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Explosive Muscular Power, Reaction Time, and Running Speed Within and Between College Athletes and Non-Athletes

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EXPLOSIVE MUSCULAR POWER, REACTION TIME, AND RUNNING SPEED WITHIN AND BETWEEN COLLEGE ATHLETES AND NON-ATHLETES

(TITLE)

BY

WILLIE CLYDE JACKSON

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CHAPTER I

INTRODUCTION

Most athletic activities involve the ability of the participants to react and move quickly. It is because of this basic fact that many coaches consider speed and reaction time as good indicators of athletic potential. These qualities are often difficult to determine accurately in an actual game situation and it is probably for this reason that there have been numerous laboratory studies concerning reaction time and speed of movement.

From these studies, there is a strong indication that there is no real significant relationship between the two. But, the majority of these studies have been concerned with reaction time and speed of limb movement rather than running speed.

There is also another basic component of motor performance that would appear to be essential in running and jumping, and that is explosive muscular power. There are numerous different composite factors operating together to produce an explosive effort, but it would seem likely that reaction and speed of movement are among these factors since there is an element of velocity and response time involved in a muscular contraction. Based on this concept

it would appear that there is some relationship between explosive muscular power, reaction time, and running speed.

I. THE PROBLEM

Statement of the Problem

The primary purpose of this investigation was to determine if there was any significant difference in explosive muscular power, reaction time and running speed within and between college athletes and non-athletes. In addition, the interrelationships between body weight, explosive muscular power, reaction time, and running speed were studied.

Basic Hypotheses

There is no difference in the explosive muscular power, reaction time, and running speed of college athletes as compared to college non-athletes.

There is no relationship between the explosive muscular power, reaction time, and running speed of college athletes and college non-athletes.

Limitations of Study

The athlete group was selected only from the varsity teams active during the spring of 1971.

The non-athlete group was limited to forty-eight volunteers from the physical education activity classes and the co-recreation program.

II. DEFINITION OF TERMS

For the purpose of this investigation, the following terms are defined:

Athlete--an individual who is currently an active member of an Eastern Illinois University varsity athletic team.

Explosive muscular power--the ability of the body to develop power relative to the weight of the individual himself, as measured by a vertical jump.

Non-athlete--an individual who is neither a current nor past member of an Eastern Illinois University varsity athletic team.

Reaction time--the time interval from the beginning of an audio stimulus to the removal of the rear foot from a footswitch.

Running speed--the time required to run a given distance. (i.e. 10 feet or 30 feet).

Vertical jump--a vertical leap into the air from a position with the legs flexed, thumbs hooked inside waistband, and an erect back.

CHAPTER II

REVIEW OF LITERATURE

Numerous studies have been conducted relating to the present investigation. After reviewing these studies, they were divided into four areas: I. Athletes versus Non-athletes, II. Movement and Reaction Time, III. Reaction-Movement Time and Athletic Success, IV. Explosive Power and Speed.

I. ATHLETES VERSUS NON-ATHLETES

Several studies comparing the reaction and movement times of athletes and non-athletes have indicated that athletes are faster movers and responders than non-athletes.

In a study by Younger,[1] 122 women athletes and non-athletes were tested on hand reaction time and speed of arm movement. It was found that women athletes were significantly faster than the women non-athletes in speed of arm movement and reaction time. In addition, it was found that within the athletic group, tennis players, swimmers, fencers and field hockey players did not differ

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[1] Lois Younger, "A Comparison of Reaction and Movement Times of Women Athletes and Non-athletes," Research Quarterly, 30:349, October, 1959.

significantly in reaction time.

Beise and Peaseley,[2] in a similar study of skilled and unskilled women in sport activities, reported that the skilled group showed significant differences from the unskilled group in reaction time of large muscle groups, speed of running and in speed when action required dexterity of moving the body. It was also interesting to note that within the skilled group different levels of speed were found to exist depending upon the sport in which the individual was proficient.

Wilkinson[3] also noted that there were differences in reaction time exhibited within the athletic groups. He found that wrestlers and baseball players showed greater speed of reactions than did football players, basketball players, and non-athletes.

It was also reported that athletes had faster reaction times than the non-athletes.

A study by Pierson,[4] dealing with fencers and non-fencers, reported that fencers were significantly

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[2] Dorothy Beise and Virginia Peaseley, "The Relation of Reaction Time, Speed, and Agility of Big Muscle Groups to Certain Sport Skills," Research Quarterly, 8:133, March, 1937.

[3] James J. Wilkinson, "A Study of Reaction-Time Measures To a Kinesthetic and a Visual Stimulus for Selected Groups of Athletes and Non-athletes" (unpublished Doctoral dissertation, Indiana University, 1958).

[4] William R. Pierson, "Comparison of Fencers and Non-fencers by Psychomotor, Space Perception and Anthropometric Measures," Research Quarterly, 27:90, May, 1956.

faster than non-fencers in those measures which involved movement of the arm. However, there was no difference between fencers and non-fencers in discriminatory or simple reaction time when it was measured by the finger-press method.

Olsen,[5] in his study of 300 athletes, intermediate athletes, and non-athletes concluded that athletes had faster simple reaction time, choice reaction time, and discriminatory reaction time than groups of intermediate and non-athletes.

Cooper,[6] also came to the conclusion that athletes in general tend to react quicker than non-athletes on reaction time and speed of free arm movement.

In a very similar study, Slater-Hammel[7] found that varsity athletes had significantly shorter over-all reaction time than physical education, music, and liberal arts majors in response to light and arm movement stimuli.

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[5] Einer A. Olsen, "Relationship Between Psychological Capacities and Success in College Athletics," Research Quarterly, 27:79, March, 1956.

[6] John H. Cooper, "An Investigation of the Relationship Between Reaction Time and Speed of Movement," (unpublished Doctoral dissertation, Indiana University, 1956).

[7] A.T. Slater-Hammel, "Comparisons of Reaction-Time Measures to a Visual Stimulus and Arm Movement," Research Quarterly, 26:470, December, 1955.

In other studies, Knapp[8] and Keller[9] reported athletes to have significantly faster reaction and quickness of movement times than non-athletes. Considine[10] also reported that athletes had faster finger reaction and reflex times than non-athletes.

It is clearly evidenced by the literature that athletes are faster and quicker than non-athletes in speed of limb movements and responses. But, within the athlete groups there were trends of variability in speed of movement and reaction time. By this, it is meant that there is no consistent agreement that one particular group was faster than another in the studies reviewed.

II. MOVEMENT AND REACTION TIME

It has been traditionally assumed that there is a high relationship between reaction time and movement time. In past years, this area has been investigated rather thoroughly.

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[8] Barbara N. Knapp, "Simple Reaction Times of Top-Class Sportsmen and Research Students," Research Quarterly, 26:470, December, 1961.

[9] Louis F. Keller, "The Relation of 'Quickness of Bodily Movement' to Success in Athletics," Research Quarterly, 13:146, May, 1942.

[10] William J. Considine, "Reflex and Reaction Times Within and Between Athletes and Non-athletes" (unpublished Masters thesis, Illinois State University, 1966).

In the study conducted by Westerlund and Tuttle[11] it was found that a high degree of relationship existed between speed in running seventy-five yards and reaction time (r=+.863) as demonstrated by twenty-two trackmen.

However, in a similar study, Henry and Trafton[12] found a low correlation (r=+.14) with reaction time and fifty yard dash times of twenty-five physical education majors.

This finding was in close agreement with that of Henry[13] in which he reported a low nonsignificant correlation of +.18 between individual reaction times and fifty yard sprint times of eighteen upper class university students.

Lotter[14], in his study of the interrelationships among reaction times and speed of movement in different limbs using a modified baseball throw and a football kick found quickness of reactions and movement distinctly different and unrelated abilities.

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[11] J.H. Westerlund and W.W. Tuttle, "Relationship Between Running Events in Track and Reaction Time," Research Quarterly, 2:95, October, 1931.

[12] Franklin M. Henry and Irving R. Trafton, "The Velocity Curve of Sprint Running With Some Observations of the Muscle Viscosity Factor," Research Quarterly, 22:409, December, 1951.

[13] Franklin M. Henry, "Influence of Reaction and Movement Times and Equivalence of Sensory Motivators of Faster Response," Research Quarterly, 23:43, March, 1952.

[14] Williard S. Lotter, "Interrelationships Among Reaction Times and Speeds of Movement in Different Limbs," Research Quarterly, 23:301, October, 1952.

Henry[15] found speed of reaction and movement time to be independent and unrelated. He substantiated this finding in later studies.[16, 17, 18, 19]

The study by Smith[20] also reported that correlations between reaction time and movement time (r=-.06 to r=+.23) were statistically nonsignificant. It was also reported that individual differences in ability to react and move quickly were almost entirely unrelated.

Hipple[21] investigated the racial differences in the influence of motivation on muscular tension, reaction time, and speed of movement. Among his conclusions he

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[15] Franklin M. Henry, "Force-Time Characteristics of the Sprint Start," Research Quarterly, 23:301, October, 1952.

[16] Franklin M. Henry, "Reaction Time-Movement Time Correlations," Perceptual and Motor Skills, 12:63, 1961.

[17] Franklin M. Henry, "Factoral Structure of Speed and Static Strength in a Lateral Arm Movement," Research Quarterly, 31:440, October, 1960.

[18] Franklin M. Henry, "Increased Response Latency for Complicated Movements and a 'Memory Drum' Theory of Neuromotor Reaction," Research Quarterly, 31:448, October, 1960.

[19] Franklin M. Henry, "Influence of Motor and Sensory Sets of Reaction Latency and Speed of Discrete Movements," Research Quarterly, 31:459, October, 1960.

[20] Leon E. Smith, "Reaction Time and Movement Time in Four Large Muscle Movements," Research Quarterly, 32:88, March, 1961.

[21] Joseph E. Hipple, "Racial Differences in the Influence of Motivation on Muscular Tension, Reaction Time, and Speed of Movement," Research Quarterly, 25:297, October, 1954.

reported low correlations for reaction time and speed of movement time with the Negro (r=+.23) and white (r=+.38) groups.

Pierson[22] reported that there was no demonstrated relationship between speed of arm movement and reaction time among fencers and non-fencers.

These findings were further substantiated by Fairclough[23], Howell[24], Cooper[25], and Phillips[26]. Both Howell and Fairclough reported negative correlations (r=-.382 and r=-.278, respectively) between reaction and movement time. But Cooper also reported that participation in athletics had no effect on the relationship between reaction time and various movement times.

Using different age groups, Mendryk[27] also found

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[22] Pierson, loc. cit.

[23] Richard H. Fairclough, "Transfer of Motivated Improvement in Speed of Reaction and Movement," Research Quarterly, 23:20, March, 1951.

[24] Maxwell L. Howell, "Influence of Emotional Tension on Speed of Reaction and Movement," Research Quarterly, 24:22, March, 1953.

[25] Cooper, loc. cit.

[26] William H. Phillips, "Influence of Warm-Up Exercises on Speed of Movement and Reaction Latency," Research Quarterly, 34:370, October, 1963.

[27] Stephen Mendryk, "Reaction Time, Movement Time, and Task Specificity Relationships at Ages 12, 22, and 48 Years," Research Quarterly, 31:2:156, May, 1960.

reaction time and speed of movement unrelated with no influence by age. The correlations were low (r=+.127 and r=+.138) and nonsignificant.

In a similar study, Hodgkins[28] found that in the majority of age groups studied of 930 men, women, and children ranging in age from six to eighty-four, there was no relationship between speed of reaction and speed of movement.

Contrary to the findings of Mendryk and Hodgkins, Pierson[29] reported that there was a statistically significant correlation (r=+.56) between reaction and movement times of males between the ages of eight and eighty-three.

Younger[30] also reported a significant, but low correlation between reaction and movement time. This was found to be true among both athletes and non-athletes.

It was further agreed by Pierson and Rasch[31] that a low but statistically significant relationship existed between reaction and movement time with both of these

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[28] Jean Hodgkins, "Reaction Time and Speed of Movement in Males and Females of Various Ages," Research Quarterly, 34:335, October, 1963.

[29] William R. Pierson, "The Relationship of Movement Time and Reaction Time from Childhood to Senility," Research Quarterly, 30:227-231, 1959.

[30] Younger, loc. cit.

[31] William R. Pierson and Philip Rasch, "Generality Of a Speed Factor in Simple Reaction and Movement Time," Perceptual and Motor Skills, 11:123, 1960.

qualities conditioned by a general factor.

Kerr[32] also supported the previous findings when he reported that knee reaction and speed of movement times on two different occasions correlated (r=.538 and r=.629, respectively).

Although there are conflicting findings concerning the relationship between reaction and movement time the writer feels that the majority of studies reviewed indicate that there is no significant relationship between reaction and movement time. Furthermore, the two qualities seem to be totally independent of each other.

III. REACTION-MOVEMENT TIME AND ATHLETIC SUCCESS

There have been many correlations reported in the literature between general athletic performance and speed of movement.

Keller[33] reported a positive relationship between the ability to move the body quickly and success in athletics as demonstrated by 755 college and high school athletes and non-athletes. It was also found that team-sport athletes (baseball, football, track) were quicker than individual sport athletes (wrestlers, gymnasts, and swimmers). Therefore it was reported that the requirements in quickness of

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[32] Barry A. Kerr, "Relationship Between Speed of Reaction and Movement in a Knee Extension Movement," Research Quarterly, 37:55, March, 1966.

[33] Keller, loc. cit.

bodily movement are not the same for all sports.

Steitz[34] also attempted to determine the relationship of reaction time and various other selected factors to success in various sports. He tested 196 Springfield College male students for reaction time, performance time, speed, Sargent Jump and physical fitness. These measurements were compared with the ratings given to each subject by his coach. The findings indicated that reaction time does appear to be an important factor in the achievement of success in specific sports.

In another study, Thompson[35] attempted to determine the effect of reaction time upon volleyball playing ability. Twenty-four college women were placed into one of two groups--skilled or unskilled--as determined by their participation. The difference in skill of the two groups was verified by means of a wall-volley test and by judges' ratings. The subjects were tested for simple reaction and total body reaction time. A t ratio was computed comparing the difference between the two groups. There was no significance found for simple reaction time, but a significance at the .01 level of confidence was found

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[34] Edward S. Steitz, "The Relationship of Reaction Time, Speed, Sargent Jump, Physical Fitness, and Other Variables to Success in Specific Sports," (unpublished Doctoral dissertation, Springfield College, 1963).

[35] Carol A. Thompson, "A Study of Various Reaction Times and Movement Times as Factors of Volleyball Playing Ability," (unpublished Master's thesis, University of Illinois, 1962).

for total body reaction time.

Thus, it was then concluded that the skilled players were not superior to the unskilled players in simple reaction time but that total body reaction time is a factor in volleyball playing ability.

Spyke[36] conducted a study with 102 high school wrestlers to determine if there was any relationship between reaction time and success in wrestling. Wrestling success was computed for each subject by assigning two points for each wrestling match won, one point for each match tied and no points for each match lost and then dividing the total points earned by the number of matches wrestled. Each subject was given a finger reaction time test. These scores were correlated with wrestling success and found to be significantly related.

Few studies have been conducted dealing specifically with reaction-movement time and success in athletics. But from the studies reviewed, there appears to be considerable evidence indicating that reaction time and movement time are related to athletic success.

IV. EXPLOSIVE POWER AND SPEED

Several studies have been conducted concerning explosive power, but very few with both explosive power

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[36] Herbert A. Spyke, "The Relationship of Reaction Time to Success in High School Wrestling," (unpublished Master's thesis, Eastern Illinois University, 1968).

and speed.

Harris[37] conducted one of the earliest studies in which she attempted to determine the relationship between force and velocity in athletic events of various kinds. One hundred and sixty-three high school girls were given a battery of tests. Among these was a Sargent Jump and forty yard dash. The correlation reported between these two tests was r=.5942.

In a later study by Carpenter[38], he found a correlation of r=.5267 when the Sargent Jump was correlated with track and field events which included a sixty-yard dash, six-pound shotput, and standing broad jump.

Similar findings were reported by Hutto[39] when he used zero-order correlations of selected events with athletic power, using factor scores. He reported a correlation of r=.6808.

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[37] Jane E. Harris, "The Differential Measurement of Force and Velocity for Junior High School Girls," Research Quarterly, 8:114, December, 1937.

[38] Aileen Carpenter, "Strength, Power, and Feminity as Factors Influencing the Athletic Performances of College Women," Research Quarterly, 9:120, May, 1938.

[39] Louis E. Hutto, "Measurement of the Velocity Factor and Athletic Power in High School Boys," Research Quarterly, 9:109, October, 1938.

A more recent study by Gray and others[40] reported that leg speed as measured by the bicycle ergometer and leg power as measured by the vertical jump correlated .470, which was significant at the .001 level. The subjects for this study were sixty-two medically fit male college students.

Based on the studies reviewed, there appears to be some relationship between explosive power and speed although only the study by Gray et al. dealt specifically with the two qualities.

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[40] R. K. Gray, K. B. Start, and A. Walsh, "Relationship Between Leg Speed and Leg Power," Research Quarterly, 33:395, October, 1962.

CHAPTER III

PROCEDURES

In order to provide an accurate account of the methodology used in the collection of data, a description of the subjects, test equipment, and procedures employed are presented in this chapter.

I. SUBJECTS

The subjects for this study were 142 male undergraduate and graduate students at Eastern Illinois University. Each subject was placed into one of two major groups--athlete or non-athlete--as defined in the definition of terms. The non-athlete group was composed of forty-eight volunteers from the physical education activity classes and the co-recreation program. The mean heights and weights for this group were 178.9 centimeters with a range of 166 to 189 centimeters and 76.0 kilograms with a range of 56.8 to 103.4 kilograms respectively.

Subjects in the athlete group were all members of the following varsity teams: spring football (35), tennis (10), gymnastics (6), baseball (16), golf (5), and track and field (22). The mean height for the athlete group was 179.9 centimeters ranging from 60.1 to 121.8

kilograms.

The athlete group was also composed of many national, conference, and school champions and record holders in track and field, gymnastics, football, baseball, tennis, and golf.

Each subject was contacted through written or oral communication and told when and where to report for testing.

II. TESTS AND EQUIPMENT

There were two basic tests administered in this study. They consisted of a vertical jump and a reaction-running speed test. The tests were administered in the Physical Education Research Laboratory and the indoor track at Eastern Illinois University.

Vertical Jump

The first test administered was a vertical jump test (VI), from which two different measurements were recorded. They consisted of the height jumped and the time elasped while in the air (TIA). The equipment used in obtaining this were a modified version of the apparatus used by Henry[1] and Fritz[2], and a Dekan Automatic Performance

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[1] Franklin Henry, "The Practice and Fatigue Effects in the Sargent Jump", Research Quarterly, May 1942, p. 18.

[2] William E. Fritz, "Effects of a Trampoline Training Program on Selected Items of Motor Fitness", (unpublished Master's thesis, South Dakota State University, 1965.

Analyzer with one switchmat.

The apparatus used to measure the vertical jump was constructed in the Physical Education Research Laboratory (see Figure 1). It consisted of a hockey helmet with a non-stretch braided nylon cord attached to the top of the helmet and extending vertically to a three pulley arrangement which allowed the cord to pass horizontally to an automatic take-up reel. The automatic take-up reel (garage trouble light cord reel) in turn placed constant tension on the cord. A five foot wooden dowel rod marked in 1/16 inch units was paralled with and one-half inch below the nylon cord. The rod was one-half inch in diameter encompassed by a moveable rubber indicator and a metal slide. The slide was attached to the cord and moved back and forth with the cord on each jump. The height of the jump was read from where the rubber indicator had been moved on the calibrated rod.

The Dekan Automatic Performance Analyzer was used to determine the amount of time spent in the air while executing the jump. The Dekan time clock was set up to start on break-contact and stop on make-contact with the switchmat.

Reaction-Running Speed

The reaction-running speed test was the second test administered. The purpose of this test was to determine: 1)reaction time, (RT) 2)running speed at ten feet (RS_{10}), and 3) running speed at thirty feet (RS_{30}).

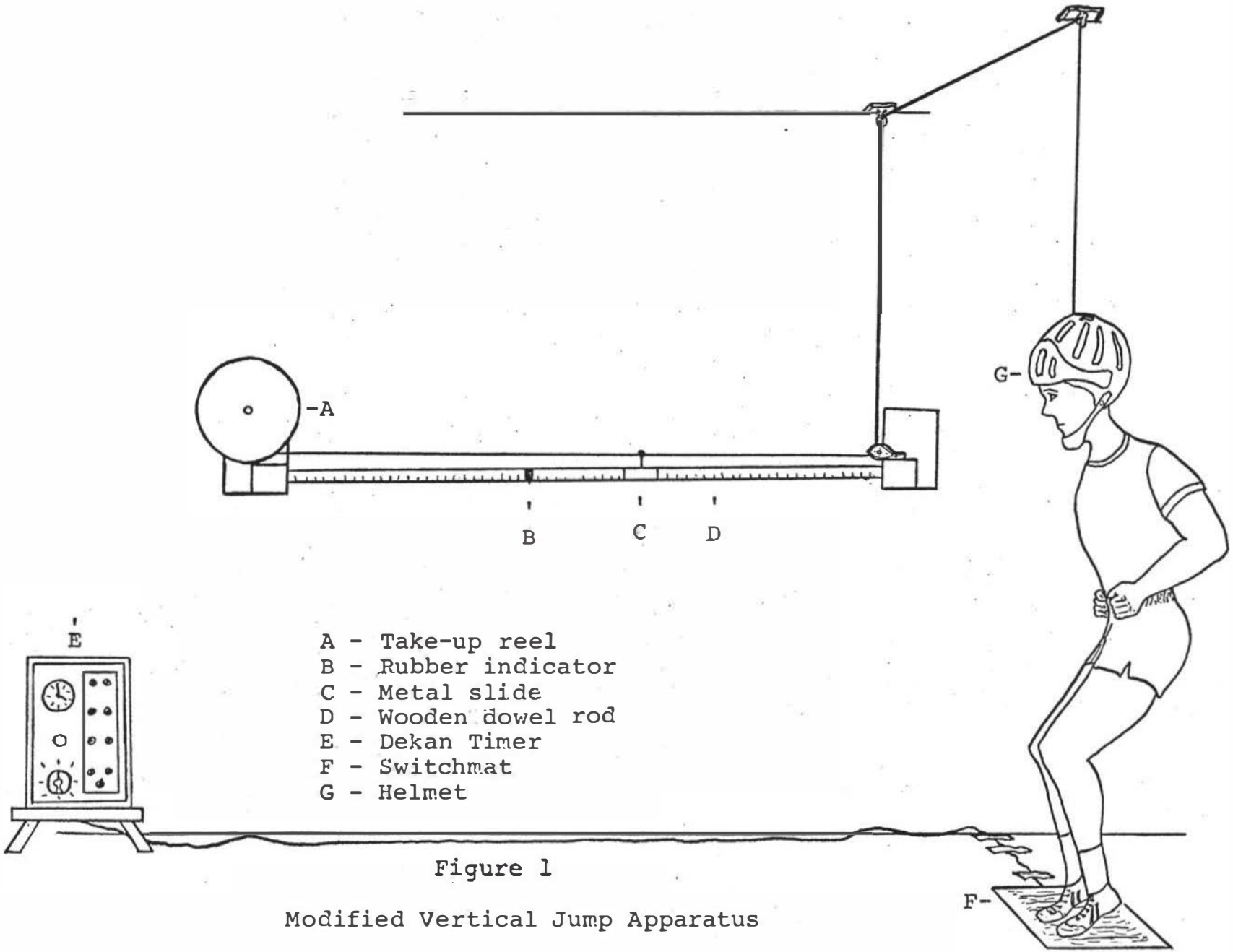

Figure 1

Modified Vertical Jump Apparatus

The equipment used was a two-piece electronic stopwatch made by Daktronics of Brookings, South Dakota. This electronic stopwatch gave a direct read and print-out. It was capable of timing to the nearest 0.00001 and split timing. The timer was started by pressing a button that initiated a low intensity sound. The other equipment consisted of a footswitch attached to a track starting block, two highly sensitive photoelectric cells mounted on tripods, and two light beam sources mounted atop two platforms three feet above the running surface. The photoelectric cells and light sources were placed ten and thirty feet from the starting line (see Figure 2).

III. TESTING AND PROCEDURES

Upon entering the research laboratory, each subject was given a data card (Appendix A) on which to fill in his name, date of birth, year in school, and athletic participation.

After completing this information, each subject's weight and height measurements were taken and recorded to the nearest quarter-pound and centimeter respectively on his data card.

Vertical Jump--Explosive Muscular Power

Each subject was instructed to put on the helmet and adjust the chin strap. He was then told to stand on the make-break switchmat with his toes placed on appropriate markings. By doing this, the subject was positioned

A - Electronic stopwatch
B - Electronic printer
C - Footswitch on back starting block
D - Starting line
E - Running lane
F - Photoelectric cell
G - Light source

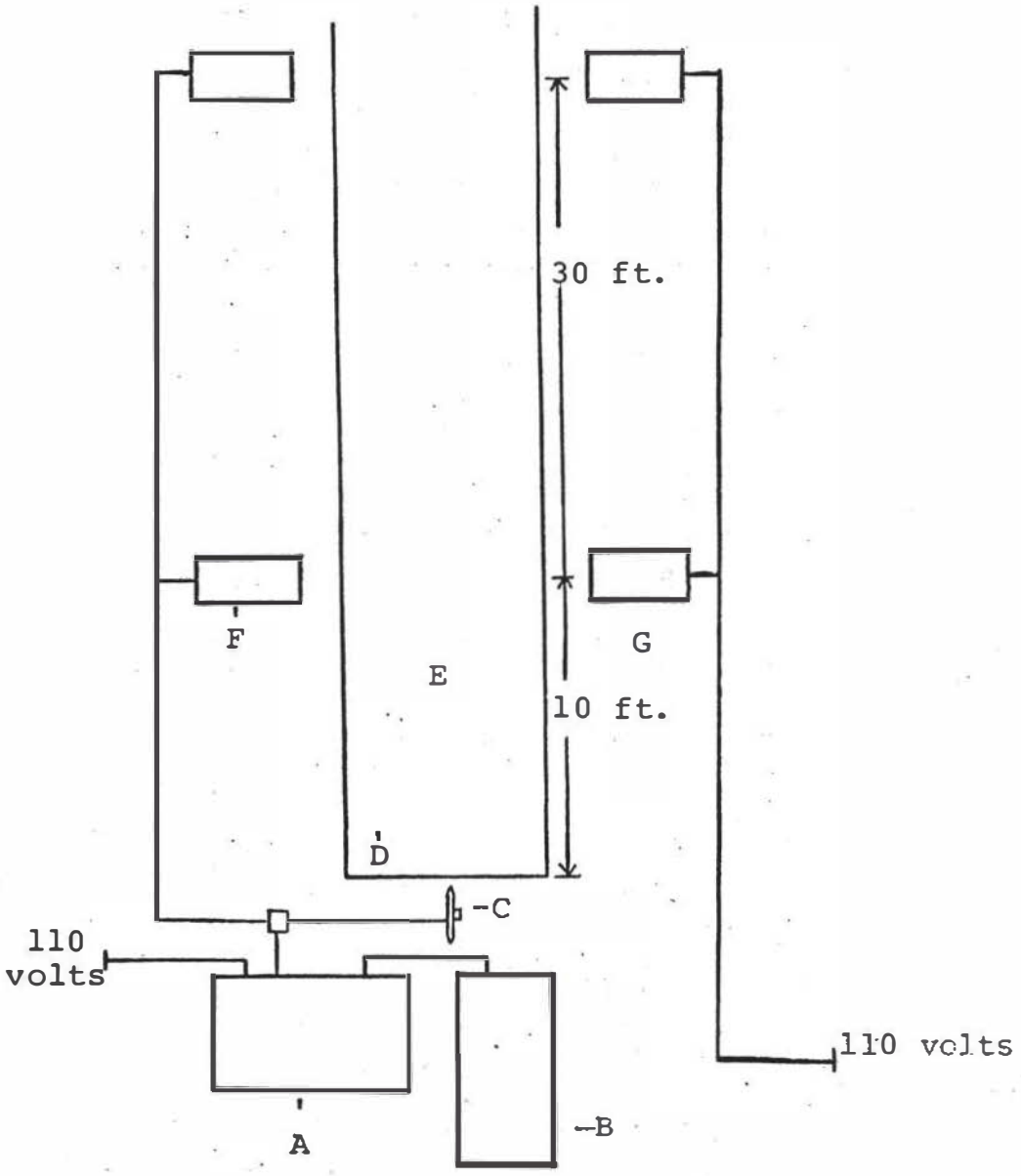

Figure 2

Reaction-Running Speed Diagram

directly under the first pulley. In order to record standing height the subject was instructed to stand erect on the balls of his feet and then return to a flat footed position. The procedure eliminated the slack that may have been in the cord by placing tension on it.

The subject was then instructed to: 1) hook thumbs inside waistband of his pants, 2) crouch, 3) keep back straight, and 4) jump upward at which time the tester determined approximately how high the subject was capable of jumping and placed the indicator at that point. The subject was given three additional trials. During each of these jumps, the indicator was adjusted as needed to record an accurate measurement. The amount of time in the air was also recorded for each jump to the nearest .01 second. The best jump and corresponding time was recorded.

After the vertical jump test, the subject was given his data card and directed to the indoor track.

Reaction-Running Speed

At the testing site--a six lane rubberized asphalt indoor track--for reaction-running speed, the tester explained the procedure to each subject. Subjects were instructed to stand in the designated lane, which was forty-two inches wide, behind the starting line and assume a stand-up starting position with the rear foot on the footswitch. Each subject was then told that he would hear the commands "Ready", "Set", and then the sound stimulus. This was done once to acquaint the subject with the starting

procedure. Each subject was told to run as fast as he could to a point beyond the second light, thirty feet away. Three trials were given to each subject and a reaction time, (RT) RS_{10}, and RS_{30} time recorded automatically with the release of the foot-switch and the interruption of the constant light beam at ten and thirty feet. Each time was recorded to the nearest .0001 second.

CHAPTER IV

ANALYSIS OF DATA

One hundred and forty-two male college athletes and non-athletes were tested for explosive muscular power reaction time, and running speed to determine if there was any significant difference in performance within and between the two groups.

Also investigated, although not of primary concern, were the interrelationships between body weight, explosive muscular power, reaction time, and running speed.

I. STATISTICAL TREATMENT

All the raw data collected in the investigation was punched into IBM cards and fed through an IBM 360 Model 2050H computer at the Computer Services Center, Eastern Illinois University. The computer was programmed to run two statistical programs--a *t* ratio and a correlation matrix. The .05 level of confidence was selected to denote statistically significant differences or relationships.

t Ratio

The *t* ratio, a program developed by DiPietro and

LeDuc,[1] was used to determine the significance of the difference between the mean vertical jump (VJ), reaction time (RT), running speed at ten feet (RS_{10}), and running speed at thirty feet (RS_{30}) performances of the non-athlete and athletes.

Correlation Matrix

A correlation matrix was used to determine the interrelationships between body weight, explosive muscular power, reaction time, and running speed for the athlete and non-athlete groups.

II. PRESENTATION OF FINDINGS

The following findings are presented under two basic headings--comparisons and interrelationships.

Comparisons

Numerous comparisons were made within and between the various groups. The findings for these group comparisons are presented according to their significance in the investigation.

Athletes vs non-athletes. The comparisons of primary concern were those between the athlete and non-athlete groups. These findings are presented in Table 1.

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[1] A. J. DiPietro and R. J. LeDuc, "Student T-Scores For Means Between Groups", (Charleston: Eastern Illinois University, May, 1964).

Table 1

Comparisons Between the Athlete and Non-athlete Groups

Variables	Athletes (94)		Non-athletes (48)			
	Mean	S.D.	Mean	S.D.	t	p
Wt. (Kg.)	79.75	13.72	75.96	12.09	1.61	.20
VJ (in.)	17.12	3.04	16.84	3.19	.495	--
T.I.A. (sec.)	.50	.05	.48	.06	1.75	.10
RT (sec.)	.3955	.1110	.4121	.1129	.832	--
RS_{10} (sec.)	1.1705	.1094	1.2414	.1117	3.60	.001*
RS_{30} (sec.)	2.2064	.1388	2.2957	.1500	3.50	.001*

*Denotes significance in the investigation

It is quite evident from the table that the athletes performed better than the non-athletes on all variables. However, only two of these were significant in the investigation. Both of these--RS_{10} and RS_{30}--were significant at the .001 level of confidence.

Football vs other athletic groups. Table 2 reveals that on the vertical jump (VJ) and time in the air (TIA) scores between the football and golf groups, the football group demonstrated better performances. They also appear to be faster reactors than the golf, track and field, and baseball groups. However, none were significant. Concerning speed, the football group tended to be the slowest movers. It should also be noted that the football group was significantly heavier in body weight than all other athletic groups.

Baseball vs other athletic groups. It is revealed in Table 3 that the baseball group ran ten feet faster than the other groups with the exception of the gymnastic group. They ran significantly faster than the track and field, and football groups. Similar findings were revealed for speed at thirty feet with significant scores only between the football and baseball groups. Nevertheless, the baseball group demonstrated the slowest reaction times.

Golf vs other athletic groups. There were no significant differences of performance for TIA, RT, and RS_{30} demonstrated between golf and the other groups. (See Table 4). It can be noted, however, that the golf group demonstrated the lowest VJ and TIA scores. In reaction

Table 2

Comparisons Between Football and Other Athletic Groups

Variable	FB(35)	BB(16)	GO(5)	TEN(10)	T&F(22)	GYM(6)
WT (kg)						
Mean	90.9	78.0	77.3	67.0	729	67.8
t	-	3.95[a]	2.38[d]	6.09[a]	5.54[a]	4.64[a]
VJ (in)						
Mean	16.78	16.94	15.30	18.25	16.98	19.71
t	-	.185	1.03	1.44	.212	2.16[d]
TIA (sec)						
Mean	.49	.50	.48	.53	.51	.53
t	-	.511	.277	2.09[d]	1.25	1.87
RT (sec)						
Mean	.3949	.4220	.4016	.2995	.4200	.3928
t	-	.830	.137	2.62[c]	.841	.059
RS_{10} (sec)						
Mean	1.2029	1.1230	1.1574	1.1264	1.1979	1.0913
t	-	2.54[c]	.833	1.87	.158	2.16[d]
RS_{30} (sec)						
Mean	2.2600	2.1544	2.1975	2.1288	2.2186	2.1250
t	-	2.55[c]	.856	2.53[c]	1.03	1.96

[a]Significant at the .001 level.
[b]Significant at the .01 level.
[c]Significant at the .02 level.
[d]Significant at the .05 level.

Table 3

Comparisons Between Baseball and Other Athletic Groups

Variable	BB(16)	T&F(22)	GYM(6)	TEN(10)	FB(35)	GO(5)
WT (kg)						
Mean	78.0	72.9	67.8	67.0	90.9	77.3
t	-	1.48	2.95[b]	3.78[a]	3.95[a]	.141
VJ (in)						
Mean	16.94	16.98	19.71	18.25	16.78	15.30
t	-	.036	2.47[d]	1.70	.185	1.55
TIA (sec)						
Mean	.50	.51	.53	.53	.49	.48
t	-	.711	1.96	2.14[d]	.511	.843
RT (sec)						
Mean	.4220	.4200	.3928	.2995	.3949	.4016
t	-	.049	.559	2.72[c]	.830	.331
Mean RS_{10} (sec)	1.1230	1.1979	1.0913	1.1264	1.2029	1.1574
t	-	2.36[d]	.861	.107	2.54[c]	1.01
Mean RS_{30} (sec)	2.1544	2.2186	2.1250	2.1288	2.2600	2.1975
t	-	1.68	.582	.749	2.55[c]	.910

[a]Significant at the .001 level.
[b]Significant at the .01 level.
[c]Significant at the .02 level.
[d]Significant at the .05 level.

Table 4

Comparisons Between Golf and Other Athletic Groups

Variable	GO	BB	FB	T&F	TEN	GYM
WT (kg)						
Mean	77.3	78.0	90.9	72.9	67.0	67.8
t	-	.141	2.38[d]	.751	.285	1.82
VJ (in)						
Mean	15.30	16.94	16.78	16.98	18.25	19.71
t	-	1.55	1.03[d]	.922	3.62[b]	3.07[c]
TIA (sec)						
Mean	.48	.50	.49	.51	.53	.53
t	-	.843	.277	.941	2.11	1.78
RT (sec)						
Mean	.4016	.4220	.3949	.4200	.2995	.3928
t	-	.331	.137	.307	1.81	.159
RS_{10} (sec)						
Mean	1.1574	1.1230	1.2029	1.1979	1.1264	1.0913
t	-	1.01	.833	.750	.616	1.14
RS_{30} (sec)						
Mean	2.1975	2.1544	2.2600	2.2186	2.1288	2.1250
t	-	.910	.856	.318	1.22	.830

[a]Significant at the .001 level.
[b]Significant at the .01 level.
[c]Significant at the .02 level.
[d]Significant at the .05 level.

time, the golf group showed better performances than the track and field, and football groups.

Gymnastics vs other athletic groups. Table 5 reveals that the gymnastic group demonstrated better performances on the vertical jump than the other groups with three of the comparisons being significant. On the contrary there was no significant difference demonstrated for TIA, although the gymnastic group remained in the air longer than the other groups. As for running speed, the gymnastic group appeared to be faster than all the other groups on both RS_{10} and RS_{30}. They were significantly faster than the football group for RS_{10}. Reaction time scores indicated that the gymnastic group responded faster than all groups with the exception of tennis. Yet, none of the comparisons were statistically significant.

Tennis and other athletic groups. It is evident in Table 6 that the tennis group had the fastest reaction times. They were significantly faster than the football, track and field, and baseball groups. Furthermore, they exhibited better vertical jump scores than all groups except the gymnastic group, with a significant difference between themselves and the golf group. It should, also, be noted that the tennis group was lightest in weight. In the matter of speed this group was faster on RS_{10} than most of the groups. At RS_{30}, they were significantly faster than the football group and faster than all the other groups except gymnastics.

Table 5

Comparisons Between Gymnastics and Other Athletic Groups

Variable	GYM	FB	BB	GO	TEN	T&F
WT (kg)						
Mean	67.8	90.9	78.0	77.3	67.0	72.9
t	-	4.64[a]	2.95[a]	1.82[a]	.205	1.00
VJ (in)						
Mean	19.71	16.78	16.94	15.30	18.25	16.98
t	-	2.16[d]	2.47[d]	3.07[c]	1.40	1.58
TIA (sec)						
Mean	.3928	.3949	.4220	.4016	.2995	.4200
t	-	.059	.559	.159	2.09	.525
RT (sec)						
Mean	.53	.49	.50	.48	.53	.51
t	-	1.87	1.96	1.78	.263	.963
RS_{10} (sec)						
Mean	1.0913	1.2029	2.1230	1.1573	1.1264	1.1979
t	-	2.16[d]	.107	1.14	.667	2.04
RS_{30} (sec)						
Mean	2.1250	2.2600	2.1544	2.1975	2.1288	2.2186
t	-	1.96	1.68	.830	.062	1.45

[a]Significant at the .001 level.
[b]Significant at the .01 level.
[c]Significant at the .02 level.
[d]Significant at the .05 level.

Table 6

Comparisons Between Tennis and Other Athletic Groups

Variable	TEN	GYM	FB	BB	GO	T&F
WT (kg)						
Mean	67.0	67.8	90.4	78.0	77.3	72.9
t	-	.205	6.09[a]	3.78[a]	.285	1.46
VJ (in)						
Mean	18.25	19.71	16.78	16.94	15.30	16.98
t	-	1.40	1.44	1.70	3.62[b]	.986
TIA (sec)						
Mean	.53	.53	.49	.50	.48	.51
t	-	.263	2.09[d]	2.14[d]	2.11	.944
RT (sec)						
Mean	.2995	.3928	.3949	.4220	.4016	.4200
t	-	2.09	2.62[c]	2.72[c]	1.81	2.77[b]
RS_{10} (sec)						
Mean	1.1264	1.0913	1.2029	1.1230	1.1574	1.1979
t	-	.667	1.87	.107	.616	1.71
RS_{30} (sec)						
Mean	2.1288	2.1250	2.2600	2.1544	2.1975	2.2186
t	-	.062	2.53[c]	.749	1.22	1.90

[a]Significant at the .001 level.
[b]Significant at the .01 level.
[c]Significant at the .02 level.
[d]Significant at the .05 level.

Track and field vs other athletic groups. Table 7 reveals that the track and field group did not perform significantly better than any group on the variables tested. But there, were better performances than other groups on some of the variables as evidenced in the table.

Interrelationships

A correlation matrix was computed for both the athlete and non-athlete groups between all the variables. The interrelationships obtained for both groups are presented below.

Athletes. Table 8 reveals the results of the interrelationships of WT, VJ, TIA, RT, RS_{10}, and RS_{30} scores. There was a very high relationship as would be expected, between TIA and VJ which means that the higher the athlete jumped the longer he remained in the air. The relationships between RT-RS_{10} and RT-RS_{30} were both significant and rather high (r=+.535 and r=+.550, respectively). Vertical jump and running speed also yield some significant, but inverse relationships. In other words, the athlete that jumped higher also ran faster.

It is clearly evidenced from the table that all the relationships within the athlete group were significant.

Non-athletes. Table 9 reveals the relationships for the non-athlete group. A significant relationship was found between VJ and TIA. There was also a significant and positive relationship between RT and RS_{10}, but there was a very low and nonsignificant relationship between RT

Table 7

Comparisons Between Track and Field and Other Athletic Groups

Variable	T&F	BB	TEN	GO	FB	GYM
WT (kg)						
Mean	72.9	78.0	67.0	77.3	90.9	67.8
t	-	1.48	1.46	.751	5.54[a]	1.00
VJ (in)						
Mean	16.98	16.94	18.25	15.30	16.78	19.71
t	-	.036	.986	.922	.212	1.58
TIA (sec)						
Mean	.51	.50	.53	.48	.49	.53
t	-	.711	.949	.941	1.25	.963
RS_{10} (sec)						
Mean	1.1979	1.1230	1.1264	1.1574	1.2029	1.0913
t	-	2.36[d]	1.71	.750	.158	2.04
Mean RT (sec)	.4200	.4220	2.995	.4016	.3949	.3928
t	-	.049	2.77[b]	.307	.841	.525
RS_{30} (sec)						
Mean	2.2186	2.1544	2.1288	2.1975	2.2600	2.1250
t	-	1.68	1.90	.318	1.02	1.45

[a]Significant at the .001 level.
[b]Significant at the .01 level.
[c]Significant at the .02 level.
[d]Significant at the .05 level.

Table 8

Interrelationships of Athlete Group

Variable	WT	VJ	TIA	RT	RS_{10}	RS_{30}
WT	—					
VJ	-.280[a]	—				
TIA	-.312[a]	.816[a]	—			
RT	.237[b]	-.311[a]	-.239[b]	—		
RS_{10}	.413[a]	-.497[a]	-.473[a]	.535[a]	—	
RS_{30}	.482[a]	-.618[a]	-.603[a]	.550[a]	.931[a]	—

[a]Significant at the .01 level.
[b]Significant at the .05 level.

Table 9

Interrelationships of Non-athlete Group

Variable	WT	VJ	TIA	RT	RS_{10}	RS_{30}
WT	—					
VJ	-.385[a]	—				
TIA	-.331[b]	.618[a]	—			
RT	.027	.090	.012	—		
RS_{10}	.169	-.291[b]	-.459[a]	.308[b]	—	
RS_{30}	.282	-.439[a]	-.704[a]	.152	.839[a]	—

[a]Significant at the .01 level.
[b]Significant at the .05 level.

and RS_{30}. Both RS_{10} and RS_{30} showed significant relationships with VJ. However, very low and non-significant relationships were found between RT-WT, RT-VJ, and RT-TIA.

III. DISCUSSION OF FINDINGS

The writer feels that many of the findings presented warrant discussion. It should also be noted that the writer was not studying cause and effect, therefore his discussions are based on observations and subjective reasoning.

Comparisons

Athletes versus non-athletes.

The comparisons between the athlete and non-athlete groups showed that the athletes were superior in their performances, especially in running speed. However, the findings for reaction time were not significant in the investigation. Some previous studies have concluded that the athletes were significantly faster reactors than the non-athletes. Although the subjects were not intentionally motivated by investigator, there appeared to be more initiative demonstrated by the non-athletes than the athletes to get a fast reaction time. In doing so they tended to slow down before they reached the RS_{30} point. The athletes, on the other hand, did not appear too concerned about reaction time but more so on running the required distance as fast as possible. This might have contributed to their very significant performances at RS_{10} and RS_{30}.

The athletes were faster reactors than the non-athletes, but unlike previous findings in other studies, there was no significant difference demonstrated between the two groups. It was, however, interesting to note the responses of the athletes to the sound stimulus. They tended to remain motionless after the stimulus had sounded. It appeared as though they were waiting for a "gun" and did not completely perceive the stimulus. Of course, when they did react it appeared as a delayed reaction. This was observed for a few of the non-athletes also but not as frequently. The writer believes that the nature of the stimulus may have contributed to slower reaction times for the athlete group.

Contrary to the findings, it would seem that the athletes should possess significantly more explosive muscular power than the non-athletes. But in reviewing the interrelationships for both groups between weight and vertical jump, it appears that there is a significant, but inverse, relationship between weight and vertical jump. Also, there is a significant difference in weight between the athletes and non-athletes. Based on these facts, it would appear that regardless of whether you are an athlete, or non-athlete, body weight is a deciding factor in vertical jump performance. Another point that should be considered is the use of the arms in the vertical jump. The athletes in general are more adept at using their arms in jumping than the non-athletes. This, too, may have contributed to

the nonsignificant differences between the two groups for vertical jump (explosive muscular power).

Athletic groups. The comparisons among the various athletic groups yielded similar findings to those in previous studies. It appears that speed, and reaction time vary among these groups depending upon the sport activity. (See Figures 3, 4 and 5). This can also be true for body weight (WT), VJ, and TIA as revealed in Figures 6, 7 and 8. However, this does not explain the relatively poor performances by the track and field, and football groups. It should be noted that weightmen and distancemen, who exhibited relatively low performance, composed sixty-four percent of the track and field group.

Nevertheless, the majority of the comparisons between the athletic groups were as expected.

Interrelationships

All relationships between different variables for the athlete group were significant. However, this was not true with the non-athlete group. There was consistency in that the lighter the individual, the higher he jumped and remained in the air. But there were very distinct differences for some of the relationships obtained for both groups. Whereas there were significant relationships demonstrated by the athlete group between RT-WT, RT-VJ, RT-TIA, WT-RS_{10}, and RT-RS_{30} they were very low and insignificant for the non-athlete group.

Again, these performances may be attributed to the non-athletes' apparent desire to get a fast reaction time and then slowing down before reaching the RS_{30} point since reaction time and running speed for the non-athletes are the only variables not indicating significance.

There are strong indications from the findings that reaction time and running speed as determined in this investigation might be invalid due to the very low intensity of the sound stimulus.

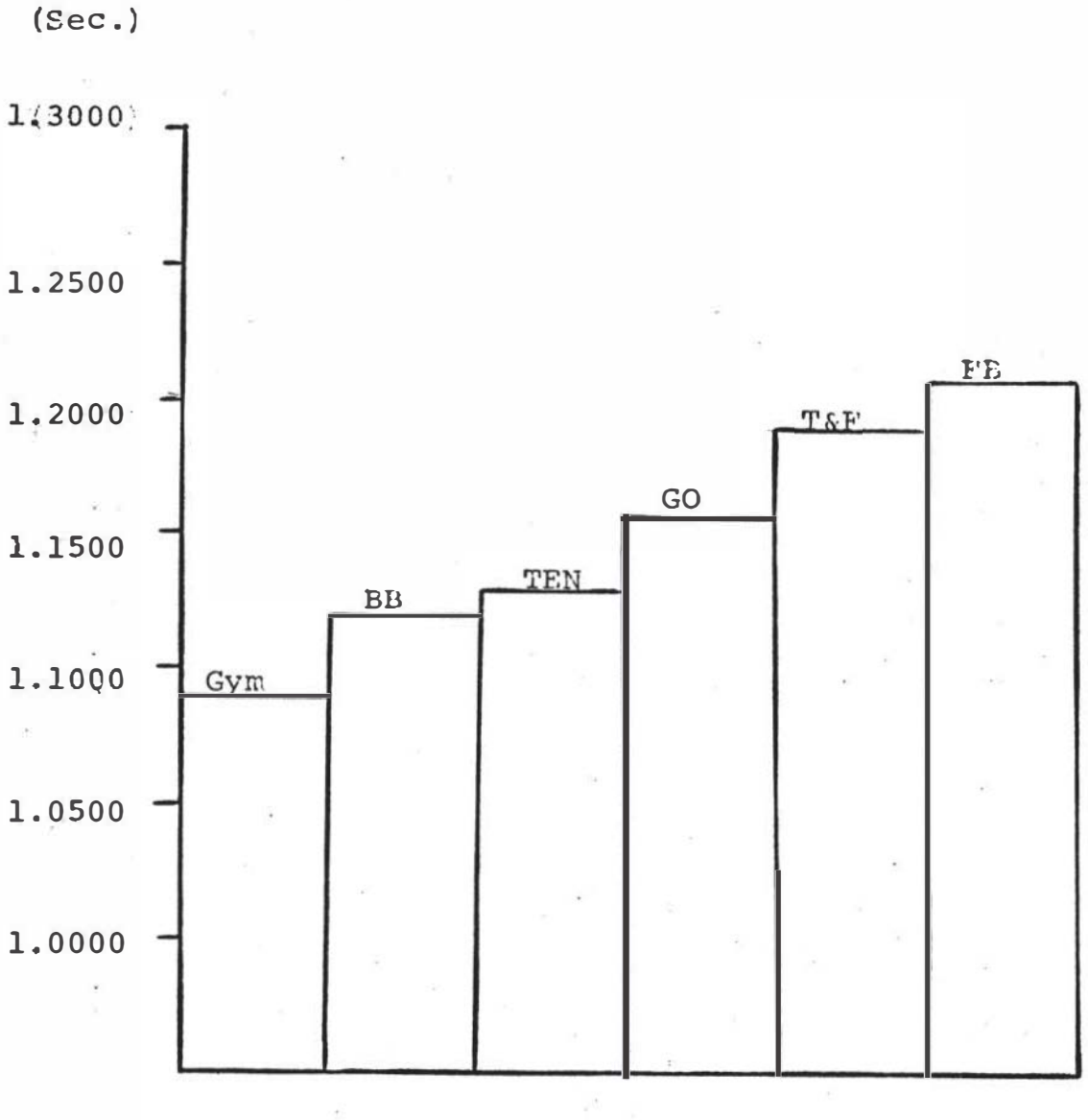

Figure 3

Summary of RS_{10} Times Among

the Athlete Groups

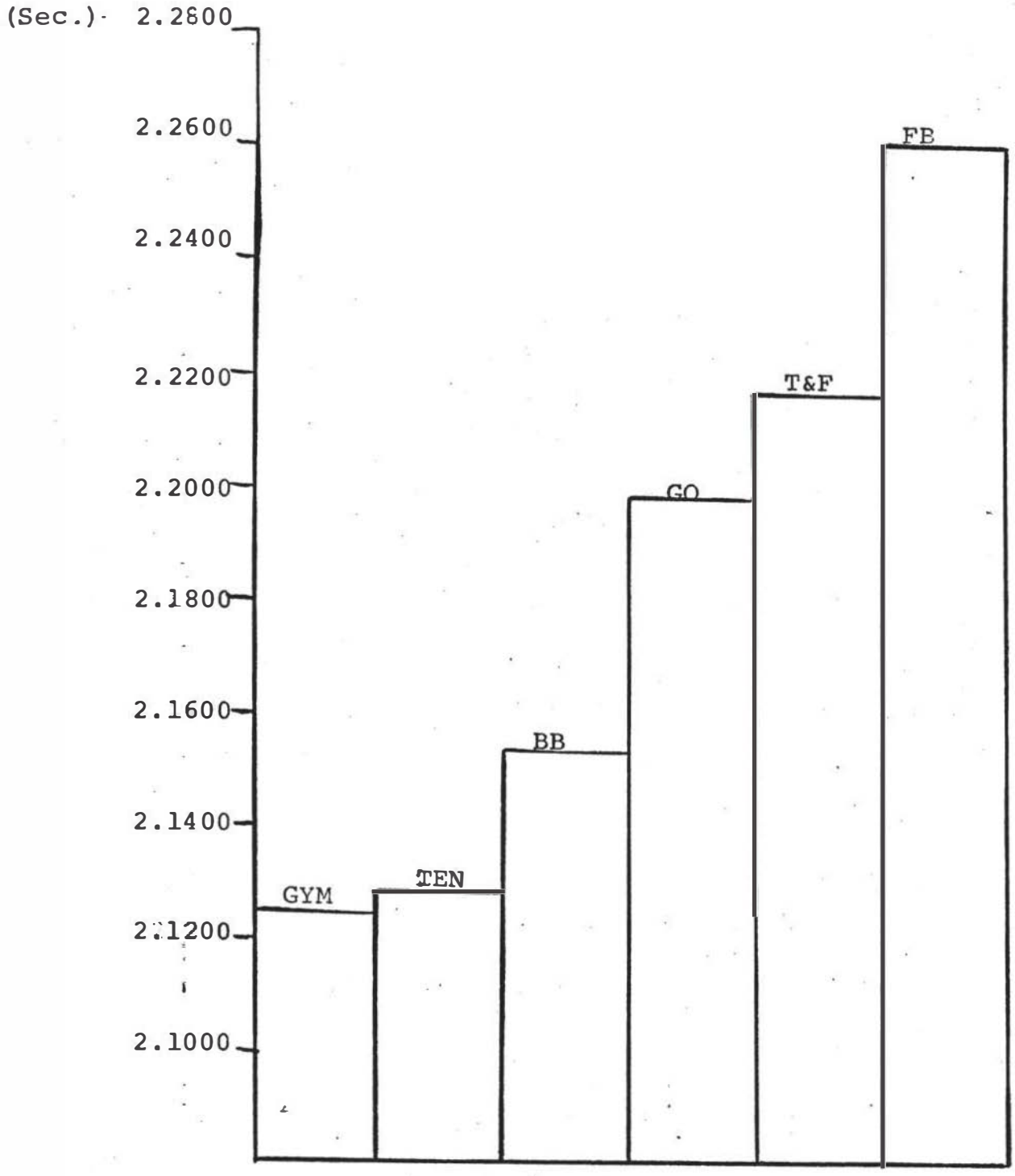

Figure 4

Summary of RS_{30} Times Among the Athlete Groups

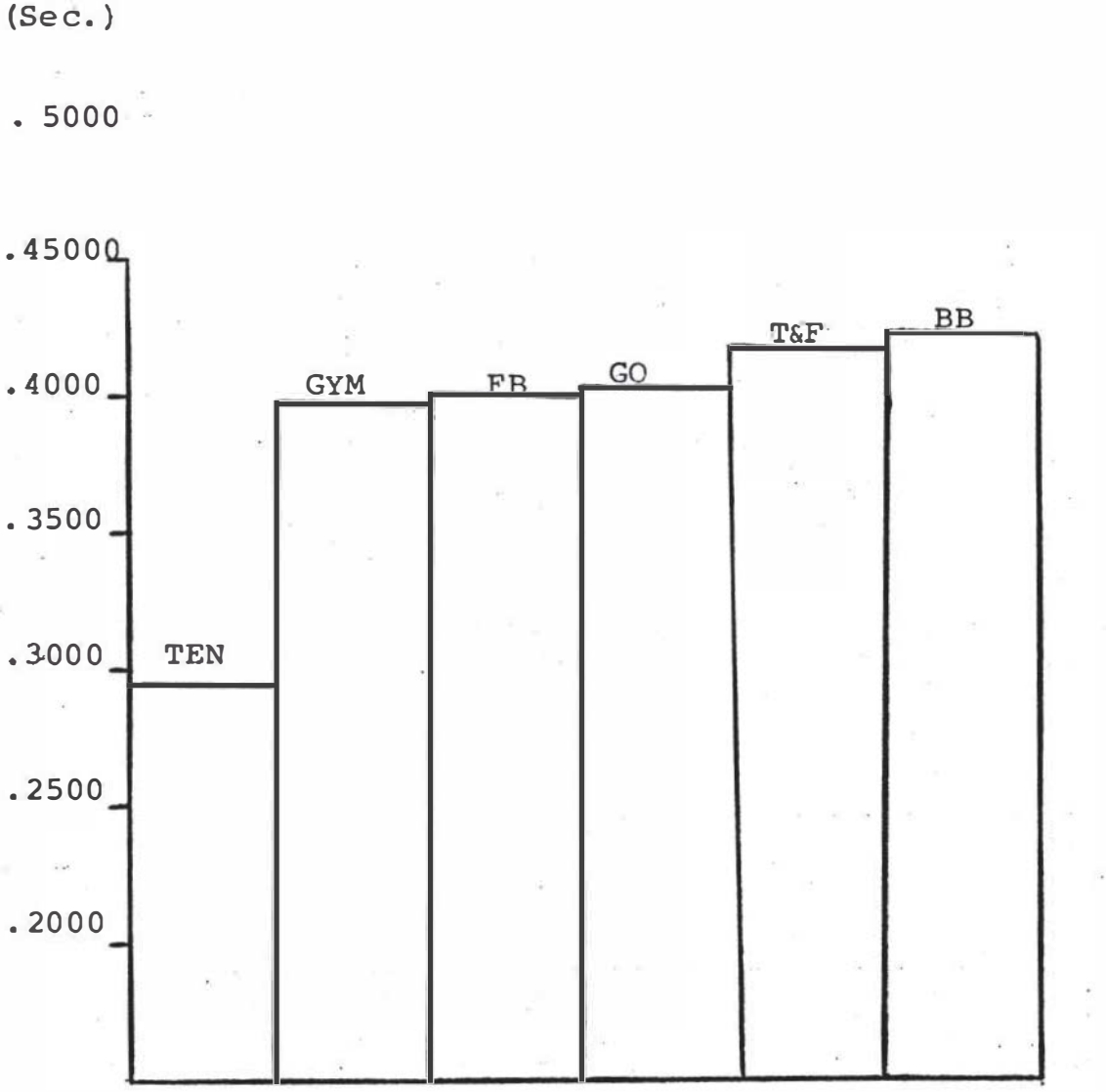

Figure 5

Summary of Reaction Time Scores

Among the Athletic Groups

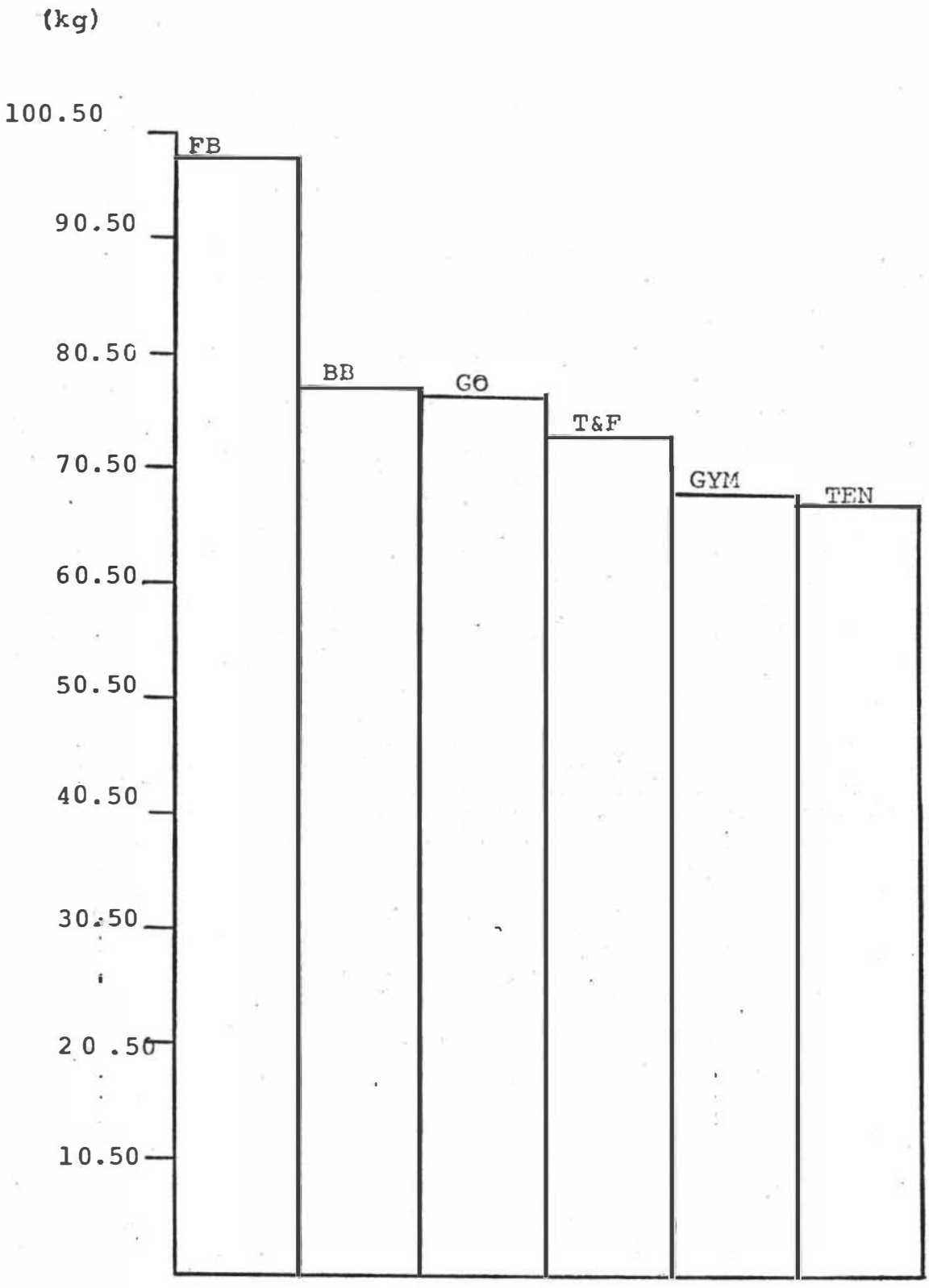

Figure 6

Summary of Body Weight Among

the Athlete Group

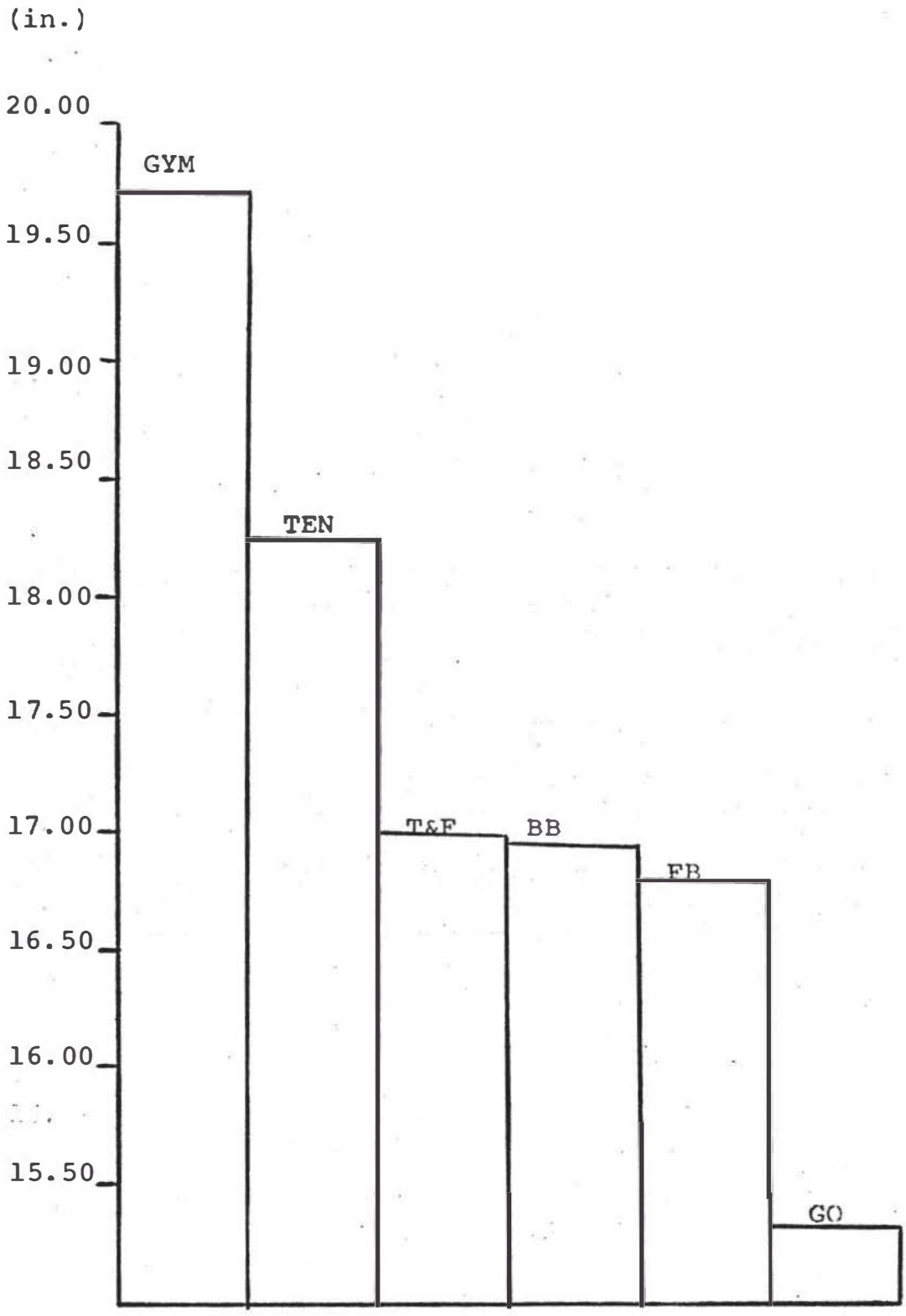

Figure 7

Summary of Vertical Jump Scores

Among the Athlete Groups

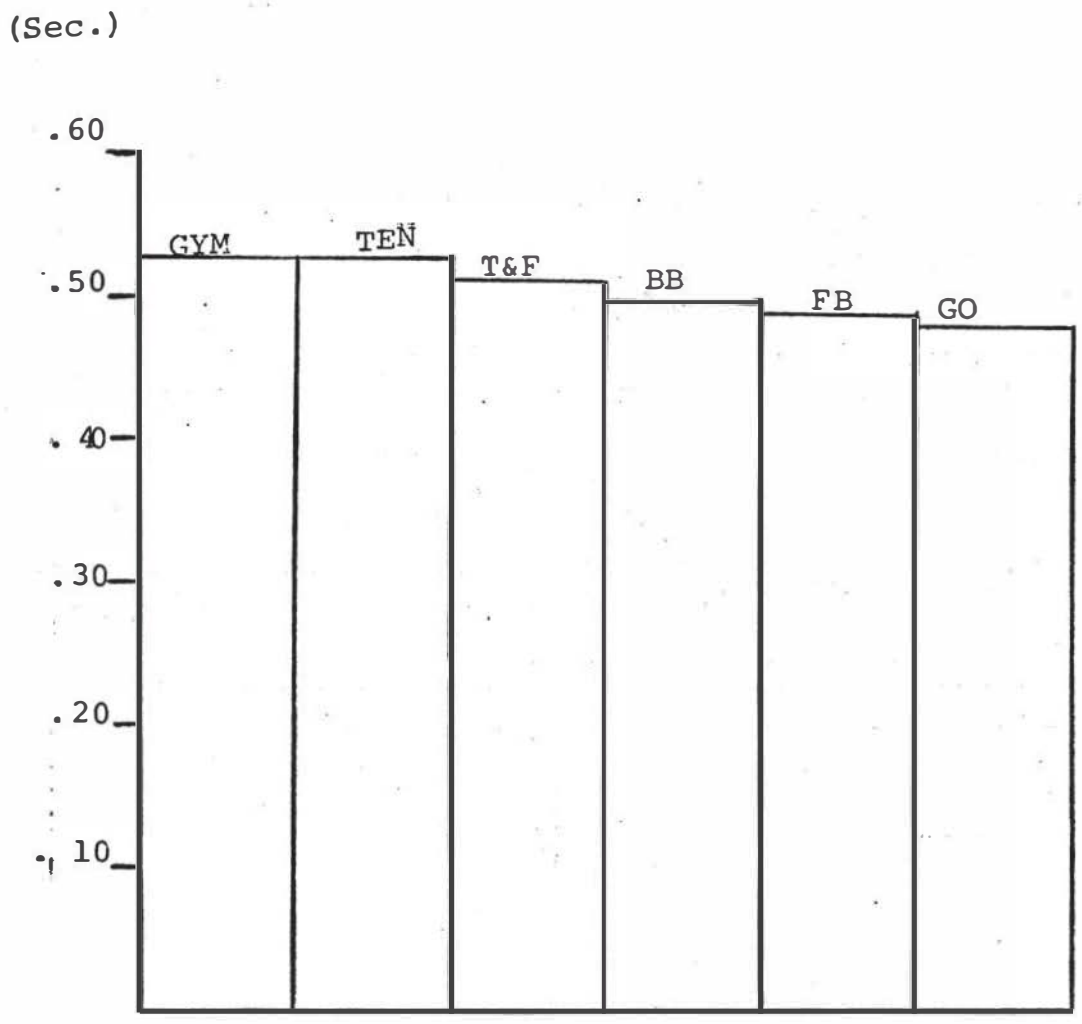

Figure 8

Summary of TIA Scores Among

the Athlete Groups

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATION

I. SUMMARY

The primary purpose of this investigation was to determine if there was any significant difference in explosive muscular power, reaction time, and running speed within and between college athletes and non-athletes. In addition, the interrelationships between body weight, explosive muscular power, reaction time, and running speed were studied.

One hundred and forty-two male undergraduate and graduate students at Eastern Illinois University were the subjects in the investigation. Each subject was placed into one of two major groups--athlete or non-athlete. The non-athlete group was composed of forty-eight volunteers from the physical education activity classes and the co-recreation program. The athlete group was composed of members from the varsity teams: spring football (35), tennis (10), gymnastics (6), baseball (16), golf (5), and track and field (22). There were several national, conference, and school champions and record holders within the athlete group.

Each subject was administered a vertical jump test which determined height jumped and the amount of time spent

in the air during execution. The other test administered was a reaction-running speed test. In this test, reaction time, running speed for ten feet, and running speed for thirty feet was determined. The best scores were recorded and punched into IBM cards and fed through a computer for statistical analysis. The *t* ratio was used to determine the significance of the means, and a correlation matrix to determine the interrelationships.

II. CONCLUSIONS

Based on the findings presented and within the limitations of this investigation, the following conclusions appear warranted:

1. College athletes are significantly faster than college non-athletes for distances of ten and thirty feet.
2. There is no significant difference in reaction time between the athletes and non-athletes although the athletes are faster.
3. There is no significant difference in vertical jump (explosive muscular power) between the athletes and non-athletes.
4. Gymnasts possess significantly greater vertical jump (explosive muscular power) than the football, baseball, and golf players.
5. Tennis players are significantly quicker than the track and field, baseball, and football players.
6. Gymnasts are faster at ten and thirty feet than track and field, golf, tennis, baseball, and football players.
7. There is a significant relationship between vertical jump and reaction time for the athlete group.
8. There is a significant relationship between vertical jump and running speed for both the athletes and non-athletes.
9. There is a significant relationship between body weight and vertical jumping ability for both groups.
10. There is a significant relationship between running speed and reaction time for both the athletes and non-athletes.
11. Speed and reaction time tend to vary depending on the sport.

III. RECOMMENDATION

The writer recommends that a similar study be undertaken employing a larger and more representative sample of athletic groups. It is also suggested that some other stimulus be used to initiate the reaction-running speed test..

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BIBLIOGRAPHY

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APPENDIXES

APPENDIX A

DATA CARD

DATA CARD

Name:_____ Birth Date:_____
Month Day Year

Year in school: Fr. Soph. Jr. Sr. Weight_____lbs. Height:_____in.

Vertical Jump

		1	2	3
Standing height:_____in.	Jump Height:	_____in.	_____in.	_____in.
Time in the air:		_____sec.	_____sec.	_____sec.

Reaction Time

Reaction Time:	_____sec.	_____sec.	_____sec.
Performance time#1:	_____sec.	_____sec.	_____sec.
Performance time#2:	_____sec.	_____sec.	_____sec.

APPENDIX B

RAW DATA
(Non-athletes)

Subject	WT(kg)	HT(cm)	VJ(in)	TIA (sec)	RT (sec)	RS_{10} (sec)	RS_{30} (sec)
001	86.5	189	16.25	.48	.4361	1.1550	2.2418
002	62.4	178	18.00	.52	.4786	1.3302	2.3159
003	71.6	175	13.00	.49	.2722	1.3060	2.3290
004	67.9	182	13.50	.44	.1785	1.2166	2.2968
005	91.4	180	14.50	.47	.5532	1.3963	2.4921
006	64.3	176	17.75	.54	.6316	1.3306	2.0937
007	70.4	188	20.50	.57	.3499	1.1619	2.1456
008	83.4	186	12.50	.48	.5245	1.2975	2.3550
009	62.5	170	14.25	.49	.3942	1.3640	2.3931
010	63.1	183	13.75	.49	.4129	1.0495	2.0934
011	83.2	188	18.25	.53	.3591	1.1728	2.1995
012	66.6	178	25.00	.58	.5005	1.0733	2.0806
013	75.2	178	17.25	.49	.2178	1.2640	2.2673
014	65.7	170	22.50	.57	.5413	1.2127	2.1508
015	60.2	181	23.75	.51	.2726	.9986	2.0370
016	97.3	185	17.25	.50	.2959	1.0021	2.1140
017	65.0	166	16.25	.46	.3577	1.0916	2.1587
018	56.8	176	16.00	.50	.4546	1.2459	2.4335
019	88.4	185	19.00	.53	.4682	1.2746	2.2985
020	70.2	179	15.75	.51	.3734	1.0136	2.0528
021	86.6	185	16.00	.48	.5276	1.2429	2.2502
022	80.4	191	15.25	.47	.4931	1.3438	2.4253
023	56.8	176	20.50	.53	.4195	1.1631	2.3012
024	75.3	184.5	19.50	.54	.5514	1.2971	2.2982
025	85.9	180	12.00	.32	.3026	1.3753	2.6298
026	61.0	172	23.75	.58	.2244	1.2765	2.2980
027	69.1	182	18.50	.52	.5350	1.3324	2.3447
028	64.5	179	17.50	.51	.4950	1.2242	2.2867
029	76.0	175	13.75	.38	.5036	1.4388	2.5800
030	78.2	173	15.50	.44	.3620	1.1881	2.3736
031	73.2	172	17.25	.61	.2004	1.0918	2.0122
032	75.4	178	16.50	.50	.5370	1.2342	2.3488
033	88.4	185	15.50	.46	.3299	1.2387	2.2612
034	71.1	180	18.00	.52	.5527	1.2629	2.2193
035	103.4	174	15.50	.49	.4021	1.2026	2.3121
036	87.3	177.5	13.25	.44	.3069	1.2360	2.3403
037	63.8	166	17.25	.47	.3381	1.1149	2.1014
038	68.2	177	15.50	.43	.5015	1.2863	2.3399
039	63.8	174	16.25	.37	.4295	1.3248	2.5233

Subject	WT(kg)	HT(cm)	VJ(in)	TIA (sec)	RT (sec)	RS_{10} (sec)	RS_{30} (sec)
040	97.4	171	17.50	.42	.5009	1.3855	2.5246
041	102.9	181	14.00	.44	.4364	1.2660	2.3237
042	87.4	187	15.25	.42	.2406	1.4652	2.6379
043	72.7	173	24.50	.44	.5703	1.3429	2.3417
044	86.0	182	14.00	.48	.4202	1.1484	2.2101
045	77.4	181	18.75	.51	.2188	1.1990	2.1472
046	92.3	188	11.00	.39	.4921	1.3259	2.4398
047	68.1	182	14.50	.45	.3726	1.3858	2.4175
048	86.4	169	16.75	.50	.4421	1.2362	2.3565

APPENDIX C

RAW DATA
(Football)

Subject	WT(kg)	HT(cm)	VJ(in)	TIA (sec)	RT (sec)	RS_{10} (sec)	RS_{30} (sec)
049	87.5	179	20.00	.52	.3840	1.0953	2.1637
050	68.2	172	22.00	.58	.3992	1.6664	2.1832
051	74.5	175.5	25.00	.64	.2469	1.0260	2.0377
052	86.8	180	20.50	.55	.4230	1.2419	2.2511
053	93.6	177	19.00	.55	.4708	1.1746	2.2224
054	82.3	181	17.50	.52	.1948	1.1840	2.1904
055	84.1	189	19.50	.48	.2785	1.0430	2.0102
056	82.7	182.5	17.00	.47	.4312	1.1274	2.1137
057	79.5	182	18.75	.58	.3925	1.0785	2.1129
058	92.7	178.5	16.00	.45	.2711	1.0878	2.1591
059	81.8	175	14.00	.42	.4923	1.3543	2.5176
060	93.4	182.5	18.75	.49	.5034	1.1712	2.2582
061	89.1	187	15.00	.47	.4147	1.2041	2.2205
062	99.8	181	16.50	.46	.3852	1.4365	2.5201
063	93.2	185.5	17.00	.49	.4960	1.3512	2.4404
064	92.3	182	16.00	.46	.4915	1.3109	2.3875
065	89.8	180	15.00	.45	.5178	1.1938	2.3251
066	89.9	176	15.00	.44	.3345	1.3231	2.3711
067	105.0	172	14.00	.42	.4680	1.2392	2.3659
068	90.7	183	15.50	.52	.3490	1.2349	2.2745
069	121.8	195.5	11.50	.43	.4157	1.4003	2.4840
070	110.4	189	11.75	.44	.6014	1.3911	2.5960
071	101.4	187	13.25	.43	.5058	1.3899	2.5429
072	115.9	190	10.75	.42	.4784	1.3017	2.4028
073	103.2	189	14.25	.50	.4654	1.2688	2.3262
074	100.0	186	14.75	.44	.3543	1.1210	2.2374
075	88.6	187	18.75	.56	.3826	1.1570	2.1261
076	87.7	181.5	15.00	.47	.3599	1.1857	2.2092
077	88.2	188.5	20.00	.51	.3682	1.1479	2.1538
078	104.5	200	16.00	.46	.5013	1.1678	2.2439
079	74.1	182	17.50	.50	.2722	.9666	2.0273
080	70.0	177.5	20.50	.55	.1471	1.0113	2.0096
081	83.6	180	20.25	.51	.3702	1.1919	2.1531
082	85.9	187.5	14.75	.47	,4359	1.1156	2.1852
083	89.5	187	16.25	.47	.2174	1.2427	2.3181

APPENDIX D

RAW DATA
(Golf)

Subject	WT(kg)	HT(cm)	VJ(in)	TIA (sec)	RT (sec)	RS_{10} (sec)	RS_{30} (sec)
084	85.0	185	17.75	.45	.2790	1.1917	2.2957
085	64.5	174	15.75	.48	.4180	1.0911	2.0847
086	90.9	181	14.00	.54	.5754	1.2691	2.3611
087	80.9	181.5	15.50	.48	.4295	1.1483	2.1619
088	65.4	183.5	13.50	.46	.3066	1.0866	2.0841

APPENDIX E

RAW DATA
(Baseball)

Subject	WT(kg)	HT(cm)	VJ(in)	TIA (sec)	RT (sec)	RS_{10} (sec)	RS_{30} (sec)
089	71.6	180	18.25	.51	.3762	1.1138	2.1074
090	72.9	176	16.25	.49	.3843	1.1683	2.1602
091	75.0	178	15.00	.51	.4176	1.1555	2.1712
092	76.4	185	18.25	.48	.3645	1.1556	2.1564
093	82.2	183	15.50	.45	.4188	1.2494	2.2873
094	78.4	186	15.25	.48	.4287	1.0666	2.1456
095	76.4	174	18.00	.53	.5107	1.1343	2.1207
096	80.2	185	13.75	.44	.3634	1.1447	2.2007
097	83.2	179	14.50	.47	.4400	1.0531	2.1050
098	69.5	166	16.00	.47	.1306	1.0418	2.0421
099	73.6	177	15.75	.53	.2937	1.0931	2.0752
100	75.6	166	16.50	.47	.6758	1.1991	2.2837
101	87.7	176	18.75	.54	.4668	1.0975	2.1829
102	100.9	186	20.25	.51	.5056	1.1193	2.1768
103	74.3	169	17.25	.51	.5728	1.1733	2.2588
104	69.8	168	21.75	.55	.4026	1.0031	1.9969

APPENDIX F

RAW DATA
(Track and Field)

Subject	WT(kg)	HT(cm)	VJ(in)	TIA (sec)	RT (sec)	RS_{10} (sec)	RS_{30} (sec)
105(W)	84.3	192	14.25	.54	.3826	1.2498	2.3149
106(W)	107.3	182	17.00	.52	.3616	1.1723	2.2108
107(W)	96.1	184	16.00	.49	.5960	1.3138	2.2514
108(S)	67.0	170	20.00	.54	.4274	1.2379	2.2002
109(S)	69.5	177	24.00	.58	.5036	1.2975	2.2498
110(J)	69.1	172	19.50	.54	.1632	.9862	2.0269
111(J)	81.8	191	18.50	.53	.3334	1.1854	2.1488
112(J)	74.6	183	25.00	.60	.2329	.9019	1.8452
113(D)	66.4	184	9.50	.35	.4840	1.2646	2.4072
114(D)	61.1	171	15.75	.53	.4564	1.0882	2.1590
115(D)	67.0	178	18.00	.49	.5412	1.2069	2.2427
116(D)	63.9	170	15.00	.47	.4403	1.2374	2.2835
117(D)	64.9	178	14.25	.45	.5040	1.3943	2.4353
118(D)	60.3	180	14.00	.53	.4315	1.1695	2.2271
119(D)	58.6	178	15.25	.49	.5173	1.2723	2.2615
120(D)	79.2	179	18.00	.56	.2585	1.1133	2.0891
121(D)	60.1	174	14.00	.45	.4466	1.2116	2.2404
122(D)	72.2	188	14.75	.45	.4158	1.3152	2.4252
123(D)	68.2	183	11.75	.43	.3613	1.1176	2.1774
124(H)	75.6	182	22.00	.57	.2269	1.0850	2.0805
125(H)	80.0	189	22.50	.56	.5534	1.2481	2.1845
126(H)	76.4	174	14.50	.50	.6031	1.2854	2.3474

D=Distance runners
H=Hurdlers
J=Jumpers
S=Sprinters
W=Weightmen

APPENDIX G

RAW DATA
(Gymnastics)

Subject	WT(kg)	HT(cm)	VJ(in)	TIA (sec)	RT (sec)	RS_{10} (sec)	RS_{30} (sec)
127	71.8	168	16.50	.47	.3498	1.2003	2.2580
128	67.6	175	22.00	.57	.4079	1.0806	2.1137
129	62.3	167	22.50	.58	.3125	.9767	1.9038
130	72.8	178	22.25	.58	.4201	.9788	1.9995
131	62.5	167	17.50	.50	.3672	1.0767	2.1478
132	70.0	169	17.50	.48	.4995	1.2349	2.3272

APPENDIX H

RAW DATA (TENNIS)

Subject	WT(kg)	HT(cm)	VJ(in)	TIA (sec)	RT (sec)	RS_{10} (sec)	RS_{30} (sec)
133	70.2	176	19.25	.58	.3746	1.1820	2.2019
134	56.8	172	18.00	.57	.4440	1.0632	2.0936
135	66.1	172	18.00	.47	.3690	1.2094	2.2095
136	63.4	175	16.00	.50	.3888	1.2814	2.2193
137	65.9	180	20.25	.54	.1666	1.9801	2.0172
138	76.8	182	18.00	.56	.3109	1.0845	2.0350
139	69.3	187	18.75	.51	.1555	1.2150	2.2726
140	73.6	189	18.00	.52	.2771	1.0777	2.0352
141	67.3	172	20.00	.55	.2565	1.1613	2.1232
142	60.9	172	16.25	.45	.2524	1.0094	2.0804

VITA

WILLIE CLYDE JACKSON

The writer was born in Shellman, Georgia on July 21, 1948. His family moved to Roanoke, Virginia in 1953. He attended elementary and junior high school from 1954 to 1962. It was during this time that he became active in the Boy Scouts, Y.M.C.A., track, and sandlot football.

In the fall of 1962, he entered Lucy Addison High School. While at Addison, he participated and was awarded three letters each in football and track. He was graduated on June 5, 1966.

After graduation from high school, he attended Knoxville College in Knoxville, Tennessee on an athletic scholarship in football from 1966 to 1970. He captained the team for three years and lettered four years. He was also very active in the intramural program. He pursued a major in physical education and a minor in Biology. He received the Bachelor of Science in Education degree on June 6, 1970.

During the summer after graduation from Knoxville, he worked as a physical education instructor in the Upward Bound Program.

The following fall, he enrolled as a graduate assistant in the School of Health, Physical Education, and Recreation at Eastern Illinois University during the school year 1970-71 and his teaching assignment was at Lake Land College in Mattoon, Illinois.

He persued a course of study leading to the degree Master of Science in Physical Education.

The writer has accepted a teaching and coaching position at Kent County High School in Chestertown, Maryland.