments of the body, and in general, reflect muscular strength, power, endurance, and coordination.

D. K. Brace² found that the best single test was found to be the fifty-yard dash in terms of total achievement scores. The coefficient of correlation for the fifty-yard dash carrying a football with a series of unrelated tests was .79.

The following important points were studied in the Ten-Year Survey of Physical Fitness Tests at Yale University conducted by T. Ervin Blesh, and Alfred Scholz³ (Yale University), New Haven, Connecticut.

To indicate the strength of the upper-arms the following test items were used:

1. Pull-ups - palms forward was used on the horizontal bar and the body pulled up until the chin was even with or above the bar, no swaying.

¹Ibid.

²D. K. Brace, "Validity of Football Achievement Tests as Measures of Motor Learning and as a Partial Basis for the Selection of Players," Research Quarterly, 4:373, 1943.

³T. Ervin Blesh, and Alfred Scholz. (Yale University) "Ten Year Survey of Physical Fitness Tests at Yale University," New Haven, Conn. Ph. D. Dissertation.

2. Push-ups - starting position lying prone on the floor, hands directly under chest, no sagging of back was permitted.

To indicate abdominal and hip flexor strength the following test items were used:

1. Sit-ups - from a supine position, hands behind neck.
2. Vertical jump - distance between standing reach and jumping touch.
3. Fence vault - using the hands.
4. Broad jump - from a standing position.

The results of this study revealed that the strength of abdominal muscles, indicated by sit-ups, seems to be developed much more quickly than the arms.

Final observation of the data of this study indicates that an individual's strength, agility and coordination can be improved in a rather short period of time where concentrated effort is placed upon that particular factor and the exercises are at regular intervals.

With this in mind, many coaches set up a program of conditioning their football squads through regular exercising of those muscle groups most needed in the performance of the sport skills.

Experience has shown that regular play develops enough fitness to sustain the player in a friendly game, but where the objective is to win in competition, the chances are that the sport, by itself, will not develop the level of strength and endurance that competition demands.

Raymond Weiss¹ relates that coaches are learning that their teams cannot attain peak physical condition solely by practicing the sport.

¹Raymond A. Weiss, "Do Sports Produce Fitness?" Journal of Health - Physical Education - Recreation, March, 1961, p. 20.

The typical practice session lacks something that is needed to build and maintain strength and endurance. In some sports intensity of exercise is lacking. In other sports, the missing ingredient is frequency. Sports that lack both intensity and frequency are least capable of building fitness.

Intensity of exercise is associated with the building of strength and power and is regulated by the amount of resistance to be overcome. Football seems to be an activity in which strength is built by exercising and drilling for the specific purpose of developing power and strength.

Frequency of exercise is associated with endurance and is regulated by the length of the interval between actions and the number of actions. Many sports have relatively low frequencies for the individual performer. Football has more rugged and continuous exercise which is conducive to the building of endurance and power, although it still cannot approach the ultimate for development.

Sports are competitive in a way that cannot be matched by non-sport physical conditioning activities. In fact, participants are often so motivated by sports that they gladly submit to supplementary physical conditioning exercises to gain that extra bit of strength, power, or endurance that it takes to beat an opponent.

McCloy¹ demonstrated in his 1935 study that there were three common factors in what was called general motor capacity and motor ability,

¹C. H. McCloy, "The Measurement of General Motor Capacity and General Motor Ability," Supplement to Research Quarterly, 5:46-61, (March, 1934).

these being (1) strength, (2) velocity, (3) large muscle coordination, all of which can be tested by the previously mentioned fitness items.

In 1924 Collins and Howe¹ of Wellesly College critically examined various tests of physical fitness and concluded that there was no single test to measure fitness. The problem was to choose a variety of tests which would differentiate subjects in good condition from subjects in poor condition. These authors proposed a schedule of tests including the fifty-yard dash for speed, as well as other climbing, jumping, push-up and pull-up items. Endurance came forward from the Wellesley studies as the most desirable emphasis in physical fitness. The study demonstrated close relationships to circulatory - respiratory condition and to training of the individual.

Individuals vary in their capacity to benefit from exercise because of hereditary limiting factors and differences in body size, strength and structure.²

An overload is any exercise that exceeds in intensity or duration the demands regularly made on the organism. Muscles grow larger and stronger only when their pulling power is taxed to the maximum. Hence, sprint running, push-ups, and pull-ups are among the excellent muscle builders, and correspondingly tests of strength.³

The re-evaluation of training procedures, plus the need for

¹V. D. Collins and E. C. Howe, "The Measurement of Organic and Neuromuscular Fitness," American Physical Education Review, 29:563-71, (December, 1924).

²Arthur Steinhaus, "The Role of Exercise," Journal of Health - Physical Education - Recreation, June, 1943, p. 345.

³Ibid.

increased emphasis in those activities which build strength, agility, speed, endurance, power is necessary if they are to be used to gauge team success in football.

MacKensie¹ found that increase in fitness depends less on the nature of the sport than on the methods used by instructors in controlling students' activities. For example, it is possible to make football more productive than at present, by changing practice techniques.

Thus in high school football, as well as college, conditioning of the athlete begins weeks before he actually plays in a game. This pre-season conditioning program is carried on with practice on skills specific to football as well as calisthenics. Calisthenics have been considered important for they provide a controlled form of exercise whereby one can make certain that all parts of the body receive adequate attention. Football coaches believe that good conditioning not only builds the body, but also conditions against injury, provided all game skills are taught properly.

Thus the questions of what actually determines a successful season for a football team and the question of just how much physical conditioning carried on during the actual football season can be related to actual success through conference standing arise. Would it be possible through physical fitness tests, to actually predict a team's success or failure through a schedule?

Hartman² claimed it is possible to predict the most probable per

¹Donald MacKensie, "Effects of Various Physical Activities on the Physical Fitness of University Men," Research Quarterly, 1:125, 1935.

²G. W. Hartman, "What Constitutes A Good Football Team?" Research Quarterly, 1:83-94, 1930.

cent of victories of a team, if we know the physical size of a squad, if it engages in winter and spring practices, and the per cent of home games it schedules. He further states that a successful team is one that wins the major portion of its scheduled games.

DiGiovanna,¹ meanwhile, in his study of the relation of selected structural and functional measures to success in college athletics, related that, within its limits, his investigation tends to substantiate the common claims that factors of body structure, muscular strength, and explosive power are associated with athletic success.

Park² notes that athletic success for men depends on mere strength more than physical fitness with the strength index of tests being the measure to apply. Strength tests are, therefore, highly valid measures of all around skill in sports, or general athletic ability.

Park³ further relates that at least half the coach's success in athletics is dependent upon picking the right participants to train in the beginning. Although poorly constituted men become fair players in a sport, the champion athletes are rich in the constitutional factors supporting above-average motor ability.

Willgoose⁴ asserts that in many respects athletes are born, not made. From a kinesiology and body mechanics point of view, the man with

¹DiGiovanna, loc. cit., p. 199.

²Bessie L. Park, "The Relation Between Physical Fitness and Success in Physical Education Activities," Research Quarterly, (Supplement, 1935), p. 263.

³Ibid.

⁴Carl Willgoose, "Body Types and Physical Fitness," Research Quarterly, September 1956, p. 26.

broad shoulders and narrow hips is engineered for high functional motor ability. While the boy who is "pear-shaped" suggest one problem after another when motor ability is solved.

Physical fitness is a prime requisite for success in basketball. A team's fitness often makes the difference between a mediocre season and a good one, and is often the determining factor in games between closely matched rivals.

Vandenburgh¹ has associated a direct relationship between the time spent in the physical and psychological preparation of a team, and each member of that team, and the degree of team success. An organized plan for the development of physical and psychological fitness will help to insure this success. Although conditioning in the first months of turnouts is important, for lasting success a conditioning program must continue throughout the season.

DiGiovanna² found in his study that height had some bearing to success in football, while weight, speed, arm push, explosive power and strength were of greater importance to ultimate success. Other conclusions from his study were:

1. Within its limits this investigation tends to substantiate the common claim that factors of body structure, muscular strength, and explosive power are associated with athletic success.
2. It also reveals that these factors are of varying importance to performance ability in different sports as is indicated by the tendency for each sport to have its own unique pattern of success.

¹Bill Vandenburgh, "Physical and Psychological Conditioning for Competitive Basketball," Journal of Health - Physical Education - Recreation, November, 1956, p. 42.

²DiGiovanna, loc. cit., Research Quarterly, May, 1943, p. 212.

3. Conformity to a normal pattern in these factors is non-conducive to success in athletics.

Inasmuch as the results of this study reveal that, for the group studied, different sports tend to favor individuals who are uniquely patterned structurally and functionally; the study has educational significance in that it should help the physical director to guide individuals into activities in which they are more apt to find success and enjoyment. It should also afford the coach rough screening measures for his athletic squads.

The results in these tests substantiate the general conclusion of the study that factors of structure, strength, and power are associated with athletic success and that different sports and athletic groups tend to have unique patterns of success.

CHAPTER III

PROCEDURE

The participants in this study consisted of one hundred thirty-five high school football players from eight competing schools of the Tri-County Football Conference in Minnesota. The boys were mostly from the junior and senior classes with a few sophomores selected by coaches who felt the boys were of varsity caliber.

The test battery of six items was administered to the athletes during the fifth week of practice when they were judged to be in good playing condition. One practice period was taken with each team divided into groups so as to utilize their practice time more efficiently. Records of results were taken with assistance from the respective coaches.

The athletes were thoroughly acquainted with the test items before the testing took place, since most of the players had been previously exposed to similar items in the Minnesota Physical Efficiency test for a period of years in regular physical education classes. Little explanation of techniques was necessary.

Before the actual testing began a short warmup was given while necessary equipment and facilities were prepared well in advance of the testing period.

The sequence which was employed in the actual testing was as follows: a preliminary warmup, followed by the push-ups, vertical jump,

pull-ups, Burpee, fifty-yard dash, and the straddle pull-up. The participants worked without football pads in each event. Each squad finished one item before going on to the next test item, thus giving the subjects time to rest a little.

Test Procedure

Tests: (Numerically scored)

The Push-Up

Purpose. - To test the strength and endurance of the arm and shoulder girdle muscles.

Equipment. - Football practice field area.

Starting position. - The athlete assumes a front-leaning position with the weight supported by the hands and toes. The body is held straight, arms fully extended shoulder width apart, fingers pointed forward, legs fully extended with the ankles flexed so that the bottom surface of the toes is on the floor.

Movement. - The pupil, at a signal to start, flexes the arms and lowers the body until the chest touches but does not rest upon the ground. The pupil next pushes up to the starting position by fully extending the arms. These movements are repeated as many times as possible.

Scoring. - A score of one is recorded for each completion of the movement done correctly. No score is recorded if: (1) the pupil rests in any position, (2) the back bends, (3) or when hips move upwards or downwards before shoulders move.

The Vertical Jump

Purpose. - To test explosive power.

Equipment. - A smooth wall, a piece of chalk and a yardstick.

Starting position. - The subject stands, faces a wall, feet together, toes touching the wall, heels on floor, and with one hand he reaches as high as possible keeping the heels on the floor and also keeping hand and forearm against the wall, and makes a mark on the wall with a short piece of chalk.

Movement. - The subject then stands with his side to wall, swings both arms vigorously and makes a jump vertically into the air reaching up and touching the wall as high as possible for him to touch, and thus marks the wall with a second mark.

Scoring. - The distance between the two marks is the individual's record. The distance is measured and the better of two trials is recorded.

The Pull-Up

Purpose. - To test the strength and endurance of the muscles of the shoulder girdle and arms.

Equipment. - Overhead ladders, horizontal bar, chinning bar, or horizontal pipe high enough so that the performer may hang at full length without touching the floor.

Starting position. - The athlete assumes a hanging position on the bar with arms and legs fully extended, grasping the bar with an overhand grasp, (palms out).

Movement. - From the starting position the pupil should flex the arms, keep the knees straight and pull up until his chin is on or above the bar. He then lowers his body to a complete free hanging position.

Scoring. - One score is given each time the pupil raises his chin above

the bar in correct form. No score is given if: (1) the pupil kicks or swings, (2) he fails to raise his chin over the bar, (3) if arms are not straight when he lowers himself to a hanging position.

Squat Thrust - (Burpee)

Purpose. - To measure the agility of the football squad members.

Equipment. - No special equipment was needed.

Starting position. - The subject stands erect with a partner placing his hand on the head of the subject doing the test. The partner will hold his hand at that height until the test is completed, thus assuring a full standing position at the end of each cycle of movement.

The subject bends to the squatting position placing his hands on the floor, arms between the legs, on the count of two, the subject extends his legs straight backward, feet together. On the count of three, he resumes the position he was in at the count of one, and on the count of four, he resumes the starting position, upright with hands on hips. Each position must be taken definitely and deliberately.

Scoring. - The test is to determine the number of times a pupil can go through the complete cycle in thirty seconds. Failure to execute any of the positions properly results in no count for the complete cycle in which the failure occurred. Each cycle completed according to directions, is counted as one successful completion.

Fifty-yard Dash

Purpose. - To measure the speed of the players involved.

Equipment. - A stop-watch was used to time the event. The football field was used, from the goal line to the fifty-yard line for the distance.

CHAPTER IV

ANALYSIS OF DATA

The purpose of this study was to determine the relation of selected measures of physical and motor development to team success in high school football. Only those items were selected which distinctly related to the measurement of strength and endurance. This factor necessitates the elimination of established groups of tests which measure many other factors of physical fitness. It became necessary to select only those test items which specifically related to the measurement of organic strength and neuromuscular skills.

Statistical Measure

Since there were no established norms available for comparison of results of the various test items, the average mean (M) of the ungrouped data for each test was found, followed by the standard deviation (σ) and then the rank order of the T-scores of each team in each selected measure.

The mean is the arithmetical average. It is obtained by adding all of the scores and dividing by the number of individuals. After all the team averages were found, the mean for all items was found by dividing by the number of teams, (eight). The mean is based on every score in the distribution and since it is a mathematically derived value, it may be

used in practically all statistical procedures.¹ The formula used:

$$M = \frac{\sum X}{N}$$

The distribution around the mean usually is interpreted by the standard deviation, or S. D. (It is also designated by the Greek sigma σ). Since it is the most reliable of the measures of variability and for that reason it is employed widely in research. It is more easily defined as the measure which indicates the scatter or spread of the middle 68.26 per cent of the scores taken from the mean of the distribution. When measured off above and below the mean, the standard deviation will designate the limits of the two-thirds of the distribution.² The formula used in this case was that used for ungrouped data.

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

The standard deviation may be interpreted in the following manner: roughly two-thirds of the cases in any normal distribution will fall within the limits of one S. D. below and above the mean. If there is a large S. D., it is an indication of a large amount of variability. The S. D. is small if the total range is small and the cases cluster around the mean. The S. D. becomes larger as the range increases and the cases spread.

Using the raw score, the mean, and the standard deviation to find the T-score, the teams were then ranked in a T-score table. A final T-score average rank was found to make it easier to correlate the rank

¹M. Gladys Scott and Esther French, "Evaluation in Physical Education," St. Louis: C. V. Mosby Co., 1950, p. 310.

²Op. Cit.

of T-score to the conference rank at the end of the season. The formula used was:

$$\text{T-score} = 50 + \frac{10(x-M)}{\sigma \text{ or S.D.}}$$

T-score is the distance of a record from the mean of the records. If the record, or raw score is equal to the mean of the raw score, the T-score is equal to 50. If the performances are considered to fall within five standard deviations above and below the mean, then each standard deviation is equal to 10, and hence the T-score of 100 and 0 are five standard deviations above and below the mean respectively.¹ Where times are recorded as scores in the fifty-yard dash the following T-score formula was used.

$$\text{T-score} = 50 - \frac{10(x-M)}{\sigma \text{ or S.D.}}$$

Tables in the appendix show the standard deviation and T-score comparisons of each team to each item of measurement.

To show the degree of relationship between two or more series of data the process of correlation was used. The calculation of P (rho) was by the method of rank difference.

$$P = 1 - \frac{6\sum D^2}{N(N^2-1)}$$

P - being the rank correlation coefficient. The values of a coefficient of correlation vary from +1.0, a perfect positive relationship, to -1.0 a perfect negative relationship. These are pure numbers and do not indicate the value of a coefficient of correlation in terms of a percentage.

¹Charles McCloy and Dorothy Young, Tests and Measurements in Health and Physical Education, New York: Appleton-Century-Crafts Inc., 1954, pp. 423-425.

If there is a relationship between two series of data, one series of data may be predicted from the other. The accuracy of the prediction depends upon the size of the degree of relationship.¹

Although the interpretation of P depends upon the variables under consideration, the following is a fair guide: P of .00 to .20 = negligible relationship; P of .20 to .40 = slight relationship; P of .40 to .70 = substantial relationship, and P of .70 to 1.00 = high to very high relationship.²

The following results were obtained by a careful analysis of the data collected in this study.

Tests of Muscular Strength and Endurance.

Push-Ups

The writer found a wide range in the T-scores between the highest score for team H, 73.5, to the low of 38.1 for team C. The T-scores of teams F and G, 54.7 and 51.9 reflects the apparent muscular strengths of the two leading teams in the conference. Only team H joins F and G in a T-score average over 50. The remainder of the teams rank below 50 in T-score rank.

A definite correlation between the T-scores average in this particular test item to the conference rank is evidenced by the fact the teams F, G and H all rank high in the final conference standings. The bottom teams at the end of the season tend to rank low in the push-up T-score rank.

¹Ibid.

²Charles McCloy and Norma Young, *Tests and Measurements in Health and Physical Education*, Appleton-Century-Crafts, New York, 1954, p. 19.

The standard deviation in the push-up was the highest (4.3) exhibited by any of the six selected items, due to the wide range of team average scores. The range extended from 35 push-ups for the high to 19.8 push-ups for the lowest average.

Pull-ups (Overhand Grasp)

The T-score rank in this item found the teams very closely ranked with a high of 53.2 to a low of 47.8. Because of the grouping of the T-scores, little correlation can be found in this test item between the T-score average and the conference rank. The only consistent performance was exhibited by team H which ranked first in the T-score rank and third in the conference standings. Both F and G ranked low in this particular item.

The means of team averages ranged from a high of 9 to a low of 5.3 pull-ups. Due to the close grouping of the means, the standard deviation was 1.25.

Straddle Pull-ups

This item particularly deviated from the conference rank standings by revealing little correlation from T-score rank to the final standings. A wide range of T-scores was reflected by a high of 63.4 to a low of 26.4. The bottom teams, E, C, and D in the conference standings, ranked high in this particular item. The co-champions G and F ranked sixth and seventh in the T-score rating.

The average means ranged from a high score of 26.3 to a low of 9. The wide range resulted in a standard deviation of 4.4. Attitude of players, plus a failure of endurance among many participants probably

accounted for the extremely low scores for most of the teams.

Test of Speed

The Fifty-Yard Dash

All the teams, except for team E, ranked above 50 in this particular item. The T-scores for the other seven teams ranged from a high of 56.7 to a low of 51.7. Three teams tied with a 51.7 T-score, while two teams tied at 53.3. Team D ranked second high with a 54.2 T-score rating, and team A, a fourth place finisher in the conference, ranked first with a T-score of 56.7.

Since all the teams were closely grouped in their T-score rank, little correlation could be seen to their conference rank.

The standard deviation in the fifty-yard dash for all the teams was 1.2, emphasizing the close grouping of average mean scores. This particular item did not indicate any special correlation to eventual team standing.

Test of Agility

Squat Thrust or Burpee

This test item revealed a wide range of T-scores, from a high of 62.7 for team H and E to a low of 31 for team D. Conference Co-champions, teams G and F ranked fourth and seventh respectively in the T-score standings.

The standard deviation was .63 for all eight teams in the conference, indicating a very close grouping of mean scores. The T-score rank of this item indicated very little correlation to the conference standing.

Test of Explosiveness

Vertical Jump

The T-scores in the vertical jump ranged from a high of 58.5 to a low of 25.4. The standard deviation for the item was 1.3. Co-champions F and G ranked fifth and sixth in the T-score rank order, indicating little correlation between the score and the eventual conference rank.

Team H consistently ranked high in the overall T-score rank of all items, while team G ranked above 50 in four items and the other co-champion F, ranked above 50 in only three items. In the final T-score rank, teams H, G and E were the only teams to rank above 50, the other five teams A, F, D, C and B ranking from 49.4 to 45.6 in order.

An assumption could be made that those teams with extremely large players ranked low in speed and the pull-up measures, but high in arm strength and agility measures.

The top four teams in the conference standings tended to stay at or near the top in the T-score rank order, although Co-champion team F, itself, ranked low in T-score averages. There was no direct comparison of the rank of conference standings to the T-score average rank.

Table 1 shows that there is a significant difference in the average weight of players on each team. Co-champions G and F had a much higher team weight average than the rest of the conference members. The table also shows a significant difference in the average age level of the squad members of the respective teams. The top four teams all had an average age level of 16 or better, while the last four teams averaged only 15 or better.

Because this study only measured muscular strength, speed and power, age and weight factors were not correlated into the final results. The final conference standings may have been influenced significantly by such variables as playing experience, personality and emotional qualities of the players and capabilities of the coaching staffs.

Year	Age	Weight	Vertical Jump	Push Up	100 Yd Dash	Points
6	16.2	167	24	25.7	22.7	1
7	16.4	180	19.25	26.9	21.4	2
8	16	179.5	19	25	22	2
4	16.2	186.9	14.8	25.3	22.5	3
5	16.7	186.5	19.1	21	21.5	3
9	15.6	184	13.7	22	22	2
0	15.6	175.2	13.25	21.9	22.5	2
8	15.5	184	17.5	24.7	21	3
Conference Avg	15.9	181.3	16	24.9	21.3	5

TABLE 2

T-SCORE RANK OF STRENGTH, SPEED AND POWER

Team	Conf. Stand.	Vertical Jump		Push- Up		Burpee		Pull- Up		Fifty-Yard Dash		Straddle Pull-Up		T-SCORE AVERAGE	T-SCORE RANK
		Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score		
G	G	B	58.5	H	73.5	H	62.7	H	53.2	A	56.7	E	63.4	58.5	H
F	F	H	57.7	F	54.7	E	62.7	E	52.2	D	54.2	A	58.9	52.1	G
H	H	D	55.3	G	51.9	A	59.5	D	51.2	G	53.3	C	53.9	50.4	E
A	A	C	52.3	E	49.5	G	57.9	A	49.3	H	53.3	D	53.9	49.4	A
B	B	F	52.3	A	46.3	B	46.8	B	49.3	C	51.7	H	50.5	48.9	F
D	D	G	51.3	D	45.6	C	43.7	F	48.7	B	51.7	G	49.8	48.5	D
C	C	E	46.9	B	40.9	F	37.3	G	48.3	F	51.7	F	48.6	47.9	C
E	E	A	25.4	C	38.1	D	31.	C	47.8	E	27.5	B	26.4	45.6	B

TABLE 3

COMPARISON OF T-SCORE RANK AND CONFERENCE STANDING

Burpee				Pull-Up			
Team	Team Average No. in 30 Sec.	T- Score	Conf. Rank	Team	Team Average Number	T- Score	Conf. Rank
H	19.	62.7	3.	H	9.	53.2	3.
E	19.	62.7	7.5	E	8.3	52.2	7.5
A	18.8	59.5	4.	D	7.5	51.2	6.
G	18.7	57.9	1.5	A	6.3	49.3	4.
B	18.	46.8	5.	B	6.3	49.3	5.
C	17.8	43.7	7.5	F	5.9	48.7	1.5
F	17.4	37.3	1.5	G	5.6	48.3	1.5
D	17.	31.	6.	C	5.3	47.8	7.5

Fifty-Yard Dash				Straddle Pull-Up			
Team	Team Average Seconds	T- Score	Conf. Rank	Team	Team Average Number	T- Score	Conf. Rank
A	7.0	56.7	4.	E	26.3	63.4	7.5
D	7.3	54.2	6.	A	23.3	58.9	4.
G	7.4	53.3	1.5	C	21.1	53.9	7.5
H	7.4	53.3	3.	D	21.1	53.9	6.
C	7.6	51.7	7.5	H	19.6	50.5	3.
B	7.6	51.7	5.	G	19.3	49.8	1.5
F	7.6	51.7	1.5	F	18.8	48.6	1.5
E	10.5	27.5	7.5	B	9.	26.4	5.

TABLE 3 - Continued

Vertical Jump				Push-Up			
Team	Team Average Inches	T- Score	Conf. Rank	Team	Team Average Number	T- Score	Conf. Rank
B	19.1	58.5	5.	H	35.0	73.5	3.
H	19.	57.7	3.	F	26.9	54.7	1.5
D	18.7	55.3	6.	G	25.7	51.9	1.5
C	18.25	52.3	7.5	E	24.7	49.5	7.5
F	18.25	52.3	1.5	A	23.3	46.3	4.
G	18.	51.3	1.5	D	23.	45.6	6.
E	17.5	46.9	7.5	B	21.	40.9	5.
A	14.8	25.4	4.	C	19.8	38.1	7.5

TABLE 4

COMPARISON OF CONFERENCE STANDINGS WITH
TEST RANK AND AVERAGE T-SCORE RANK

Team	Conf. Rank	Test Rank	T-Score Average Rank
G	1.5	2	52.1
F	1.5	5	48.9
H	3.	1	58.5
A	4.	4	49.4
B	5.	8	45.6
D	6.	6	48.5
C	7.5	7	47.9
E	7.5	3	50.4

The rank correlation tables in Appendix B, reveal the fact that only the push-up, with a P of .71, and the fifty-yard dash with a P of .37, showed any significant relationship to the conference standings. The rank correlation coefficient of .71 for the push-up a high to very high relationship to predicting team success.

The rank correlation coefficient for the vertical jump .04, and for the Burpee .02, showed a very negligible relationship to the prediction of eventual success for the football team. This was brought about by the extremely low T-score rank of the two conference champions G and F, and a high rank for teams C, D and B.

The P (rho) for the pull-ups $-.18$ and straddle pull-ups $-.25$ revealed a perfect negative relationship according to the table. In the pull-ups, teams G and F ranked seventh and sixth respectively while the bottom teams in conference rank E and D, ranked second and third in the T-score order. Teams A and B tended to remain in the middle of both the conference and T-score ranks. The straddle pull-up showed a complete reversal of conference standings with co-champions G and F ranking fifth and sixth, while the bottom three teams E, C and D ranked first and third in T-score order.

The rank correlation coefficient $.45$ for the comparison of the conference standings to the T-score rank revealed the fact that the first three teams G, F and H ranked high in both. The last three teams D, C and E tended to rank in the bottom although E had a high T-score rank. The tendency remains, for the top teams to rate high while the bottom conference teams tend to remain low in the T-score rank order. A rho of $.45$ indicates the correlation to be somewhat significant.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The participants in this study were members of the varsity high school football teams comprising the eight-team Tri-County Conference in Minnesota. The total number of players tested were one hundred thirty-five, mostly senior high school students comprising grades ten, eleven and twelve.

The following factors were measured in this study and the test items selected to measure them: (1) muscular strength and endurance - push-ups, pull-ups, and straddle pull-ups, (2) speed - the fifty-yard dash, (3) agility - the squat thrust, (4) explosive power - the vertical jump.

The team averages and their means were found, the standard deviations were calculated, and the team T-scores were ranked. Finally the rank correlation coefficient was established by the rank difference method, comparing T-score rank to the final conference standings.

Conclusions

A high test rank indicates probability of a team finishing high in the conference standings. However, it cannot accurately predict the exact finish of a team.

Several reasons are apparent for the difference in ranks. Such

variables as playing experience, personality and emotional qualities, player attitudes at the time of testing, and capabilities of the coaching staffs influence athletic performance a great deal.

This type of study may afford a prediction of some success for those teams that are mainly composed of young, inexperienced players returning for another year of competition. The coach might be able to use the results to measure the team strengths and weaknesses and determine, for an ensuing year, plans for further development.

Recommendations

The results reveal many limitations in this type of study and it is recommended that expanded studies into the intelligence quotient of the players be included as well, or perhaps additional testing procedures before and at the close of the season. In addition, perhaps the coaches of the participating schools might be asked to rank their eleven best football players in order, and then this battery of tests be given to these boys as well as the remaining varsity players. The correlation between the two groups might be more significant in the prediction of the conference standings. Limitations again would arise, especially as to the amount of practice time each coach would allow to disrupt his regularly planned schedule.

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