THE COMPOSITION AND ESTABLISHMENT OF STANDARD SCORES ON SELECTED PHYSICAL FITNESS TESTS FOR INDIAN GIRLS BETWEEN THE AGES 10 YEARS AND 17 YEARS

BY

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D A T E

S U P E R V I S O R S

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D E D I C A T I O N

To the memory of
my beloved daughter
A N U S H A

P R E F A C E

In recent years the area of physical fitness has been of special interest. In a number of countries national fitness programmes have been launched to increase the awareness of the importance of physical fitness at all levels.

Literature on the testing of physical fitness abounds, particularly in the United States of America. Several books on tests and measurements in physical education are available, and these provide invaluable guidelines to teachers of physical education in the important aspects of evaluating and assessing the physical fitness and progress of pupils. However, in South Africa, research in this important area is limited, especially in so far as Indian pupils are concerned.

In the present study an attempt is made to establish norms on selected tests of physical fitness for Indian girls. The study is divided into five parts as follows:

CHAPTER ONE	presents the rationale for the establishment of norms for Indian girls in South Africa.
CHAPTER TWO	gives a review of the relevant related literature.
CHAPTER THREE	gives an outline of the method of study.
CHAPTER FOUR	gives an analysis and presentation of the results.
CHAPTER FIVE	includes a discussion of the results, a summary and conclusion; and some recommendations for further research.

The writer wishes to record his sincere thanks to Professor A.L. Behr and Dr S.F. du Toit for invaluable guidance, advice and suggestions in their joint supervision of this thesis.

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RAMPERSADH HEMRAJ

SPECIAL NOTE

In this Thesis a comma is used instead of a full stop in respect of data quoted from references

e.g. 0,78 instead of .78.

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CHAPTER ONE

Rationale for the Establishment of Standard Scores for Physical Fitness Tests for Indian Girls in South Africa for the age range 10 years to 17 years

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1.1 INTRODUCTION

DURING the last thirty years there has been a growing interest in physical fitness in most countries. Physical fitness is an area in which health considerations are stimulating recreational activity on a much wider scale than ever before.

JUST over a decade ago the American people were shocked when research showed an alarming decline in the physical strength and fitness of its youth. President Kennedy[1] tried to increase the national concern by pointing out that an

> "... increasingly large number of young Americans were neglecting their bodies and were getting soft ...",

a trend which he stressed would

> "... help to strip and destroy the vitality of a nation."

THE national fitness campaign organised under the President's Council of Youth Fitness in the United States involves millions of youth and thousands of school and recreation programmes and organisations.[2]

SIMILAR physical fitness schemes exist in most of the other well-developed countries of the world. In Sweden fitness awards have been granted since the turn of the century, while Holland and Germany introduced this scheme in 1912-1913. Since then many European countries have also introduced similar schemes. The "European Athletics Diploma", an international fitness scheme presented by the "Council of Europe"; "The Duke of Edinburgh's Award Scheme" in the British Commonwealth; and the physical fitness programme considered by the Commonwealth Council for National Fitness and designed to suit people of all ages in Australia - all provide examples of such schemes.(3), (4)

IN South Africa attention was focussed on physical fitness with the introduction in 1966 of the National Fitness Scheme for young and old.(5) This scheme was initiated by the South African Federation for Youth and Sport and was sponsored by the Old Mutual Insurance Company. A committee of experts under the chairmanship of Mr R.W.J. Opperman was appointed to draw up the tests.

THE growing emphasis on, and the present interest in, physical fitness is reflected not only in the physical education programmes in schools, but also, by the fact that physical fitness is getting more publicity today than at any time in the last thirty years. This is particularly so in the United States of America.

THE measurement and evaluation of an individual's status in physical fitness is an important step towards a better understanding

of his needs, capabilities and development. A good educational programme should include periodic testing and evaluation which will allow teachers to gauge progress and assess individual needs.

ACCORDING to Scott,[6] for physical activity to be construed as a worthwhile educational endeavour, physical fitness tests and test results should be evaluated to give a picture of the individual as a total person. There exists a close and obvious relationship between test scores and physical fitness. This provides an effective means of motivation and a useful basis for discussion with students concerning their progress.

THE basic philosophy of the *National Fitness* movements in South Africa and in overseas countries is to develop an awareness and an appreciation of the need for attaining and maintaining personal health or total fitness, of which physical fitness is an important part.

REFSHAUGE[7] emphasises the value of physical fitness for the maintenance of total fitness or personal health as follows:

> "In the human product of material civilization, for whom the sickness of experience is a measure of life, physical fitness not only serves as a door to active recreation, but also has a real part to play in the promotion of health."

THE development of physical fitness is of paramount importance in order to protect people from the stresses of daily tasks. However,

before any development can take place it must be known where development is necessary.

THE physical education teacher in the school has a moral obligation to select activities for his programme, and to adopt those methods in conducting it which will satisfy the different objectives of physical education, viz. the physical, social and mental-emotional objectives. Of these the physical objective is basic and all pupils should be assured of at least some physical education in order that this objective shall be attained.

WITHOUT this basic requirement other aspects of the programme are ineffective. It is, therefore, important for the physical education teacher to strive to obtain the optimum standard of physical fitness for each child.

1.2 DEFINITION OF TERMS

SEVERAL attempts have been made to define the nature of physical fitness. Definitions range from the broad concept of physical fitness as the degree of general well-being to a detailed description of the numerous components of fitness as enumerated by statistical analysis and critical thinking.

IN order to obtain a clear understanding of the concept of physical fitness it is essential to view it in relation to total fitness of which it is a part.

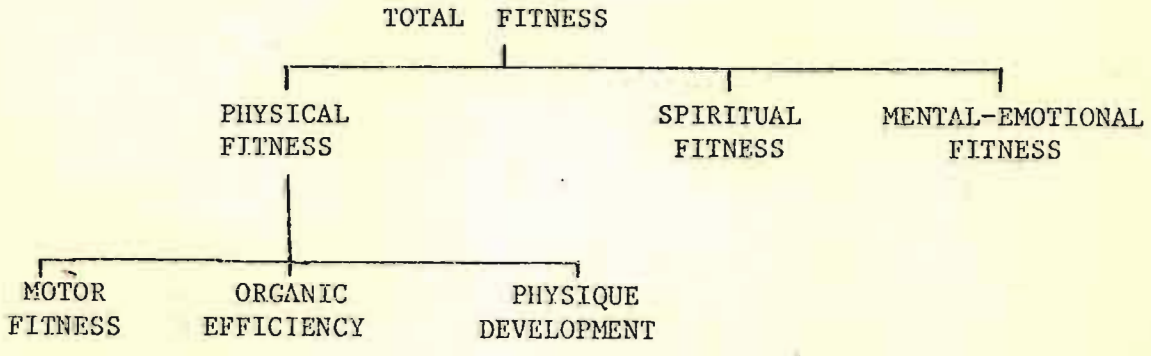
BOTH these terms - "physical fitness" and "total fitness" - were in general use during the war years in the early 1940's. The terms were applied to the various capacities which had been recognised for decades as part of the contribution of physical education. Although the term "fitness" and its usage were relatively new, the concept and its meaning were not new.(8)

ANOTHER term - which came into being during World War II - is *Motor Fitness* which involves a specific type of measurement in which there has been much interest.(9)

SINCE this study is concerned essentially with motor fitness it becomes necessary to show the relationship between the three concepts. This relationship is shown in the following figure:

FIGURE 1.1

RELATIONSHIP BETWEEN TOTAL FITNESS AND ITS COMPONENTS

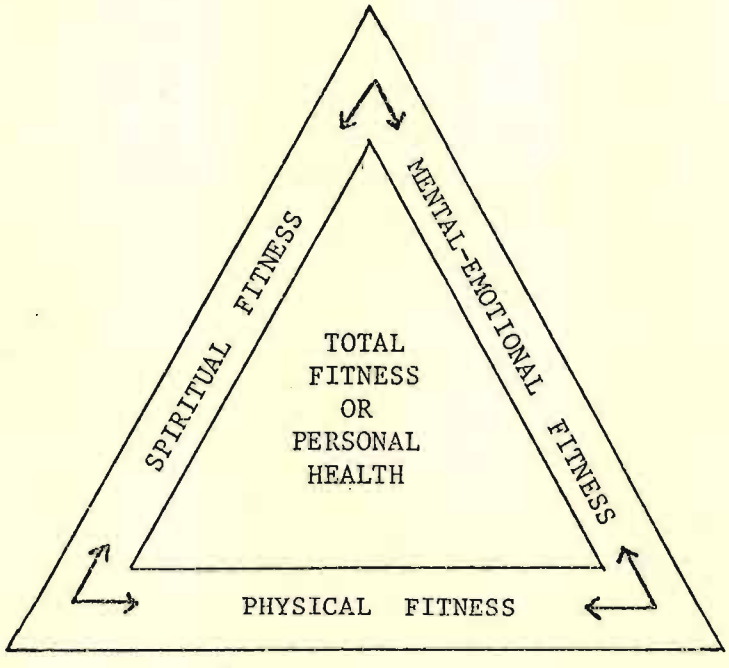


TOTAL fitness, which has been interpreted in many ways, rests upon a solid foundation of good health. It involves not only

physical fitness but also mental and emotional fitness, and spiritual fitness. These three elements which are closely inter-related form parameters or dimensions of personal health and may be represented as follows:

FIGURE 1.2

THE THREE BASIC DIMENSIONS OF TOTAL FITNESS AND THEIR INTER-RELATIONSHIPS



THE basic concept of *Total Fitness* is that of an effective total response to work or activity of a given intensity. It is immediately apparent that individual needs of "fitness" vary. However, this does not in any way alter the situation that there is need for an efficient operation of the total organism, i.e. an efficient organic mechanism, mental functioning, and motor

mechanism, all of which are, in turn, sparked off by sound emotional control.[10]

BRIEFLY, total fitness implies freedom from limiting and debilitating ailments; having the

> "stamina and skill to do a day's work"; and having "sufficient reserve of energy not only to meet emergencies but to provide a zest for leisure-time living."[11]

ACCORDING to Jones[12] total fitness is vital for effective living and it implies

> "... freedom from disease, enough strength, agility, endurance and skill to meet the demands of daily living, sufficient reserves to withstand ordinary stresses without causing harmful strain; and mental development and emotional adjustment appropriate to the maturity of the individual. Optimal fitness permits enjoying life to the fullest. In addition to the day's ordinary work requirements, one should still have enough vitality to enjoy avocational interests and to meet special challenges that may interrupt the daily routine."

NEISON and Bronson[13] view total fitness as an ecological problem concerned with the relationship of the organism to its environment. They define total fitness as:

> "the adequacy with which the organism adjusts to its environment as it grows, develops, matures and strives to achieve its goals."

THE concept of physical fitness has evolved from a great deal of literature and research on the subject of tests and measurements, and is related to the physical aspect of personal health. Physical fitness is one of the most important keys to a healthy body, and the basis of dynamic and creative intellectual activity. It is concerned with the capacity for sustained physical activity and can be demonstrated through motor activity involving the total organism, and this includes the development of the physique, organic efficiency and motor fitness.

ANDERSON and Langton[14] assert that physical fitness does not imply that an individual should

> "... attain the fitness of a champion athlete, ... but the level of well-being appropriate to his individual needs."

FLEISHMAN[15] offers an operational definition of physical fitness, which recognises the total functional capacity of individuals to perform certain kinds of tasks requiring muscular activity in which all the systems of the body work in complete harmony.

ACCORDING to Cureton,[16] physical fitness is the

> "ability to handle the body well and the capacity to

work hard over a long period of time without diminished efficiency."

IN any appraisal of physical fitness consideration must be given to tests relating to:

(a) Physique Development

(b) Organic Efficiency, and

(c) Motor Fitness(17)

PHYSIQUE development refers basically to the appearance of an individual and includes such characteristics as:

(a) Healthy and robust appearance

(b) Good posture with appearance of ease, alertness and poise

(c) Good proportions of bone, muscle, and fat

(d) Normal bones and muscles, and

(e) Good size for age and sex

ORGANIC efficiency is concerned with the state of health and efficiency of the various organs of the body under stress and normal conditions. Specific aspects related to this component include:

(a) Freedom from germinal or chronic disease

(b) Possessing normal sense organs

(c) Efficient heart and circulatory system, and

(d) Efficient functioning of all other systems during rest and under conditions of stress and exercise

MOTOR fitness with which this study is primarily concerned is, therefore, a limited aspect of physical fitness; just as physical fitness is a phase of total fitness. Today it is regarded as the ability to perform well in basic movements such as running, jumping, climbing, throwing, pushing and swimming. The emphasis in motor fitness is placed on the underlying elements of vigorous physical activity which include muscular power, muscular strength, agility, speed, balance, flexibility and muscular endurance.

MOTOR fitness is, therefore, concerned with the fundamental or gross big muscle movements, as distinct from the higher refined motor movements such as sport skills which are characteristic of motor ability and which take years to perfect.

1.3 THE NEED FOR THE STUDY

INDIVIDUAL needs, or the effects of individual programmes cannot be known without tests and re-tests of the individuals themselves. Tests and measurements help in the determining of physical fitness and the identification of specific inadequacies. Programmes may then be adapted to improve the physical fitness of individuals generally. Remedial and developmental programmes may also be instituted for those who are physically unfit. A knowledge of the fitness status of children, therefore, is important and seems to be the logical starting point for conducting effective physical education programmes.

SOUND tests and measurements, according to Powell,[18]

> "provided they are used judiciously not only save time, energy and effort by the teacher and his pupils but they are challenging within themselves, and they give a positive guide to potentiality and replace guess work by facts."

IN schools in the United States of America testing has become well established and some authorities suggest that approximately ten percent of class time should be spent on testing to evaluate the effectiveness of the teaching programme, to select children for teams, and for other purposes. There has been disagreement over the amount of time that should be allocated to testing, but there is no doubt about the immense value of testing, since it forms an integral part of any educational programme.[19] Every objective held valid by the teacher requires some evaluation of results.

THE physical education teacher, like his colleagues who are concerned with the teaching of other subjects, ought to use testing as a useful teaching and learning device not only to identify strengths, weaknesses, and for remedial measures to improve performances, but also to compare test results with existing norms. When a pupil obtains a score on a test it is necessary to find out whether this score is poor, average or good. In other words, the score has to be evaluated. In order that a realistic comparison may be made, data are needed from a

large number of similar children, and these are usually provided in the form of norms.

A norm is a standard with which the score obtained by an individual in a test may be compared. Most standardised tests are published with norms which can be used to interpret the test scores. A test which has a set of norms is of more value than one without norms.(20)

THE only norms available for Indian pupils are those for boys in the age range of 10 years to 14 years on a test battery of five individual tests measuring Explosive Strength, Dynamic Strength, Static Strength and Cardiovascular Endurance.(21) Norms for the same test battery have also been compiled for male Indian University students in the age range of 18:7 years to 25:6 years.(22)

MENTION of other research carried out in South Africa has been made in the Review of Literature in Chapter Two.

MOST of the tests have been constructed in the United States of America, the published norms being derived from samples of American children and young adults. Research indicates that where norms are used they should be constructed from the same population as the subjects to be tested. (Reference to such studies is made in Chapter Two.) Hence it becomes necessary for standard score tables to be established for Indian pupils in order to make comparisons on a scientific basis, as it would be

strictly incorrect to compare the score of an Indian child of a given age, sex, height and weight with the norm of an American child of the same age, sex, height and weight. For the same reason separate norms are necessary for the different population groups in South Africa.

IN the present study, therefore, an attempt has been made to establish standard score tables for certain selected tests on some of the components of physical fitness for Indian girls.

1.4 PURPOSE AND SCOPE OF THE STUDY

THE purpose of this study was to establish standard scores for selected physical fitness tests for Indian girls at primary and secondary schools.

800 girls between the ages 9:7 and 17:6 years were used as subjects. They were drawn from 36 schools in the Durban area. (Reference has been made to these schools in Appendix C). Care was taken that the schools should be representative of areas of high-, average-, and low socio-economic groups.

THE children were divided into eight age groups as follows:

10 year-olds	:	9:7	to	10:6 years
11 year-olds	:	10:7	to	11:6 years
12 year-olds	:	11:7	to	12:6 years
13 year-olds	:	12:7	to	13:6 years
14 year-olds	:	13:7	to	14:6 years

15 year-olds : 14:7 to 15:6 years

16 year-olds : 15:7 to 16:6 years

17 year-olds : 16:7 to 17:6 years

(Ages were calcualted as at 30 June 1973)

ONE hundred pupils i.e. ten from each of ten schools were tested in each age group. The testing was conducted between September and December 1973.

THE subjects were tested on a battery of five tests which represent some of the most important basic components of physical fitness. All five tests were concerned with the area of motor fitness while one of these, viz. the 250 metre Shuttle Run, also tested organic efficiency. The tests used in this battery were:

(a) Fifty metre Shuttle Run for Explosive Strength

(b) Sit-ups (for one minute) for Dynamic Strength (Trunk)

(c) Modified pull-up for Girls for Dynamic Strength (Arm)

(d) Medicine Ball Put for Static Strength

(e) 250 metre Shuttle Run for Endurance

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CHAPTER TWO

Physical Fitness Norms, Motor Development in Relation to Age and Sex, Factor Analysis in Physical Fitness Testing - A Review Of Previous Research

2.1 CONSTRUCTION OF NORMS IN PHYSICAL FITNESS

SEVERAL studies involving the construction of norms on physical fitness tests have been undertaken, particularly in the United States of America. (1), (2), (3) Tables of norms in the form of T Scores, Standard Scores and Percentile Scores have been compiled to measure the various elements of the three basic components of physical fitness, viz., the physique aspect, motor fitness and organic efficiency.

CURETON(4) has compiled standard score tables on several tests and measurements for age groups ranging from six to sixty years. In a study of pre-adolescent boys in the age range 6 to 13 years he used a battery of 100 tests which were representative of the three aspects of physical fitness. Standard scores were constructed for physique measures, body type rating, reaction measures, respiratory measures, strength measures and cardio-vascular items.(5)

TABLES of norms for 14 tests in physical fitness for boys and girls ranging in age from 12 to 18 years were constructed by

Fleishman.[6] These tables of norms are presented in percentile form. Some of the tests used in this study were Pull-ups, Leg lifts, Cable Jump, 600 Yard Run-Walk, 50 Yard Dash.

THE American Association for Health, Physical Education and Recreation sponsored a national survey of physical fitness in 1957.[7] A total of 8 500 boys and girls were tested on a battery of seven tests. The tests used were Pull-ups (for girls the Modified Pull-ups Test was used), Sit-ups, Shuttle Run, Standing Broad Jump, Softball Throw, 50 Yard Dash and 600 Yard Walk.

THE same tests were subsequently administered to 10 040 British boys and girls of similar age in 1957.[8]

A comparison between these two groups revealed the following data:

1. British boys and girls were superior to their American counterparts in all areas of fitness measured except the Softball Throw for distance.

2. British girls were superior to American boys at ages 10, 11, 12 and 13 in five of the seven tests.

3. American girls deteriorated badly in upper body strengths (Pull-ups) after 14 years of age, whereas the British girls showed continued improvement.

IN 1956 Yoshiyuki Noguchi[9] administered tests of physical fitness to Japanese children. He used a large sample, and a comparison between American and Japanese children showed that Japanese youths were superior to American youths in endurance, strength and flexibility.

THE results of these comparisons encouraged educational, professional and governmental bodies in America to adopt measures to improve the physical fitness of American people of all ages.

IN South Africa several studies have been undertaken in the field of Physical Education. However, only a few of these are concerned with the construction of norms for physical fitness.

STUDIES by Bodenstein,[10] Du Toit,[11] Human,[12] De Jager,[13] Le Roux,[14] Putter,[15] Van Zijl,[16] and Van der Merwe,[17] are a few that were involved with physical fitness. Only three of the studies referred to above were concerned with girls, viz. those of De Jager, Le Roux and Van Zijl. The study by Bodenstein involved Indian boys in the age groups of 13, 14 and 15 years. Two other studies involving Indian pupils were undertaken by Bodenstein[18] and Roos,[19] while the study by Human mentioned above, also included Indian boys.

DU TOIT[20] carried out a study which involved the drawing up of standard score tables on five selected physical fitness tests among Indian boys from 10 to 14 years of age. A similar study

was undertaken for Indian students at the University of Durban-Westville.[21]

2.2 MOTOR DEVELOPMENT IN RELATION TO AGE AND SEX

ADOLESCENCE is characterised by a number of physiological and structural changes which affect the physical performance of both boys and girls. The changes in body size and physique and in biological and physiological functioning are very well marked in boys during adolescence. The increased leverage, strength and endurance associated with these changes result in large improvements in performance in all motor activities. Although the changes in girls are equally as marked as in boys, both in physique and biological functioning, the changes associated with body size and physiological functioning in girls are not as great as in boys; and furthermore, increments in leverage, strength and endurance are less than for boys.[22] Hence, the performance of girls tends to level off, and in some instances declines with the onset of puberty.

ALTHOUGH there are a number of changes other than those directly associated with puberty which affect physical performance, it is significant that there appears to be no improvement; in fact, there is even performance decrement with the onset of puberty in girls. Figures 2.1 to 2.6, which are based upon averages compiled from the data of a number of investigators, illustrate the changes with age in these activities for boys and girls from 5 to 17 years.[23]

THESE figures show that girls reached their maximum in running at 13 years of age and that there was little change in distance throwing and jumping after this age.

MORE recent cross-sectional studies with an emphasis on physical fitness show a slightly different trend. In a study in California slight improvements in running and jumping were noted for girls of 13 to 16 years.(24)

ESPENSCHADE(25) reported that the failure of girls to improve after puberty in physical performance is, apparently, strongly influenced by cultural milieu.

FIGURE 2.1

DASH - COMPARISON BETWEEN BOYS AND GIRLS (BASED ON DASHES OF UP TO 60 YARDS)

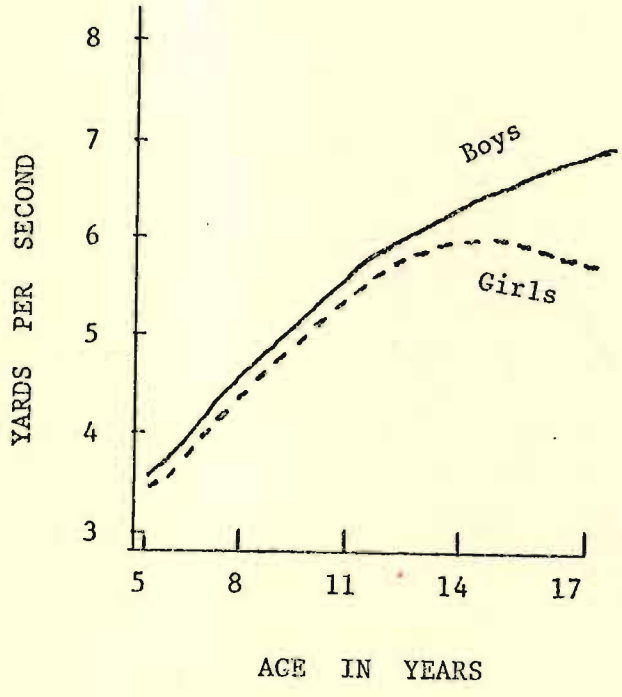


FIGURE 2.2

YOUTH FITNESS TEST NORMS OF 1958 AND 1965 FOR THE 50-YARD DASH

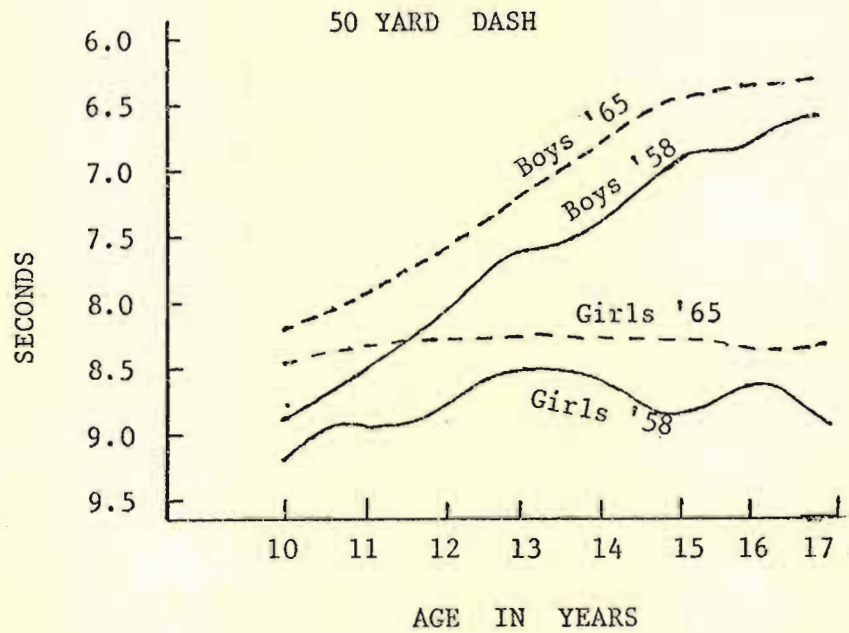


FIGURE 2.3

STANDING BROAD JUMP - COMPARISON BETWEEN BOYS AND GIRLS AT VARIOUS AGE LEVELS

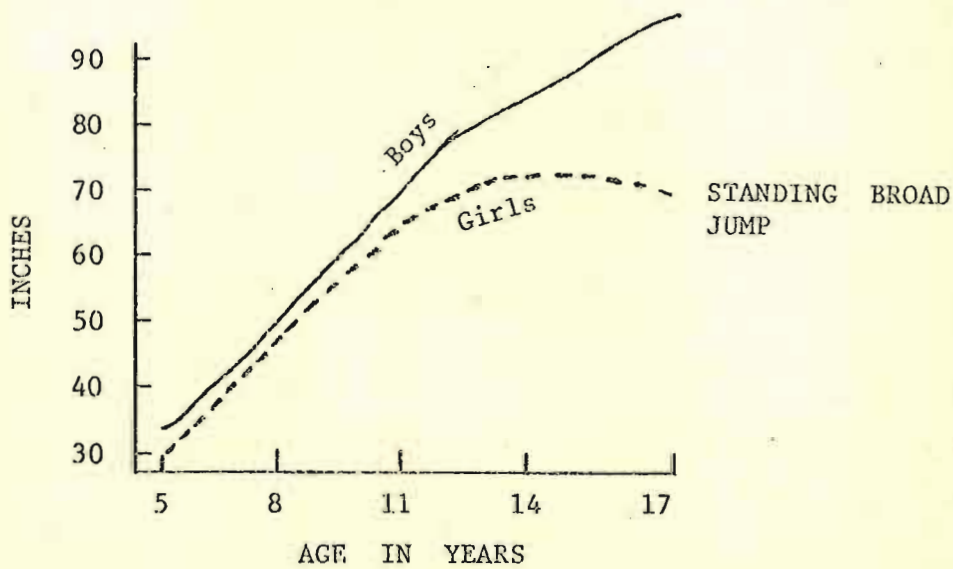


FIGURE 2.4

YOUTH FITNESS TEST NORMS OF 1958 AND 1965

FOR THE STANDING BROAD JUMP

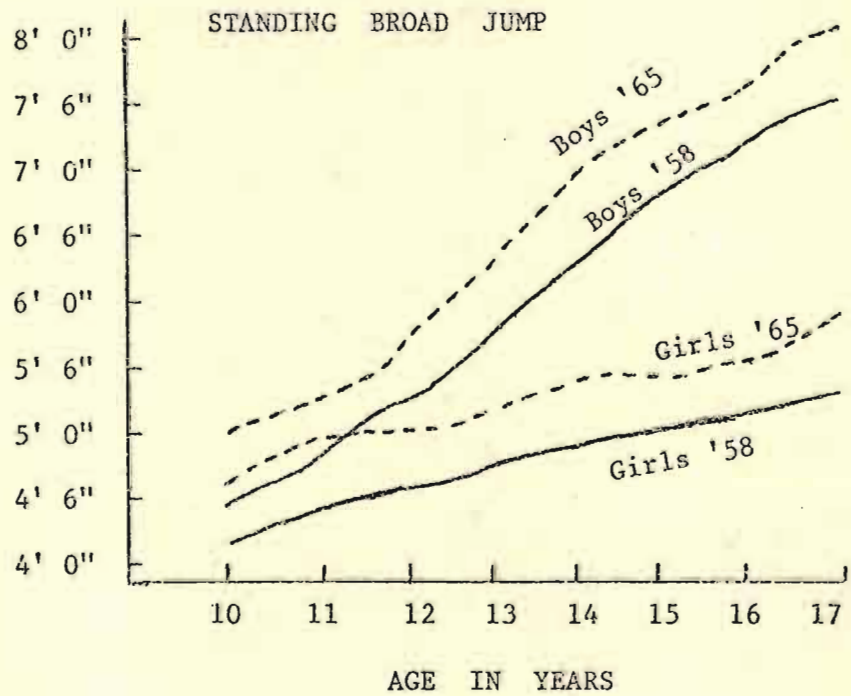


FIGURE 2.5

DISTANCE THROW - COMPARISON BETWEEN BOYS

AND GIRLS AT VARIOUS AGE LEVELS

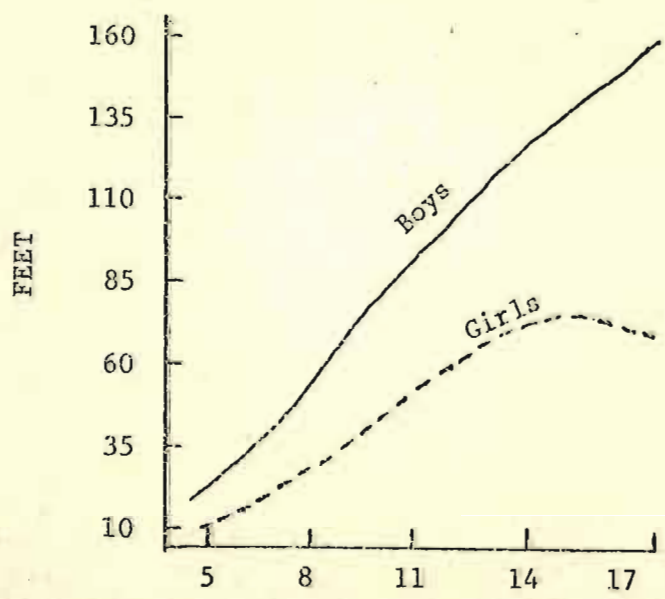
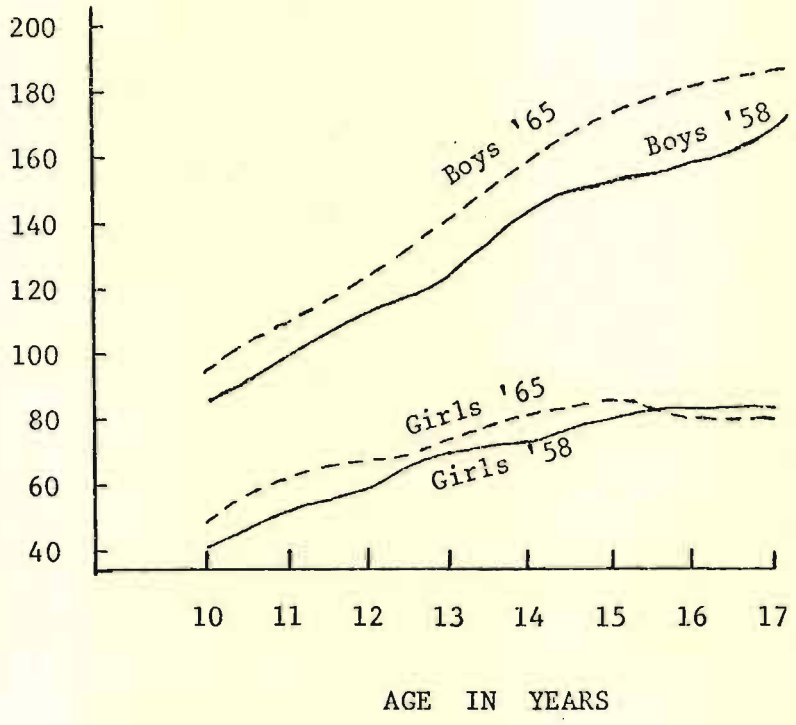


FIGURE 2.6

YOUTH FITNESS TEST NORMS OF 1958 AND 1965

FOR THE SOFTBALL THROW FOR DISTANCE



IN a comparative study of efficiency having special regard to the three components of physical performance, viz., speed, strength and endurance, Jokl *et al*[26] found that in boys, strength and endurance improve throughout maturation at about equal rates. The girls, on the other hand, although they become stronger, become more readily fatigued after puberty. They also reported that the performance in Shot Put increased at the same rate for boys and girls even though boys are generally stronger than girls. In the 600 Yard Run test the performance growth of girls reached a maximum between the ages of 13 and 14 years, after which there was a decline; while the performance of the boys

showed improvement up to adulthood.

ASTRAND[27] reported that, among girls, there was an increase in maximal speed up to the age of 14 after which there seemed to be no improvement.

ASMUSSEN[28] reported that physiological functions relating to sexual maturity have a bearing on performance in physical activities.

FROM the foregoing review of previous research the following observations are made:

1. There are structural and physiological differences between boys and girls at different age levels.

2. During adolescence changes in body size and physique, and in biological and physiological functioning occur differently in boys and girls.

3. While in most activities, boys seem to improve in motor performance from adolescence to adulthood, with the onset of puberty there appears to be no improvement and in some instances a decline in the performance of girls. The decline is particularly noticeable in activities in which the weight is supported by the relatively smaller muscles of the arm and shoulder girdles e.g. Arm Pull.

4. Physical performance appears to reach a peak between the ages of 12 and 14 years in girls. However, there was no evidence that girls suffer physiological damage through participation in physical activities.

5. Occasionally there is concern about the possibility that heavy training may result in increased growth rates in girls; or that on cessation of activity unseemly weight increases may detract from their appearance. No evidence has been found to substantiate these fears.

6. Another factor of concern to girls with regard to training is that of becoming less feminine in appearance because of larger or more *bunchy* muscles. All evidence, however, suggests that properly designed exercise programmes improve rather than hinder feminity. It has been observed, also, that muscular girls are more likely to succeed in such sports as track and field athletics, and therefore they are more likely to want to participate in such activities.

SEVERAL test batteries in use today include tests which are used for both boys and girls. However, it has been found that certain tests are unsuitable for girls, e.g. the Pull-ups test; in which case either a completely different test, or a modified form of the test used for boys, is included to test girls on a specific component. For example, where the Pull-ups test is used

for boys, the girls are tested on either the Modified Pull-ups or the Knee Push-ups.

THE following three are examples of test batteries in use for school-age children, and they are used for both boys and girls.[29]

2.2.1 Indiana Motor Fitness Indices

NORMS are available for high school boys and girls on the following four motor fitness indices which were developed and validated at Indiana University:

1. (Chins + push-ups x vertical jump)
2. (Chins + push-ups x standing broad jump)
3. (Partner chins + push-ups x vertical jump)
4. (Partner chins + push-ups x standing broad jump)

2.2.2 California Physical Performance Test

THIS test battery is a recent development of the California Decathlon for High School Girls and Boys (1918), and the California Physical Fitness Pentathlon (1942). The Test is suitable for boys and girls from grades 5 to 12 and includes the following test items:

1. Standing broad jump, for girls and boys
2. Pull up, for boys
3. Knee push up, for girls
4. Knee bend sit up, for time, for girls and boys
5. Fifty yard dash, for girls and boys
6. Softball throw for distance, for girls and boys

2.2.3 AAHPER Youth Fitness Test Battery

A committee of members of the National Research Council of the American Association of Health, Physical Education Recreation under the direction of Paul A. Hunsicker designed the Youth Fitness Test for boys and girls from the fifth to twelfth grades. National norms were drawn up for these age groups. The Battery consists of the following tests:

1. Pull up, for boys
2. Modified pull up, for girls
3. Sit up, for boys and girls
4. Standing broad jump, for boys and girls
5. Fifty yard dash, for boys and girls
6. Softball throw, for boys and girls
7. 600 yard run and walk, for boys and girls

2.3 FACTOR ANALYSIS IN PHYSICAL FITNESS TESTING

NUMEROUS attempts have been made to identify the basic components of physical fitness but most of these have been of a philosophical nature.

THE fundamental problem is to understand how many kinds of physical fitnesses there are and the relative efficiency of the various tests in predicting each of these types of fitness.

THE factor analysis technique has been developed in recent years

as the best way of factoring out the principal factor and group factors from a matrix of inter-correlations. At the present time this seems to be the most efficient procedure in showing which tests go together and which tests are relatively independent of each other.(30)

2.3.1 A Brief Description of Factor Analysis as applied to Physical Education

THE principle involved in factor analysis may be briefly described as follows:

FIRSTLY a number of tests are selected or developed with certain hypothesized abilities in mind, e.g. the push-ups test may be selected to measure a hypothesized factor of arm strength.

A large number of tests are administered to a large number of subjects. Correlation co-efficients are computed among all the tests. It is assumed that tests which show high correlations with each other measure the same common factor, while tests that are uncorrelated measure different factors. Factors, therefore, represent clusters or groupings of tests which measure some common component.

AS an illustration the following hypothetical example is presented:

IF out of a battery of 15 tests, five tests correlate highly with

one another, but have zero, very low or even negative correlation with the remaining ten tests, then these five tests form a cluster which is called a factor, and which will be referred to as Factor A. Another six tests may correlate with each other, but not with the first five tests. These six tests form a second cluster and will be referred to as Factor B. The average score on the first five tests taken together, and the average score on the next six tests, would represent an individual's scores on the two separate factors, A and B.

HAVING calculated the factor scores, it will now be possible to calculate the correlations of scores on each separate test with each of the two factors. This will indicate how predictive or diagnostic each test is of each factor. This new value is called a "factor loading" and it represents the correlation of each test with a particular factor.

IN the hypothetical example, the first five tests would have high factor loadings on Factor A, but low to zero factor loadings on Factor B. The next six tests will show the opposite trend. It is now possible to describe each of the tests in terms of these two factor loadings.

A close examination is made of the tests which fall on the same factor to ascertain what they have in common, and how they are different from the tests which do not fall on that factor. In this way the factor is "named" in terms of the common requirements assumed, e.g. Shuttle Run, 50 Yard Dash, and the 10 Yard Dash

measure the common factor called Explosive Strength.[31] Table 2.1 presents factor loadings of tests which were originally selected to measure the Dynamic Strength Factor.

TABLE 2.1

LIST OF TESTS AND THEIR LOADINGS ON THE DYNAMIC STRENGTH FACTOR[32]

T E S T S	LOADING
Pull-ups (to limit)	0,81
Pull-ups (in 20 sec.)	0,78
Push-ups (to limit)	0,74
Bent Arm Hang	0,73
Dips (in 10 sec.)	0,70
Push-ups (in 15 sec.)	0,68
Hold Half Push-up	0,68
Rope Climb (in 6 sec.)	0,67
Dips (to limit)	0,63
Squat Thrusts (in 30 sec.)	0,45
50 Yard Dash	0,44
Shuttle Run	0,39
Push Weights-Arms (in 20 sec.)	0,38
Standing Broad Jump	0,35
Leg Raiser	0,35
Leg Lifts (in 20 sec.)	0,32
Sit-ups (in 20 sec.)	0,31
Vertical Jump	0,30
Hold Half Sit-up	0,30

IT is possible for certain tests to have some correlation with more than one factor, e.g. the remaining four tests in the above battery of 15 may have some correlation with most of the other tests, i.e. they probably fall on both factors A and B. The extent to which they measure them depends on the loadings on each factor.

HOWEVER, tests of this type alone in any test battery will make it difficult to identify separate factors. For this reason investigators prefer to select "pure" tests i.e. tests which clearly fall on a particular factor. This eliminates the possibility of ambiguous interpretations.

THUS, when a test battery is selected each indiviudal test in the battery will have a relatively high loading on a specific factor, and low to zero loadings on other factors which may be included in the battery.

2.3.2 Factor Analysis Studies applied to Physical Education

THE factor analysis technique is not new. It has been applied to a large number of studies in education, and more recently to a number of studies in health and physical education.

McCLOY[33] reviews these studies in the Health and Physical Education field up to 1940 and concludes on the basis of a critical analysis of the various factor analysis methods that the Thurstone multiple factor procedure is the most meaningful and is directly applicable to the study of physical fitness problems. McCloy mentions such factors as muscular strength, dynamic energy, ability to change direction, flexibility, agility, good vision, good peripheral vision, concentration, understanding mechanics, absence of emotional complications, spatial judgment, complex co-ordination, arm control factors in balance, timing, motor rhythm, general kinesthetic sensitivity and control, and aesthetic feeling. Not all of these factors were derived from actual factor analyses, though most of them were.

THE studies which have some relation to physical fitness deserve special consideration, and particularly the factors in general motor fitness.

McCLOY,[34] in his study in 1935, demonstrated that there were three common factors in what he termed "general motor capacity or motor ability", viz. (a) Strength, (b) Velocity and (c) Large muscle co-ordination.

IN 1936 Emma McCloy[35] presented a similar study showing results supporting three factors (a) Strength, (b) Velocity and (c) Dead Weight.

WENDLER,[36] in 1935, made a factor analysis of 40 events including a number of motor ability events and strength items. He isolated (a) Strength as the most important factor, other factors being (b) Velocity, (c) Motor Educability and (d) Sensory-Motor Co-ordination.

ROULHAC,[37] in 1940, identified four factors viz. (a) Speed, (b) Co-ordination, (c) Endurance, and (d) Dead Weight.

LARSON,[38] in 1940, factored a correlational matrix of 15 athletic events, using test results on one hundred and fifty college men, and identified two factors: (a) Dynamic Strength and (b) Static Dynamometer Strength.

CURETON[39] established a balanced 30-item criterion in 1942 and, from data on 171 men, obtained validity and inter-correlations for six groups of items, five in each group being scored on a weighted point score basis. The factor analysis showed that the inter-correlations between the groups of balance, flexibility, agility, strength, power and endurance produced three factors: (a) Flexibility, (b) Kinesthetic Sense and Agility, and (c) Muscular Strength.

LATHAM[40] further analysed the data gathered by Cureton and

factor-analysed the 14 test items in the Illinois Motor Fitness Test and obtained six factors:

(a) Endurance

(b) Power

(c) Strength

(d) Agility

(e) Flexibility

(f) Balance

IN a review of literature on physical fitness factors, Fleishman[41] presents a basis for describing the multiplicity of available tests in terms of the fitness factors which they measure. These factors seemed to fall into certain broad areas of ability, viz.:

(a) Strength

(b) Flexibility - speed

(c) Balance

(d) Co-ordination

(e) Endurance

WHEN inter-correlations among tests in each of these areas were computed other factors emerged repeatedly, and Fleishman identified 14 factors of physical proficiency as follows:

(a) Strength Area

Explosive Strength

Dynamic Strength

Static Strength

(b) Flexibility-Speed Area

Extent Flexibility

Dynamic Flexibility

Speed of Change of Direction

Running Speed

Speed of Limb Movement

(c) Balance Area

Static Balance

Dynamic Balance

Balancing Objects

(d) Co-ordination Area

Multi-limb Co-ordination

Gross Body Co-ordination

(e) Endurance Area

FLEISHMAN[42] undertook two large-scale follow-up studies to clarify the factor definitions of previous research. One study[43] carried out at the Great Lakes Naval Training Centre, Illinois, involved an investigation of the strength and related areas. The other study which involved an investigation of some ability areas which minimize strength and emphasize such features as speed, flexibility, balance, and co-ordination was undertaken at San Diego.[44] Thirty tests were developed for each of these studies. From these investigations, Fleishman isolated nine factors as

follows:

(a) Strength Area (Great Lakes study)

Explosive Strength

Dynamic Strength

Static Strength

Trunk Strength

(b) Speed-, Flexibility-, Balance-, Co-ordination Area (San Diego study)

Extent Flexibility

Dynamic Flexibility

Gross Body Equilibrium

Balance with Visual Cues

Speed of Limb Movement

THUS, Fleishman reported ten physical fitness factors, made up of the nine which he isolated in the two studies referred to above, and the Endurance factor.

FLEISHMAN has specified the tests which seem to provide the best measures of each factor. Table 2.2, extracted from Fleishman's factor matrix in the Strength area, provides a basis for selecting tests which provide "purest" measures of each factor, i.e. high loading on one factor and close to zero loading on other factors. The standard deviation and the test-retest reliability for each test are also included in the Table.

TABLE 2.2

STANDARD DEVIATIONS, AND RELIABILITIES OF TEST SCORES AND FACTOR LOADINGS OF TESTS (GREAT LAKES STUDY)[45]

TEST	SD	REL. r	FACTOR LOADINGS			
			ES	DS	TS	SS
Leg Lifts	3,50	0,84	0,23	0,32	0,47	0,13
Push-ups (in 15 sec.)	3,86	0,76	0,23	0,68	0,22	0,15
Reverse Sit-ups	3,78	0,76	0,26	0,04	0,06	0,04
Deep Knee Bends	4,57	0,85	0,25	0,25	0,21	0,08
Sit-ups	4,15	0,72	0,33	0,31	0,23	0,05
Squat Thrusts	4,46	0,70	0,11	0,45	0,14	0,11
Pull Weights-Arms	11,34	0,80	0,22	0,11	0,08	0,33
Hand Grip	18,36	0,91	0,03	0,09	-0,09	0,72
Push Weights-Arms	3,58	0,90	0,21	0,38	0,11	0,51
Arm Pull-Dynamometer	29,68	0,83	0,03	0,16	-0,02	0,71
Push Weights-Feet	3,46	0,78	0,08	0,25	0,26	0,35
Trunk Pull-Dynamometer	34,61	0,67	0,06	-0,13	0,13	0,59
Rope Climb	2,35	0,80	0,41	0,67	-0,01	-0,03
Dips (in 10 sec.)	2,19	0,92	0,33	0,70	0,16	0,09
Vertical Jump	2,66	0,90	0,64	0,30	-0,02	0,18
Dips (to limit)	4,46	0,91	0,27	0,63	0,17	0,05
Standing Broad Jump	8,73	0,90	0,66	0,35	0,11	0,15
Leg Raiser	35,63	0,71	-0,02	0,35	0,43	-0,10
10 Yard Dash	0,14	0,62	0,70	0,28	0,12	0,07
Bent Arm Hang	13,54	0,77	0,16	0,73	0,18	-0,06
50 Yard Dash	0,45	0,86	0,75	0,44	0,02	0,07
Pull-ups (to limit)	3,61	0,93	0,29	0,81	-0,07	-0,05
Shuttle Run	1,08	0,85	0,77	0,39	0,04	-0,04
Pull-ups (in 20 sec.)	2,00	0,95	0,40	0,78	-0,10	0,04
Medicine Ball Put (Standing)	2,73	0,70	0,25	0,09	0,06	0,71
Hold Half Sit-up	21,81	0,88	0,13	0,30	0,45	0,09
Medicine Ball Put (Sitting)	1,41	0,73	0,26	0,02	0,11	0,44
Hold Half Push-up	21,98	0,85	0,08	0,68	0,12	0,05
Softball Throw	26,58	0,93	0,54	0,09	0,25	0,32
Push-ups (to limit)	7,99	0,88	0,04	0,74	0,17	0,14

KEY : ES : Explosive Strength
DS : Dynamic Strength
TS : Trunk Strength
SS : Static Strength

FLEISHMAN reported that the area which appeared to be most clearly defined in factor analysis literature was the area of strength. He also observed that there was a close relationship between endurance and the strength area.

IN the present study the components selected were the three strength areas, viz. Explosive Strength, Dynamic Strength, and Static Strength and the Endurance Factor. These four components are concerned with large muscle areas which are characteristic of motor fitness, with which this study is specifically concerned.

THE strength area was selected because it was the most clearly defined in previous research, and, together with the endurance factor, would produce an adequate idea of the physical fitness status of individuals.

IT is of some importance to note that batteries in widespread use tend to emphasise only, or mainly, the strength area.

2.4 SELECTION OF TESTS FOR THE STUDY

IN the present study five tests were selected to measure the three strength components and the endurance factor. Table 2.3 presents the tests and the components which they measure.

TABLE 2.3

TESTS SELECTED FOR PRESENT STUDY

AND THE COMPONENTS THEY MEASURE

TEST	NAME	COMPONENT
A	50 Metre Shuttle Run	Explosive Strength
B	Sit-ups (in one minute)	Dynamic Trunk Strength
C	Pull-ups (to limit)	Dynamic Arm Strength
D	Medicine Ball Put	Static Strength
E	250 Metre Shuttle Run	Endurance

THE selection of the tests has been based largely on data provided by the Great Lakes Study in which Fleishman[46] tested 201 subjects whose average age was 18 years 3 months. Some statistical details of the thirty tests which were used in that study are presented in Table 2.2 above.

FLEISHMAN[47] asserted that a minimal test battery in the strength area would employ one test for each factor, which he claimed would adequately reproduce most of the information which can be derived from all tests loading on the same specific factor. A description of the components and a few tests which measure these components are given in the following pages.

2.4.1 Explosive Strength[48]

THIS factor appears to emphasise the ability to expend or exert a maximum of energy in one or a series of explosive efforts. In some earlier studies this factor has been referred to as speed and velocity, and agility.

THE common feature of tests of Explosive Strength is that one is required to exert either a single short burst of effort, or a series of such bursts, rather than a continuous stress or repeated exertion.

SHORT runs, dodging runs and shuttle runs, due to the "push-off" type motions involved in these tasks, were found to have appreciable loadings on this factor.

IN the present study the 50 metre Shuttle Run was selected as a test for this factor. Fleishman found this type of run to have a very high correlation (0,77) on this component.

ALTHOUGH the Shuttle Run used in this study was not over the same distance, it approximated to that used by Putter[49] in his study. Fleishman used a distance of 100 yards completed in five runs, and Putter used a distance of 60 yards completed in 6 runs; whereas in this study 50 metres completed in five runs was used. This change was made to conform with metric measure.[50] Putter found a correlation of 0,745 between the 60 yard shuttle run and the 60 yard dash which is a recognised test for this component.

Fleishman found the 50 metre dash to have a factor loading of 0,75 with this component.

THE following table includes some of the tests which Fleishman found to have a factor loading on this component:

TABLE 2.4

TESTS WITH LOADING ON EXPLOSIVE STRENGTH[51]

TESTS	FACTOR LOADING
Shuttle Run	0,77
50 Yard Dash	0,75
10 Yard Dash	0,70
Sit-ups (in 30 seconds)	0,33

THE four tests in this table have been extracted from Fleishman's table to serve as an illustration. It must be observed that the sit-ups test is not a satisfactory test for this component.

2.4.2 Dynamic Strength[52]

DYNAMIC strength involves the ability to exert muscular force repeatedly or continuously over a period of time. It is also a test of muscular endurance and emphasises the resistance of the muscles to fatigue. The majority of the tests defining this factor involve arm muscles where the arms are required to move or

support the weight of the body. A few tests which have been used to measure this factor are given in the following table:

TABLE 2.5

TESTS WHICH LOAD ON THE DYNAMIC STRENGTH FACTOR

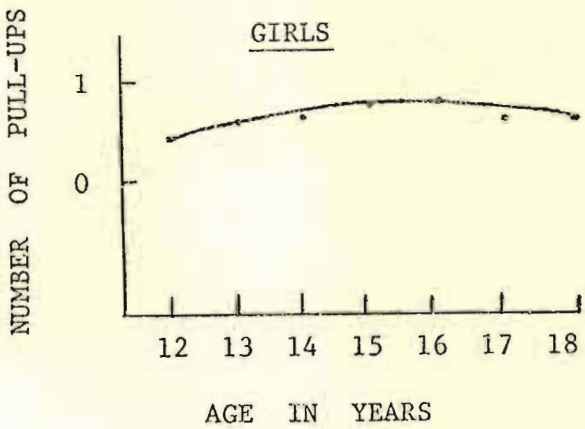
(Extracted from Fleishman's list of tests loading on this factor) (53)

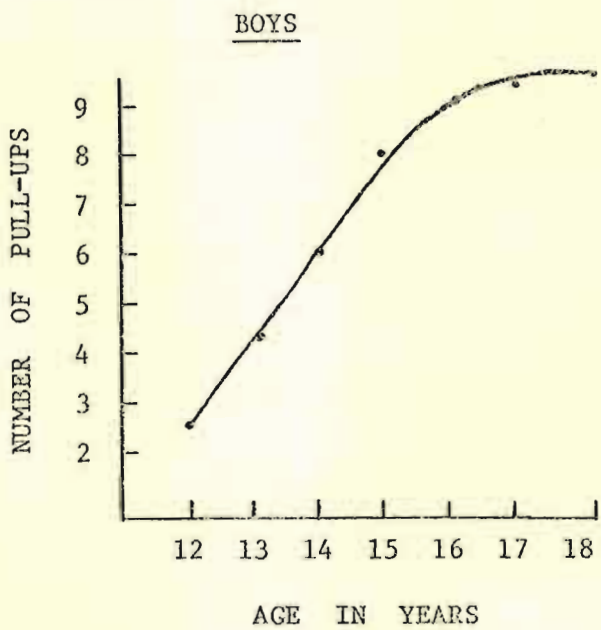
TESTS	FACTOR LOADING
Pull-ups (to limit)	0,81
Push-ups (to limit)	0,74
Bent Arm Hang	0,73
Rope Climb (in 6 seconds)	0,67

THE Pull-ups (to limit) test is a widely recognised test for measuring arm strength among boys. However, this test was found to be unsuitable for girls. This is clearly shown in the following figure. The development curve for boys is included for comparison.

FIGURE 2.7

DEVELOPMENT CURVES FOR THE PULL-UPS TEST FOR BOYS AND GIRLS





(54)

IN the present study the Modified Pull-ups (to limit) test[55], [56] was used to measure the Dynamic Strength component for arm muscles.

THE Dynamic Strength factor was found to extend beyond the arm-

muscles group, to tests involving the trunk muscles. Sit-ups, Leg Lifts and Leg Raisers are examples which emphasise the strength of the trunk muscles. The factor loadings of these tests, viz. 0,31, 0,32 and 0,35 respectively on this factor are low, and they are, therefore, imperfect measures of the Dynamic (Trunk) Strength factor. However, these three tests are the best measures of this factor. Of the three tests, the Sit-ups test seems to be the most commonly used in test batteries. The Sit-ups test was chosen for the present study, but it was modified. Whereas Fleishman's Sit-ups was done with straight knees and for 30 seconds. The subjects in the present study were required to do the test with bent knees for one minute. The test was done with bent knees to minimise the effect of the quadriceps group of muscles and to emphasise the muscles of the trunk. The time for the test was increased to one minute as this longer time gives a higher reliability. The reliability coefficient for the one minute Sit-up is presented in Chapter Four. Fleishman[57] obtained a reliability coefficient of 0,72 on his 30 second Sit-ups. In the study at the University of Durban-Westville the reliability coefficient for the bent-knee Sit-ups done in two minutes was 0,83.[58] However, the time of two minutes was found to be too long for the girls.

2.4.3 Static Strength[59]

STATIC strength involves the application of force against some external resistance, e.g. a dynamometer, a relatively heavy

weight, or some fairly immovable or heavy object.[60], [61] The important feature of this test is that a maximum force should be exerted for a brief period of time, where the force is exerted continuously up to this maximum. Whereas Explosive Strength and Dynamic Strength involved a substantial movement of the body or limbs, in Static Strength the force is exerted against external objects and not in supporting one's own body weight.

FLEISHMAN[62] found that weight and height are positively related to this component with factor loadings of 0,70 and 0,42 respectively.

TABLE 2.6

TESTS WHICH LOAD ON THE STATIC STRENGTH FACTOR

(Extracted from Fleishman's list of tests loading on this factor) (63)

TESTS	FACTOR LOADING
Hand Grip	0,72
Arm Pull-Dynamometer	0,71
Medicine Ball Put (Standing)	0,71
Medicine Ball Put (Sitting)	0,44
Softball Throw	0,32

IN the present study the Medicine Ball Put (standing) test was used to measure Static Strength.

ALTHOUGH there appears to be certain drawbacks in using the medicine ball - viz. it is unwieldy, it could not be put far, and it must be put from a static position with very little leverage - there are two important reasons for selecting the Medicine Ball Put test. Firstly, the medicine ball is more readily available at schools and it is cheaper than the Hand Grip and the Arm Pull Dynamometer. Secondly, it seems evident that the heavier the object to be "put" or "thrown" the higher will be the loading on this factor.[64] This is borne out by the fact that the Softball Throw loaded only 0,32 on this factor.

2.4.4 Endurance[65]

THIS factor seems to represent prolonged exertion of the whole body, and seems to be indicative of organic efficiency, particularly cardio-vascular or stamina. This is distinct from muscular endurance in the Strength area, which could be measured by tests such as Dips, and Pull-ups when performed over time.

SEVERAL studies[66], [67] with physical fitness tests have isolated this factor of Endurance which has been defined by long runs in various studies.[68], [69] Tests which have been used to measure cardio-vascular endurance include Step Test, Treadmill Test and the 600 Yard Run-Walk.[70]

THE test used to measure the Endurance factor in the present study was the 250 Metre Shuttle Run[71] which is similar to Putter's[72] 800 Feet Shuttle Run. Putter's test was completed in 40 runs over a distance of 20 feet; whereas in the present study the distance was covered in 25 runs over 10 metres. The change to this new distance was made to comply with metric measure, the difference between the two distances being small.

PUTTER obtained a correlation of 0,624 between his shuttle run and the 880 Yard Run which is a recognised test for this component. In the present study a correlation of 0,726 was obtained between the 250 Metre Shuttle Run and the 600 Yard Run.

THE 250 Metre Shuttle Run was preferred to both the 600 Yard Run and the 880 Yard Run because of the limited space that is available at a number of schools. (Reference to this is made in Appendix B.2).

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N.B.: Reference No. 18 must be ignored as it was erroneously included.

CHAPTER THREE

Method of Study

3.1 COLLECTING THE DATA

THE tests were administered at the schools referred to in Appendix C between September and December 1973 after permission was obtained from the Director of Indian Education.

CARE was taken to avoid disruption of the normal school programme. Prior arrangement was made with the principals of the schools where the tests were carried out.

THE ten pupils who were tested in each age group at each school were selected at random from a list of names supplied by the school. The name of each pupil was written on a slip of paper and put into a box. The slips of paper were then mixed thoroughly. Ten slips were picked out of the box. The pupils did the tests in suitable clothes. For the sake of consistency pupils did the tests with bare feet.

ALL tests were administered out of doors on a dry grass surface.

A brief explanation of the procedure to be followed was given. The tests were demonstrated, and each subject was allowed a trial attempt in the different tests so that she knew exactly what was

required of her. Pupils were encouraged to give of their best at all times. Each subject was given a score sheet on which she recorded her name, age, height and weight. Test scores were recorded by the examiner or his assistant.

A check was made to ensure that the subjects were free from injury, physical defect or any other condition which could have affected the tests adversely, thus invalidating the results.

THE tests were given in the following order:

1. 50 m Shuttle Run
2. Sit-ups
3. Pull-ups
4. Medicine Ball Put
5. 250 m Shuttle Run

3.2 DESCRIPTION AND ADMINISTRATION OF THE TESTS

THE tests described here have been selected on the basis of the criteria outlined in chapter two. The reliability co-efficient and the factor loading for specific components of each of the tests were found to be high. The five tests described below are frequently used in test batteries, and they measure the most important elements of physical fitness.

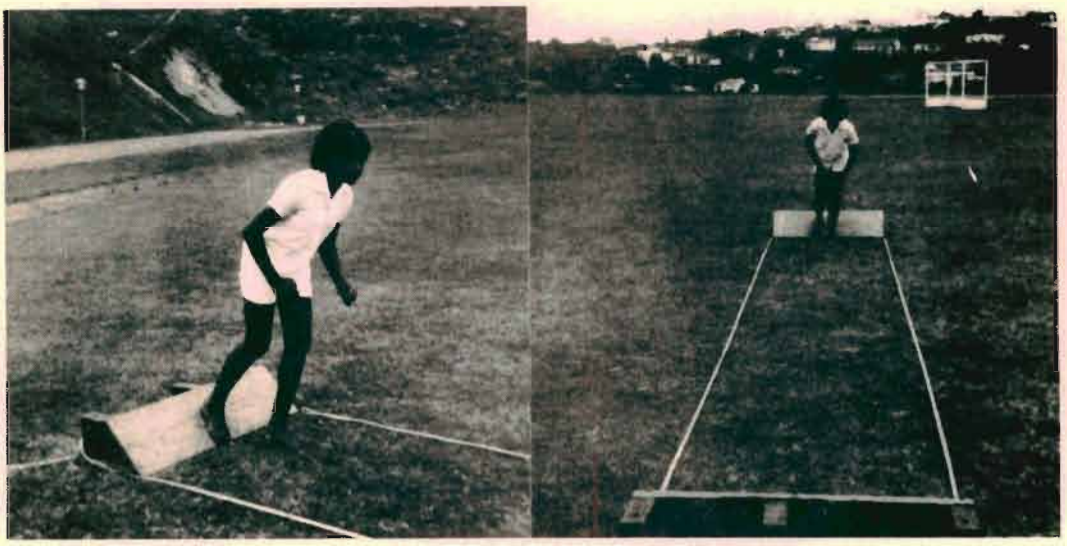
3.2.1 Fifty Metre Shuttle Run[1]

THE run was made on a grass surface of area 10 x 1 metres. The

distance to be covered was indicated by two planks placed at the turning points at an angle of 45^{0} to the ground and parallel to each other. The planks were fixed to the ground as shown in the following figure and measured 1 m x 30 cm x 1,25 cm.

FIGURE 3.1

TURN-OFF PLANKS, DISTANCE FOR 50 METRE SHUTTLE RUN



THE subject stood with one foot against the plank at the preferred end and commenced her run on the command "GO!", this being preceded by the word "READY". On the command "GO!" she ran to the opposite end as fast as she could, stepped against the other board with either foot and returned to the first plank to repeat the procedure. The distance between the two planks was covered five times to complete 50 metres. On the last lap the subject was told to exert maximum effort and to run over the plank at the finishing end to complete the distance in the fastest time possible.

Before the test the subject was allowed a "dummy" run to ensure an efficient turn-around movement. The time, to the nearest tenth of a second, was taken as she crossed the plank at the end of the fifth run.

3.2.2 Sit-ups[2] (One Minute)

THE subject started from a supine position on the ground, with hands clasped behind the neck. She then plantar-flexed both feet and brought them toward the buttocks until they were flat on the ground. A partner held her feet firmly down on the ground. She pulled herself up to a vertical position as many times as possible in one minute.

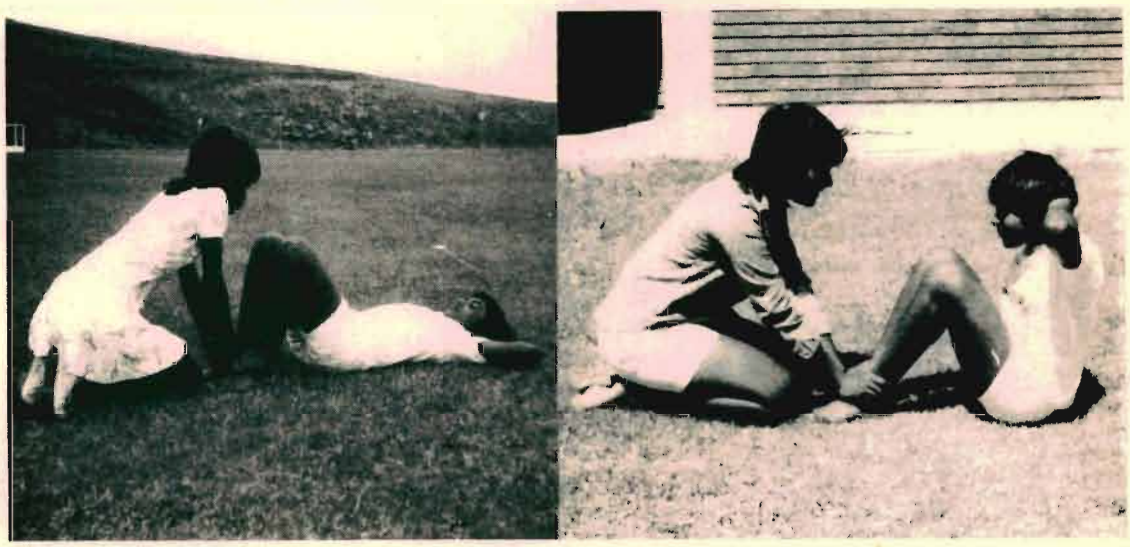
A full sit-up was executed when the subject raised her trunk until the lower back was perpendicular to the ground, and returned to the starting position. Both shoulders were required to touch the ground before each sit-up, and the subject was cautioned that her trunk was not to go further forward than a 90 degree angle with the ground. She was not allowed to touch her knees. To emphasise the trunk, jerky movements were discouraged and the hands were kept behind the neck and not behind the head.

THE exercise was done rapidly and continuously. A demonstration was given and the subject tried it two or three times to get the feel of it. One point was awarded for each complete movement. No point was scored if the subject unclasped her hands from behind her neck. The total score was the number of times the vertical

position was attained in one minute.

FIGURE 3.2

SHOWS THE STARTING AND SIT-UP POSITIONS OF THE TEST



3.2.3 Modified Pull-up Test for Girls[3], [4]

THE test was performed from an adjustable bar adjusted to approximately the height of the apex of the sternum, thus requiring each girl to pull approximately the same proportion of her weight.

THE subject grasped the bar with palm facing away from the body, i.e. the over-grasp grip. She had to slide her feet under the bar until her straight body and her arms were at right angles. The weight rested on the heels. To prevent the heels from slipping a heel rest was fixed into the ground once she had assumed the

required starting position.

IN this test the subject had to pull up to the bar, with body perfectly straight, by pivoting on her heels until her chin was level with her hands. She then lowered herself to the starting position with arms and body straight. The subject had to pull a "dead" weight, the exercise being performed by the muscles of the arms and shoulder girdles only.

ONE pull-up was counted when the subject pulled herself up and returned to the starting position, and this exercise was repeated until the maximum was reached. A half credit was recorded if any of the following was observed:

(a) if the subject did not pull the full distance, or did not lower to a fully extended position of her arms;

(b) if she bent her body i.e. allowed her body to sag or raised her hip;

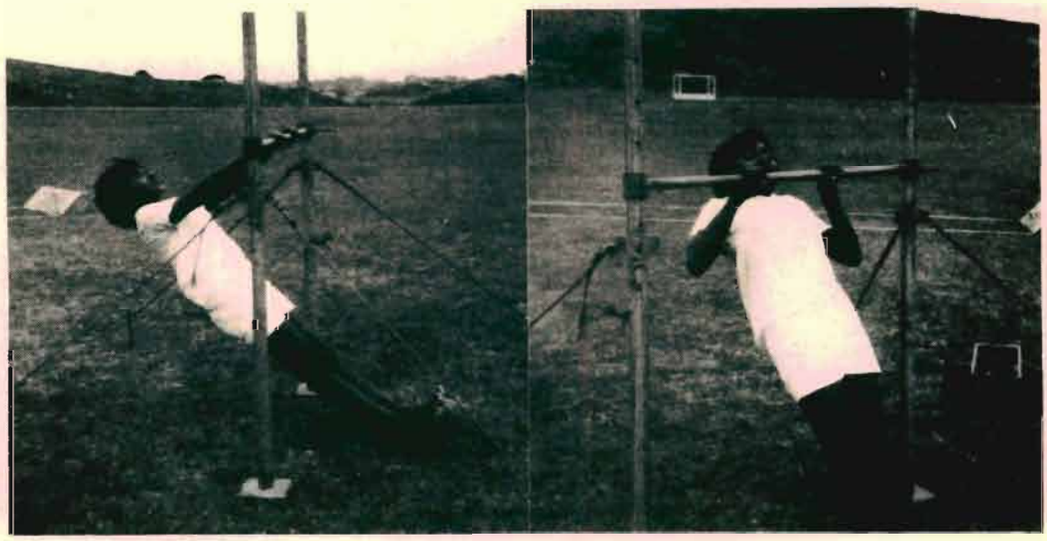
(c) if she bent her knee, or assisted the movement with a foot thrust.

ONLY four half-credits were permitted. At the fifth incomplete performance, the subject was stopped and the test was repeated after a rest period. The score was recorded to the nearest whole number.

COUNTING was audible to the subject, being made sharply at the end of each evolution and the reason for each half count was given at the time it occurred.

THE position of the body at the start of the test was most important and this was demonstrated before the test. The following figures show the starting and heave positions:

FIGURE 3.3



3.2.4 Medicine Ball Put - Standing

THE medicine ball used had a mass of 4.45 Kg. The subject held the ball in her preferred hand and balanced it with the other hand. She placed her forward foot behind a base line and placed her other foot in a comfortable position. Once in position she was not allowed to move her feet although she could twist her body. In order to prevent her from lifting the heel of her back foot, a partner held it down firmly. This was done to emphasise the arm-

shoulder involvement and to minimise leg contributions, i.e. a static position was aimed at. The subject was to throw the ball as far as possible with one hand. If the form was wrong, the throw did not count, but the subject was allowed three correct throws. The distance of the best throw out of three measured in centimetres was recorded.

FIGURE 3.4

SHOWS THE STARTING POSITION OF THE MEDICINE BALL PUT

3.2.5 250 Metre Shuttle Run[6]

THE run was made on a grass surface area of 10 x 1 metres. The subject stood behind one of the lines in a chosen starting position. She started her run on the command "GO!" which was preceded by the word "READY". On the signal "GO!" she ran the 10 metres to the

second line at the opposite end, bent over it and touched the ground on the other side with both hands. She then turned around and returned to the starting line to repeat the procedure. She completed the 250 metres in 25 runs. On the last lap she ran across the finishing line i.e. the line at the opposite end of the starting line. The subject was advised to maintain an even pace.

THE score was the time it took the subject to complete the 25 runs. The time taken as the subject crossed the finishing line at the end of the 25th run was recorded in seconds to the nearest tenth of a second. Only one attempt was allowed.

3.3 STATISTICAL METHODS

THE statistical methods employed in the various computations are summarised as follows:

3.3.1 Means

THE means were calculated by dividing the sum of the raw scores for each test by 100, which was the number of subjects tested:

$$M = \frac{\text{Sum of Scores}}{N}$$

3.3.2 Standard Deviation

IN calculating the standard deviation the technique of

grouping the raw scores was employed to make the data manageable. The formula used to arrive at the standard deviation was

$$SD = \sqrt{\left\{\left[\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2\right]\right\}} \; i \qquad (7), (8)$$

where SD = standard deviation

Σ = sum of

f = frequencies

d = deviations from the mean

i = size of interval

3.3.3 Standard Error of Measurement ($S.E._{meas}$)

THE formula used to calculate the standard error of measurement was

$$SE_{meas} = SD\sqrt{(1 - r)} \qquad (9)$$

where SD = standard deviation

r = reliability coefficient for test

3.3.4 Standard Error of Mean ($S.E._{mean}$)

THE $S.E._{mean}$ for each test in all age groups was calculated by using the formula

$$SE_{mean} = \frac{SD}{\sqrt{N}} \qquad (10), (11)$$

where SD = standard deviation of sample

and N = size of sample

3.3.5 CR Test of Significance

THE CR test for the significance between means was used to determine whether or not there were significant differences between the different age groups on the various tests. The following formula was used for the calculation of the critical ratio:

$$CR = \frac{M_2 - M_1}{\sqrt{\left[(SE_{mean_1})^2 + (SE_{mean_2})^2\right]}} \qquad (12)$$

where CR = critical ratio

M_2 = mean of second sample (large mean)

M_1 = mean of first sample

SE_{mean_1} = standard error of mean of first sample

SE_{mean_2} = standard error of mean of second sample

3.3.6 Reliability

RELIABILITY coefficients, using the test-retest technique, were calculated for all five tests. The formula used in computing the reliability coefficient was the Pearson's Product Moment Correlation:

$$r = \frac{\Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{N}}{\sqrt{\left\{\left[\Sigma X^2 - \frac{(\Sigma X)^2}{N}\right]\left[\Sigma Y^2 - \frac{(\Sigma Y)^2}{N}\right]\right\}}} \quad (13)$$

where r = reliability coefficient

Σ = sum of scores

X = individual scores in initial test

Y = individual scores in retest

N = number of people in sample

3.3.7 Standard Scores

THE Standard Score is used as a 100-point common denominator score computed according to the statistical equation:

$$\frac{6\ SD}{100} = \text{standard score in 100 units.} \quad (14)$$

Each increment of 5 standard scores is then computed according to the equation:

$$\frac{6\ SD}{100} \times 5 = \text{standard scores in 20 units.} \quad (15)$$

These are equal increment units over a range of six standard deviations, i.e. three above and three below the mean. Each unit is valued at 5 points.

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CHAPTER THREE

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CHAPTER FOUR

Analysis and Presentation of Results

4.1 MEANS AND STANDARD DEVIATIONS

IN Table 4.1 the means and standard deviations for each of the five tests in the different age groups are presented.

TABLE 4.1

MEANS AND STANDARD DEVIATIONS

Age in Years	50 Metre Shuttle Rn		One Minute Sit-Ups		Pull-ups To limit		Medicine Ball Put		250 Metre Shuttle Rn	
	Mean (Sec)	SD	Mean (No)	SD	Mean (No)	SD	Mean (Cm)	SD	Mean (Sec)	SD
10	15,8	1,06	13,6	8,0	24,5	9,0	230,0	48,0	103,4	6,16
11	15,1	0,90	15,9	7,9	28,7	12,5	277,2	53,4	99,3	5,40
12	15,1	0,75	17,1	7,4	17,8	5,2	322,0	61,4	99,1	5,63
13	15,0	0,96	16,0	7,0	18,0	5,8	349,6	52,6	98,4	6,55
14	15,1	1,24	16,2	6,3	16,5	5,0	387,2	56,5	101,7	7,20
15	15,1	1,14	15,7	7,8	18,0	6,1	397,0	50,4	101,9	7,80
16	14,7	0,79	19,0	6,0	20,0	8,3	418,8	67,2	100,6	6,30
17	14,6	0,80	19,0	6,4	19,0	5,0	427,0	55,3	102,1	7,50

4.2 RELIABILITY COEFFICIENT

TABLE 4.2 presents the test-retest reliability coefficients for each test in this study. The correlations were obtained by testing twenty girls in the various age groups. The retest was done one week after the original testing.

TABLE 4.2

TEST-RETEST RELIABILITY COEFFICIENTS FOR THE FIVE TESTS

(1), (2)

Test	Correlation Coefficient	Significance at 1% level
50 m Shuttle Run (Explosive Strength)	0,80	Significant
Sit-ups (for one minute) (Dynamic Trunk Strength)	0,89	"
Pull-ups (to limit) (Dynamic Arm Strength)	0,81	"
Medicine Ball Put (Static Strength)	0,92	"
250 m Shuttle Run (Endurance)	0,78	"

4.3 STANDARD ERRORS OF MEASUREMENT

THE standard errors of measurement for the five tests per age group are summarised in Table 4.3 below:

TABLE 4.3

	AGE GROUPS							
TEST	10	11	12	13	14	15	16	17
50 m Shuttle Run	0,47	0,40	0,33	0,33	0,55	0,51	0,35	0,36
Sit-ups	2,65	2,62	2,45	2,32	2,06	2,55	1,99	2,12
Pull-ups	3,92	5,45	2,27	2,53	2,18	2,66	3,62	2,13
Med. Ball Put	13,57	15,10	17,36	14,87	15,98	15,02	19,00	15,61
250 m Shuttle Run	2,91	2,53	2,63	3,05	3,38	3,66	2,95	3,52

4.4 STANDARD ERRORS OF MEAN

A summary of the standard errors of the mean is given in Table 4.4 below:

TABLE 4.4

	AGE GROUPS							
TEST	10	11	12	13	14	15	16	17
50 m Shuttle Run	0,11	0,09	0,08	0,09	0,12	0,11	0,08	0,08
Sit-ups	0,80	0,79	0,74	0,74	0,62	0,77	0,60	0,64
Pull-ups	0,90	1,25	0,52	0,58	0,50	0,61	0,83	0,49
Med. Ball Put	4,80	5,34	6,14	5,26	5,65	5,31	6,72	5,52
250 m Shuttle Run	0,62	0,54	0,56	0,65	0,72	0,78	0,63	0,75

4.5 HISTOGRAMS

FIGURES 4.01 to 4,40 show the distribution of the scores for the different tests and age groups presented in the form of histograms.

HISTOGRAMS FOR AGE GROUP 9:7 TO 10:6 YEARS

FIGURE 4.01

50 METRE SHUTTLE RUN

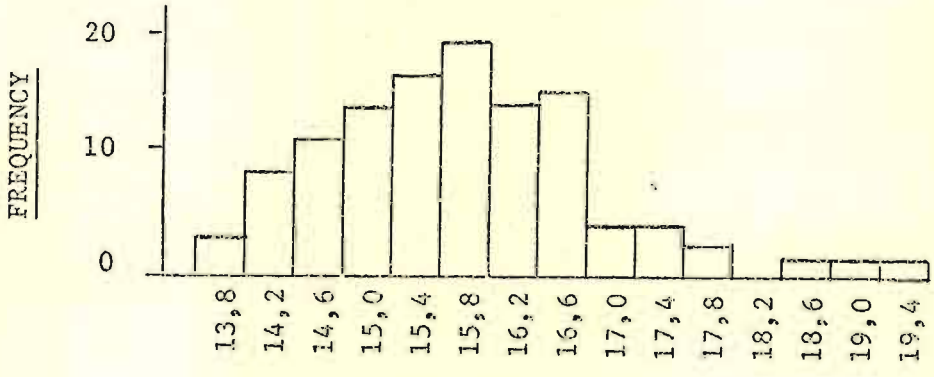


FIGURE 4.02

SIT-UPS IN ONE MINUTE

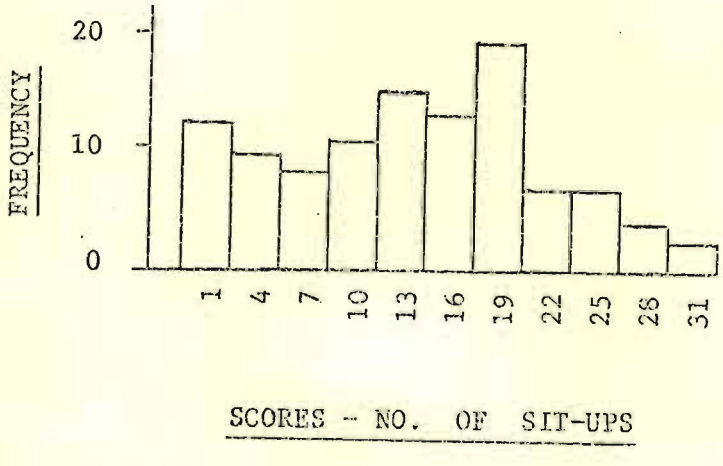
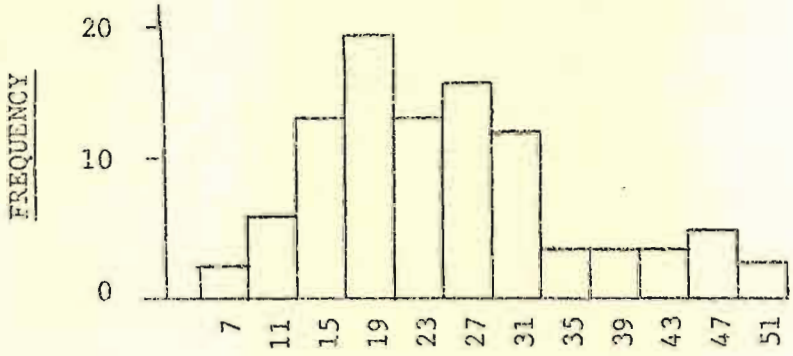


FIGURE 4.03

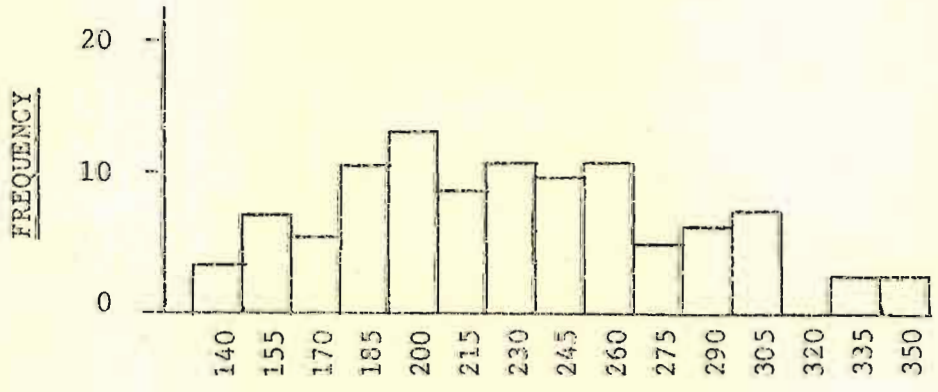
PULL-UPS TO LIMIT



SCORES - NO. OF PULL-UPS

FIGURE 4.04

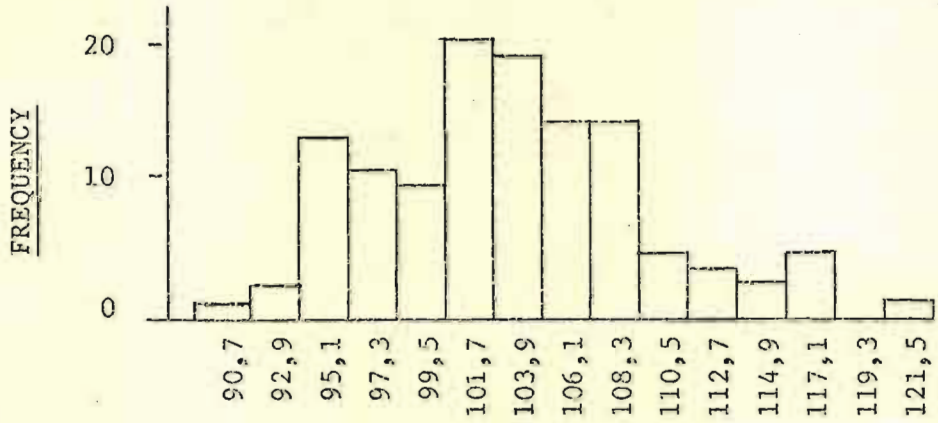
MEDICINE BALL PUT



SCORES IN CENTIMETRES

FIGURE 4.05

250 METRE SHUTTLE RUN



HISTOGRAMS FOR AGE GROUP 10:7 TO 11:6 YEARS

FIGURE 4.06

50 METRE SHUTTLE RUN

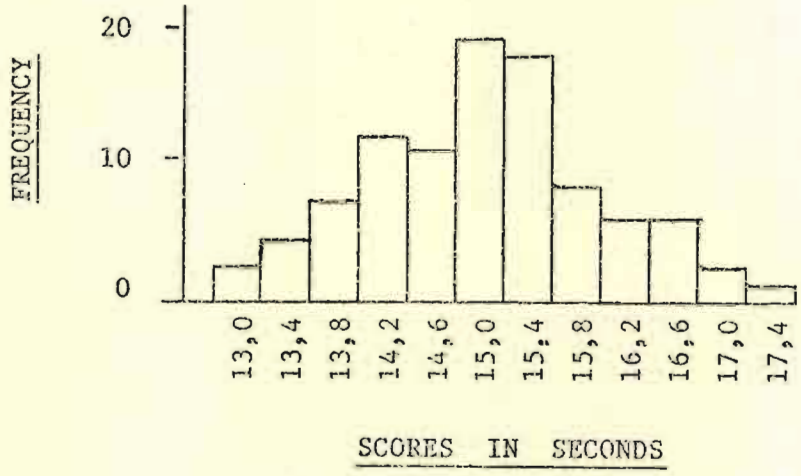


FIGURE 4.07

SIT-UPS IN ONE MINUTE

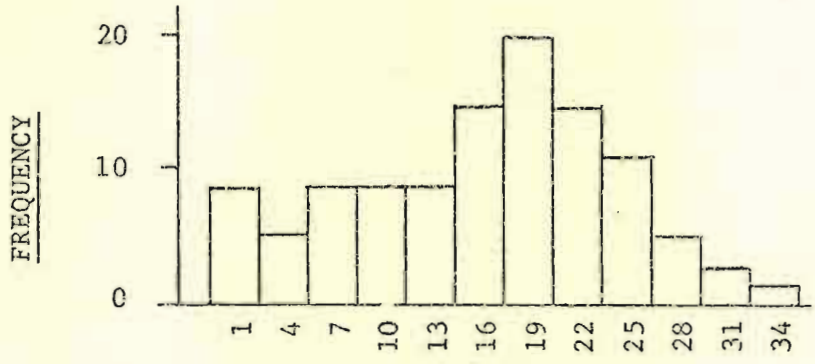


FIGURE 4.08

PULL-UPS TO LIMIT

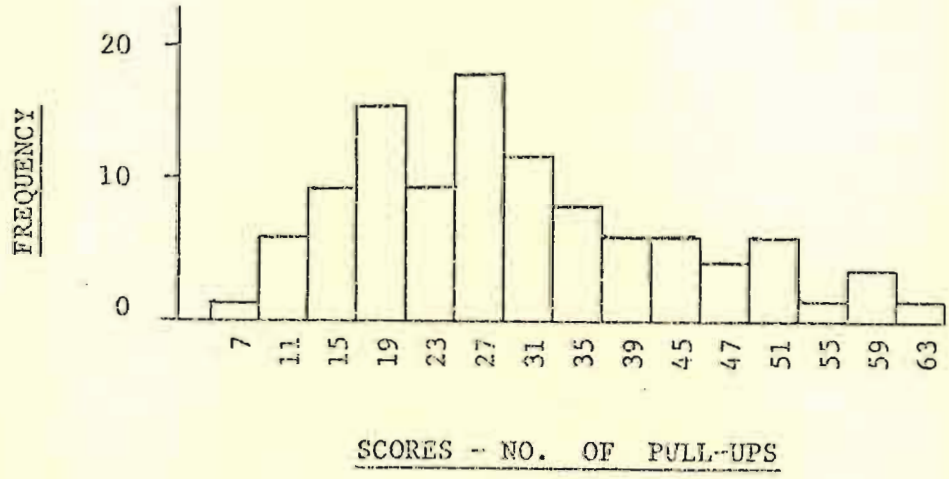


FIGURE 4.09

MEDICINE BALL PUTS

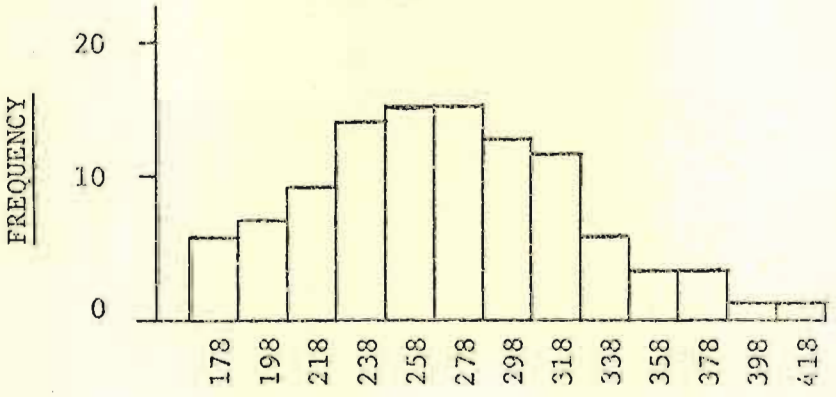
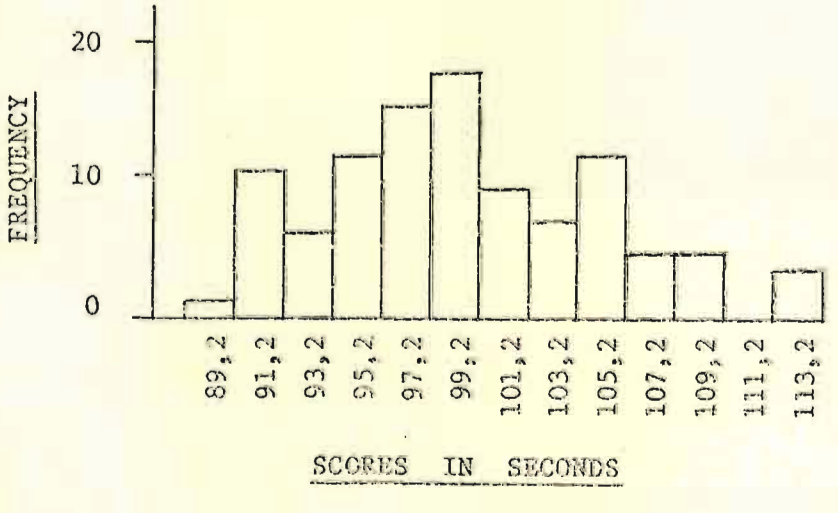


FIGURE 4.10

250 METRE SHUTTLE RUN



HISTOGRAMS FOR AGE GROUP 11:7 TO 12:6 YEARS

FIGURE 4.11

50 METRE SHUTTLE RUN

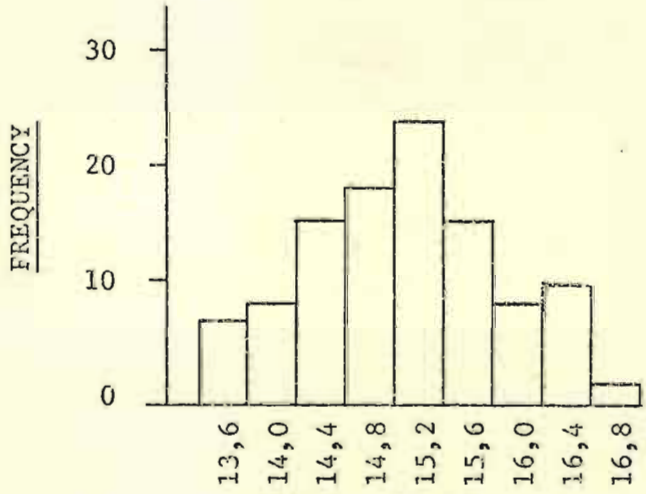


FIGURE 4.12

SIT-UPS IN ONE MINUTE

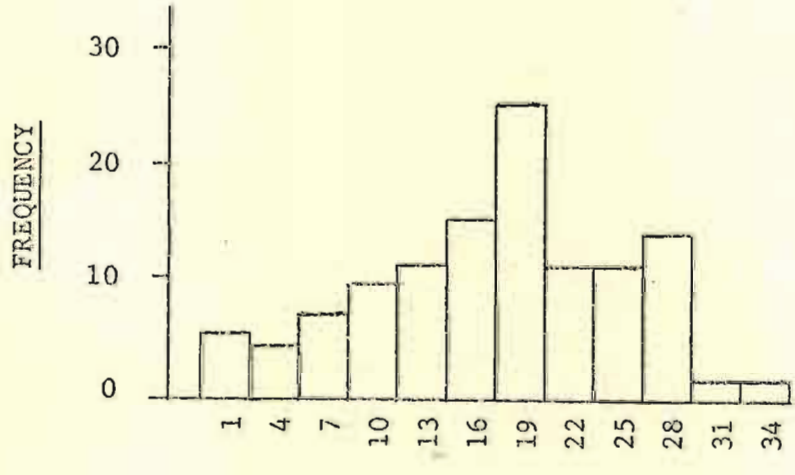


FIGURE 4.13

PULL-UPS TO LIMIT

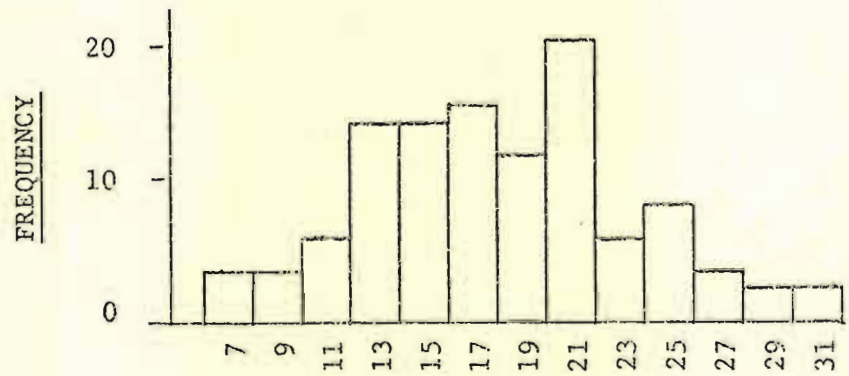


FIGURE 4.14

MEDICINE BALL PUTS

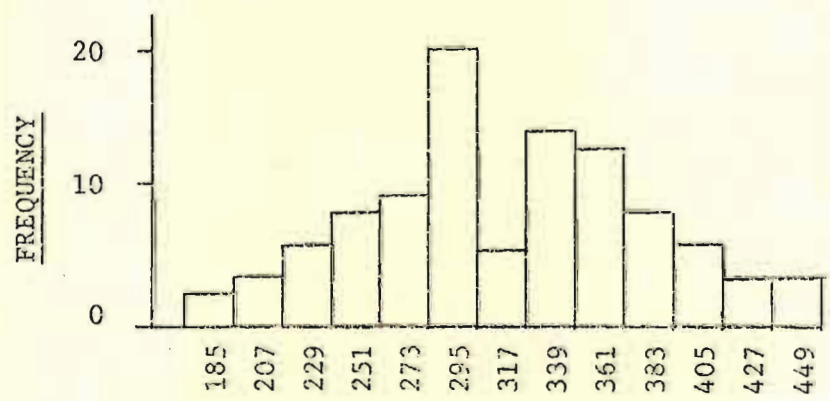
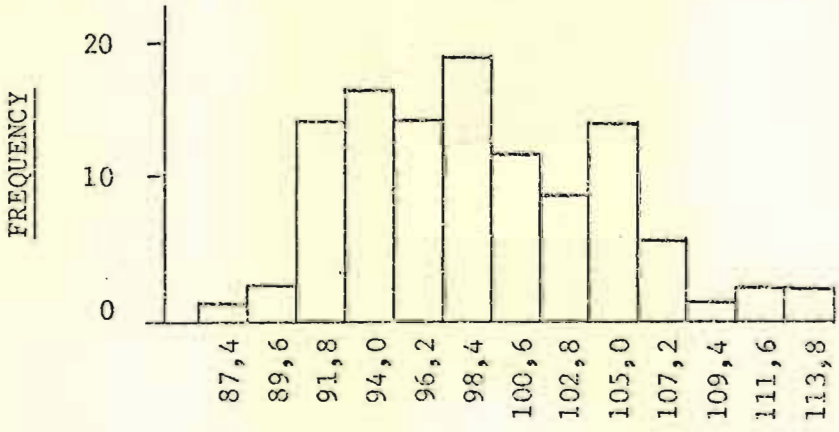


FIGURE 4.15

250 METRE SHUTTLE RUN



HISTOGRAMS FOR AGE GROUP 12:7 TO 13:6 YEARS

FIGURE 4.16

50 METRE SHUTTLE RUN

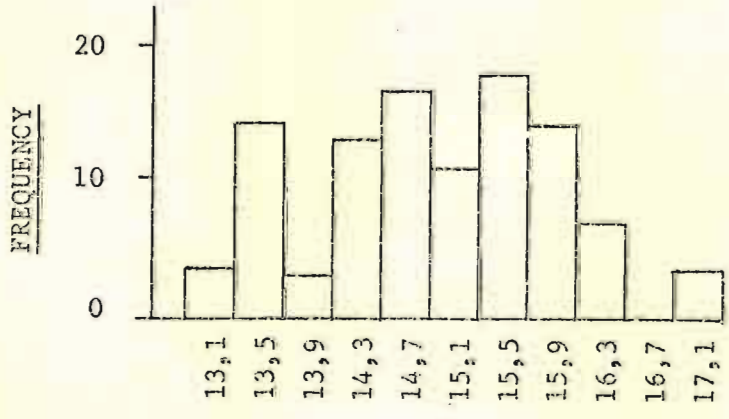
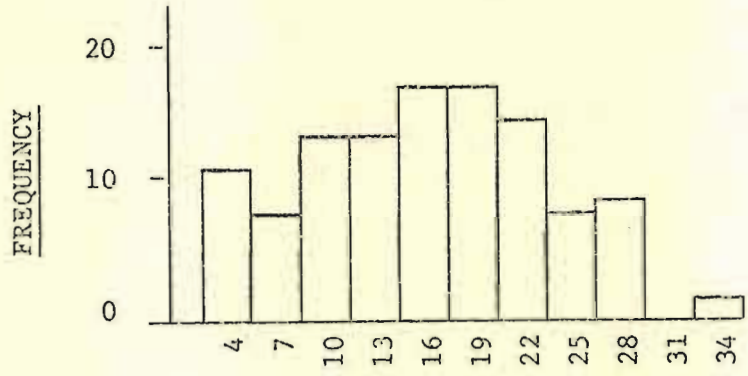


FIGURE 4.17

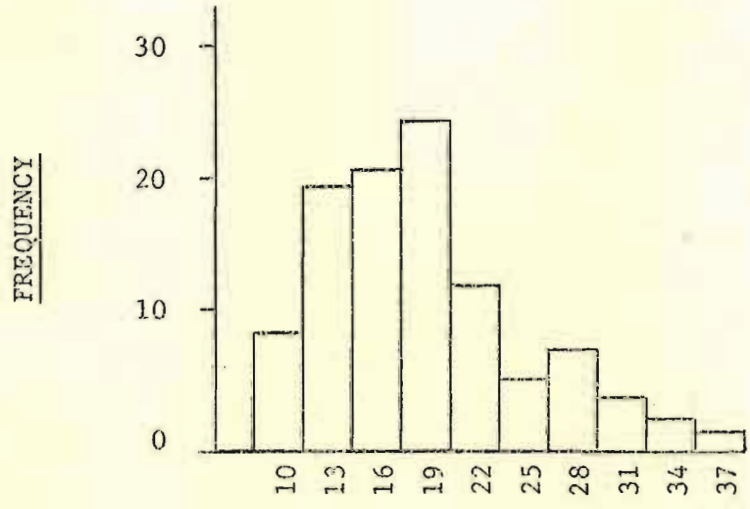
SIT-UPS IN ONE MINUTE



SCORES - NO. OF SIT-UPS

FIGURE 4.18

PULL-UPS TO LIMIT



SCORES - NO. OF PULL-UPS

FIGURE 4.19

MEDICINE BALL PUT

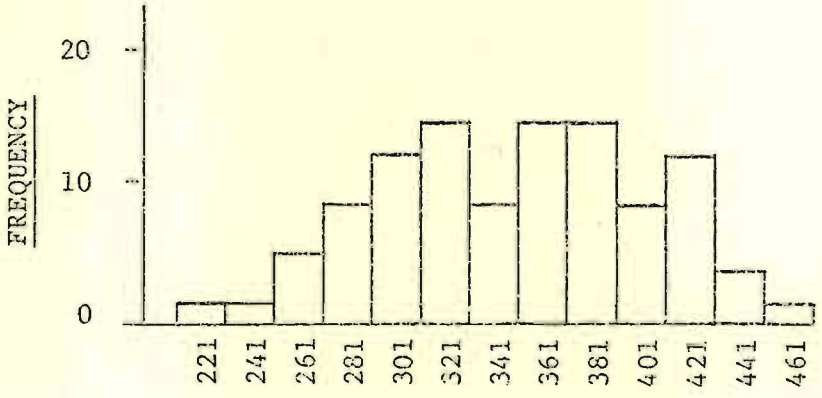
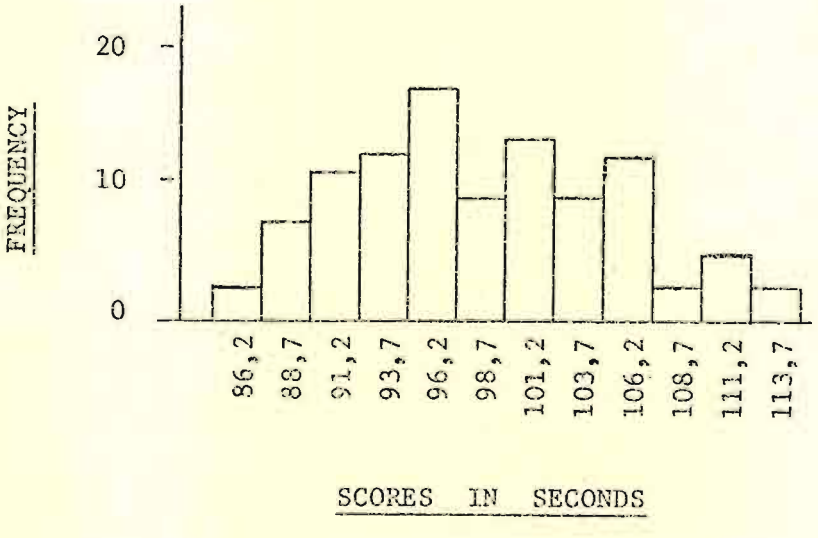


FIGURE 4.20

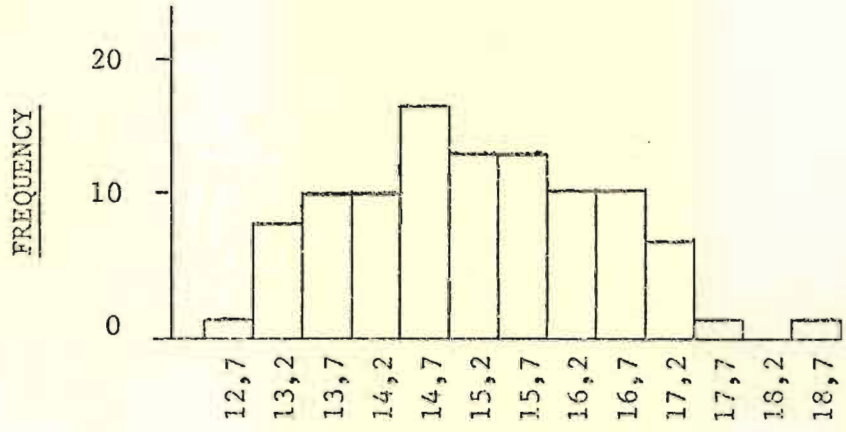
250 METRE SHUTTLE RUN



HISTOGRAMS FOR AGE GROUP 13:7 TO 14:6

FIGURE 4.21

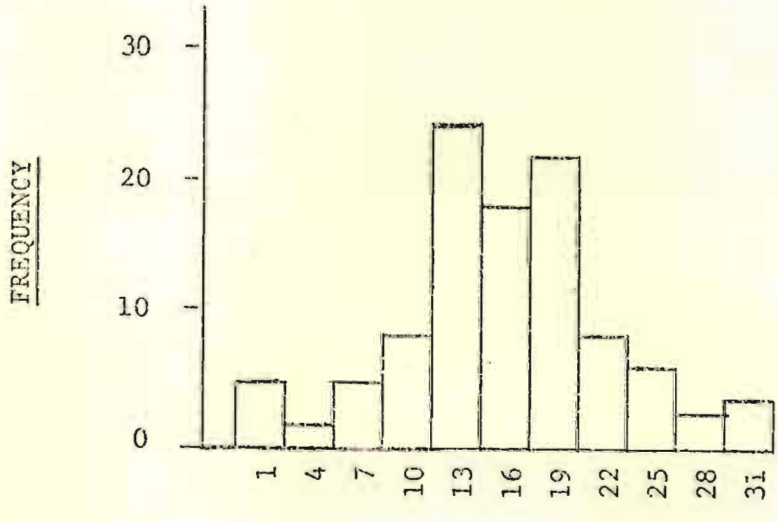
50 METRE SHUTTLE RUN



SCORES IN SECONDS

FIGURE 4.22

SIT-UPS IN ONE MINUTE



SCORES - NO. OF SIT-UPS

FIGURE 4.23

PULL-UPS TO LIMIT

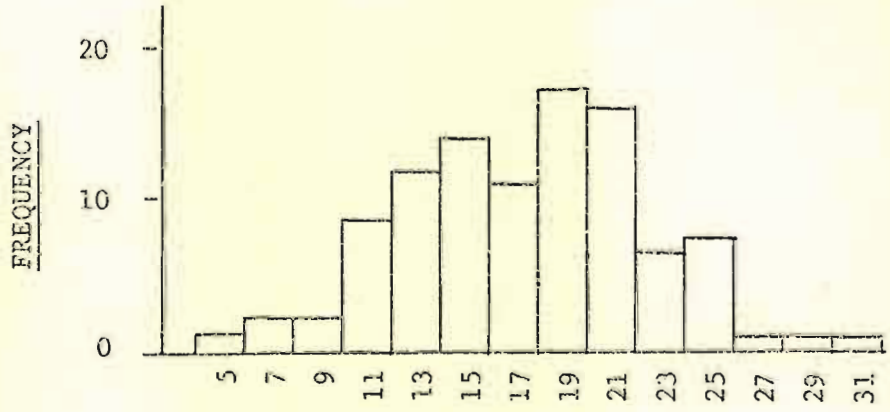


FIGURE 4.24

MEDICINE BALL PUT

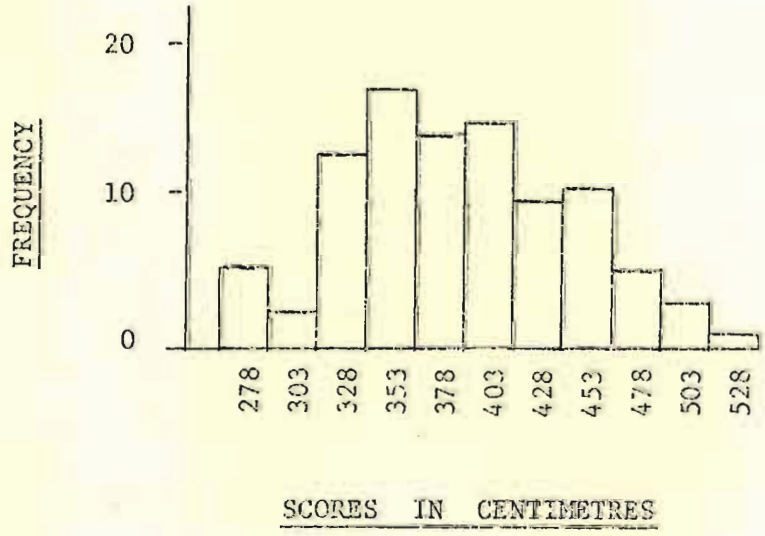
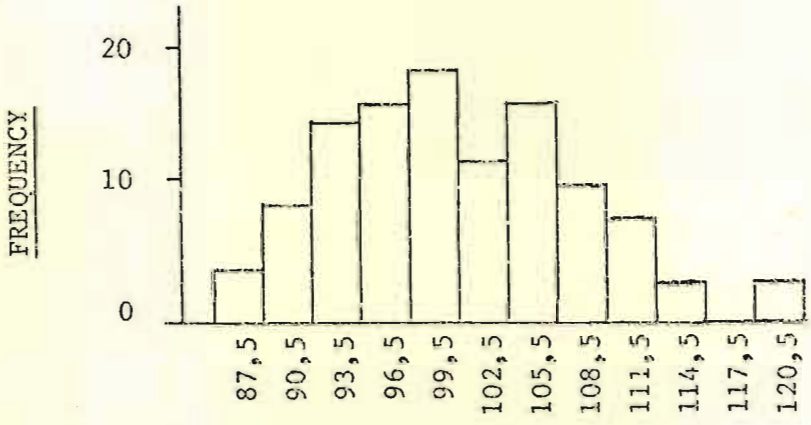


FIGURE 4.25

250 METRE SHUTTLE RUN



HISTOGRAMS FOR AGE GROUP 14:7 TO 15:6 YEARS

FIGURE 4.26

50 METRE SHUTTLE RUN

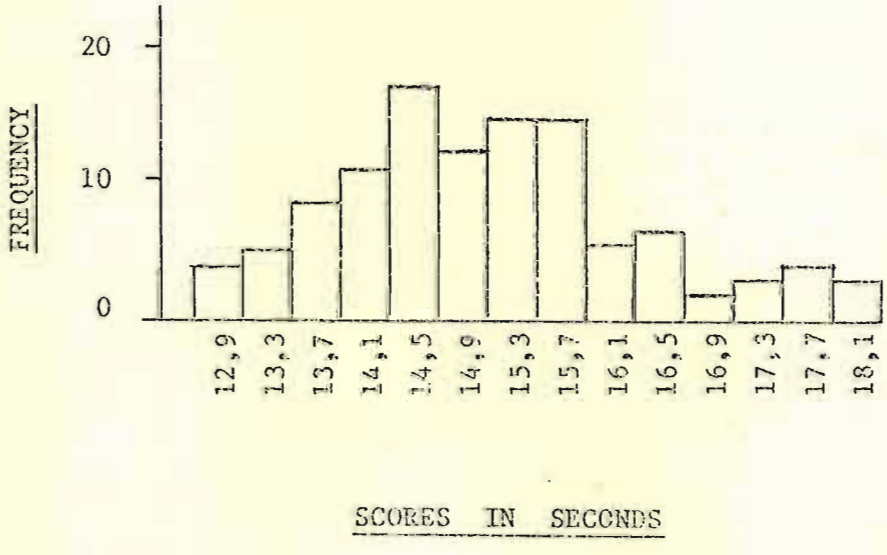
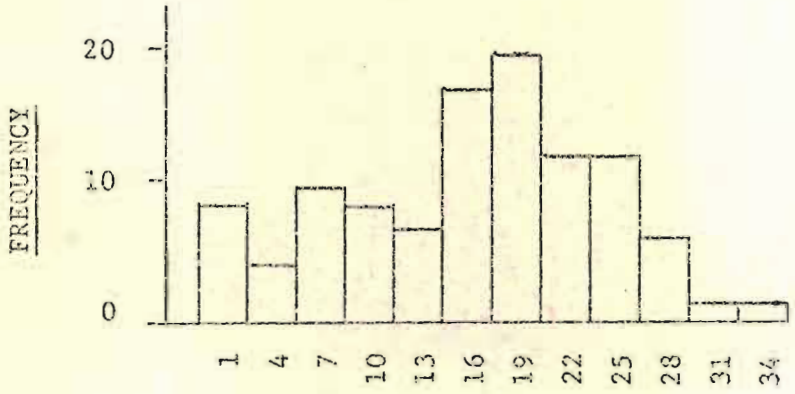


FIGURE 4.27

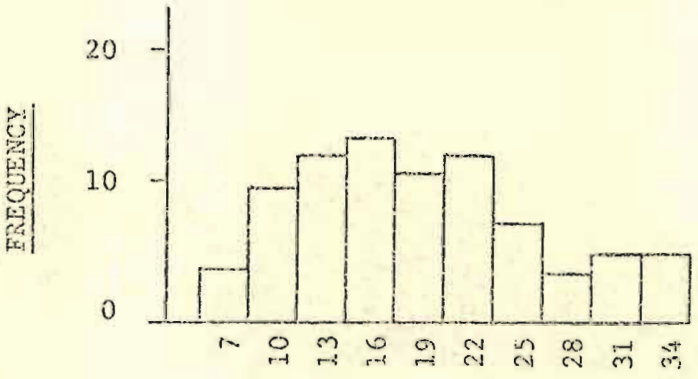
SIT-UPS IN ONE MINUTE



SCORES - NO. OF SIT-UPS

FIGURE 4.28

PULL-UPS TO LIMIT



SCORES - NO. OF PULL-UPS

FIGURE 4.29

MEDICINE BALL PUT

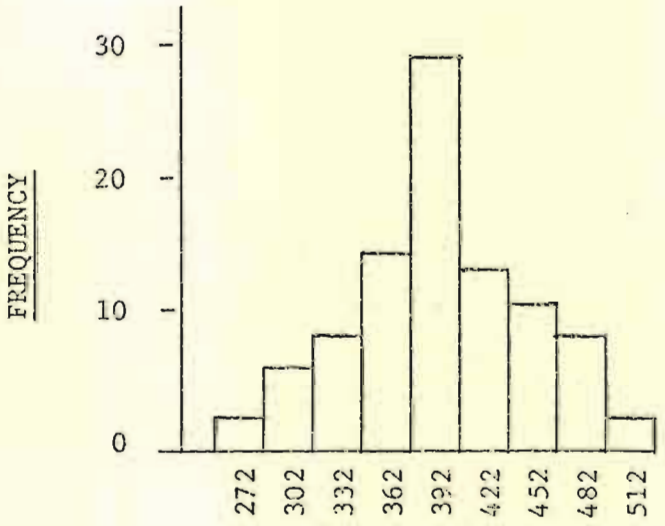
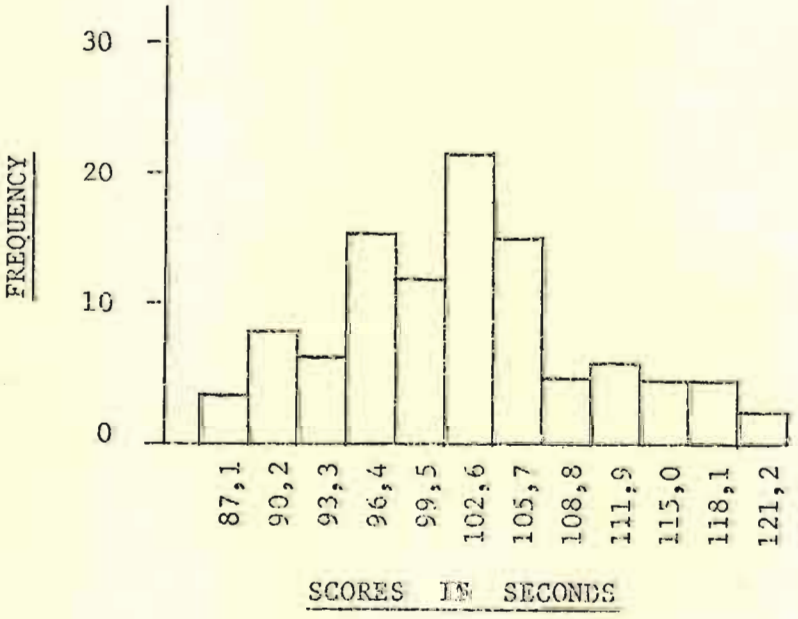


FIGURE 4.30

250 METRE SHUTTLE RUN



HISTOGRAMS FOR AGE GROUP 15:7 TO 16:6 YEARS

FIGURE 4.31

50 METRE SHUTTLE RUN

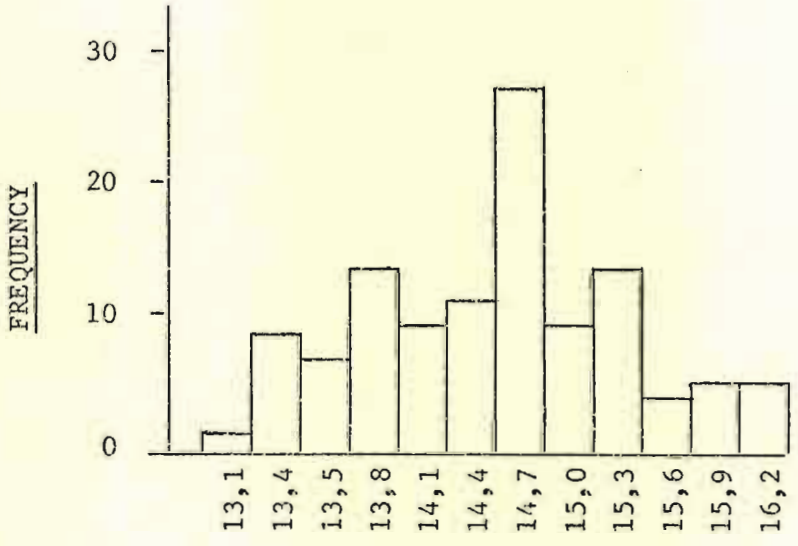


FIGURE 4.32

SIT-UPS IN ONE MINUTE

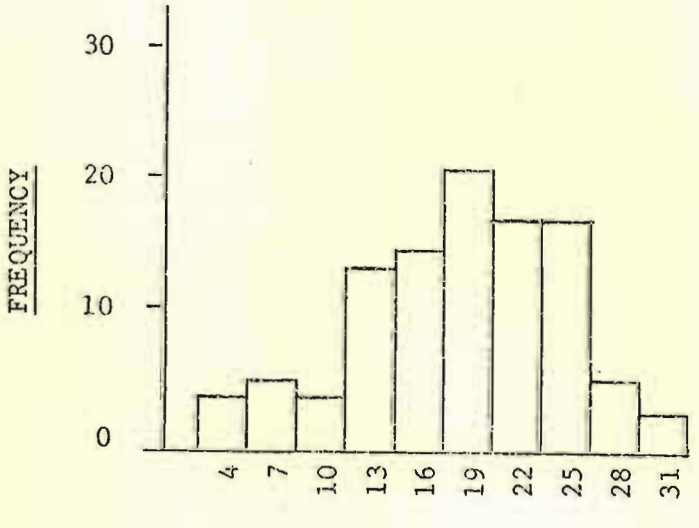
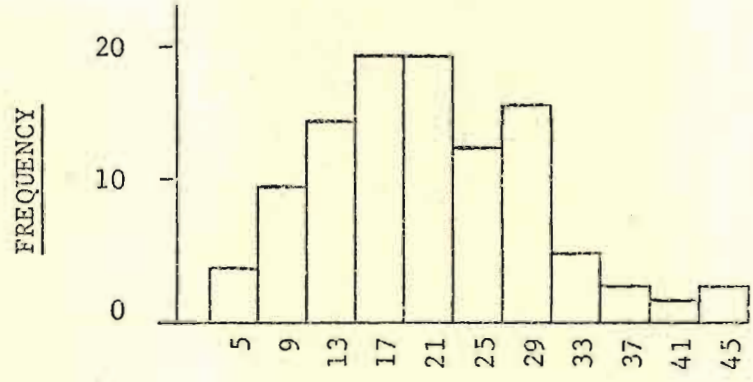


FIGURE 4.33

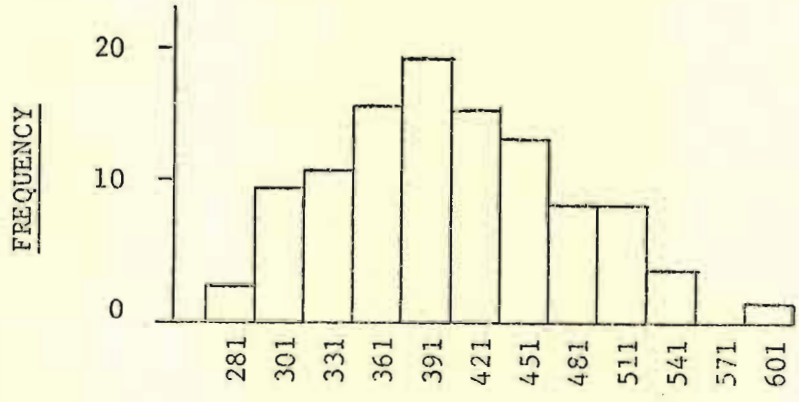
PULL-UPS TO LIMIT



SCORES - NO. OF PULL-UPS

FIGURE 4.34

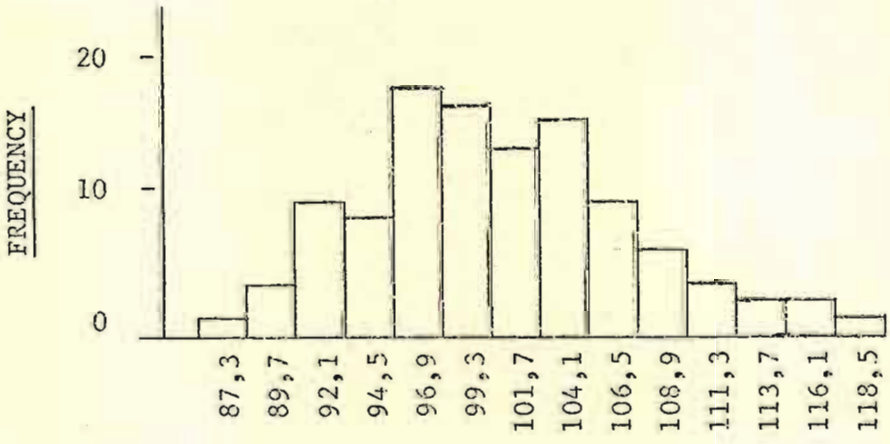
MEDICINE BALL PUT



SCORES IN CENTIMETRES

FIGURE 4.35

250 METRE SHUTTLE RUN



HISTOGRAMS FOR AGE GROUP 16:7 TO 17:6 YEARS

FIGURE 4.36

50 METRE SHUTTLE RUN

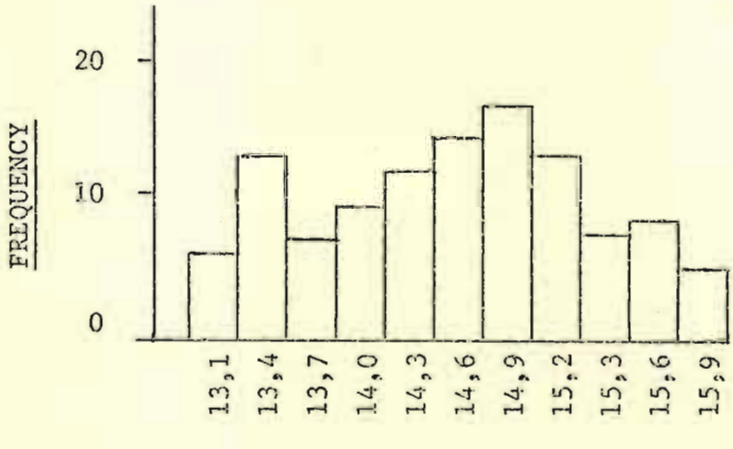
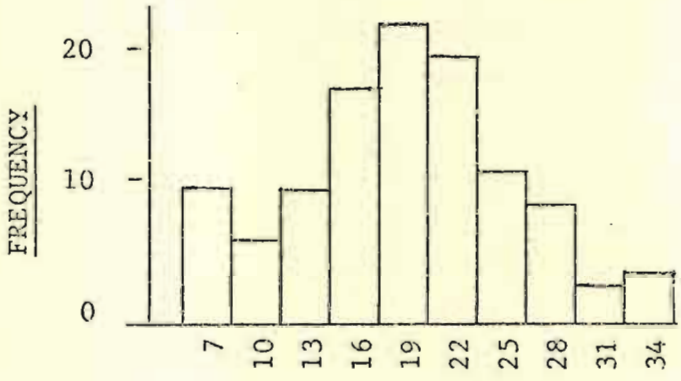


FIGURE 4.37

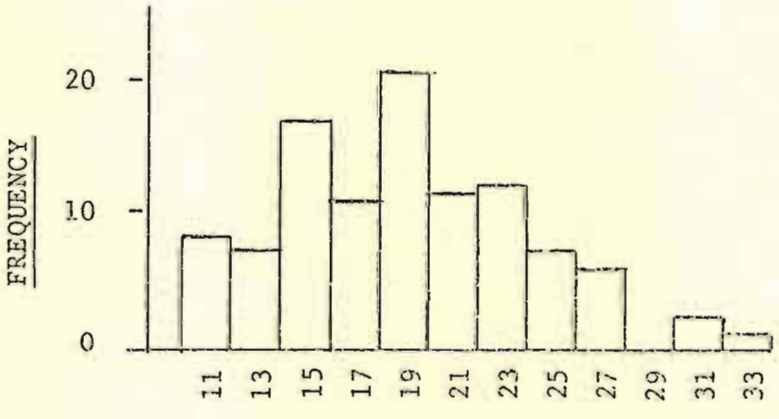
SIT-UPS IN ONE MINUTE



SCORES - NO. OF SIT-UPS

FIGURE 4.38

PULL-UPS TO LIMIT



SCORES - NO. OF PULL-UPS

FIGURE 4.39

MEDICINE BALL PUT

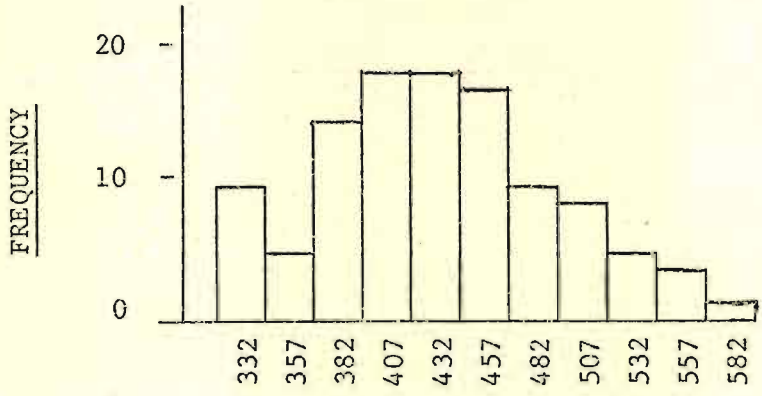
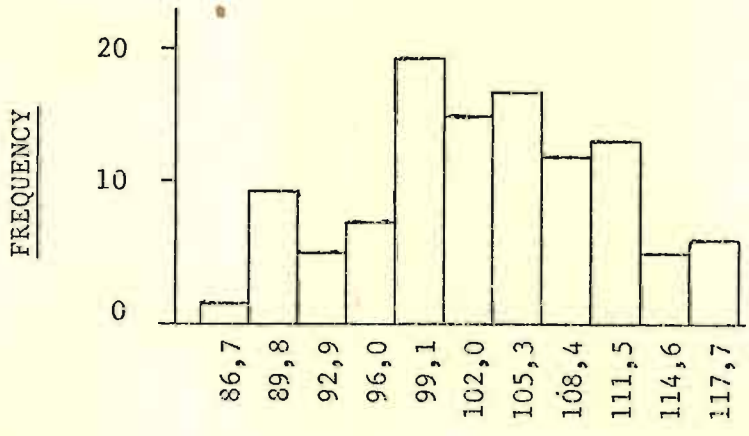


FIGURE 4.40

250 METRE SHUTTLE RUN



4.6 STANDARD SCORES

THE standard scores for each of the five tests for the different age groups are presented in Tables 4.5 to 4.12 in the eight pages that follow.

IN the tables the tests are described as follows:

50 Metre Shuttle Run . . .	Test A
Sit-ups (for one min) . . .	Test B
Pull-ups (to limit) . . .	Test C
Medicine Ball Put . . .	Test D
250 Metre Shuttle Run . . .	Test E

THE key to the symbols used in the tables are:

ES	-	Explosive Strength
DS/T	-	Dynamic Strength (Trunk)
DS/A	-	Dynamic Strength (Arm)
SS	-	Static Strength
END	-	Endurance

THE mean (M), standard deviation (SD), and the range (R), of scores for each test are given at the foot of the respective columns.

TABLE 4.5

STANDARD SCORES ON PHYSICAL FITNESS TESTS

FOR 10 YEAR OLDS

TEST A ES In sec to nearest 10th	TEST B DS/T Number	TEST C DS/A Number	TEST D SS In cm	TEST E END In sec to nearest 10th	STANDARD SCORE
12,6	38	52	374	84,9	100
12,9	35	49	360	86,8	95
13,2	33	46	345	88,6	90
13,6	30	43	331	90,5	85
13,9	28	41	316	92,3	80
14,2	26	38	302	94,2	75
14,5	23	35	288	96,0	70
14,8	21	33	273	97,9	65
15,2	18	30	259	99,7	60
15,5	16	27	244	101,6	55
15,8	14	25	230	103,4	50
16,1	11	22	216	105,3	45
16,4	9	19	201	107,1	40
16,8	6	16	187	109,1	35
17,1	4	14	172	110,8	30
17,4	2	11	158	112,7	25
17,7		8	144	114,5	20
18,0		6	129	116,4	15
18,4		3	114	118,2	10
18,7			100	120,1	5
19,0			86	121,9	0
15,8	13,6	24,5	230	103,4	M
1,06	8,0	9,0	48	6,16	SD
13,8/ 19,4	0/32	5/53	142/357	92,9/ 117,9	R

TABLE 4.6

STANDARD SCORES ON PHYSICAL FITNESS TESTS

FOR 11 YEAR OLD GIRLS

TEST A ES (sec)	TEST B DS/T (No)	TEST C DS/A (No)	TEST D SS (cm)	TEST E END (sec)	STANDARD SCORE
12,4	40	67	437	83,1	100
12,7	38	63	421	84,7	95
12,9	35	59	405	86,3	90
13,2	33	55	389	88,0	85
13,5	30	52	373	89,6	80
13,8	28	48	357	91,2	75
14,0	26	44	341	92,8	70
14,3	23	40	325	94,4	65
14,6	21	36	309	96,1	60
14,8	18	33	293	97,7	55
15,1	16	29	277	99,3	50
15,4	14	25	261	100,9	45
15,6	11	21	245	102,5	40
15,9	9	17	229	104,2	35
16,2	6	14	213	105,8	30
16,5	4	10	197	107,4	25
16,7	2	6	181	109,0	20
17,0		2	165	110,6	15
17,3			149	112,3	10
17,5			133	113,9	5
17,8			117	115,5	0
15,1	15,9	28,7	272,2	99,3	M
0,90	7,9	12,5	53,4	5,4	SD
13,0/ 18,2	0/34	6/63	168/440	90,4/ 114,1	R

TABLE 4.7

STANDARD SCORES ON PHYSICAL FITNESS TESTS

FOR 12 YEAR OLD GIRLS

TEST A ES (sec)	TEST B DS/T (No)	TEST C DS/A (No)	TEST D SS (cm)	TEST E END (sec)	STANDARD SCORE
12,8	39	34	506	82,2	100
13,0	37	32	488	83,9	95
13,3	35	31	469	85,6	90
13,5	33	29	451	87,3	85
13,7	30	27	432	89,0	80
14,0	28	26	414	90,7	75
14,2	26	24	396	92,3	70
14,4	24	23	377	94,0	65
14,6	22	21	359	95,7	60
14,9	19	19	340	97,4	55
15,1	17	18	322	99,1	50
15,3	15	16	304	100,8	45
15,6	13	15	285	102,5	40
15,8	11	13	267	104,2	35
16,0	8	11	248	105,9	30
16,3	6	10	230	107,6	25
16,5	4	8	212	109,2	20
16,7	2	7	193	110,9	15
16,9		5	175	112,6	10
17,2		3	156	114,3	5
17,4		1	138	116,0	0
15,1	17,1	17,8	322	99,1	M
0,75	7,4	5,3	61,4	5,63	SD
13,5/ 17,8	3/35	2/30	174/456	86,4/ 115,0	R

TABLE 4.8

STANDARD SCORES ON PHYSICAL FITNESS TESTS

FOR 13 YEAR OLD GIRLS

TEST A ES (sec)	TEST B DS/T (No)	TEST C DS/A (No)	TEST D SS (cm)	TEST E END (sec)	STANDARD SCORE
12,1	37	35	508	78,7	100
12,4	35	33	492	80,7	95
12,7	33	32	476	82,6	90
13,0	31	30	460	84,6	85
13,3	29	28	444	86,6	80
13,6	26	27	429	88,6	75
13,8	24	25	413	90,5	70
14,1	22	23	397	92,5	65
14,4	20	21	381	94,5	60
14,7	18	20	365	96,4	55
15,0	16	18	350	98,4	50
15,3	14	16	334	100,4	45
15,6	12	15	318	102,3	40
15,9	10	13	302	104,3	35
16,2	8	11	286	106,3	30
16,5	6	10	271	108,3	25
16,7	3	8	255	110,2	20
17,3	1	6	239	112,2	15
17,6		4	223	114,2	10
17,9		3	207	116,1	5
18,2		1	192	118,1	0
15,0	16,0	18,0	349,6	98,4	M
0,96	7,0	5,8	52,6	6,55	SD
13,0/ 17,2	3/35	9/38	221/ 465	85,0/ 114,9	R

TABLE 4.9

STANDARD SCORES ON PHYSICAL FITNESS TESTS

FOR 14 YEAR OLD GIRLS

TEST A ES (sec)	TEST B DS/T (No)	TEST C DS/A (No)	TEST D SS (cm)	TEST E END (sec)	STANDARD SCORE
11,4	35	31,5	557	80,0	100
11,8	33	30	540	82,2	95
12,1	31	28,5	523	84,3	90
12,5	30	27	506	86,5	85
12,9	28	25,5	489	88,7	80
13,3	26	24	472	90,9	75
13,6	24	22,5	455	93,0	70
14,4	22	21	438	95,2	65
14,7	20	19,5	421	97,4	60
15,1	18	18	404	99,5	55
15,5	16	16,5	387	101,7	50
15,8	14	15	370	103,9	45
16,2	12	13,5	353	106,0	40
16,6	11	12	336	108,2	35
17,0	9	10,5	319	110,4	30
17,3	7	9	302	112,6	25
17,7	5	7,5	285	114,7	20
18,1	3	6	268	116,9	15
18,4	1	4,5	251	119,1	10
18,8		3	234	121,2	5
19,2		1,5	217	123,4	0
15,1	16,2	16,5	387,2	101,7	M
1,24	6,3	6,3	56,5	7,2	SD
12,7/ 18,5	0/31	0/31	253/ 529	86,0/ 123,5	R

TABLE 4.10

STANDARD SCORES ON PHYSICAL FITNESS TESTS

FOR 15 YEAR OLD GIRLS

TEST A ES (sec)	TEST B DS/T (No)	TEST C DS/A (No)	TEST D SS (cm)	TEST E END (sec)	STANDARD SCORE
11,7	39	37	548	78,4	100
12,0	36	35	533	80,8	95
12,4	34	33	518	83,1	90
12,7	32	31	503	85,5	85
13,1	30	29	488	87,8	80
13,4	27	28	473	90,2	75
13,7	25	26	457	92,5	70
14,1	23	24	442	94,9	65
14,4	20	22	427	97,2	60
14,8	18	20	412	99,6	55
15,1	16	18	397	101,9	50
15,4	13	16	382	104,3	45
15,8	11	14	367	106,6	40
16,1	9	12	352	109,0	35
16,5	7	10	337	111,3	30
16,8	4	9	322	113,7	25
17,1	2	7	306	116,0	20
17,5		5	291	118,4	15
17,8		3	276	120,7	10
18,2		1	261	123,1	5
18,5			246	125,4	0
15,1	15,7	18,0	397	101,9	M
1,14	7,8	6,1	504	7,84	SD
13,0/ 18,2	0/34	6/35	262/614	86,0/ 119,2	R

TABLE 4.11

STANDARD SCORES ON PHYSICAL FITNESS TESTS

FOR 16 YEAR OLD GIRLS

TEST A ES (sec)	TEST B DS/T (No)	TEST C DS/A (No)	TEST D SS (cm)	TEST E END (sec)	STANDARD SCORE
12,3	37	45	621	81,6	100
12,5	35	42,5	601	83,5	95
12,8	33	40	580	85,4	90
13,0	32	37,5	560	87,3	85
13,3	30	35	540	89,2	80
13,5	28	32,5	520	91,1	75
13,7	26	30	500	93,0	70
14,0	24	27,5	479	94,9	65
14,2	23	25	459	96,8	60
14,5	21	22,5	439	98,7	55
14,7	19	20	419	100,6	50
14,9	17	17,5	399	102,5	45
15,2	15	15	378	104,4	40
15,4	14	12,5	358	106,3	35
15,7	12	10	338	108,2	30
15,9	10	7,5	318	110,1	25
16,1	8	5	298	112,0	20
16,4	6	2,5	277	113,9	15
16,6	5		257	115,8	10
16,9	3		237	117,7	5
17,1	1		217	119,6	0
14,7	19,0	20,0	418,8	100,6	M
0,79	6,0	8,3	67,2	6,36	SD
13,3/ 16,4	3/32	3/46	276/612	86,6/ 117,0	R

TABLE 4.12

STANDARD SCORES ON PHYSICAL FITNESS TESTS

FOR 17 YEAR OLD GIRLS

TEST A ES (sec)	TEST B DS/T (No)	TEST C DS/A (No)	TEST D SS (cm)	TEST E END (sec)	STANDARD SCORE
12,1	38	34	593	79,6	100
12,4	36	32,5	576	81,8	95
12,6	34	31	560	84,1	90
12,9	32	29,5	540	86,4	85
13,1	30	28	527	88,6	80
13,4	29	26,5	511	90,9	75
13,6	27	25	494	93,1	70
13,9	25	23,5	477	95,4	65
14,1	23	22	460	97,6	60
14,4	21	20,5	444	99,9	55
14,6	19	19,0	427	102,1	50
14,9	17	17,5	440	104,4	45
15,1	15	16	394	106,6	40
15,4	13	14,5	377	108,8	35
15,6	11	13	361	111,1	30
15,9	10	11,5	344	113,4	25
16,1	8	10	327	115,6	20
16,4	6	8,5	311	117,9	15
16,6	4	7	294	120,1	10
16,9	2	5,5	278	122,4	5
17,1	0	4	261	124,6	0
14,6	19,0	19,0	427	102,1	M
0,8	6,4	5,0	55,3	7,5	SD
13,0/ 16,2	3/35	3/33	324/589	85,7/ 118,8	R

4.7 RELATIONSHIP BETWEEN AGE AND MEANS

FIGURES 4.41 to 4.45 presents the age-mean relationships for the various tests.

FIGURE 4.41

50 METRE SHUTTLE RUN

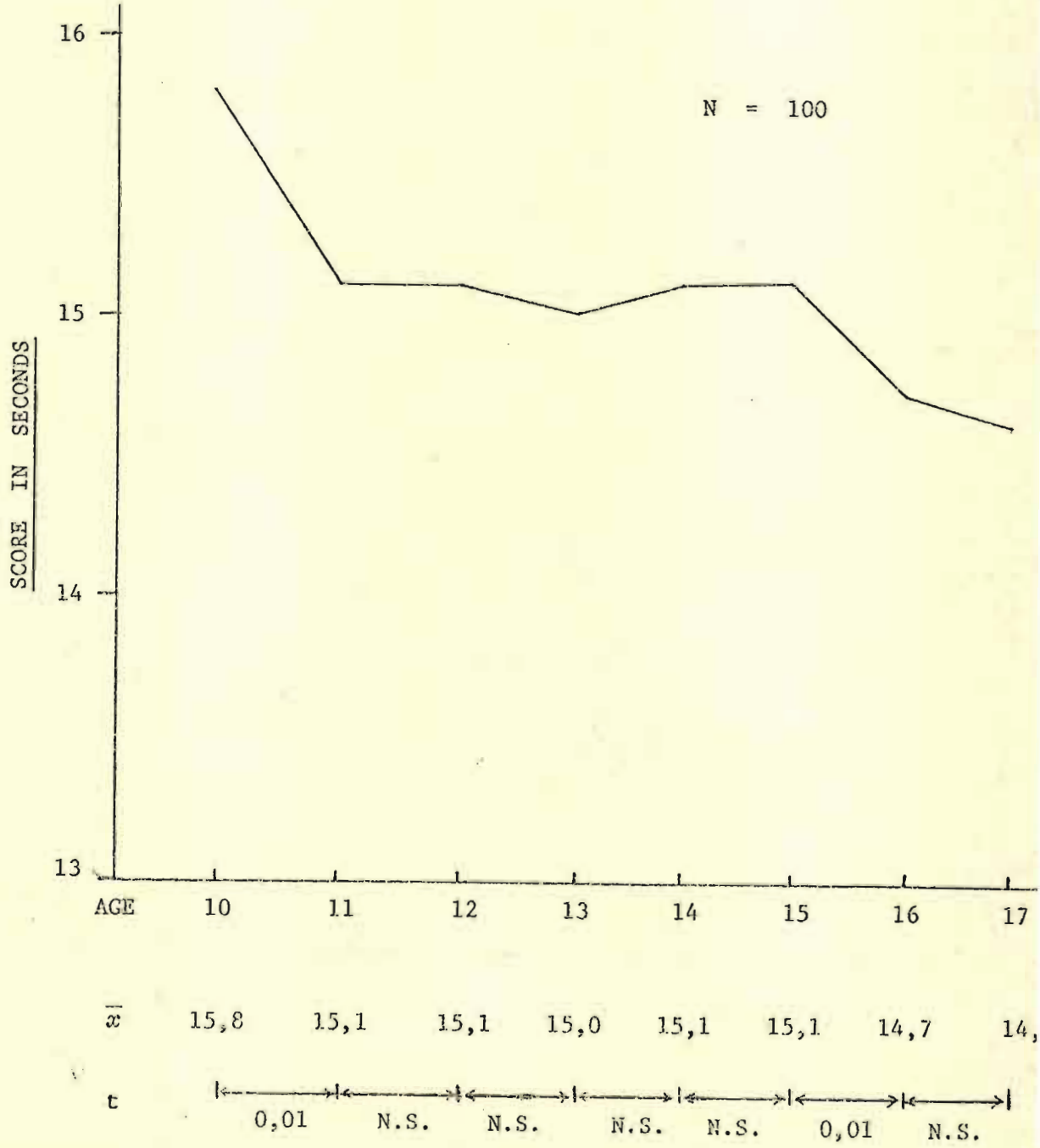
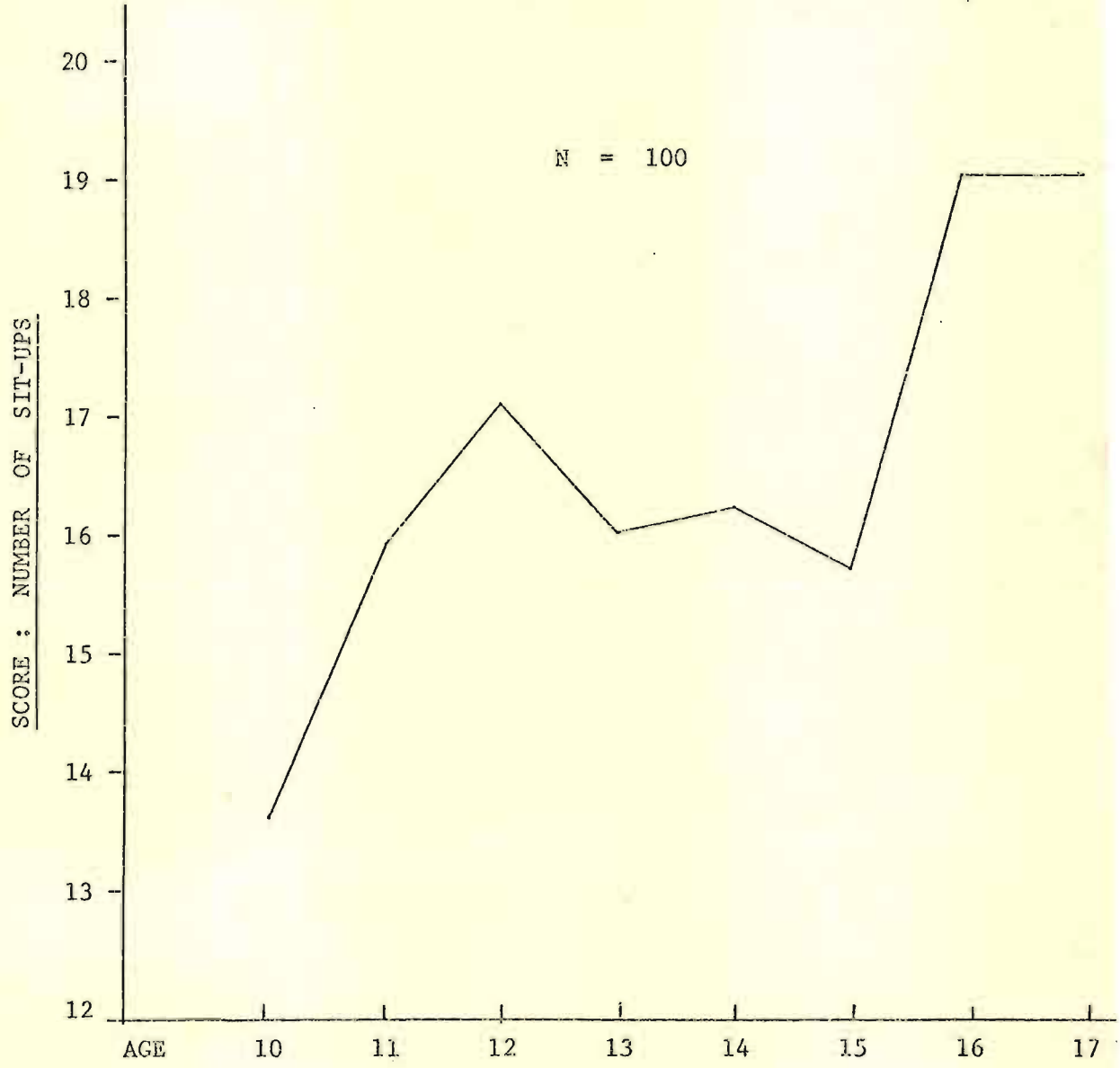


FIGURE 4.42

SIT-UPS IN ONE MINUTE



$\bar{x}$	13,6	15,9	17,1	16,0	16,2	15,7	19,0	19,0
t:		0,05	N.S.	N.S.	N.S.	N.S.	0,01	N.S.

FIGURE 4.43

PULL-UPS TO LIMIT

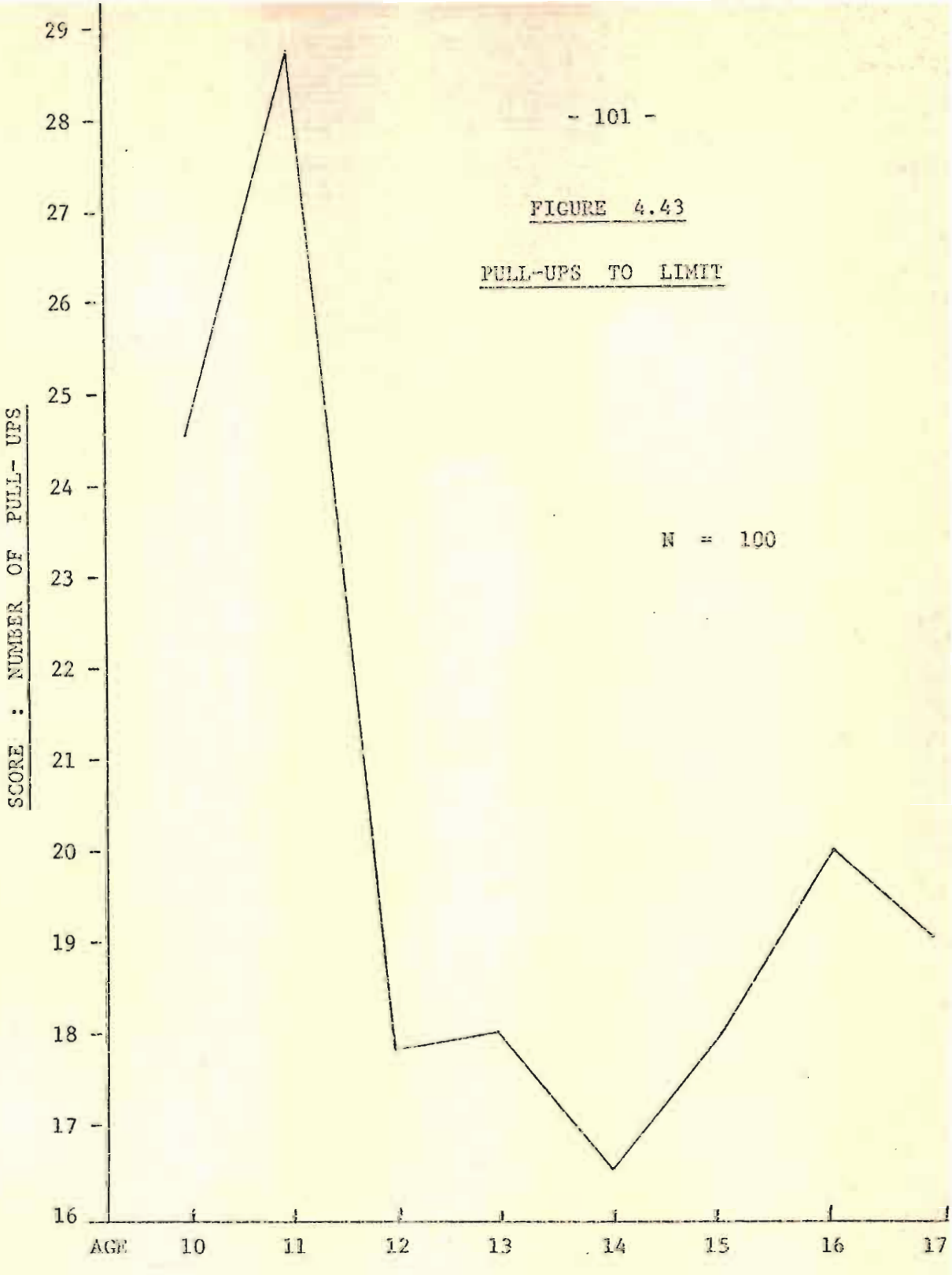
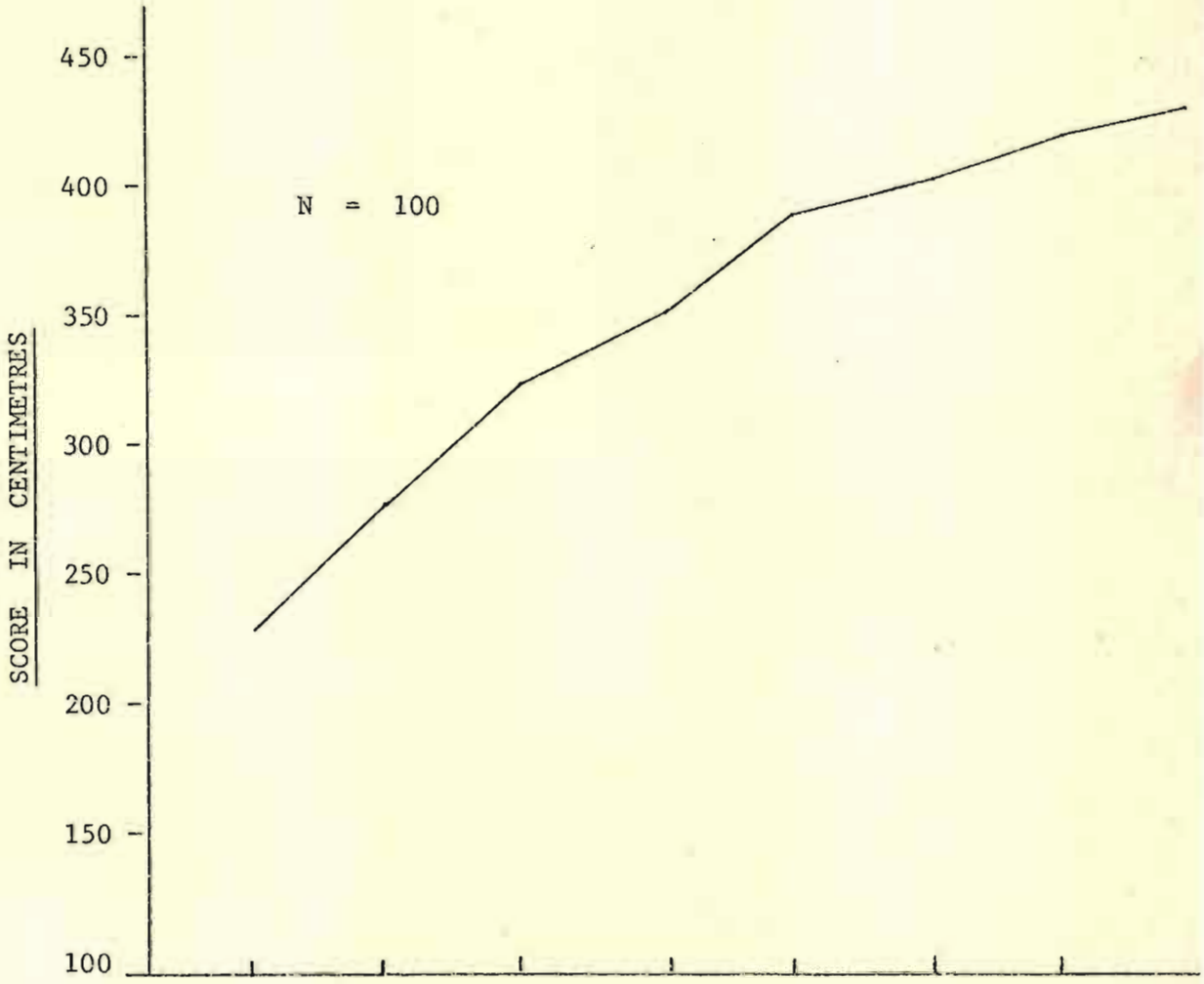


FIGURE 4.44

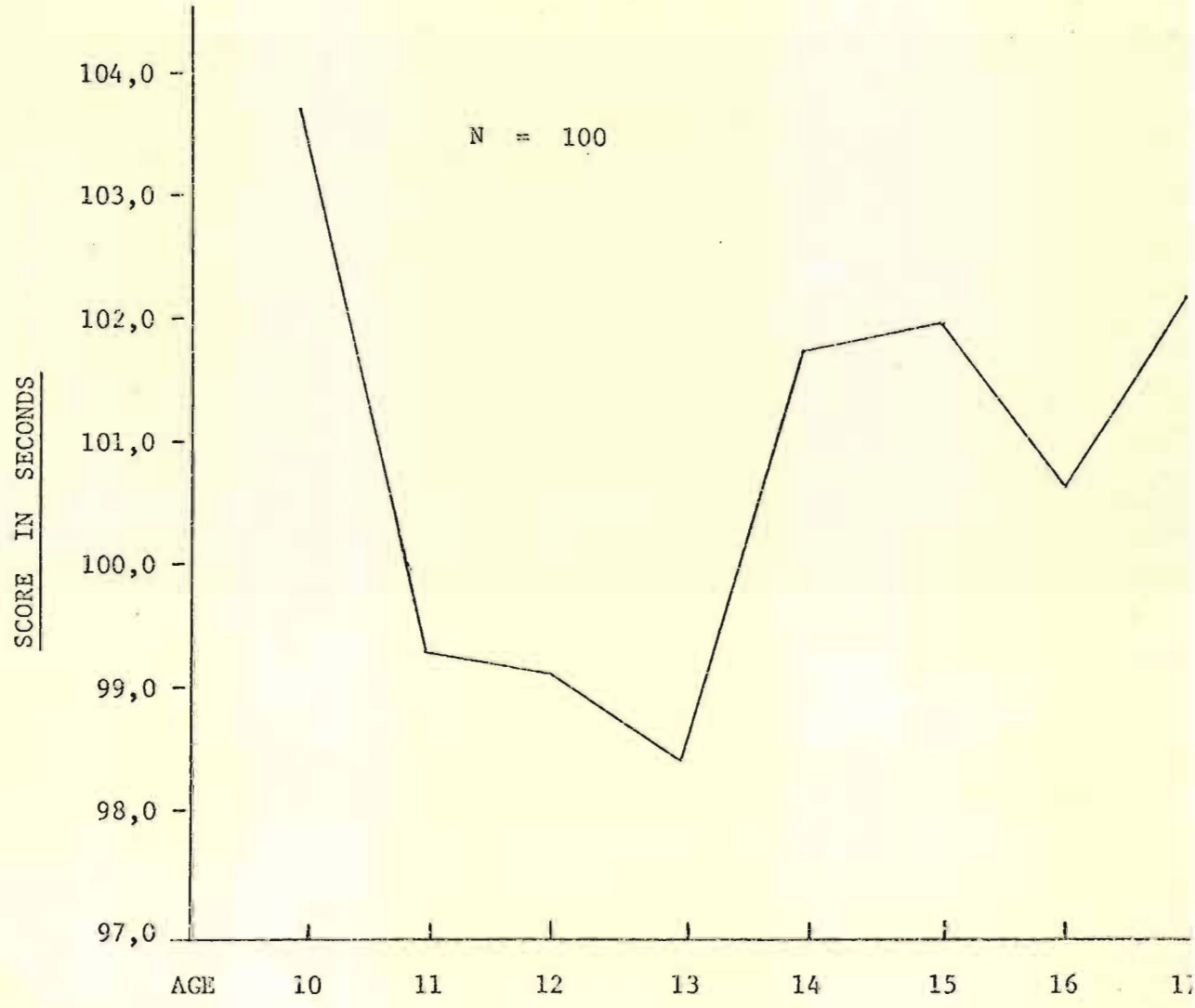
MEDICINE BALL PUT



$\bar{x}$	230,0	277,2	322,0	349,6	387,2	397,0	418,8	427
t		0,01	0,01	0,01	0,01	N.S.	0,05	N.S.

FIGURE 4.45

250 METRE SHUTTLE RUN



$\bar{x}$	103,4	99,3	99,1	98,4	101,7	101,9	100,6	102,
t		0,01	N.S.	N.S.	0,01	N.S.	N.S.	N.S.

4.8 VALIDITY

CORRELATION coefficients were found between the 50 metre Shuttle Run and the 50 metre Dash, and between the 250 metre Shuttle Run and the 600 yard Run. The 50 metre Dash and the 600 yard Run are recognised tests for testing the physical fitness components of Explosive Strength and Endurance respectively.

THE tests were administered to 20 girls and their scores were correlated. The correlation coefficients which were obtained by using the Pearson's Product Moment Correlation Coefficient formula are as follows:

(a) Between the 50 m Shuttle Run and the 50 m Dash: 0,813; and

(b) Between the 250 m Shuttle Run and the 600 yard Run: 0,726.

BOTH values of r are significant beyond the 1% level.[1], [2]

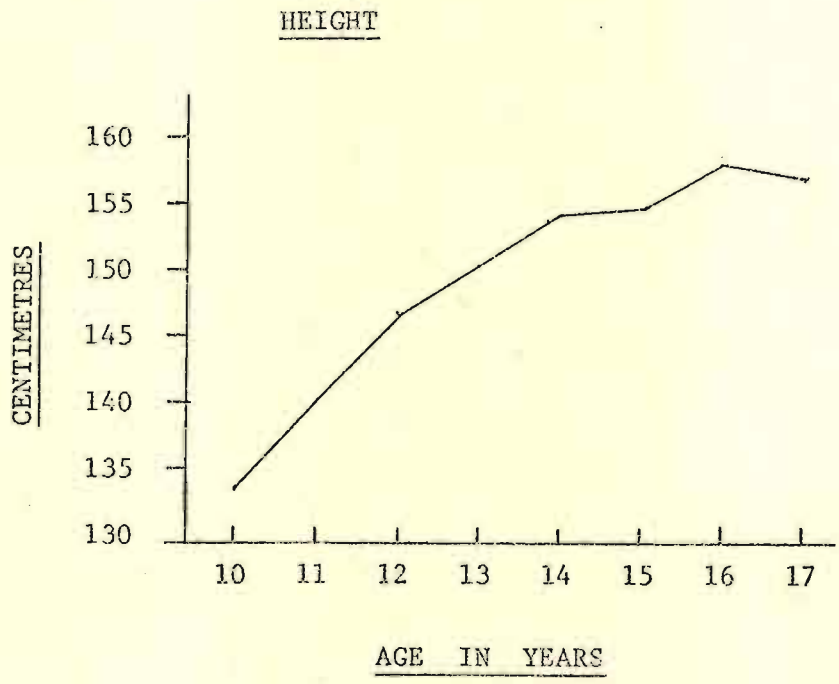
4.9 GROWTH CURVES

FIGURE 4.46 shows the growth curves for height and mass for the subjects who participated in this study.

FIGURE 4.46

GROWTH CURVES FOR HEIGHT AND MASS FOR GIRLS IN THE AGE GROUPS 10 YEARS TO 17 YEARS

(The mean height and the mean of the mass for each age group has been used).



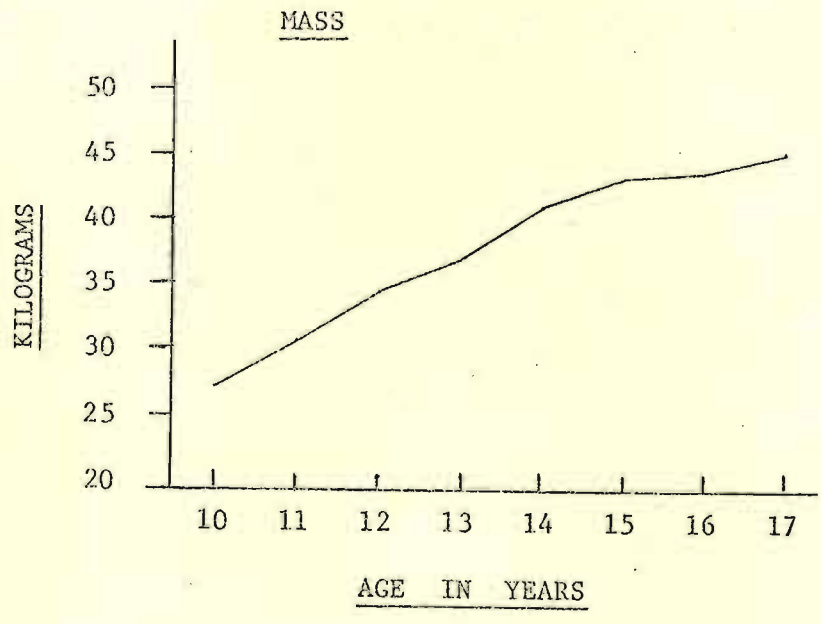
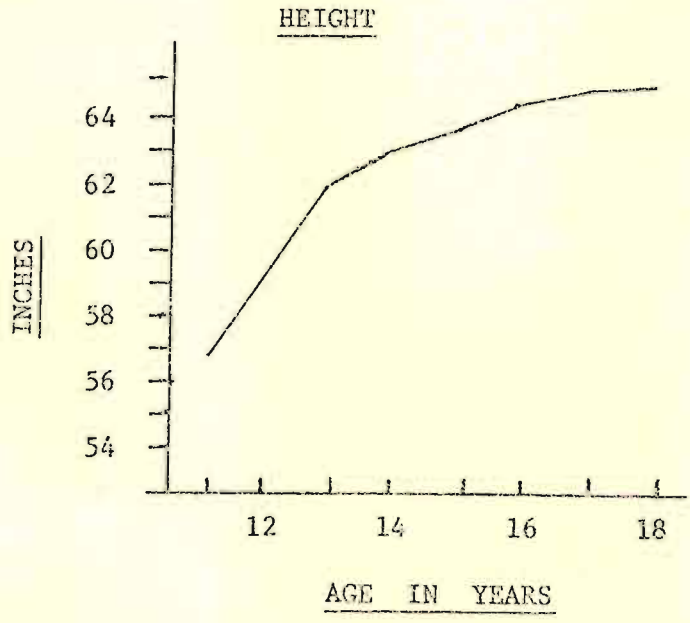


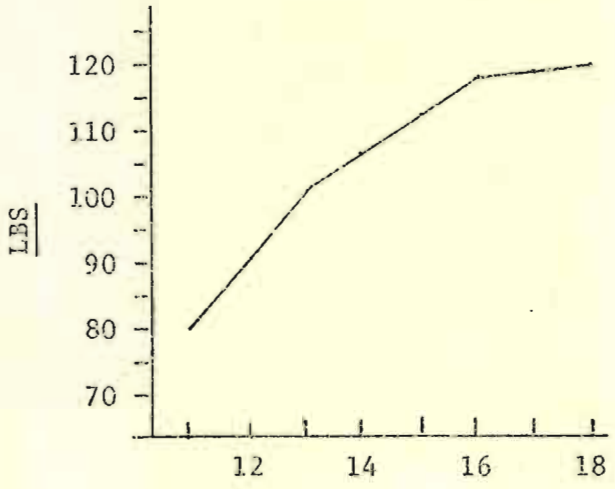
FIGURE 4.47 shows the differences in height and weight for American girls at different age levels in 1930.[3] The trend of increased height and weight appear to be basically similar in these two studies.

FIGURE 4.47

GROWTH CURVES FOR HEIGHT AND WEIGHT FOR AMERICAN GIRLS IN THE AGE GROUPS 11 YEARS TO 18 YEARS (1930)



WEIGHT



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CHAPTER FIVE

5.1 DISCUSSION

5.1.1 Standard Scores

THE main purpose of this study was to compile standard scores on selected physical fitness tests for use by physical education teachers in schools. These are presented in Tables 4.5 to 4.12.

THE range from 0 to 100 standard scores represents the over-all spread of the scores for each test within each age group. The mean was first determined and located at the 50 standard score level. Each increment of 5 standard scores was then calculated and added successively to the mean, and also subtracted from the mean, to obtain the values at each of the 5 standard score intervals in the table.

TO obtain an individual physical fitness profile, the test is scored in raw scores. The corresponding standard score values are looked up in the relevant table. These standard score values indicate the level of fitness in respect of a specific fitness component.

WHEN a raw score does not correspond to any standard score value on the table of norms, i.e. when it lies between two standard score intervals, the actual standard score can be extrapolated.

The method in which this is done is shown in the two examples which follow.

Example One:*

Subject A.M. aged 12 years 5 months obtains a score of 20 on the Pull-ups Test. SS = ?

Step 1 : Obtain the mean score and the standard deviation for this test from Table 4.7

Mean = 17,8 SD = 5,3

Step 2 : Find the difference between the mean and raw scores:

20 - 17,8 = 2,2 ..... (A)

Step 3 : Find the standard score per unit

$$\frac{6\ SD}{100} = \frac{6 \times 5,3}{100} = 0,318 \text{ .. (B)}$$

Step 4 : Divide (A) by (B) to obtain the standard score value for the difference between the mean and the raw score.

$$\frac{(A)}{(B)} = \frac{2,2}{0,318} = 7$$ (to the nearest whole number)

Step 5* : This SS value of 7 is then added to the mean standard score of 50

50 + 7 = 57

Thus, a raw score of 20 for the Pull-ups Test for 12 year old girls corresponds to a standard score of 57.

Example Two:*

Subject A.S. aged 16 years 8 months obtains a score of 113 on the 250 metre Shuttle Run Test.

Step 1 : Look up Table 4.12

Mean = 102,1 SD = 7,5

Step 2 : Difference between mean and raw scores is

102,1 - 113,1 = -10,9 ..... (A)

Step 3 : The SS unit is

$$\frac{6 \times 7,5}{100} = 0,45 \quad \ldots\ldots\ldots\ldots\ldots \quad (B)$$

Step 4 : $$\frac{(A)}{(B)} = -\frac{10,9}{0,45} = -24$$

Step 5* : The SS value is 50 - 24 = 26

TABLE 5.1 below shows the raw scores and corresponding standard scores on each of the five tests of two pupils, A.S. aged 16 years 8 months and A.M. aged 12 years 5 months.

---

*The following formula is used to obtain the intermediate standard score value:

$$SS = 50 + \frac{x - \bar{x}}{SD \times SD_{ss}}$$

where: SS = standard score; 50 is the mean standard score value; x = raw score of subject; $\bar{x}$ = mean for the test; SD = standard deviation; SD_{ss} = standard deviation of standard scores (this value which is equal to $\frac{6}{100}$ is constant).

TABLE 5.1

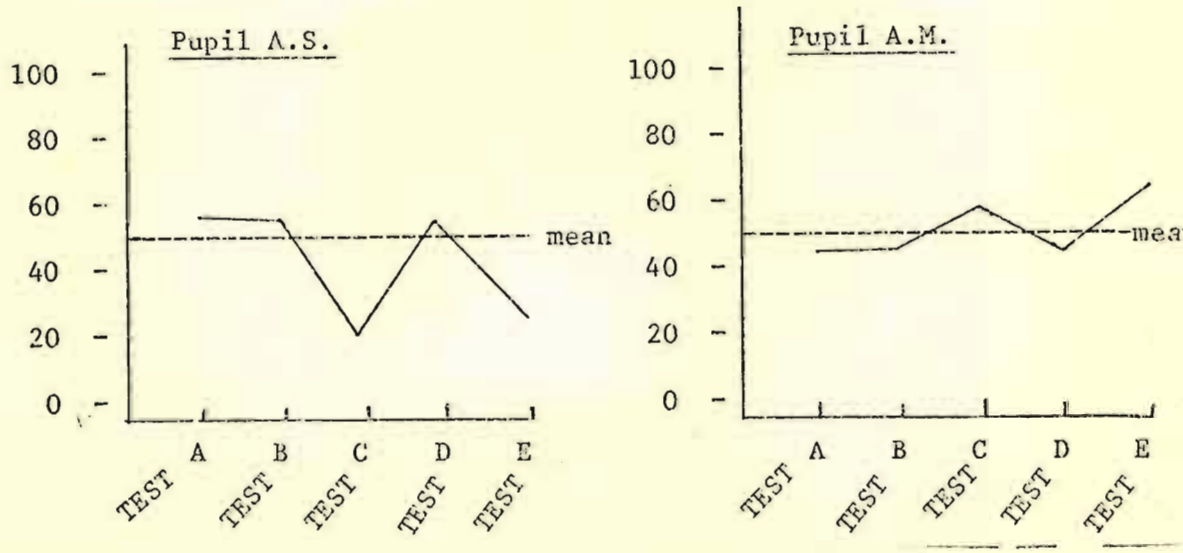
RAW SCORES AND CORRESPONDING STANDARD SCORES FOR SUBJECTS A.S. AND A.M.

	A.S.		A.M.	
	RAW SCORES	STANDARD SCORES	RAW SCORES	STANDARD SCORES
50 m Shuttle Run	14,3	56	15,4	43
Sit-ups	21	55	15	45
Pull-ups	10	20	20	57
Medicine Ball Put	445	55	297	43
250 m Shuttle Run	113,0	26	94,9	62

FROM these standard scores the physical fitness profiles for the pupils may be drawn up as follows:

FIGURE 5.1

PHYSICAL FITNESS PROFILES ON PUPILS A.S. AND A.M.



PHYSICAL fitness profiles for pupils in the physical education class, in sports teams, and in specialised groups can be obtained in this way. This will enable the teacher to pin-point weak areas and plan specific training programmes to remedy these weaknesses.

5.1.2 Distribution of Scores : Histograms

THE histograms presented in Figures 4.01 to 4.40 show a fairly normal distribution of scores for the different tests. Hence it has been possible to draw up the standard scores which can only be drawn up from normal distribution.

5.1.3 Relationship between Age and Mean Scores

AN examination of the relationship between age and mean scores as shown in Figures 4.41 to 4.45 reveals some notable features. In the 50 metre Shuttle Run (Fig. 4.41) which was used to measure Explosive Strength there is some improvement in performance between 10 year olds and 11 year olds, the difference being significant at the 1% level. The mean scores for the different age groups between 11 years and 15 years shows no improvement in performance. Performances improve again after 15 years, with the difference between 15-year-olds and 16-year-olds significant at 1%, while the difference between 16-and 17-year-olds is not significant.

IN the 250 metre Shuttle Run Test, measuring the Endurance Factor (Fig. 4.45), a marked improvement significant at 1% level of

confidence between 10-year-olds and 11-year-olds is followed by slight increments in performance up to age 13, the differences not being significant. There is a decline in performance between 13 years and 14 years, the difference being significant at 1%. The performances then fluctuate at subsequent age levels and no significant differences are observed.

IN the Sit-ups Test, which measures Dynamic Strength (Fig. 4.42) of trunk muscles, the mean scores show improvements up to the age of 12. The difference in the mean scores of 10-year-olds and 11-year-olds is significant at the 5% level, while those between the 11- and 12-year-olds is not significant. From 12 years to 15 years there appears to be a decrease in the mean scores, but the differences are not significant. There is a marked improvement again at the age of 16 and the difference is significant at the 1% level. The performance then levels out for the 17-year-olds.

IN the Pull-ups Test measuring Dynamic Strength for arm muscles (Fig. 4.43) the highest mean scores were found for the 10 and 11-year-olds, with the difference between the two being significant at 5%. A substantial decrease in performance is observed between the 11-year and 12-year age groups, the difference being significant at 1%. The performances then fluctuate for subsequent age groups with no significant differences between successive age levels except between 13- and 14-year-olds where the difference is significant at the 5% level.

THE relationship between age and the mean scores on the Static Strength factor represented by the Medicine Ball Put Test (Fig. 4.44) shows a more or less straight line function indicating progressive improvement with age. The differences between the mean scores of successive age groups from 10 years to 14 years are significant at the 1% level of confidence. The difference between the mean scores of 15-year-olds and 16-year-olds is significant at 5%; while differences between 14- and 15-year-olds and between 16- and 17-year-olds are not significant.

THE age-mean score graphs for the two running tests and the two dynamic strength tests reflect developmental stages during which there is either no improvement or even performance decrement. There appears to be a close relationship between the onset of puberty and the physical performance of the girls in these four tests. This trend is not evident in the Medicine Ball Put Test; for Static Strength.

WHEREAS weight is negatively related to Dynamic Strength,[1] it is positively related to Static Strength. Fleishman[2] reported that weight had a loading of 0,70 on the Static Strength, compared with -0,43 on the Dynamic Strength factor. He reported further that height also loaded positively (0,42) on the Static Strength factor and negatively (-0,39) on the Dynamic Strength factor.

IN the present study the girls showed a normal developmental pattern

for height and mass as shown by Figure 4.46. This finding bears close resemblance to the one reported by Espenschade.[3]

PHYSIOLOGICAL and structural changes associated with adolescence are by no means the only factors which would affect performances in physical activities. Changes in interest patterns with age have been found to influence performances significantly. Fleishman[4] reported that at different stages in the adolescent period girls seem to show marked shifts away from athletic interest and participation.

TWO other factors which may have had some influence on the performances of the girls in this study and which cannot be discounted altogether are:

(a) a possible lack of emphasis on specific areas of development in the schools' physical education programme; and

(b) a lack of adequately trained physical education teachers to implement the physical education programme in schools. This factor seems to warrant some consideration, since 101 out of 126 schools reported that they did not have qualified teachers to teach physical education (Appendix B).

5.1.4 Reliability and Validity

THE reliabilities (Table 4.2) are high, comparing favourably with those obtained in previous studies, and indicate that stable measures of performance can be obtained from these tests.

VALIDITY figures were calculated for the 50 metre Shuttle Run and the 250 metre Shuttle Run. The 50 metre Shuttle Run was compared with the 50 metre dash which is a recognised test for measuring Explosive Strength. A correlation of 0,813 was obtained between the two tests. This compares favourably with the figure of 0,745 obtained by Putter when he compared the 60 yard Dash with the 60 yard Shuttle Run. Table 2.2 shows that the 50 yard dash has a factor loading of 0,75 on the Explosive Strength component.

THE 250 metre Shuttle Run was compared with the 600 metre run. The correlation obtained was 0,726. Putter obtained a correlation of 0,624 between his shuttle run (800 feet in 40 runs) and the 880 yard run.

THE change to these distances was made to comply with metric measures. The distances used in this study, viz. the 50 metre and the 250 metre runs, are close to the distances used by Putter for these tests, i.e. 60 yards and 800 feet respectively.

VALIDITY figures were not calculated for the other three tests in this battery. The pull-ups test and the sit-ups test are widely used for Dynamic Strength, and are designed to test the specific

components for which they were selected. The Medicine Ball Put with a factor loading on Static Strength, (Table 2.5), is the third test in this battery for which validity was not calculated.

5.1.5 Standard Errors

IT is an accepted fact that no matter how carefully measurements are made errors will occur. Furthermore, the chances are that an individual will not obtain the same score on a test on two separate occasions, although she would be likely to approximate fairly closely to her original score. For the population as a whole the closeness of the scores depends on chance.

THE standard errors fluctuate according to a definite pattern for normal distribution, i.e. most scores will vary only a small amount, and only a few will vary widely. The variation is called *Standard Error of Measurement* (SE_{meas}). Table 4.2 shows the SE_{meas} for the different tests in each age group.

JUST as the individual scores fluctuate around the mean score, the sample means fluctuate around the population mean. It must be remembered that the bigger the sample the closer will the sample mean approximate to the population mean. If, therefore, the entire population were tested the exact mean can be reported. The measure of fluctuation of the mean is termed the *Standard Error of the Mean* (SE_{mean}). Table 4.3 summarizes the SE_{mean} for all the tests for the

various age groups. The size of the SE_{mean} are small enough to justify high confidence in the calculated mean as being representative of the true mean of the population.

5.1.6 Questionnaire

THE questionnaire which was sent to principals of schools in Durban and its suburbs has been analysed and the summary appears in Appendix B.2. The summary does not feature in the main text since it does not have a direct bearing on the study. However, some observations are listed below:

(a) Physical education is taught in all schools.

(b) 101 schools out of the 126 that submitted returns indicated that they did not have qualified women physical education teachers. This represents 80% of the schools. Of this number 91 were primary schools which represented approximately 90% of the primary schools in the Durban area.

(c) In view of the shortage of suitably qualified teachers many schools made use of other teachers on the staff to conduct the physical education programme of the school.

(d) 50% of the primary schools and 40% of the high schools reported that they did not have a large enough ground attached to the school where their sports programmes

could be conducted. A number of schools, particularly in the central Durban area, do not have a regular sports programme. Even their physical education programme is restricted.

(e) The popular games for girls at high schools are netball, athletics, tennisette, tenniquoit and volleyball. Other games which are offered in some schools include tennis, table tennis and badminton.

(f) The popular games at the primary schools appear to be netball, tenniquoit, tennisette and athletics.

(g) Some schools make use of grounds away from school to conduct their sports programmes.

5.2 SUMMARY

FIVE tests were used in this study. Four of them measured the most important components of physical fitness. The fifth, viz., the 250 metre Shuttle Run Test, measured endurance as an indication of organic efficiency.

THE tests were administered to a total of 800 girls in eight age categories ranging from 10 to 17 years. 100 girls were used in each age group. The tests were carried out at 36 different schools.

STANDARD score tables have been compiled for the five tests for each of the age groups.

HISTOGRAMS were drawn to show the distribution of the raw scores, and the CR-test was used to ascertain whether there were any significant differences between the various age groups for each of the tests.

A summary of the data obtained from the questionnaire has been included in Appendix B.2 and certain points have been highlighted in the text.

5.3 CONCLUSION

PHYSICAL fitness is the unique contribution of Physical Education to the total development of the whole child. Physical fitness is also the immediate gain to be obtained in physical education. While there may be gains in other respects, - e.g. moulding of character, emotional and spiritual development - these are obtained in an indirect way and, therefore, with less certainty, Physical Education is regarded as an upbringing of the whole human being with the physique only as a starting point. However, there is in this concept an inherent danger of losing sight of the primary aim of physical education, viz. its physical side.

PHYSICAL fitness, therefore, should be acknowledged as

> "the paramount aim of physical education - as something that is not merely a stepping stone towards more or less vaguely conceived spiritual values, but, whilst forming the basis for the consummation of these, is valuable enough for its own sake."(4)

TODAY there is a tremendous amount of pressure on man to attain and maintain even a semblance of physical fitness in the midst of luxuries provided by the advances in science and technology. The physical education teacher must ensure that the children at school are provided with adequate opportunities for attaining a reasonable degree of fitness. Even more important is the fact that the physical education programmes should include activities with carry-over values, so that school leavers will be sufficiently motivated to maintain this fitness through participation in wholesome activities.

THE value of tests in this regard cannot be over-emphasised. The teacher and the pupil obtain some estimate of fitness, or lack of it, in such things as symptoms of chronic fatigue, and the degree of endurance in games. The tests are invaluable in helping to clarify for both the teacher and the pupil the objectives and the capacities which are being developed.

5.4 SOME RECOMMENDATIONS FOR FURTHER RESEARCH

5.4.1 A Battery of Basic Physical Fitness Tests

SINCE a good educational programme includes periodic testing and evaluation which will help teachers to gauge progress and assess individual needs, it is important that a simple physical fitness programme covering most of the physical fitness components should be developed and made available to teachers of physical education.

IN the present study, standard scores have been drawn up for five tests which measured the components of strength and cardio-vascular endurance. Although these five tests are adequate for evaluating the physical fitness status of pupils, there are other factors which need to be investigated and require further research.

A battery of *Basic Physical Fitness Tests*, comprising tests which would measure the *nine* basic fitness factors isolated by Fleishman,[6] ought to provide a wider range of tests. The suggested battery of tests and the nine factors which they measure are presented in Table 5.2 below.

TABLE 5.2

A BASIC PHYSICAL FITNESS TEST BATTERY AND THE FACTORS THEY MEASURE

TESTS	FACTORS
1. 50 m Shuttle Run	Explosive Strength
2. Sit-ups (for 1 minute)	Dynamic Trunk Strength
3. Pull-ups (to limit)	Dynamic Arm Strength
4. Medicine Ball Put	Static Strength
5. 250 m Shuttle Run	Endurance
6. Extent Flexibility	Extent Flexibility
7. Dynamic Flexibility	Dynamic Flexibility
8. Cable Jump	Gross Body Equilibrium
9. Balance	Gross body Co-ordination

THIS battery of nine tests includes the five tests used in the present study. The four additional tests give a broader range of variables and factors. These tests are brief and can be easily administered, and standard scores need to be drawn up for them.

5.4.2 Comparison of Physical Fitness of Different Race Groups

COMPARATIVE studies of physical fitness of boys and girls of the different race groups will be useful to determine:

(a) whether there are differences in the physical fitness between the groups, and

(b) what factors, if any, cause these differences.

STUDIES on international comparisons of physical fitness between American children and (a) British and Australian children (Campbell and Pohndorf), (b) Japanese children (Noguchi) and (c) European children (Kraus and Hirschland)[7] have been undertaken. Fleishman points out that, although these studies have revealed differences between the groups compared, their authors have made little attempt to relate the differences observed to specific environmental, cultural, training and genetic factors. In any comparative study it is important to take cognisance of these factors.

5.4.3 Other Research Possibilities

IT is important to note that, while comparisons between different groups may be useful in their own right as descriptive cross-cultural data, and may reveal strengths and weaknesses of the various groups, it may prove to be more valuable if the time and energy devoted to such comparisons were directed towards more fundamental research into the nature of physical fitness, the relation of physical fitness to important real-life variables, the discovery of specific causes of poor physical performance, the development of better standards of fitness, and the most favourable methods of training and evaluation in this area.

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APPENDIX A

In this appendix the letter and the questionnaire which were sent to principals of schools have been reproduced.

UNIVERSITY OF DURBAN-WESTVILLE

phone: 821211
grams: INKOL

Private Bag X54001,
Durban,
4000.

APPENDIX A

5th September 1973

To:

Principals of Schools in Durban and its Suburbs,
Department of Indian Education.

Dear Sir/Madam

The purpose of this letter is to obtain your co-operation in a study on Physical Fitness of girls in Durban and its suburbs. The aim of the study is to compile standard scores on a selected battery of tests which will be useful in physical education programmes at schools.

Permission for carrying out tests at schools has been obtained from the Director of Indian Education.

In order to select a suitably adequate and representative sample the information requested in the accompanying questionniare is valuable. Your kind co-operation is earnestly requested.

It is hoped that the actual testing will be completed by the end of this school year. It is also the intention to provide all schools with a complete report of the study.

I hope to hear from you soon.

Yours faithfully

R. HEMRAJ
LECTURER IN PHYSICAL EDUCATION

APPENDIX A

The following Questionnaire was sent to Schools.

Q U E S T I O N N A I R E

A. In the following table kindly insert the number of girls in each age group according to standards. (Ages to be calculated as at 30/6/73.)

AGE GROUPS	STANDARDS										TOTAL
	1	2	3	4	5	6	7	8	9	10	
Y:M Y:M 9:7 to 10:6											
10:7 to 11:6											
11:7 to 12:6											
12:7 to 13:6											
13:7 to 14:6											
14:7 to 15:6											
15:7 to 16:6											
16:7 to 17:6											
17:7 to 18:6											

B. 1. Is physical education taught at your school? / YES/ NO /*

2. Number of periods physical education is taught at your school per week per standard.

STANDARD						
No. of Periods Per Week						

3. Do you have a qualified Physical Education teacher? / YES / NO /*

4. If the answer to (3) is "NO", please indicate the number of teachers involved in teaching physical education: _____

5. Does your school have grounds for the following?:

(a)

	YES	NO
Athletics		
Netball		
Tenniquoit		
Tennis		
Tennisette		

(b) For any other activity (please state activity)?

_____

_____

_____

_____

6. If no ground/facility is available at your school, is there some space/ground near your school which could be used for activities? / YES / NO /*

If so, approximate distance from school _____

C. Distribution of girls into socio-economic groups, i.e. Upper S.E. Group; Middle S.E. Group; Lower S.E. Group. (This classification is an approximation.)

	MAJORITY	FAIRLY EVENLY DISTRIBUTED	VERY FEW
Upper S.E. Group			
Middle S.E. Group			
Lower S.E. Group			

*Please insert an "X" in the relevant block.

APPENDIX B

ANALYSIS OF QUESTIONNAIRE

Questionnaires were sent to 28 high schools, and 103 primary schools. 25 high schools and 101 primary schools completed the questionnaire, giving an overall percentage of 97,7%.

The data obtained from the questionnaire are summarised below:

A. The number of girls who were at school up to the end of 1973 in the different age groups are presented in the following table:

TABLE B.1

NUMBER OF GIRLS PER AGE GROUP

AGE GROUP (Yrs : Mths)	NUMBER
9:7 to 10:6	4683
10:7 to 11:6	4137
11:7 to 12:6	4145
12:7 to 13:6	3934
13:7 to 14:6	3166
14:7 to 15:6	2394
15:7 to 16:6	1772
16:7 to 17:6	1183

B.1 Physical Education was taught at all the 126 schools that submitted returns.

B.2 The number of periods allocated to physical education at schools was as follows:

Standards 1 to 6 : two periods per week per class unit.

Standards 7 to 10 : one period per week per class unit.

B.3 In 1973, 15 high schools and 10 primary schools had qualified physical education teachers, i.e. with diplomas in physical education. This represents less than 20% of the schools under consideration.

B.4 Of the 10 high schools and 91 primary schools that did not have qualified physical education teachers, the number of persons who were engaged in teaching the subject ranged from one teacher per school to as many as 18 teachers per school.

B.5 The following table summarises the availability of grounds at schools for the different activities:

TABLE B.2

NUMBER OF SCHOOLS WITH FACILITIES FOR THE ACTIVITIES INDICATED

ACTIVITIES	NUMBER OF SCHOOLS	
	HIGH	PRIMARY
Athletics	15	51
Netball	21	82
Tenniquoit	14	90
Tennisette	15	58
Volleyball	11	10
Tennis	4	3
Softball	1	1
Hockey	1	-
Rounders	1	-

From the above table it seems evident that at only 66 schools (52,5%) is a reasonably large ground available.

B.6 Seven high schools and 15 primary schools reported that they used grounds at some distance (up to one kilometre) from the school.

APPENDIX C

The schools which participated in the testing programme and the number of pupils tested in each age group at these schools are shown in Table C.1 below.

TABLE C.1

NUMBER OF SUBJECTS TESTED AT THE DIFFERENT SCHOOLS

		AGE GROUPS							
	HIGH SCHOOLS	17	16	15	14	13	12	11	10
1.	Southlands	6	1						
2.	Isipingo	9							
3.	Reservoir Hills	10	9						
4.	Merebank	10	11						
5.	Westcliff	10	10						
6.	Avoca	10	10						
7.	Lakehaven	10	10						
8.	Centenary	10	10						
9.	Burnwood	4	10						
10.	Meadowlands	11	10	10					
11.	Chatsworth	10	9	10					
12.	Witteklip		10	10	10				
13.	Protea			10	10	10			
14.	Risecliff			10	10	10			
15.	Depot Road Memorial			10	10		10		
16.	St. Anthony			10	10		10		
17.	Apollo				10	10			
	PRIMARY SCHOOLS								
18.	Junagarth Road			10	10				
19.	Nizam Road			10	10		10		
20.	Sea Cow Lake			10		10	10		
21.	Primrose				10	10	10		
22.	Mayville				10	10	10		
23.	Silverglen					10	10		
24.	Seven Hills					10	10		
25.	Southern Cross					10	10		
26.	Alipore					10	10		
27.	Durban Heights							10	10
28.	Everest							10	10
29.	Roseheights							10	10
30.	St. Mary							10	10
31.	Clairwood Girls							10	10
32.	Belvedere							10	10
33.	Excelsior							10	10
34.	S.M. Jhavary							10	10
35.	Avoca							10	10
36.	Greenvale							10	10

In addition 20 girls from Sunnyvale Primary School were used for test-retest reliability correlations on the five tests and for validity correlations between the 50 Metre Shuttle Run and 50 Metre Dash and between the 250 Metre Shuttle Run and 600 Yard Run.

APPENDIX D : STATISTICAL DETAILS

In Appendix D a few of the calculations that were made in the study are presented.

D.1 Calculations based on scores obtained by 10 year old girls in Tests A and B

D.1.1 Test A : Fifty Metre Shuttle Run (in seconds)

(a) Grouped Data

INTERVALS		f	d	fd	fd^2
13,7 - 14,0	11	2	5	10	50
14,1 - 14,4	~~1111~~ 11	7	4	28	112
14,5 - 14,8	~~1111~~ ~~1111~~ 1	11	3	33	99
14,9 - 15,2	~~1111~~ ~~1111~~ 111	13	2	26	52
15,3 - 15,6	~~1111~~ ~~1111~~ ~~1111~~ 1	16	1	16	16
15,7 - 16,0	~~1111~~ ~~1111~~ ~~1111~~ 11	17	0	0	0
16,1 - 16,4	~~1111~~ ~~1111~~ 1	11	-1	-11	11
16,5 - 16,8	~~1111~~ ~~1111~~ 11	12	-2	-24	48
16,9 - 17,2	111	3	-3	-9	27
17,3 - 17,6	111	3	-4	-12	48
17,7 - 18,0	11	2	-5	-10	50
18,1 - 18,4		0	-6	0	0
18,5 - 18,8	1	1	-7	-7	49
18,9 - 19,2	1	1	-8	-8	64
19,3 - 19,6	1	1	-9	-9	81
i = 0,4		100		23	707
		N		Σfd	Σfd^2

(b) Mean

The mean was obtained by dividing the sum of the raw scores by 100 which is the number in the sample.

Sum of raw score = 1 576,6
Mean = 15,8 (to the nearest 1st dec.)

(c) Standard Deviation

$$SD = \{\sqrt{[\frac{\Sigma fd^2}{N} - (\frac{\Sigma fd}{N})^2]}\} i = \{\sqrt{[\frac{707}{100} - (\frac{23}{100})^2]}\} 0,4$$

$$= \{\sqrt{[7,07 - 0,05]}\} 0,4$$

$$= \{\sqrt{7,02}\} 0,4$$

$$= 2,65 \times 0,4$$

$$= \underline{1,06}$$

(d) Drawing up of the Standard Score Table

The standard score interval in units of 5 was calculated by using the formula:

$$SS = \frac{6 \times SD}{100} \times 5$$

$$SSI = \frac{6 \times 1,06}{100} \times 5$$

$$= \underline{0,318}$$

The mean of 15,8 was fixed at the 50 standard score limit. The standard score table was then drawn up by subtracting 0,32 progressively from the mean for every 5 standard score unit above 50, and also by adding 0,32 successively to the mean for every 5 SS unit below 50. This calculation is shown in Column B below:

A	B	C
100	12,60	12,6
95	12,92	12,9
90	13,24	13,2
85	13,56	13,6
80	13,88	13,9
75	14,20	14,2
70	14,52	14,5
65	14,84	14,8
60	15,16	15,2
55	15,48	15,5
50	15,80	15,8
45	16,12	16,1
40	16,44	16,4
35	16,76	16,8
30	17,08	17,1
25	17,40	17,4
20	17,72	17,7
15	18,04	18,0
10	18,36	18,4
5	18,68	18,7
0	19,00	19,0

In Column C the standard score equivalents have been rounded off to the nearest tenth of a second.

D.1.2 Test B : Sit-ups in one minute

(a) Grouped Data

		f	d	fd	fd^2
0 - 2	𝍸 𝍸 11	12	-4	-48	192
3 - 5	𝍸 1111	9	-3	-27	81
6 - 8	𝍸 111	8	-2	-16	32
9 - 11	𝍸 1111	9	-1	-9	9
12 - 14	𝍸 𝍸 111	13	0	0	0
15 - 17	𝍸 𝍸 1	11	1	11	11
18 - 20	𝍸 𝍸 𝍸 1111	19	2	38	76
21 - 23	𝍸 11	7	3	21	63
24 - 26	𝍸 11	7	4	28	112
27 - 29	111	3	5	15	75
30 - 32	11	2	6	12	72
i = 3		N= 100		Σfd= 25	Σfd^2= 723

(b) Mean

Sum of raw scores = 1 363

N = 100

Mean = 13,6

= 14 (to the nearest whole number)

(c) Standard Deviation

$$SD = \{\sqrt{[\frac{\Sigma fd^2}{N} - (\frac{\Sigma fd}{100})^2]}\} i = \{\sqrt{[\frac{723}{100} - (\frac{25}{100})^2]}\} 3$$

$$= \{\sqrt{[7,23 - 0,06]}\} 3$$

$$= \{\sqrt{7,17}\} 3$$

$$= 2,68 \times 3$$

$$= 8,04$$

= 8 (to the nearest whole number)

(d) Standard Score in 20 units

$$\text{Standard Score Interval} = \frac{6 \times SD}{100} \times 5$$

$$= \frac{6 \times 8}{100} \times 5$$

$$= 2{,}4$$

The mean score of 13,6 was fixed at the 50 standard score unit. 2,4 which is equivalent to 5 standard score units was then added progressively to the mean for every 5 units above 50, and also subtracted from the mean for every 5 units below 50. This is shown in Column B of the Standard Score Table that follows:

A	B	C
100	37,6	38
95	35,2	35
90	32,8	33
85	30,4	30
80	28,0	28
75	25,6	26
70	23,2	23
65	20,8	21
60	18,4	18
55	16,0	16
50	13,6	14
45	11,2	11
40	8,8	9
35	6,4	6
30	4,0	4
25	1,6	2
20		
15		
10		
5		
0		

D.2 Reliability

The following details are presented to show how the reliability coefficients were calculated:

TEST-RETEST DATA ON 50 METRE SHUTTLE RUN TEST

	X	Y	X^2	Y^2	XY
	14,6	14,2	213,2	201,6	207,3
	14,5	14,7	210,3	216,1	213,2
	14,6	14,0	213,2	196,0	204,4
	15,4	14,5	237,2	210,3	223,4
	14,8	14,6	219,0	213,2	216,1
	14,0	14,2	196,0	201,6	198,8
	15,2	15,5	231,0	240,3	235,6
	13,2	13,5	174,2	182,3	178,2
	14,8	14,1	219,0	198,8	208,7
	14,4	14,8	207,4	219,0	213,2
	15,5	14,8	240,3	219,0	229,4
	14,0	13,9	196,0	193,2	194,6
	13,6	14,4	185,0	207,4	195,9
	14,2	14,1	201,6	198,8	200,2
	14,0	13,9	196,0	193,2	194,6
	14,8	15,0	219,0	225,0	222,0
	13,8	13,9	190,4	193,2	191,8
	13,5	13,3	182,3	176,9	179,6
	13,8	13,7	190,4	187,7	189,1
Σ	272,9	271,1	3 921,5	3 873,6	3 896,1

X - Scores obtained by pupils on initial test

Y - Scores of same pupils on retest

X^2 - Squares of initial test scores

Y^2 - Squares of retest scores

XY - Product of X and Y scores

Σ - Sum of scores

Calculation based on Pearson's Product Moment Correlation

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

$$r = \frac{3\ 896{,}1 - \frac{(272{,}9)\ (271{,}1)}{19}}{\sqrt{[3\ 921{,}5 - \frac{(272{,}9)^2}{19}][3\ 873{,}6 - \frac{(271{,}1)^2}{19}]}}$$

$$= \frac{3\ 896{,}1 - 3\ 891{,}0}{\sqrt{(3\ 921{,}5 - 3\ 914{,}0)\ (3\ 873{,}6 - 3\ 868{,}2)}}$$

$$= \frac{5{,}1}{\sqrt{(7{,}5 \times 5{,}4)}}$$

$$= \frac{5{,}1}{\sqrt{40{,}25}}$$

$$= \frac{5{,}1}{6{,}36}$$

$$= \underline{0{,}804}$$

D.3 Validity

The calculations for the correlation coefficient between the 50 Metre Shuttle Run test and the 50 Metre Dash are shown:

X	Y	X^2	Y^2	XY
15,5	10,0	240,25	100,00	155,00
14,8	9,8	219,04	96,04	145,04
14,8	10,2	219,04	104,04	150,96
14,7	9,2	216,09	84,64	135,24
14,6	9,1	213,16	82,81	132,86
14,5	10,1	210,25	102,01	146,45
14,4	8,9	207,36	72,21	128,16
14,4	10,0	207,36	100,00	144,00
14,2	10,2	201,64	104,04	144,84
14,1	9,2	198,81	84,64	129,72
14,1	8,8	198,81	77,44	124,08
14,0	8,2	196,00	67,24	114,80
14,0	8,5	196,00	72,25	119,00
13,9	8,4	193,21	70,56	116,76
13,9	8,4	193,21	70,56	116,76
13,9	8,2	193,21	67,24	113,98
13,8	8,4	190,44	70,56	115,92
13,5	10,0	182,25	100,00	135,00
13,3	8,4	176,89	70,56	111,72
13,2	9,5	174,24	90,25	125,40
283,6	183,5	4 027,26	1 687,09	2 605,69

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

$$= \frac{2\,605{,}69 - \frac{(283{,}6)\ (183{,}5)}{20}}{\sqrt{\left[4\,027{,}26 - \frac{(283{,}6)^2}{20}\right]\left[1\,687{,}09 - \frac{(183{,}5)^2}{20}\right]}}$$

$$= \frac{2\,605{,}69 - 2\,602{,}03}{\sqrt{(4\,027{,}26 - 4\,021{,}44)\ (1\,687{,}09 - (1\,683{,}61)}}$$

$$= \frac{3{,}66}{\sqrt{(5{,}82 \times 3{,}48)}}$$

$$= \frac{3{,}66}{\sqrt{20{,}25}}$$

$$= \frac{3{,}66}{4{,}50}$$

$$= \underline{0{,}813}$$