A COMPARISON OF THE FITNESS LEVELS OF INDIAN HIGH SCHOOL BOYS IN TWO COHORTS : 1977 AND 1997.

by

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Dedication

This dissertation is dedicated to my Husband,

Kenny

For his love, support and inspiration.

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ABSTRACT

The main aim of this study was to compare fitness levels of Indian high school boys in two cohorts: 1977 and 1997. A secondary aim was to identify if the same problem areas or strengths still exist in 1997 as in 1977 or if the levels of fitness have further deteriorated or improved, as well as the establishment of norms for boys 14 – 18 years.

Ten different Secondary schools from the Durban Metropolitan area participated in this study. The test battery included eight tests measuring four components of motor fitness based on the Fleishman study. The tests that were used consisted of fifty metre shuttle run, fifty metre dash, sit-ups, pull-ups, medicine ball put, shot-put, 250m shuttle run and 12 minute run/walk test.

Data from 500 hundred boys were included in the research analysis and these were categorized into 5 different age groups, 13,6 – 14,6 years; 14,7 – 15,6 years; 15,7 – 16,6 years; 16,7 – 17,6 years and 17,7 – 18,6 years.

Basic statistical procedures were used to determine the normality of the samples for height and weight in each age group. Standard score tables were drawn for each age group. A paired t-test was used to determine if a significant difference between the means existed. The level of significance was set at 0,05. The means of both studies were compared to ascertain the difference in fitness levels in the two cohorts.

The analysis of the data revealed that the fitness status of adolescent boys have deteriorated over two decades.

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CHAPTER ONE

1.1 INTRODUCTION

Recently, considerable attention has been given to physical fitness testing. Of particular concern are physical fitness parameters such as cardiovascular fitness, body fatness, muscular strength, explosive strength, static strength and flexibility. Schools, sports clubs and other public and private institutions have become agents for fitness testing. The history of tests and measurements has moved through several stages from anthropometric to motor fitness parameters to health related physical fitness. At the present time there is a renewed emphasis on health related physical fitness testing. This branch of fitness testing has always been measured, however, named differently. During World War II great stress was placed on fitness and this emphasis brought about urgency to develop fitness tests. During these two decades of scientific testing the army, the air force, and the navy devised fitness tests with appropriate norms ***(Barrow and Mc Gee, 1979).***

Physical fitness must be defined with consideration for an individual's age and lifestyle. For a young person, physical fitness is defined as a physical condition that allows an individual to work without becoming overly fatigued, perform daily chores and have enough energy left over to engage in leisure activities.

According to ***Bouchard et al.(1990)*** physical fitness is the ability to perform muscular work satisfactorily. ***Cureton(1947)*** defines physical fitness as a facet of total fitness and distinguishes the other facets as emotional, mental and social fitness. The definition of physical fitness might vary by individual but most experts in the field agree that there are five basic components of physical fitness which involve cardiorespiratory endurance, muscular endurance, muscular strength, flexibility and body composition.

In developing the Health – Related Physical Fitness Test ***(AAHPERD, 1980, 1984),*** three components of health related physical fitness were identified, cardiorespiratory endurance, body composition and musculoskeletal function of the low back and abdominal area. The underlying theme of this approach is that physical fitness should have a definition that is meaningful across the lifespan. Thus the focus shifted to health concerns in adulthood and a desire for good health. Health-related fitness comprising aerobic fitness, strength, leanness and flexibility are equated with good health and are thought to lower one's risk for cardiovascular disease and other degenerative conditions.

Although these degenerative diseases do manifest themselves during adulthood, the processes underlying these diseases often begin during childhood and adolescence ***(Despre's, Bouchard, & Malina, 1990).***

Studies conducted on physical fitness have been well documented ***Cureton (1947), AAHPER (1958), AAHPERD (1988)*** and ***Fleishman (1964).*** There is widespread use of the fitness and AAHPERD test battery in American schools. Other countries such as Japan, Great Britain, and Canada have also developed standardized norms for physical fitness ***(AAHPER, 1958; CAHPER, 1966 and Ishiko, 1977).*** In 1965 National Fitness Tests were administered to the Japanese population for the first time. These tests consisted of both youth and adult fitness tests. From these data National norms were published ***(Ishiko, 1977).*** In 1963 the Canadian Association for Health, Physical Education and Recreation ***(CAHPER)*** conducted a national fitness-testing program. Norms were published by ***CAHPER*** in 1966. Other countries were encouraged to use the ***CAHPER*** testing instrument in order to compare results with Canadian norms ***(CAHPER, 1966).***

Various related literature pertaining to tests and measurements clearly reveal that the determination of the fitness status of youth of many countries has received considerable attention for many years.

1.2 PURPOSE OF STUDY

The main objective of this study is to compare fitness levels amongst cohort of Indian high school boys in 1997 with those of 1977. The secondary objective will be to identify if the problem areas or strengths that exist in 1997 was in 1977 or if the levels of fitness have further deteriorated or improved.

1.3 NEED FOR THE STUDY

Coopoo (1978) conducted a study twenty years ago to measure the levels of fitness of Indian high school boys between 14 to 18 years. Since then there have been no follow up studies with regard to Indian boys at Secondary school level, in ex-House of Delegate schools. There is an urgent need to re-evaluate and scientifically assess the levels of fitness of Secondary School boys. It is important to know whether fitness levels have changed over this period of study. If the fitness levels changed, then a new set of norms will have to be developed for the changing circumstances.

On going tests and measurements play an integral role in determining the current fitness performance level and health status of test participants. This presupposes a systematic gathering and interpretation of information. This systematic collection of evidence is vital in determining whether changes are taking place in learners as well as to determine the amount or degree of change in individual students.

Fitness testing is a key factor not only in determining children's fitness, but also to ensure effective instruction. In schools, tests and measurements have great impact, especially in the physical education programme. To this end the monitoring of children's progress is vital. Thus tests and measurements should be an integral part of the schools physical education programme. According to ***Zhu (1997)*** " without conducting fitness testing and monitoring children's current fitness status, effective instruction is impossible".

Another need for physical fitness testing is to develop norms from average scores for each component of fitness that is collected from a large sample; so local norms can be established. Thus a norm is a performance standard based on the analysis of data, which is obtained by gathering scores for a large number of individuals similar in age, sex and other characteristics to the subjects with whom the norms will be used.

In South Africa norms were developed on Indian boys on a test battery, which comprised the following components, namely, static strength, explosive strength, dynamic strength and cardiovascular endurance. Research was done on Indian boys in the 1970's and norms were developed. However, research is needed now twenty years later to ascertain if there are any significant changes that may have occurred over the last twenty years. Therefore, the need for this research has now become imperative. The norms are revisited to ascertain their applicability more than two decades later. A marked general improvement in fitness over the last two decades or a marked deterioration could provide a set of norms, which will reflect the degree of change that has taken place.

Finally, the academia needs to know whether we have moved forward or backwards since the last study as this would provide us with a measure of progress (or lack of it) in this area of the discipline. Only through scientific testing one can ascertain possible changes that may have occurred in fitness of different cohorts of high school boys from 1977 to 1997 and the factors affecting these changes.

1.4 HYPOTHESIS

The fitness levels of a cohort of High School boys in 1997 is better than the cohort of boys in 1977.

1.5 LIMITATIONS, DELIMITATIONS AND ASSUMPTIONS OF THE STUDY

This section allows the author to discuss specific limitations, assumptions, and delimitations of this study.

1.5.1 LIMITATIONS

The data used in this study were limited to those students who volunteered to undergo the test battery, and were randomly selected. The sample cannot be regarded as representative of all Indian Secondary School pupils in South Africa. The subjects were well motivated, however, motivation is always a problem with respect to field-testing.

1.5.2 DELIMITATIONS

This study was delimited to the data obtained from five hundred Indian secondary school boys between the ages 14 to 18 years of age. The subjects who volunteered for this study, who were randomly selected were limited to the Durban Metropolitan area. The schools selected in this study were restricted solely to ex-HOD schools in the Durban region. It was further delimited to the test protocol used in the ***Coopoo (1978)*** study, which was based upon the ***Fleishman (1964)*** test battery.

1.5.3 ASSUMPTIONS

It would be assumed that all pupils participating in this study are representative of a normal population and represent an equal distribution of fitness levels to validate the study. It is also assumed that all the students tested, performed their very best.

1.6 DEFINITION OF TERMS

1.6.1 *MOTOR FITNESS*: Motor fitness is thought to be a limited phase of general motor ability. Elements of motor fitness are endurance, strength, power, flexibility, balance, speed and agility. These elements are usually reflected in motor performance such as running, jumping, dodging, climbing, swimming, lifting weights and carrying loads for a prolonged period of time.

1.6.2 *PHYSICAL FITNESS:* The President's Council on Physical Fitness and Sports defines physical fitness as "the ability to carry out daily tasks with vigor and alertness without undue fatigue, with ample energy to enjoy leisure time pursuits, and to meet unforeseen emergencies.

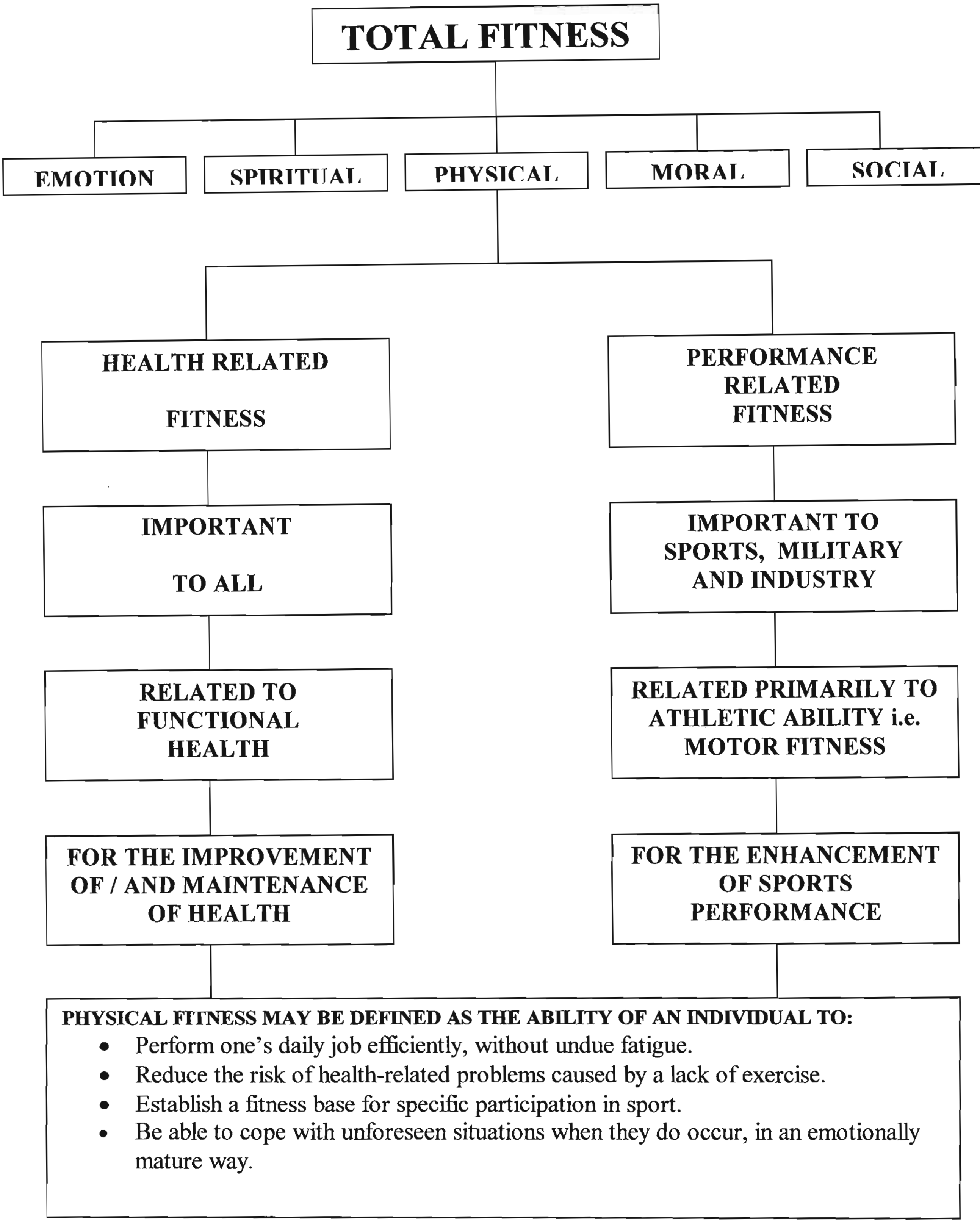


Figure 1.1 Total Fitness and its components Coopoo (1998)

1.6.3 EXPLOSIVE STRENGTH: is the ability to release maximum force in the shortest possible time.

1.6.4 STATIC STRENGTH: is the maximum force a person can exert over a brief period of time against a fairly immovable or heavy object.

1.6.5 DYNAMIC STRENGTH: is the maximum load that can be moved once through a specific joint range of motion with the body in a particular position, supported by the limbs of the body.

1.6.6 CARDIOVASCULAR FITNESS: Refers to the combined efficiency of blood vessels, heart and lungs. It determines the ability of an individual to continued physical exercise for prolonged periods.

1.6.7 STRENGTH: Strength is the capacity of a muscle to exert maximal force against resistance.

1.6.8 NORM: is a scale that permits conversion from raw score to a score capable of comparisons and interpretations. Norms are based on age, grade, height and weight. Scores must be evaluated in relationship to others in the same population.

1.6.9 FLEXIBILITY: is the ability to move a joint through its full range of motion, the elasticity of the muscle.

1.6.10 BODY COMPOSITION: The proportion of fat in your body compared to your bone and muscle.

1.6.11 MAXIMAL OXYGEN UPTAKE: is the highest volume of oxygen that can be consumed or utilized by the body per unit time. It reflects the highest metabolic rate via oxidative or aerobic pathways that one can attain.

1.7 ABBREVIATIONS

1.7.1 $\bar{X}$	-	Mean
1.7.2 S.D	-	Standard Deviation
1.7.3 cm.	-	centimeters
1.7.4 kg.	-	Kilograms
1.7.5 sec.	-	seconds
1.7.6 m.	-	metres
1.7.7 $p < 0.05$	-	Significance at 5% level
1.7.8 $p > 0.05$	-	Not Significant at 5% level
1.7.9 SS	-	Standard Scores
1.7.10 n	-	Number of Subjects
1.7.11 P.F.I	-	Physical Fitness Index

CHAPTER TWO

REVIEW OF LITERATURE

This chapter explores the subject of physical fitness paying specific attention to the various test batteries that were developed to measure the components which comprise physical fitness. The researcher traces the history of tests and measurements briefly from its earliest beginnings. The researcher proposes the need to illustrate how the status and popularity of scientific testing has changed over the decades.

The area of physical fitness has received widespread attention for many years. Researchers in many countries have been developing batteries of tests to measure the components which comprise physical fitness. Thus various test batteries have been constructed to measure components that make-up physical fitness.

No single test could measure all the components, so different components were measured by different tests as will be seen later in the literature review. A test of a single fitness component had limited value, therefore a comprehensive battery of tests was needed in order to establish norms that expressed the general fitness of the individual.

Early tests were anthropometric in nature and in 1861 Edward Hitchcock developed standards for age, height and weight. Hitchcock (1861) was considered the leading researcher in anthropometry during this era. This type of measurement still holds an important place in measuring mass, height and body composition. At the turn of the century there was a growing interest in measuring cardiorespiratory function. This led to the development of endurance tests, heart and lung tests. The first test of cardiac function was the Blood Ptosis Test that was developed by Crompton in 1905. The Harvard Step Test (1943) and the Balke Treadmill Test (1954) were tests designed to test the efficiency of the circulatory system. All these tests were excellent as starting points for measuring cardio respiratory fitness, however, all of them had their criticisms. This will be discussed later.

Cureton (1947) and ***McCloy (1934)*** devoted considerable attention to anthropometry in the appraisal of nutritional status on Chinese and United States children. The National Youth fitness testing began in the 1950's in most overseas countries. An example of this was the ***Kraus Weber Test of minimum muscular fitness (1954).*** This test showed that European children demonstrated greater fitness than children in the United States. In Europe only 9% of the children failed the test, but 57,8 % in the United States. The Kraus Weber Test comprised of six items namely, abdominals plus psoas, abdominals minus psoas, psoas and lower abdominals, upper back, lower back and flexibility. The Kraus-Weber test for minimum muscular fitness was also conducted in East Pakistan in 1958 where 2325 Pakistani male and female school children were subjects. The results of the Pakistani study were compared to test results in the United States and Europe. The results showed that Pakistani children were less able than European children in passing the six test items. They were found to be more successful than the American children (Kelliher, 1960). The children tested in East Pakistan seldom have any of the opportunities of American children. Their play and recreational opportunities are inferior, unsatisfactory diet, hot humid weather and diseases such as malaria and small pox. Inspite of these astonishing deficiencies the children in East Pakistan delivered better results than the American children. In the author's opinion the genetic difference may account for these differences. The Kraus-Weber test of minimum muscular fitness was criticized on the basis that it was a range of motion test and not fitness test thus giving way to the development of the AAHPER Youth Fitness Test (1958).

The AAHPER Youth Fitness test battery is most commonly used in public schools in the United States. The ***AAHPER (1958)*** testing instrument permitted the first assessment of the overall physical fitness levels of American boys and girls at the secondary school level. The battery of tests comprised seven items, namely : pull-ups, sit – ups, shuttle-run, fifty-yard dash, standing broad jump, softball throw and six hundred yard run- walk. This test became the first fitness test with national norms to be developed in the physical education profession. This test was developed as a result of a need to upgrade and assess the fitness status of the youth of our nation.

Much criticism has been levelled at the early ***AAHPER (1958)*** test battery example the softball throw was a sport specific test and measured explosive strength, the sit – up test was straight leg and could lead to lower back problems, 600 yard run was too short as a test for endurance. Four of the tests were from the explosive strength factor namely, standing broad jump, 50 m dash, 50 m shuttle run and soft ball throw. Not all fitness factors were included in the items on the AAHPER test, only a limited aspect of total fitness is measured and some test items are culturally determined. Thus with this bias in components and the hall - mark study by ***Fleishman (1964)*** where fitness components were classified, this AAHPER fitness test underwent drastic changes. As a result in 1965 some 9200 children from 10 to 17 years were tested on the AAHPER test battery and new norms were compiled on the basis of this data. These norms were published by ***AAHPER (1965).*** The original battery has undergone two revisions, one in 1975 and another in 1979. In the 1979 revision of the test battery the 600 yard run was discarded and replaced by the 9 minute or 1 mile run. The sit-up position changed from extended to flexed leg. The grip for pull-ups was changed from forward to reverse. The sit and reach and sum of skinfold tests were introduced. Although the test has undergone major revisions and updating of normative data in 1975 and 1979, it recommends three test items which according to Fleishman all measure explosive strength (shuttle run, standing broad jump and 50 yard dash). There is an optional item, vertical jump instead of standing broad jump because of its relevance to sports such as basketball and volleyball. The standing broad jump and vertical jump have low factor loadings of 0,66 and 0,64 compared to shuttle run 0,77 and 50 m dash 0,75.

Smit (1965) and Sloan (1966) compared results from samples of South African children with AAHPER norms and both reported higher levels of physical fitness among the South African samples.

Fleishman (1964), was a scholar who made a significant contribution to the understanding of physical fitness through his application of the correlation research technique of factor analysis to fitness test items. He cleared most of the confusion that existed with regards to the basic components of motor fitness. He applied factor analysis to a large set of motor variables, isolating several basic factors. He then established a corresponding test battery and in 1962 he published United State norms. The Fleishman test battery has been used in various countries to establish norms, including South Africa.

Du Toit (1970), Hemraj (1975), Coopoo (1978) and ***Hudgson (1983),*** used the Fleishman test battery to establish norms for various race groups.

The components of fitness discussed by ***Fleishman (1964),*** include dynamic strength, explosive strength, balance, static strength, flexibility and endurance. The battery of test developed by ***Fleishman (1964)*** is all embracing as it employs little in the way of equipment. It is highly recommended for use in schools. The reliability co-efficient for each test item is high, ranging from 0,70 to 0,93 and the validity of the test battery is also high. ***Fleishman (1964)*** has made a significant contribution to the understanding of physical fitness.

Four components of fitness were selected in this study. These components include static strength, explosive strength, dynamic strength and endurance. The researcher believes that a test battery incorporating the four important components outlined by Fleishman will provide a good estimation of routine fitness status of high school boys.

2.1 HEALTH RELATED TESTING

The Texas Governor's Commission on Physical Fitness (1973) developed one of the first health-related physical fitness tests. The battery is split into physical fitness components and motor ability components. Tests included are chin-ups, bent leg sit-ups (2 minutes) and 12-minute run/walk test. This test ushered a new era in fitness testing in schools, that of health related fitness. Very soon changes to batteries, which included health, related fitness sprang up all over the world.

The South Carolina health related fitness test was published in 1978 with statewide norms ***(Pate, 1978).*** This test includes both criterion and norm referenced standards. The test provides norms for boys and girls ages 9 to 16 and includes students from 17 schools. Included in this test battery are the 1-minute timed bent knee sit-ups, sit and reach, distance runs and skinfolds. This was the first health related test developed by AAHPER. The emphasis now shifted from fitness testing to more specific health related test batteries.

Much criticism has been leveled at the early AAHPER test battery and in 1981 AAHPERD (dance was included) introduced the Health Related Lifetime Physical Fitness test. The 1980's gave way to an introduction of a new health related fitness testing. This test measured those variables, which were likely to be related to health problems. This kind of health related fitness testing has been acknowledged more recently by the American Academy of Physical Education (1987) and the American School Health Association (1987) who has given utmost support for health based fitness testing. According to ***Corbin (1987)*** "the goal for the nation for 1990 is to have 70% of youth between 10 and 17 years of age involved in an annual fitness testing program."

The AAHPERD Health Related Lifetime Physical Fitness Testing supported the principle that society should become more active. Exercise itself should not be thought of as a cure-all, but as one of the important health habits associated with a prudent lifestyle. ***Corbin (1987)*** has shown that children lack in one or more of the various health-related components of fitness.

In 1987, AAHPERD endorsed the National Youth Fitness Task Force. They theorised physical fitness as a physical state of well being. The Physical Best Fitness Program has as its main objective "the motivation of all children and youth to engage in physical activity in a manner which promotes health as physical well being."

This program replaces all other fitness programs previously endorsed by AAHPERD and intended to aid physical education and classroom teachers with those aspects related to their physical education programs. The main objective of this program is to instill in children the knowledge, skills and attitudes that will encourage them to participate in physical activity throughout their lifetime. It is therefore imperative to develop a lifelong commitment to regular participation. The major emphasis is on improving and maintaining optimal levels of the health related fitness components of aerobic endurance, body composition, flexibility, muscular strength and muscular endurance. The AAHPER Youth fitness tests can be easily administered with very little equipment required.

Items of the AAHPERD test batteries are compared in a number of after test batteries currently in use in the United States. These are AAHPERD Physical Best ***(AAHPERD,***

1988); FITNESSGRAM (Institute for Aerobics Research, 1987); President's Physical Fitness Test (President's Council on Physical Fitness and Sport, 1987); Chrysler AAU (Chrysler Fund - Amateur Athletic Union, 1987), National Children and Youth Fitness Test ***(Ross & Pate, 1987***) and Fit Youth Today (American Health and fitness Foundation, 1986).

The Fit Youth Today Program is a comprehensive health related youth fitness program designed to promote health and moderate to vigorous physical activity in children. The program was initiated in many public schools in Texas in 1986. The Fit Youth Today test includes components of health related fitness in its test battery. It includes the 30-minute steady state jog as a measure of cardiorespiratory endurance.

The National Children and Youth Fitness Study II ***(Ross & Pate, 1987)*** have received widespread attention. Several thousand pupils selected randomly from 25 countries participated in this study. A total of 4360 children ages 6-9 years and 2170 boys and 2190 girls were involved in this study. Each pupil completed a set of fitness tests including the 1-mile run/walk, sit and reach, modified pull-ups, 1-minute bent knee sit-ups and skinfolds. The NCYFS II data have provided national norms that are used for comparisons. The results of a study conducted by ***Cotton (1990)*** on the modified pull up test, were compared to results of NCYFS II, which showed that the means for the male subjects were higher than the means from the NCYFS II study results.

A new development in physical fitness testing of youth is the use of Criterion referenced standards. Physical fitness tests given to children and adolescents have traditionally been scored using percentile norms by age and sex. Scoring of this type has allowed the individual to be evaluated in relation to one's peers. The use of criterion reference standards sets a criterion or cut off score. In 1987, The Institute for Aerobics Research published Criterion reference standards for the FITNESSGRAM, a computerized Youth Fitness testing program. The Criterion reference standards consisted of scores considered to be consistent with good health on the mile run/walk, % fat, body mass index, sit and reach, sit-ups, pull-ups and flexed arm hang. The FITNESSGRAM was designed to be used with children in kindergarten through 12^{th} grade, ages 5 to 17 years.

AAHPERD (1988) published Criterion reference standards as part of the Physical Best Program for the mile run/walk, sum of skinfolds, body mass index, sit and reach, sit-ups and pull-ups in children 5 to 18 years of age. These were the first Criterion Reference Standards for Youth Health Related Physical Fitness put into widespread national use***(Cureton & Warren, 1990).*** These tests allow the assessment of comparative physical fitness of American children. Being published nationally they also allow comparisons with children of other countries.

Blair et al. (1989) performed a study on a group of 37 454 children 6 to 17 years of age who were tested on the mile run/walk test as part of the FITNESSGRAM program during 1987 to 1988. Sixty three percent of the girls and 69 % of the boys exceeded the FITNESSGRAM Criterion Reference Standards. The results of the study is consistent with the relatively high average maximal oxygen consumption of young children compared to the criterion standards.

Pate et al. (1993) also used factor analysis to analyse the components of performances on the five field tests, namely, upper body muscular strength and endurance, pull-ups, flexed arm hang, push-ups and the Vermont Modified pull-up test. In this study the above five field tests of muscular strength were examined and found to be valid measures of weight relative muscular strength. The Vermont Modified pull-up test yielded the highest correlation of 0,73 with weight relative muscular strength. ***Pate et al. (1993)*** recommend that this test of muscular strength be included in field fitness test batteries.

If all of these health related tests are analysed the following are noted:

- That all the components are the same, namely, muscular endurance, cardio respiratory fitness, body composition and flexibility.
- The striking difference is that fitness norms are developed separately for the different populations.
- The Fitnessgram ***(Blair et al., 1989)*** was the largest were 37 454 children were tested.
- This is one of the few test batteries, where consensus of components for testing is reached. This state of consensus goes well for health and fitness evaluation of children, ushering a new era of testing in schools.

In summary it could be reinforced that studies of this nature provides solid scientific evidence to support the importance of the administration of fitness tests. According to ***Zhu (1997),*** administration of fitness tests led to an improvement of children's cardiovascular endurance.

In South Africa research in the area of physical fitness have been undertaken in the field of physical education. Some of the earliest studies in this country were undertaken by Jokl in the late 1930's at the University of Stellenbosch. This appears to be the first study of fitness of Children of note in this country. This followed by studies by ***Cluver , de Jong and Jokl (1942).*** In the seventies, du Toit and associates of the Department of Physical Education initiated a number of studies on fitness of school children. These are listed below.

du Toit (1970)	- Composition of Standard Scores on Indian Boys.
Hemraj (1973)	- Composition of Standard Scores on Indian male students.
Hemraj (1975)	- Indian Girls (10 – 17) years.
Chetty (1975)	- Indian female students.
Coutts (1977)	- White female students in Natal.
Coopoo (1978)	- Standard Scores of Indian Boys (14 – 18 years).
Bredenkamp (1983)	- Norms for White Boys in Natal ages (14 – 18 years).
Hudgson (1983)	- White Girls (10 – 17 years).
Du Toit et al. (1985)	- Structural and physiological characteristics of male Physical Education students.
Andrews (1990)	- Status of physical fitness of South African Adults (18 – 55 years).

In reviewing the literature on studies undertaken in South Africa, it is evident that there has not been an abundance of theoretically grounded research on the area of health related physical fitness of Indian Secondary School boys. This remains a shortfall in South African research. The study by ***Coopoo (1978),*** on the establishment of standard scores on Indian boys (14 to 18 years) was undertaken twenty years ago in the Durban region. ***Coopoo (1978)*** study was on motor fitness of children in Indian schools. The Indian community was targeted, as there was a shortfall in research for this race group.

Interracial studies of the physical fitness of children have been reported in South Africa in the 1940's. ***Cluver, De Jongh and Jokl (1942)*** applied 3 tests (100 yard run, 600 yard run and shot put) to 9214 South African children, classified as White, Bantu and Asiatic. Up to puberty, the Bantu boys and girls were superior to the other groups, except at the shot put, where White boys were better than Bantu boys. After puberty the white boys led in all the tests and White girls were better than other girls at the 100 yard run. Asiatic children (Chinese and Indian) were the most inferior at all the tests. The study also notes the greatest post puberty decline of endurance in the Bantu and Indian race groups. These were the first semblance of fitness testing in South Africa; however, in one study all three components may be classed as explosive. Therefore, only one component was measured and however, cannot be termed a physical fitness test. The advantage though, that some form of fitness testing did occur, although, in an unequal situation due to government policy.

In the 1960's several studies were conducted in South Africa on children and the results of these studies were compared to American, British and Chinese children using AAHPER Youth Fitness data. A brief review of these studies will be presented.

Haig (1960) conducted a study on East London schoolgirls 12 – 16 years on a seven motor fitness test using the test battery of AAHPER (1958). The tests included a modified pull-up, sit-up, shuttle run, standing broad jump, 50 yards dash, softball throw for distance and 600 yard run/walk test. The results of the South African girls were compared to American schoolgirls. South African results indicated that the East London scores were superior to the American in most of the test variables. Again, the criticisms must be leveled at the AAHPERD choice of tests as was discussed previously.

Johnstone (1960) compared the motor fitness of 500 East London schoolboys 12-16 years of age with National norms of AAHPER test battery. This study showed that the East London schoolboys 12-16 years of age are superior to their American counterparts in muscular endurance in the arms, legs and abdomen, agility and leg power. American boys were found to be better at all age levels in arm power as reflected in the softball throw. This result of the softball throw could be explained as a sport specific test, as it was a part of the American culture to play softball in schools as compared to rugby and soccer in South African schools. Thus, the criticisms against the AAHPER test, that it had sport specific skill contained in it, thus not a true test of motor fitness.

In 1964, Putter conducted a study to ascertain physical fitness differences between South African white men and Bantu men aged 19 to 35 years. Two hundred and ninety three Bantu men and two hundred and seventy seven white men participated in this study. The test battery consisted of 6 items namely back strength, standing broad jump, 60 yards shuttle run, shot put, pull-ups and 800 feet shuttle run. The results of the study showed that the White men were superior to the non-white men in physical achievement. White men however showed a decline in physical fitness after the age of 24 years. The decline in physical achievement of non-whites appeared after the 29th year. The non whites achieved their highest score in pull-ups and the lowest score in standing broad jump. This could be explained that the Bantu men were involved with manual labour for the large part of their lives, thus the lesser decline compared to the white men in this study.

Sloan (1966) and Smit (1965) compared fitness levels of school children in South Africa, America and Britain, using the Youth Fitness Test of the American Association for Health, Physical Education and Recreation ***(AAHPER) (1958).*** The results of the study by ***Smit (1965)*** showed that children in South Africa displayed a higher level of fitness than children in America and Britain. ***Sloan (1966)*** reported that the South African children were fitter than both the American and the British children, but there was a decrement in the fitness levels of older age groups in the South African sample.

The first comprehensive testing on a race group in South Africa was done by **du Toit (1970).** He established standard score tables for Primary School Indian Boys for the age group 10-14 years. His work was based on the ***Fleishman (1964)*** study. The variables selected for measurement included 250 m shuttle run, 50 m shuttle run, sit-ups for one minute, pull-ups and medicine ball put. The main objective of his study was to develop norms for primary school boys that could be used for comparisons at school.
This was a pioneering study in fitness in the Indian community.

Hemraj (1973) established standard scores for selected physical fitness measures for male students between 18 and 25 years at the University of Durban Westville. The tests selected for measurement included 50 metre shuttle run as a measure of explosive strength, two minute sit-ups as a measure of dynamic strength, pull-ups to limit as a measure of dynamic arm strength, medicine ball put as a measure of static strength and 250m shuttle run for endurance. This was a hallmark study with respect to the fitness of adult Indian men on selected fitness components.

The ***Coopoo (1978)*** study led the research into the testing of Indian high school boys. This study would complete the first set of norms for high school children. Du Toit (1970) completed the first complete set of norms for Indian primary school children and the Hemraj study (1973) for Indian adult males. This was a comprehensive set of norms for any South African racial population group. ***Coopoo's (1978)*** study investigated the fitness of Indian high school boys between 14 to 18 years. His study was the first to show a decline in fitness of school children after the age of 16 years. It was this study that initiated a comparison as described in the current study.

In the early 1980's ***Hudgson (1983)*** established standard scores on five motor fitness tests based on the Fleishman study namely, modified pull-up, one minute bent knee sit-ups, medicine ball put, fifty metre dash and twelve minute run/walk test. These norms were established for white girls between the ages 10 to 17 years in the Durban area.

Andrews (1980) compared South African and Canadian youth fitness levels using the fitness performance test of the Canadian Association for Health, Physical Education and Recreation ***(CAHPER) (1966)***. ***Andrews (1980)*** reported studies by Smit (1965) and Sloan (1966) that showed South African children to be fitter than their overseas counterparts.

Andrews (1980) published norms for schoolboys aged 13 to 17 years. No similar norms for schoolgirls have yet been published. ***Andrews (1985)*** published fitness norms for South African adults aged 18-24 years. In the area of international comparative fitness levels ***(Andrews et al., 1985)*** compared fitness levels of a selected group of university students from the University of Cape Town, Stellenbosch and the Western Cape to a selected group of American students of the University of Utah. The results of the study indicated that American men and women age 18 to 24 years were generally fitter than the South African students. The test battery comprised of sit-ups, long jump, flexibility, skinfolds and a physical working capacity test.

Du Toit et al. (1985) investigated the maximal oxygen consumption as a measure of aerobic work potential of Indian males in the Department of Physical Education in the University of Durban Westville. The results of the study showed that Indian males displayed a greater aerobic potential than was hypothesized and were in good physical condition.

Andrews (1990) undertook his study to determine the levels of physical fitness of a selected group of South African adults aged 18 to 55 years. By testing an appropriate sample of the population ***Andrews (1990)*** was able to standardize these performance scores for national usage. It is important to derive norms, as norms that have been developed in other countries cannot be used effectively in South Africa, because of the scientific requirement of standardization.

The studies on motor fitness in South Africa is by far the best researched in the Indian population as completed by ***du Toit (1970), Hemraj (1973), Hemraj (1975), Coopoo (1978)*** and ***du Toit (1978).*** It is the only population that has norms from primary school to high school into adulthood. Their selection of tests was based on the Fleishman study (1964). He was the first to logically classify test in different components. These researchers must be commended for their insight in fitness testing in the Indian population.

2.2 A REVIEW OF TESTS SELECTED:

Since this study is a comparative study of a cohort of high school boys tested in 1997 to a cohort of boys tested in 1977, the researcher felt that the same tests used in the ***Coopoo (1978)*** study would be used in this research project. Since the ***Coopoo (1978)*** study based his selection of tests on the Fleishman study, the components tested are still used in current fitness testing so the duplication of ***Coopoo (1978)*** battery is based on scientific grounds. It would be prudent for the researcher to discuss each of the component areas selected for this study. The first is that it is related to aerobic endurance.

2.2.1 TESTS RELATED TO ENDURANCE

Astrand and Rodahl (1970) have reported that aerobic capacity is largely attributed to heredity and can be increased by about 10 to 20% with endurance training. Some people are endowed with greater aerobic capacity than others. Cardiorespiratory function depends on several factors namely; efficient lungs, heart and blood vessels, the quality and quantity of blood and the cellular components that help the body utilize oxygen during exercise. It is essential that students be motivated to increase their fitness levels. The 50^{th} percentile is a realistic goal for most properly trained and motivated students.
The administration of reliable run/walk distances is considered a valuable part of a total fitness program for young children ***(Cureton, 1982, Whitehead et al., 1990).*** Distance running as a form of aerobic exercise has been found to be related to cardiovascular health. It is important that young children participate in such activities to develop habits that will continue throughout their lifetime, and to minimize the effects of degenerative diseases as related to lack of exercise.

Early attempts at developing a good test of aerobic fitness were the Harvard Step Test developed by ***Lucian Brouha (1943).*** This test proposed an estimate of the capacity of the body to adjust to and recover from hard muscular work. The PFI classification for high school boy's ages 12 to 18 years were as follows: -

50 or less - very poor
51 to 60 - poor
61 to 70 - fair

However, the Harvard Step test can be criticized on the basis that workloads are unequal for different persons example the stepping height is the same (24 inches), the stepping cadence is the same, and norms are drawn on these basis. However, weight of the person is not taken into account. So a heavier person will work harder than a lighter person for the same test. Thus, the heavier persons heart rate will be higher thus, less fit according to the standards as compared to the lighter individual. A poor test for comparative purposes, but a start in aerobic fitness testing.

Fleishman (1964) indicated that there are two types of endurance, namely resistance to time and maximum resistance to fatigue. Resistance to time emphasizes specific muscle groups and is marked by relatively short repetitions. Resistance to fatigue is tests that emphasize stamina and cardiovascular endurance. Therefore, cardiovascular endurance emerges as a separate factor in the domain of fitness testing. Many researchers attempted to develop a good indirect method to assess cardiovascular fitness, however, the most successful of the field tests developed was that of ***Cooper (1968)*** at the Coopers Aerobic Institute in Dallas, Texas.

The Cooper 12 minute run / walk test was designed to measure VO_2 max or maximum functional capacity of the cardiorespiratory system indirectly. Cardiorespiratory endurance is the most essential component of physical fitness. Cooper's study (1968) involving 115 men aged between 17 and 52 years established the validity of distance runs as a means of evaluating aerobic working capacity in runners. A correlation of 0,90 was achieved between maximal oxygen uptake and the distance covered during the 12-minute run/walk test was reported ***(Cooper,1968).***

Studies by ***Cooper (1968), Doolittle and Bigbee (1968), Burris (1970)*** and ***Burke (1976)*** have shown that the 12-minute run / walk test is a valid field test for the measurement of maximal oxygen uptake. Cooper's 12-minute performance test was also used in the ***Coopoo (1978)*** study as an objective measure of cardiovascular fitness. The two hundred and fifty metre shuttle run, which assesses speed, agility and aerobic fitness was used for younger children where space is limited for testing in schools. A high positive correlation coefficient of reliability was found in the Hemraj study (1973). In adults the same 250m-shuttle run was found to be a good test of anaerobic fitness ***(Maritz, 1998).***

Baumgartner and Jackson (1975) give evidence that indicates that up to a point the longer the run the greater the correlation with maximum oxygen uptake. These researchers found that the 9 minute run for elementary children and the 12 minute run for adolescents and adults were the most valid measure of aerobic power when compared to the shorter 600 yard run. Validity coefficients of 0,82 were reported for elementary boys and 0,90 for college men.

The 12-minute run test is a sound and practical measure of cardio respiratory endurance. The Cooper study reported a validity coefficient of 0,897. ***Doolittle and Bigbee (1968)*** reported reliability coefficients of 0,94 on the 9th grade males and ***Maksud and Coutts (1971)*** reported a reliability coefficient of 0.92.

Balke (1963) developed a longer distance run-walk test of (15 min) and was a valid indicator of maximal oxygen uptake and thus of cardiorespiratory fitness. The study shows the longer the running test the better the reliability for aerobic fitness. Table (2.1) shows validity coefficients, which were determined by correlating twelve minute run test scores with maximal oxygen uptake. This was determined using a laboratory test. ***Doolittle and Bigbee (1968)*** reported a high validity coefficient of 0,90 on the 12 minute run test. ***Cooper (1968)*** reported a correlation of 0.90 between maximal oxygen uptake and the distance covered during a 12-minute run/walk test.

TABLE 2.1: CORRELATION BETWEEN RUNNING TEST AND VO_2 max

Source	Sample	Distance	Correlation with VO_2 max
Vodak &Wilmore (1975)	Boys ages 9 - 12	6 minute run	0,50
Safrit (1973)	Males age 6-17	600 yard run	0,71
Maksud & Coutts (1971)	Boys 11 – 14 years	12 minute run	0,65
Dolittle & Bigbee (1968)	9 9th grade males	12 minute run	0,90
Cooper (1968)	Adult Males	12 minute run	0,897

Cooper (1968) also noted that the fitter the individuals are when tested, the better the correlations with VO_2 max. This is logical, as you have to be quite fit to reach your maximal oxygen consumption while running to your maximum on a treadmill. Only fit athletes will be able to run to maximal exhaustion on a treadmill, tested directly for VO_2 max.

Rikli et al. (1992) undertook a study to test the retest reliability of the 1-mile, 3/4-mile and 1/2-mile distance run/walk tests. Results of the study indicated that the 1-mile run/walk test is recommended for young children in most national test batteries had acceptable reliability of 0,83 to 0,90 for both boys and girls. Results of the study also indicated that reliability estimates remained stable across age groups. The 1/2-mile run/walk was seen as a reliable measure for boys and girls in Grade 1.

All the major health related physical fitness test batteries currently being used in the United States include a distance run as an indication of cardiovascular endurance or aerobic capacity. Most batteries AAHPERD Physical Best, ***(AAHPERD, 1988),*** FITNESSGRAM (Institute for Aerobic Research, 1987) employ the mile or mile and a half run or the equivalent 9 or 12 minute run/walk.

Maximal oxygen consumption is the most important determinant in 12 -15 year old youngsters ***(Cureton et al., 1997).*** Increasing attention is being paid in Canada and Europe to a 20 m shuttle test as a measure of cardiovascular endurance. The 20 m shuttle test was developed by ***Leger and Lambert (1982).*** In 1988 the same researcher undertook a test on males and females 8-19 years and found a validity of 0,71 and a reliability of 0,89. In order to make comparisons of Canadian or European youngsters to American children, a study was undertaken to test the reliability of the 20 m shuttle test on American children 12-15 years old ***(Liu et al., 1992).*** The results of the study showed a validity of 0,69 and a reliability of 0,91 respectively. It was concluded that the 20m-shuttle test is a valid field test of cardiovascular respiratory endurance as other distance run tests for males 12-15 years of age. It was also recommended that the 20 m shuttle test be considered as an alternative test for inclusion in physical fitness batteries for school children in this age range. However, maturation and pacing plays an important role in the result of this test.

However, to date the best field test to measure aerobic capacity, still remains the 12 minute run walk test developed by ***Cooper, (1968).*** After this review of literature related to cardiovascular fitness, the 12-minute run/walk test was confirmed as the test of choice for this factor.

2.2.2 TESTS RELATED TO DYNAMIC STRENGTH

Dynamic strength factor has been identified by ***Fleishman (1964)*** as the most common of the strength factors. It involves the strength of the limbs in moving or supporting the weight of the body repeatedly over a period of time. Examples are pull – ups, rope climb and dips.

Upper body muscular strength is considered an important component of health related physical fitness ***(AAHPERD, 1988).*** Most of the current field tests of health related physical fitness include test items designed to measure upper body muscular strength. The most commonly used field tests of upper body muscular strength are the pull-ups and flexed arm hang tests. Some batteries included push-ups and modified pull-ups. Other examples of tests relating to dynamic strength are rope climb, bent arm hang and dips. Field tests like the pull-ups are valid measures of absolute muscular strength or muscular endurance ***(Pate et al., 1993). Pate et al. (1993)*** used a factor analysis technique to analyse the components of performances on five field tests, namely: -

Upper body muscular strength and endurance

Pull-ups

Flexed arm hang

Push-ups

Vermont Modified pull up test.

The above five field tests of muscular strength were examined and found to be valid measures of weight relative muscular strength. However, the Vermont Modified pull-up test yielded the highest correlation r (.87) = 0.75, $p < .0001$ with weight relative muscular strength, and yielded a low % of zero scores. ***Pate et al. (1993)*** recommended that this test of muscular strength be included in field test batteries. This conclusion is consistent with that of ***Cotton (1990),*** who found performance on the modified pull-up to be reliable and less weight dependent than either the pull-up or flexed arm hang. ***Fleishman (1964)*** also reinforce the notion that height and weight loads negatively on dynamic strength. He found inter-correlations in the range of 0,47 to 0,65 for flexed arm hang, push-up and pull-up test performances in young adult males.

Although most of the dynamic strength tests involve the use of the arms, tests such as sit-ups, leg lifts and leg raiser are used to measure the strength of the trunks. In this study the sit-up (two minutes) test was used to measure strength of the trunk, as it is a very popular test which indicates endurance status and strength of the abdominal.

A study was conducted by ***Safrit et al. (1992)*** on the difficulty of various sit-ups test. Eighteen sit-up tests were administered and measured under three conditions; feet not anchored, feet anchored, and inclined board (30 degree angle). The number of sit-ups performed in one minute measured each test. The easiest sit-up test was executed with hands on thighs and feet anchored. The results of the study revealed smaller means for sit-ups performed without anchoring the feet than for items performed with the feet held. ***Safrit et al. (1992)*** revealed a difficulty estimate of –3,57 on a sit-up test performed with elbows to the side of the body and feet not anchored. Thus the body movement required a high degree of control of the abdominal muscles, not only to raise the upper body but also to stabilize the hip and legs.

De Vries (1980) recommend bent knee sit-ups as the straight leg sit-ups tend to pull on the lumbar spine causing the back to arch thus placing excessive strain on discs and facet joints. This can result in injury. These researchers also found that when performing a bent knee sit-up contraction of the abdominal muscles help lift the trunk off the floor. The ***Coopoo (1978)*** study also endorses similar sentiments with the sit-up test. The results of ***Hemraj (1975)*** study report a reliability co-efficient of 0,83 for the bent knee sit-up. ***Coopoo (1978)*** showed that performance on sit-up by the 17-year-old boys were better than the 18-year-old boys. The decline in dynamic strength of the trunk by senior boys was attributed to a decrease in physical activity during physical education classes. Thus to date the bent-knee sit-up test is still the best to test dynamic strength of the abdomen.

2.2.3 TESTS RELATED TO EXPLOSIVE STRENGTH

This factor was the most common of the strength factors to appear in tests. ***Fleishman (1964)*** reports that explosive strength requires the individual to exert their maximum energy in one explosive act, such as in the standing broad jump, vertical jump or medicine ball put and the softball throw. According to ***Fleishman (1964)*** short dashes and sprints load positively on this factor as speed in these tests requires effective mobilization of force against the ground in order to propel one self forward.

This study used the fifty-metre shuttle run and fifty-metre dash to measure explosive strength as a significantly high correlation was found in the ***Fleishman (1964)*** study for shuttle run 0,77 and 0,75 on the dash. The tests chosen to measure explosive strength are easy to administer and requires very little equipment. Two tests in explosive strength were used in this study. In routine fitness testing only one of two are selected. The reason for developing norms for both, was, twofold:

- For schools where there is limited space for testing, then the 50 m shuttle run will be chosen.
- In schools were they do have a 50 metre straight, then this test will be used.

Both tests correlate highly for the factor of Explosive Strength as determined by the Fleishman study. The standing broad jump has become a popular test to measure explosive strength ***Viitasalo, (1988).*** Research by ***Johnson and Nelson (1979)*** showed the standing broad jump to have a reliability as high as 0,96. ***Fleishman (1964)*** reported a reliability coefficient of 0,90. Other studies done by ***Jackson and Baumgartner (1969)*** used the 50-yard dash as a measure of speed. The above researchers reported that although the 50-yard dash is a very reliable measure, a great source of error occurs during the first 20 yards of the dash. They computed reliability coefficients from 0 to 50 yards as 0,949 and from 20 to 50 yards as 0,975. The latter 30 yards show a more reliable score. Other researchers such as ***Klesius (1968)*** reported reliability scores of between 0,83 and 0,86.

Fleishman (1964) reported high reliability coefficients of 0,93 for the softball throw, however, this is a sport specific skill rather than a fitness test. This study selected the 50 m shuttle run and 50 m dash because of the lack of space in schools and the high factor loading for these tests. Also the school will have a choice of which test to assess on this factor as both of these tests were measured in this study, for the development of norms for these tests. In routine fitness testing only one test will be chosen depending on the school's space. For schools where there is limited space for testing, then the 50m shuttle run will be chosen. In schools were they do have a 50 m straight, then the 50 m dash will be chosen.

2.2.4 TESTS RELATED TO STATIC STRENGTH

Fleishman (1964) defines static strength as a maximum exertion of force for a brief period of time where the force is exerted continuously to a maximum. Tests used in this factor include dynamometrical tests applied to handgrip, arm, back and leg muscles. In this study the medicine ball put and shot put was used, since ***Fleishman (1964)*** in his study on static strength showed this test to have a high correlation of 0,71.

Coopoo (1978) showed that weight and height are negatively related to dynamic strength but are positively related to static strength. The study also showed that the relationship between body weight and performance on this factor is especially high namely (r= 0,70).

Another battery of tests used to measure static and dynamic strength is the Physical Fitness Index Test (PFI). Muscular strength is an important component of physical fitness and has been extensively used. The Physical Fitness Index test has a reliability and objectivity coefficient of 0,86 to 0,97. The medicine ball put and shot put was used as tests of choice in this study because most schools have this equipment available and the Fleishman study showed a high correlation between these tests. ***Fleishman (1964)*** also indicated that the heavier the object the better the correlation, thus, the shot put was also used as a back up test. In certain schools they may have a shot or a medicine ball. In routine fitness testing either shot or medicine ball put will be used and not both tests. Both tests were employed in this study in order to develop norms for this factor.

The selection of the components used in this study, is confirmed to be the best tests that can be selected for routine fitness testing in high schools. They are all valid and reliable and can be backed by research as described in this chapter.

CHAPTER THREE

METHODS AND PROCEDURE

The Methodology and Procedures undertaken in this study are presented under the following subheadings: -

3.1 Selection of Subjects

3.2 Data Collection

3.3 Administration circuit or order of tests

3.4 Test components

3.5 Test Administrative Methods and protocols.

3.1 SELECTION OF SUBJECTS

Volunteer subjects were randomly recruited from ten different high schools in the Durban Metropolitan area. The Researcher had requested permission from the Principals, in some schools Acting Principals to conduct the fitness test. Every fifth student from a class list was selected. The Researcher together with physical education teachers ensured that students selected did not suffer from any ailments, particularly chronic illnesses such as any form of heart disease, diabetes, asthma and back problems. Subjects were required to fill in an Informed Consent, prior to testing. The University of Durban Westville's ethics committee granted ethical clearance for this study. The testing programme was conducted in the mornings and afternoons depending on the availability of subjects as well as facility.

The Researcher ensured that subjects represented both the elite population as well as students who belonged to the lower socio economic groups. The schools selected were from the predominantly Indian areas of Chatsworth, Kharwastan, Umhlatuzana, Shallcross and Phoenix. The following secondary schools were selected, namely, Montarena, Newhaven, Nilgiri, Protea, Welbedene, Kharwastan, Apollo, Witteclip, Crossmoore and Woodview. Fifty male subjects were tested from each of the ten schools making the total number of subjects tested five hundred.

Careful consideration was taken to ensure that equal number of subjects was tested in each of the age category to ensure representivity of a normal distribution. Groups of 15 subjects were tested during one testing session. Subjects were classified under the following age categories:

13,6 – 14,6 years (14 year olds)
14,7 – 15,6 years (15 year olds)
15,7 - 16,6 years (16 year olds)
16,7 – 17,6 years (17 year olds)
17,7 – 18,6 years (18 year olds)

Hundred subjects were selected from each age category, giving a total of five hundred subjects tested.

3.2 DATA COLLECTION

The testing programme was conducted at the Chatsworth Stadium grass and track facilities as well as the sporting grounds of the respective schools. Tests were administered on a grass and track surface. The testing programme spread over a period of time from July 1997 to July 1998.

Trained postgraduate assistants who were used to assist in the recording of scores during testing collected the data. The researcher ensured that the assistants familiarised themselves with the test procedures and scoring.

The author also ensured that test administration and test procedures were the same to ensure validity and reliability of results. In administering the battery of tests careful attention was given to ensure that each test measured a particular component. The same measuring instruments were used throughout the testing programme.

Volunteer subjects were asked to wear suitable training clothing and shoes to participate in the study. Prior to the actual testing the battery of tests was discussed with the students and a demonstration was held at each station. The reasons for giving each test and the correct techniques were explained, to ensure reliability of results.

Score cards ***(Appendix A)*** were given to each subject to write down details such as name, age, height and weight. Thereafter, assistants at each station recorded the scores. The researcher stressed the importance of accuracy in counting, timing, execution of the test and most importantly the accurate recording of the score.

3.3 ADMINISTRATION CIRCUIT OF THE TESTS

A typical circuit with stations ***(Figure 3.1)*** was used as a procedure for testing. Nine stations were set up with two assistants at each station, one to execute the test and the other to count and record the score. The researcher found that the circuit system provided a variety and created interest and motivation amongst subjects. Their enthusiasm was overwhelming.

In setting up the order of tests the Researcher tried to ensure that tests involving muscles of the same area did not follow one another. Due to the demanding nature of the 12-minute run walk test the instructor decided that it would be conducted at the end where four pupils ran at a time. Subjects were given a five-minute rest period between tests and allowed water breaks at any time during the testing. It was imperative that between tests pupils did not undertake any form of practice or training. All subjects were encouraged to give their best performance. Subjects were given verbal encouragement to facilitate a high motivation level. The instructor kept a close watch for fatigue, as fitness testing can be exhausting for the participant especially being tested for the first time.

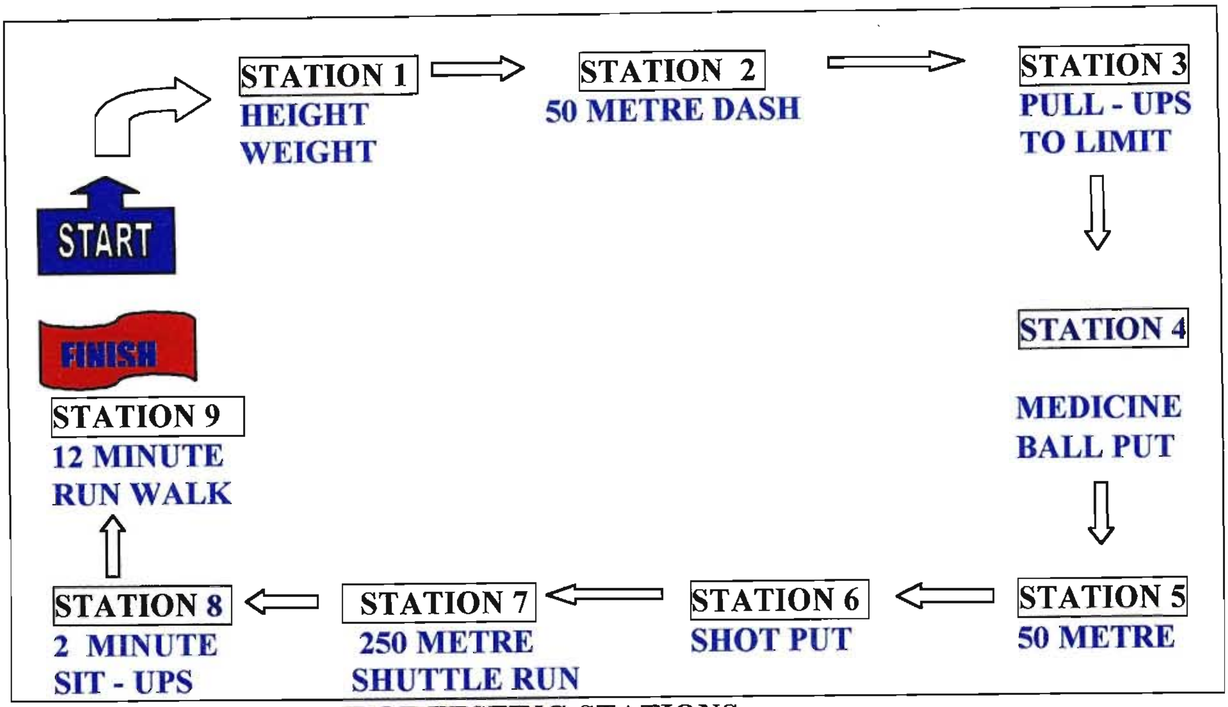


Figure 3.1 : LAYOUT OF TESTING STATIONS

3.4 TEST COMPONENTS

The fitness variables selected for measurement was identical to the battery of tests used in the **Coopoo (1978)** study. It comprised of the following components and the tests ***(Table 3.1)*** that was selected for each component.

Table 3.1: TESTS SELECTED

COMPONENTS	TEST SELECTED
Explosive strength	50 m shuttle run
Explosive strength	50 m dash
Dynamic Strength (abdomen)	2 minute sit - ups
Dynamic Strength (upper body)	pull – ups to limit
Static Strength	shot – put (5,4 kgs)
Static Strength	medicine ball put
Endurance	250 m shuttle run
Endurance	12 minute run walk test
Anthropomorphic Indices	Height
Anthropomorphic Indices	Weight

The Researcher enquired from each participant whether they were on any medication or had any illness. This is especially important for the cardiorespiratory endurance tests as it will hinder performance and may injure the child. The duplication of tests in the same components such as in Explosive, Static, Dynamic and Endurance was included for the purpose of norm establishment.

3.5 TEST ADMINISTRATIVE METHODS

3.5.1 HEIGHT

3.5.1.1 Equipment:

Height measurement stick

3.5.1.2 Procedure:

Subjects removed their shoes. Subjects stood with back against the measurement stick and a reading was taken.

3.5.1.3 Scoring:

The height was measured in centimeters as read off the metre stick.

3.5.2 WEIGHT

3.5.2.1 Equipment

Bathroom scale.

3.5.2.2 Procedure

Subjects removed their shoes, and stood on the scale with feet together.

3.5.2.3 Scoring

The mass was measured in kilograms (kg) to the nearest gram.

3.5.3 TWO MINUTE SIT – UPS

3.5.3.1 PURPOSE:

To test muscular endurance namely abdominal strength.

3.5.3.2 EQUIPMENT:

Stop watch, recording material and gym mat.

3.5.3.3 PROCEDURE:

The subject lies on his back on the mat. His hands are placed on the back of his neck with the fingers interlaced. This was executed with knees bent and the feet held flat on the floor by a partner. The subject had to sit up and touch both elbows to his knees and then return to starting position. Only one trial was allowed and rests were not permitted between sit-ups. The test was started by the researcher giving the command 'Go' and was stopped on the command 'Stop'. **(Figure 3.2)**

3.5.3.4 SCORING:

The total score was the number of completed executions performed in two minutes (120 seconds).

3.5.3.5 PRECAUTIONS:

3.5.3.5.1 Subjects feet were kept flat on the ground.

3.5.3.5.2 Knees were flexed.

3.5.3.5.3 The fingers must remain in contact behind the neck throughout the exercise.

3.5.3.5.4 It was also stressed to the children that the hands behind the neck should not be used to pull against the neck, but merely to support the neck throughout the movement. Because the ***Coopoo(1978)*** study used this method, it was important to replicate the test exactly in order to make comparisons.

Figure 3.2 : THE SIT UP SEQUENCE (Coopoo, 1995).

3.5.4 250 METRE SHUTTLE RUN

3.5.4.1 PURPOSE:

To test aerobic ability, and has a component of anaerobic fitness as well.

3.5.4.2 EQUIPMENT:

Two parallel lines ten metres ***(Figure 3.4)*** apart stop watch, a whistle and recording material . Subjects should wear sneakers or run barefoot.

3.5.4.3 TECHNIQUE:

3.5.4.3.1 Subject stood behind the line and at the sound of the whistle ran to the opposite line, placed both palms outside the line ***(Figure 3.3)***

3.5.4.3.2 Subject turned around quickly and ran back to the starting line.

3.5.4.3.3 The procedure was repeated on the other end until 25 runs have been completed, so as to cover the 250 metres.

3.5.4.3.4 On the last run the subject runs across the finishing line, which is the line opposite to the starting line. ***(Figure 3.3)***

3.5.4.4 SCORING:

Fastest time taken to complete 250 metres.

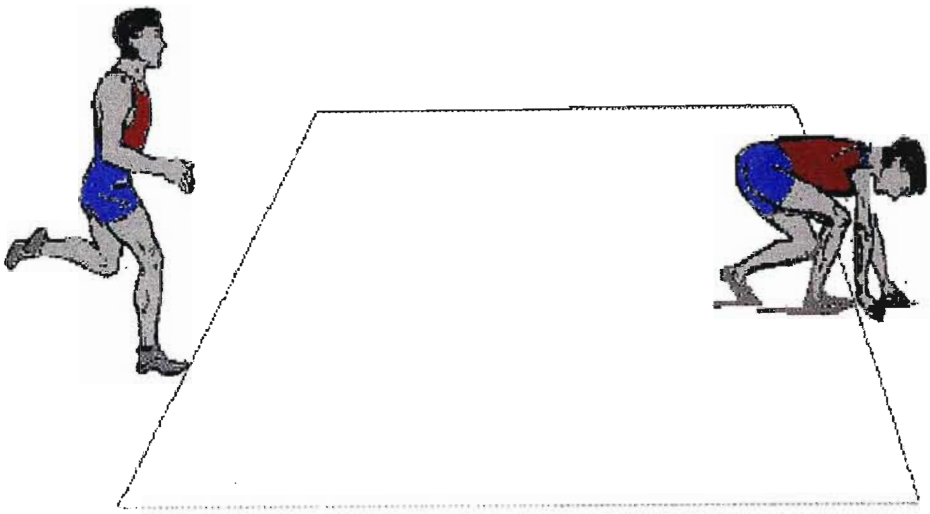


Figure3.3: Plan for 250 m Shuttle run

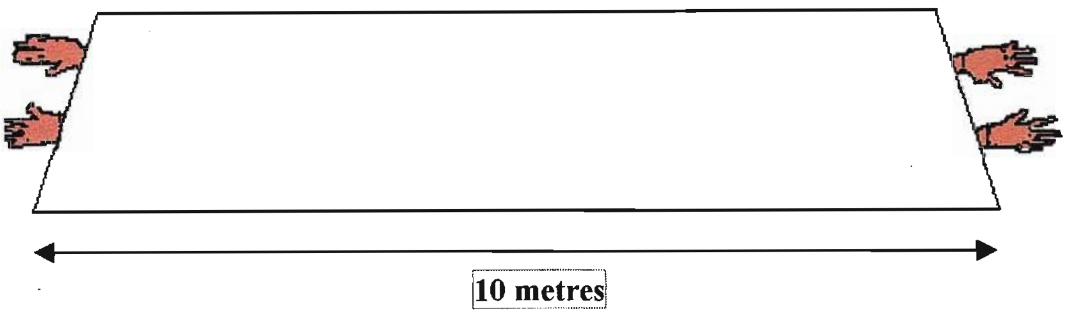


Figure 3.4 : Hand placement of 250 m shuttle run (Coopoo, 1978)

3.5.5 PULL - UPS TO LIMIT

3.5.5.1 PURPOSE:

The purpose of this test is to measure the strength of the upper body and shoulders. It tests biceps, latissimus, rhomboids and trapezius.

3.5.5.2 EQUIPMENT:

The equipment that was used in this test is a Horizontal bar 2,5 metres from the ground.

3.5.5.3 DESCRIPTION:

3.5.5.3.1 The subject hangs from the bar with fully extended arms and body using an "Under hand " grip. *(Figure 3.5)*

3.5.5.3.2 Subjects thumbs and palms facing towards the body.

3.5.5.3.3 The subject pulls himself up as many times as possible until his chin is level with the top of his hands.

3.5.5.3.4 The subject then lowers himself until his arms are straight.

3.5.5.3.5 This is one complete pull-up, and the exercise is repeated until the Maximum is reached. (See Figure 3.5)

3.5.5.4 **SCORING:**

Each time the subject pulls himself above the level of the bar, it is counted as one pull-up. He executes this task until the maximum number of pull - ups are completed.

3.5.5.5 **CAUTIONS**

3.5.5.5.1 The body must not swing during the execution of the movement

3.5.5.5.2 Kicking of the legs will not be permitted.

3.5.5.5.3 Knees must not be raised.

3.5.5.5.4 The counting of completed pull-ups should be loud.

3.5.5.6 **PRECAUTION**

The pull-ups will not be counted if:-

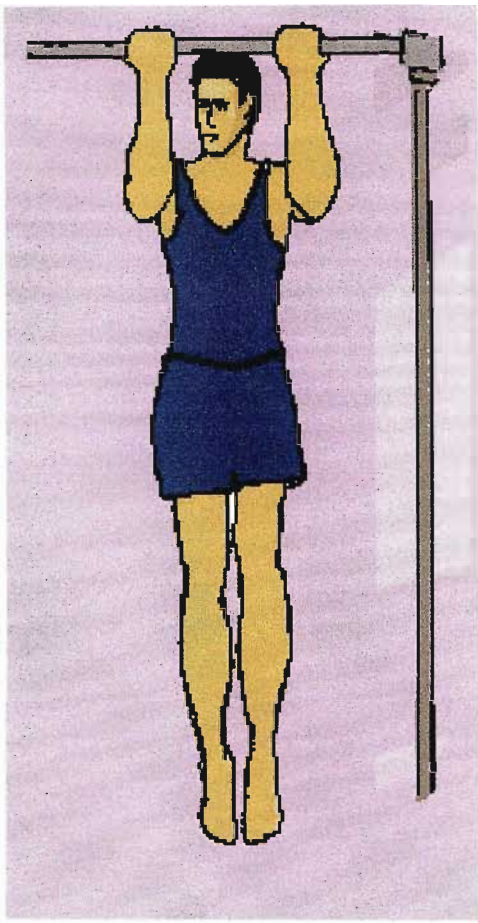
3.5.5.6.1 The subject's arm is not straight at the beginning of the pull-up;

3.5.5.6.2 The chin is not raised above the bar;

3.5.5.6.3 If the subject stops and rests for more than five seconds;

1. THE STARTING POSITION HANGING ON BAR

2. THE PULL-UP



3. THE LOWERING TO STARTING

Figure 3.5: THE PULL – UP SEQUENCE

3.5.6 50 METRE DASH:

3.5.6.1 PURPOSE

To measure speed.

3.5.6.2 APPARATUS:

Stop watch, recording material.

3.5.6.3 DESCRIPTION:

The test was administered to two pupils at a time. The runners took their positions behind the starting line. " Are you ready " and " Go " were used by the starter, who on the command "Go" dropped his arm to give a visual signal to the timers who stood at the finish line. ***(Figure 3.6)***

3.5.6.4 SCORING:

The score is the amount of time between the starters signal and the instant the pupil crosses the finish line. The score was recorded in seconds to the nearest tenth of a second.

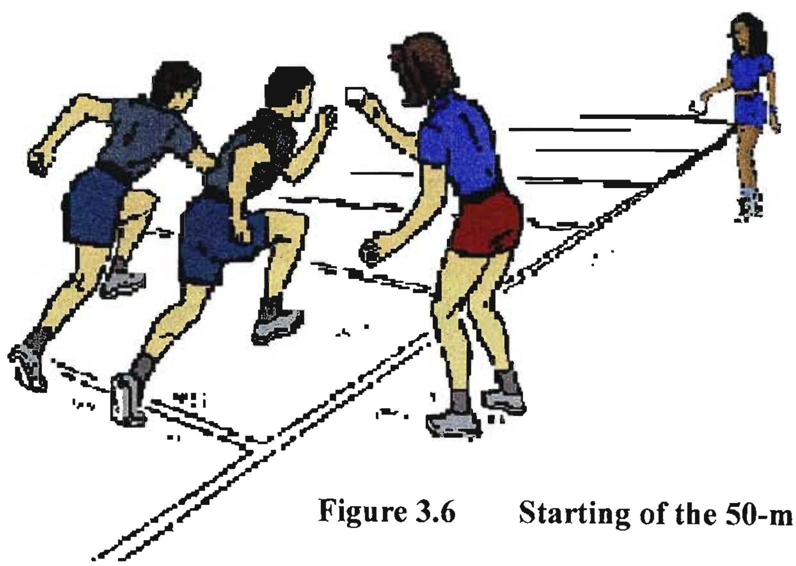


Figure 3.6 Starting of the 50-metre dash

3.5.7 MEDICINE BALL PUT

3.5.7.1 PURPOSE

To measure static strength

3.5.7.2 APPARATUS:

Medicine ball, measuring tape in centimeters, markers and recording material.

3.5.7.3 DESCRIPTION:

The subject holds the medicine ball in his dominant hand, close to the neck and balances the ball with the other hand. The subject then placed his foot forward, behind a base line and positions the other foot in a comfortable position. A partner held the rear foot at the ankles to the ground ***(Figure 3.7)***

The subject is not allowed to move his feet, but is allowed to twist or bend his body in any direction to assist in the put. The subject when ready threw the medicine ball in a forward velocity as far as possible with one hand. If incorrect throwing techniques are used the put is not counted. The subject is allowed three attempts.

3.5.7.4 SCORING

The distance of the best throw of the three is recorded in centimeters.

3.5.7.5 PRECAUTIONS:

3.5.7.5.1 The heel of the back foot should not be raised.

3.5.7.5.2 The subject's toes should be behind the line.

3.5.7.5.3 The medicine ball is held close to the neck as possible.

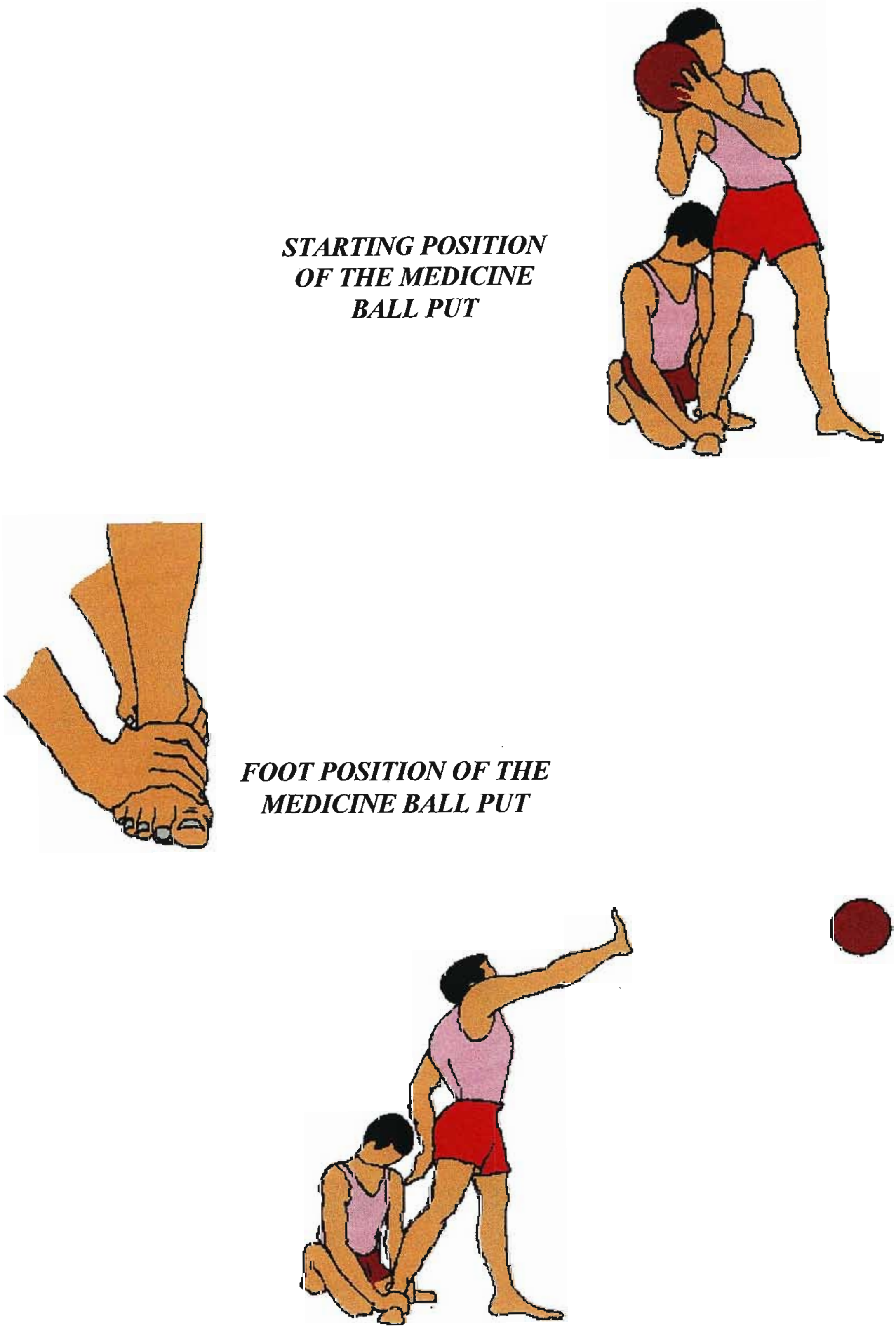


Figure 3.7: MEDICINE BALL PUT (Coopoo, 1978)

3.5.8 SHOT PUT

3.5.8.1 PURPOSE:

To measure static strength.

3.5.8.2 APPARATUS:

A shot put weighing 5,4 kg, tape measure in centimeters, recording material.

3.5.8.3 DESCRIPTION:

The subject holds the shot put in his dominant hand, close to the neck and balances the shot put with the other hand. The subject then placed his foot forward, behind a base line and positions the other foot in a comfortable position. A partner held the rear foot at the ankles to the ground. The subject is not allowed to move his feet, but is allowed to twist or bend his body in any direction to assist in the put. The subject when ready threw the shot put in a forward velocity as far as possible with one hand. If incorrect throwing techniques are used the put is not counted. The subject is allowed three attempts.

3.5.8.4 SCORING:

The distance of the best throw of the three is recorded in centimeters.

3.5.9 50 METRE SHUTTLE RUN

3.5.9.1 PURPOSE:

To measure speed and agility.

3.5.9.2 APPARATUS:

Stopwatch, recording material, two blocks of wood 3cm x 3cm x 6cm.

3.5.9.3 DESCRIPTION:

Two parallels lines are marked on the floor 10 m apart. The subject starts from behind the other line. On the signal " Ready? Go " the subject runs to the blocks, ***(Figure 3.8)*** picks one up, runs back to the starting line and places the block behind the line; he then runs back and picks up the second block which he carries back to the starting line. On the fifth run the subject runs across the finishing line on the side opposite to that from which he started.

3.5.9.4 SCORING:

The time is recorded to the nearest tenth of a second.

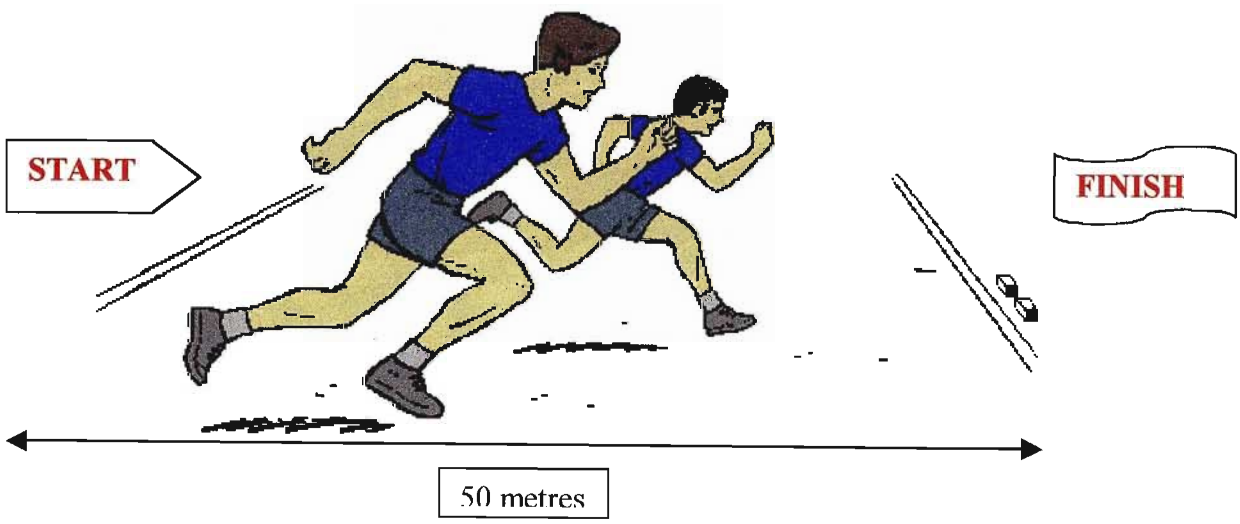


Figure 3.8 : **THE 50 METRE SHUTTLE RUN**

3.5.10 12 MINUTE RUN WALK TEST

3.5.10.1 PURPOSE

To measure cardio respiratory endurance.

3.5.10.2 APPARATUS

Stop watch, recording material, a bell and a whistle.

3.5.10.3 DESCRIPTION:

The subject is required to run or run and walk as far as possible in twelve minutes; that is the greatest distance covered in 12 minutes. The running track was clearly marked with flags at every forty metres. This enables runners to measure scores in laps and tenths of a lap. Where it was not possible for a 400m track the researcher measured a 200 m track and flags were placed at every twenty metres.

Each subject had a scorer who recorded the number of laps during the run within the twelve-minute period. The subjects started from behind a restraining line on the signal "Go" they proceeded to run/walk around the track.

The subjects were constantly motivated to give off their best as well as they were reminded of the amount of time that remained for the test. On the 11^{th} minute a bell was rung indicating there is one minute left to complete the test. At the end of the 12 minutes, a whistle was blown to indicate the end of the run, which was timed with a stopwatch.

Subjects remained where they were and scorers moved across to the subjects to calculate the total number of laps.

3.5.10.4 SCORING

The score is the total distance in metres covered by the subject. The distance is calculated by adding the completed number of laps x 400 to the number of flags completed in the last round x 40 i.e.

No. of laps X 400 + No. of flags X 40 = x metres

3.6 STATISTICAL ANALYSIS

The following statistical techniques were used to compute the raw score data. Norms were developed in percentiles. The means, standard deviations and standard scores were computed for each test. The results of the tests were grouped into five age categories. The different age groups were analysed separately. Inferential and descriptive statistical procedures were used in order to analyse the data.

3.6.1 NORMS

A norm is a standard with which the score obtained in a test may be compared. Most standardised tests are published together 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.

3.6.2 THE MEAN

The mean is the arithmetical average and can be calculated by adding up all the scores and dividing the total by the number of cases. The following formula was used to calculate the mean.

$$\bar{X} = \frac{\sum X}{n}$$

Where:

$\bar{X}$ = **arithmetic mean**

$\sum$ = **Sum of**

X = **each of the scores**

n = **number of scores**

3.6.3 STANDARD DEVIATIONS

The standard deviation is the square root of the average of the squared deviations from the mean. The standard deviation tells us the spread of the scores for each under the normal curve.

The computational formula is:

$$\sqrt{\frac{\Sigma X - \frac{(\Sigma X)^2}{n}}{n - 1}}$$

Where:

SD	=	Standard Deviation
Σ	=	sum of
X^2	=	each score squared
$(\Sigma - X)^2$	=	sum of all scores squared
n	=	number of scores

3.6.4 STANDARD SCORES

A z score is the number of standard deviations and the direction a raw score lies in relation to the mean which is zero. Converting the raw score to z scores makes direct comparisons possible.

The following formula was used to compute the standard scores.

$$Z = \frac{X - \bar{X}}{S}$$

Where:

Z	=	standard score
S	=	standard deviation
X	=	raw score
$\bar{X}$	=	mean of distribution

3.6.5 T - TEST

The t - test is defined as the ratio of the difference between the means divided by the standard error of the difference. This test was used to ascertain difference in mean scores between the different age groups.

The t - test can be defined in terms of the following formula: -

$$tc = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left[\frac{ED_1^2 + ED_2^2}{N + N - 2}\right]\left[\frac{N_1 + N_2}{N_1 N_2}\right]}}$$

df = N + N - 2

Where:

$\bar{X}_1$ **and** $\bar{X}_2$	- Means of the two samples
ED_1	- Sum of the squared deviations from the mean for the one sample
ED_2	- Sum of the squared deviation from the mean for the other sample
N and N	-Number of subjects in the two samples
df	-Degrees of freedom

3.6.6 HISTOGRAMS

Histograms were drawn for height and weight in each age category. The histogram depicts the number of cases or scores falling in each interval. On the Histogram the ordinate of the graph represents the frequencies or the number of cases, while the abscissa represents the intervals.

CHAPTER FOUR

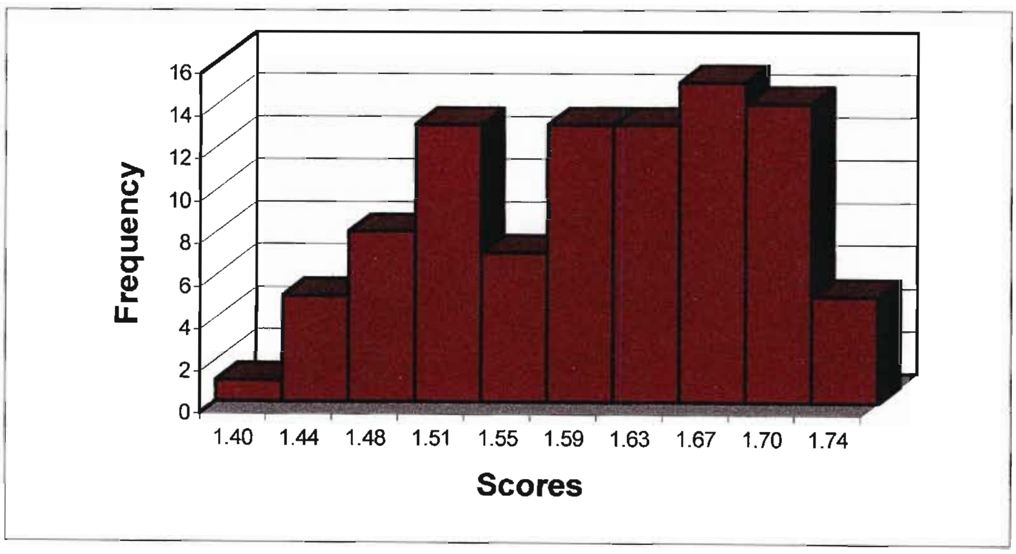
ANALYSIS AND PRESENTATION OF RESULTS

The results will be presented in the following format, where histograms for height and weight will be presented for each age group of the fitness scores. Following this means and standard deviations for each age group, developmental curves, T- tests of significance and finally standard score tables will be presented.

4.1 HISTOGRAMS

Figure 4.1 to 4.10 show the distribution of the scores for selected anthropometric measures for each age group, presented in the form of histograms.

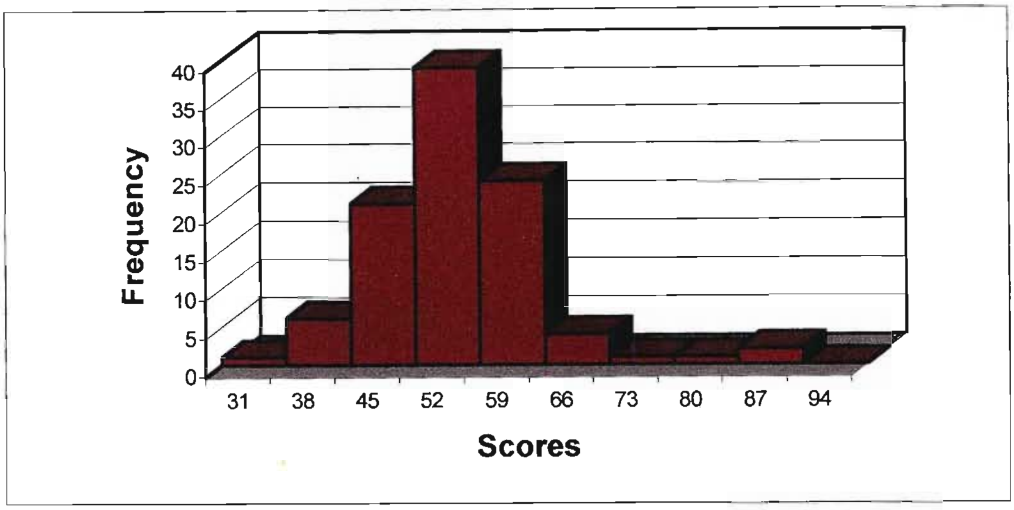
HISTOGRAMS FOR THE AGE GROUP 13,7 TO 14,6 YEARS



$\overline{X}$	1.59
S.D.	0.09

FIGURE 4.1 : REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES BOYS 14 YEARS ON HEIGHT.

The histogram indicating spread of Height shows a fairly normal distribution of scores.

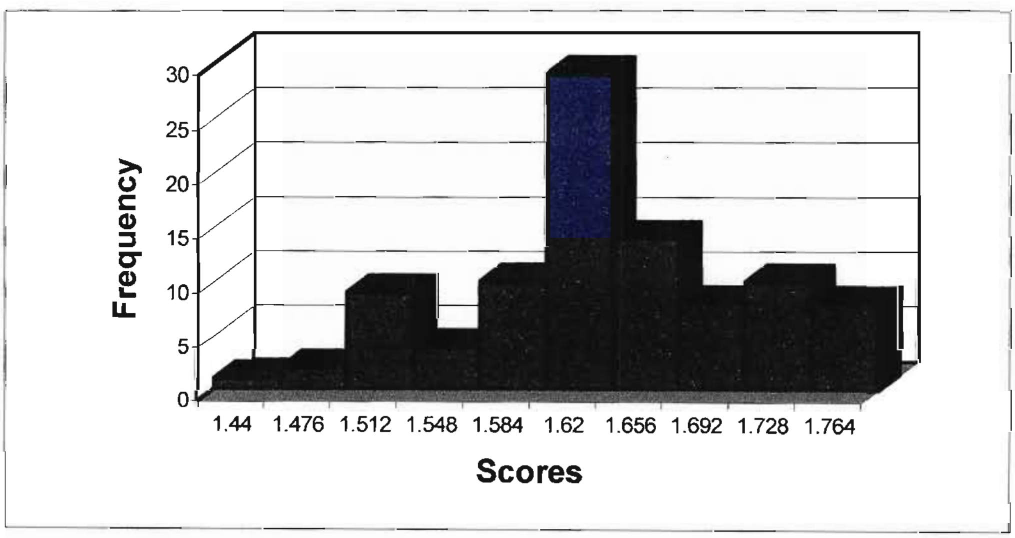


$\bar{x}$	54
S.D.	7.42

FIGURE 4.2 : REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES FOR BOYS 14 YEARS ON WEIGHT.

The histogram indicating spread of mass shows that the distribution of scores is fairly normal for the age group measured.

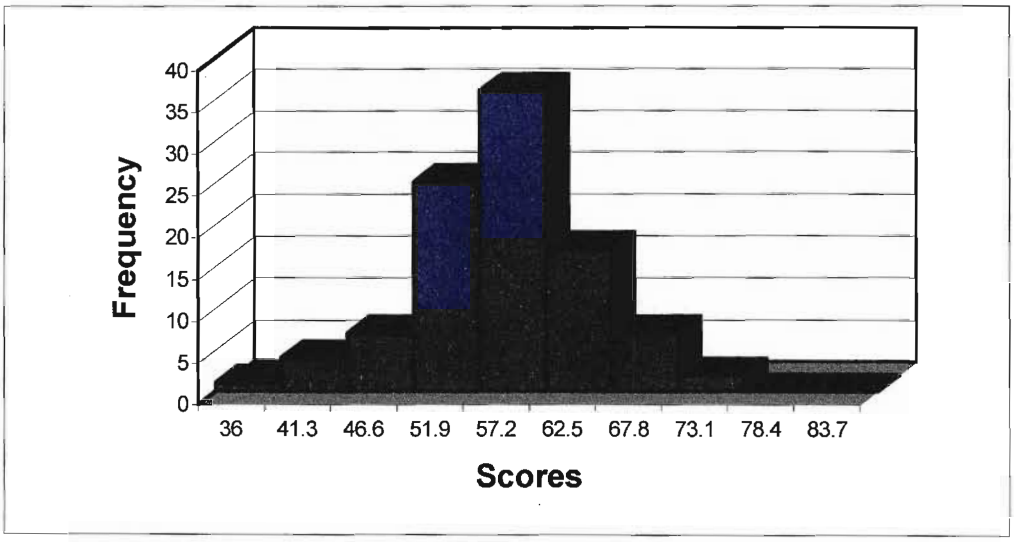
HISTOGRAMS FOR THE AGE GROUP 14,7 TO 15,6 YEARS



$\bar{x}$	1.63
S.D.	0.08

FIGURE 4.3 : REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES FOR BOYS 15 YEARS ON HEIGHT.

The histogram indicating spread of height shows a fairly normal distribution on scores.

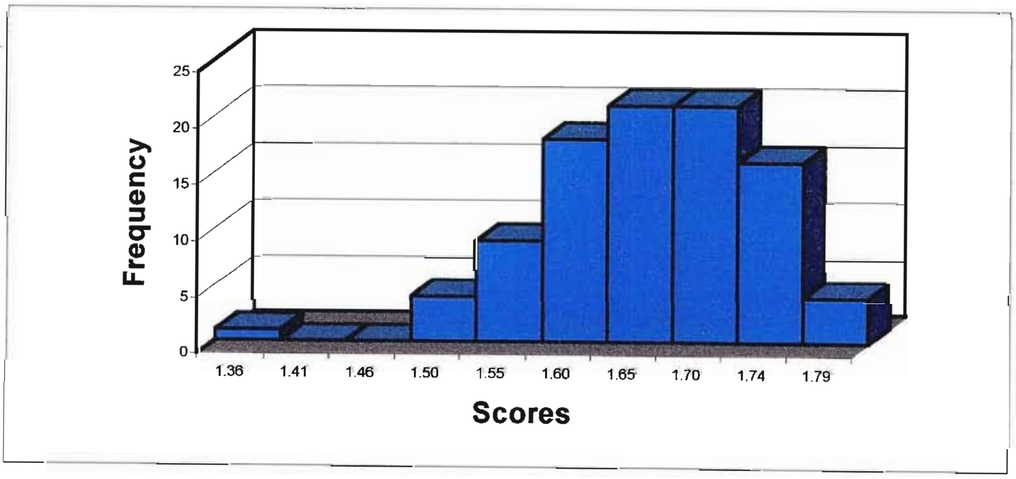


$\overline{X}$	54
S.D.	7.42

FIGURE 4.4 : REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES FOR BOYS 15 YEARS ON WEIGHT.

The histogram indicating spread of mass shows that the distribution of scores is fairly normal for the age group tested.

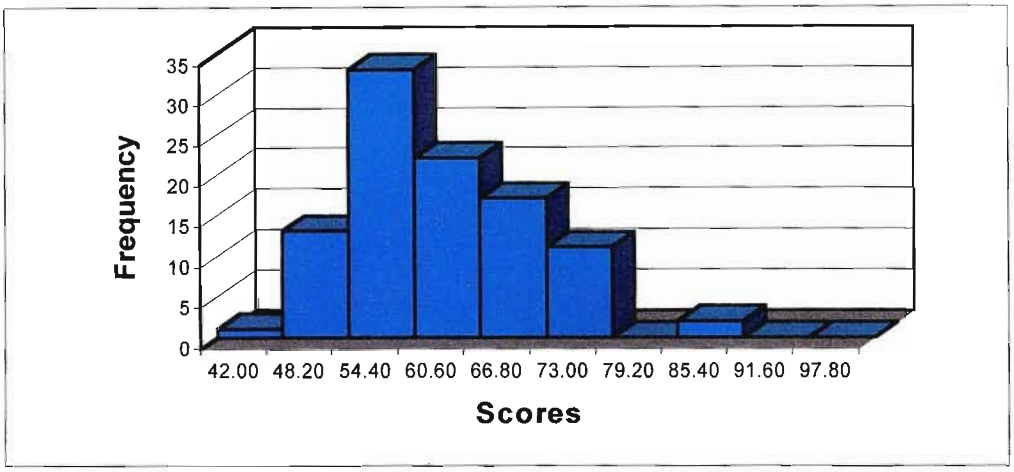
HISTOGRAMS FOR THE AGE GROUP 15,7 TO 16,6 YEARS



$\overline{X}$	1.64
S.D.	0.08

FIGURE 4.5: REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES FOR BOYS 16 YEARS ON HEIGHT.

The Histogram indicating spread of height shows a fairly normal distribution of scores.

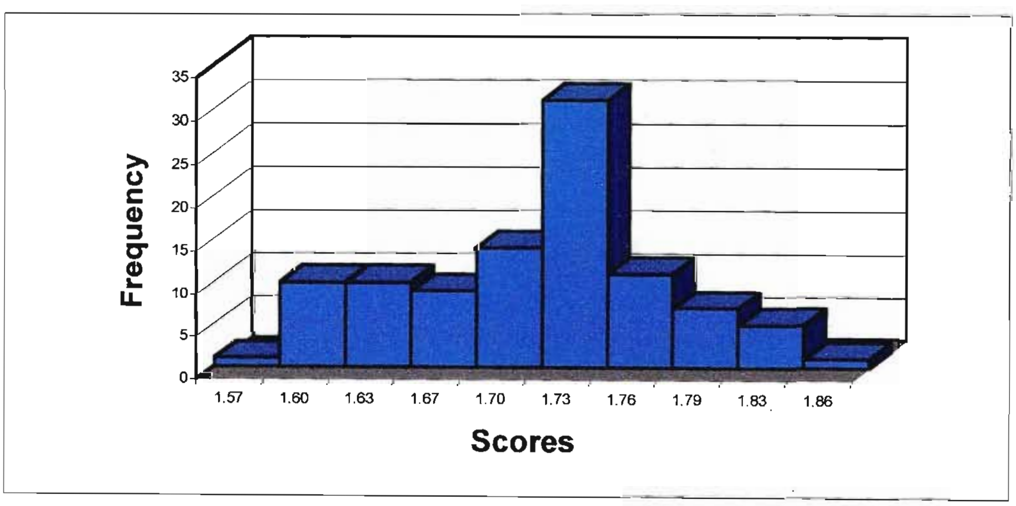


$\bar{x}$	57.02
S.D.	9.58

FIGURE 4.6: REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES FOR BOYS 16 YEARS ON WEIGHT.

The Histogram indicating spread of mass shows that the distribution of scores is fairly normal.

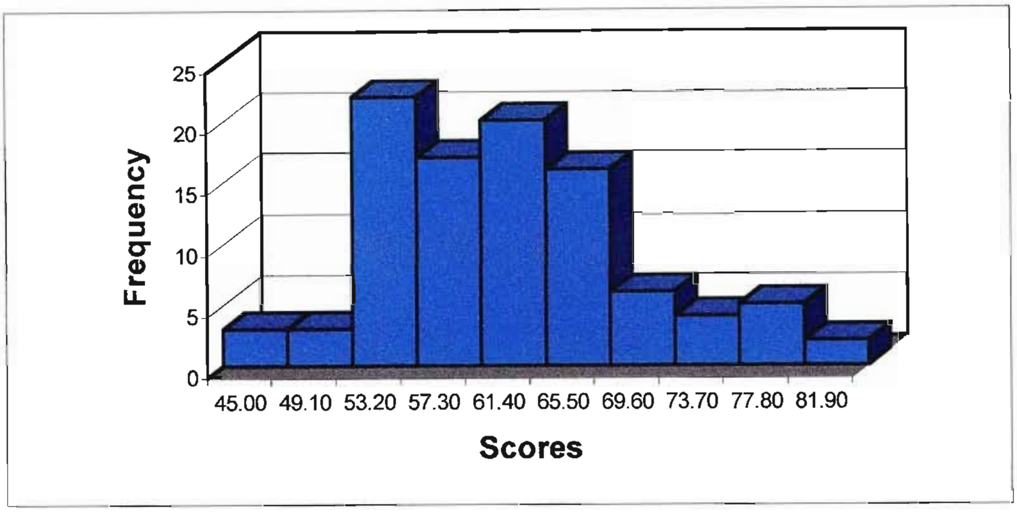
HISTOGRAMS FOR THE AGE GROUP 16,7 TO 17,6 YEARS



$\bar{x}$	1.70
S.D.	0.06

FIGURE 4.7: REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES FOR BOYS 17 YEARS ON HEIGHT.

The Histogram indicating spread of Height reveals that the distribution of scores is fairly normal.

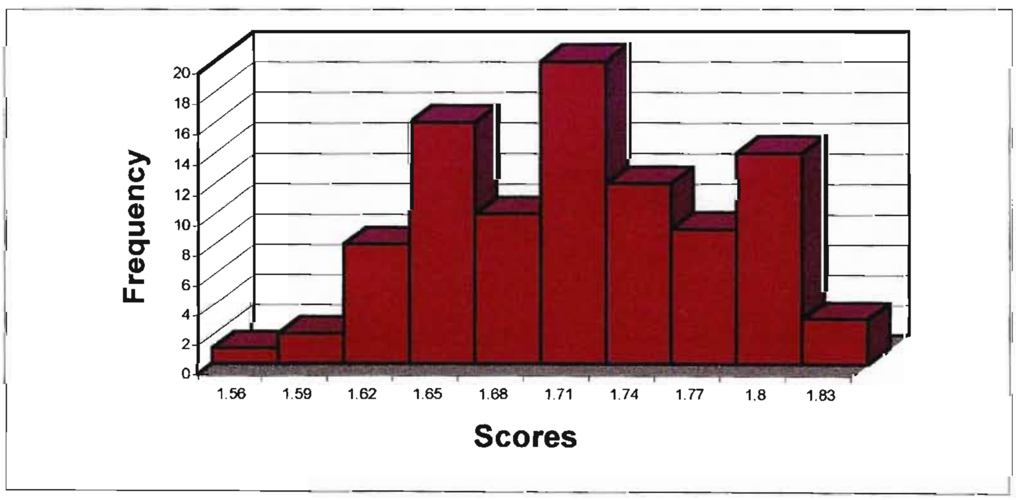


$\bar{x}$	59.45
S.D.	8.57

FIGURE 4.8: REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES FOR BOYS 17 YEARS ON WEIGHT.

The Histogram indicating the spread of mass shows a fairly normal distribution of scores.

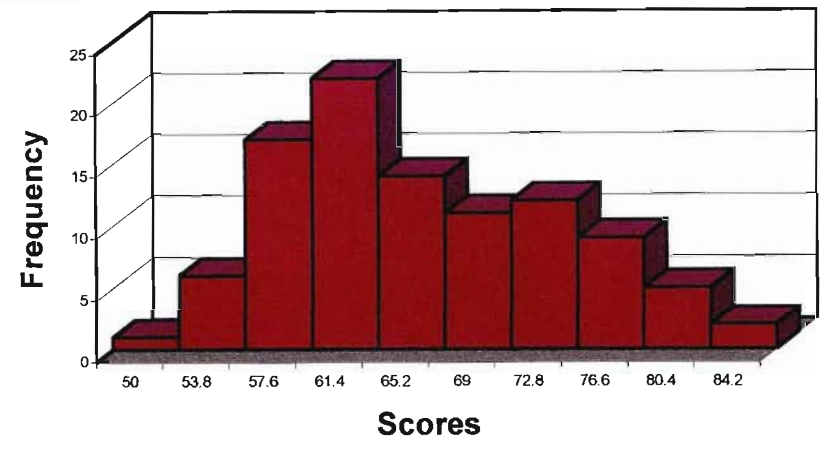
HISTOGRAMS FOR THE AGE GROUP 17,7 TO 18,6 YEARS



$\bar{x}$	1.71
S.D.	0.07

FIGURE 4.9: REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES FOR BOYS 18 YEARS ON HEIGHT.

The Histogram indicating spread of scores for Height shows a fairly normal distribution of scores.



X̄	64.11
S.D.	8.28

FIGURE 4.10: REPRESENTS THE FREQUENCY DISTRIBUTION OF SCORES FOR BOYS 18 YEARS ON WEIGHT.

The Histogram indicating spread of mass shows a fairly normal distribution of scores.

4.2 MEANS AND STANDARD DEVIATIONS

In tables 4.1, 4.2, 4.3, 4.4 and 4.5 the means and standard deviations of each of the eight tests in each age group are presented.

TABLE 4.1: MEANS AND STANDARD DEVIATION OF FITNESS SCORES OF 14 YEAR OLD BOYS

	50 metre shuttle run (sec.)	50 metre dash (sec.)	Medicine Ball Put (cm.)	Shot Put (cm.)	Pull-ups (No.)	Sit-ups (No.)	250 metre Shuttle run(sec.)	12-minute run/walk test (m.)
MEAN	15,29	10,83	461,76	449,56	10,49	51,67	100,78	1861,2
STANDARD DEVIATION	3,67	1,92	104,84	106,59	7,29	11,75	25,89	252,4

N =100

Table 4.1 indicates the arithmetic mean and standard deviation for each of the tests for the age group 13,6 – 14,6 years (14 year olds).

TABLE 4.2: MEANS AND STANDARD DEVIATION OF FITNESS SCORES OF 15-YEAR-OLD BOYS.

	50 metre shuttle run (sec.)	50 metre dash (sec.)	Medicine Ball Put (cm.)	Shot Put (cm.)	Pull-ups (No.)	Sit-ups (No.)	250 metre Shuttle run (sec.)	12-minute run/walk test (m.)
MEAN	12,32	9,13	590,79	559,12	8,42	55,46	91,85	2065,8
STANDARD DEVIATION	1,94	1,26	142,85	130,18	5,88	16,48	18,53	464,87

N = 100

Table 4.2 indicates the arithmetic mean and standard deviation for each of the tests for the age group 14,7 – 15,6 years (15 year olds)

TABLE 4.3: MEANS AND STANDARD DEVIATION OF FITNESS SCORES OF 16-YEAR-OLD BOYS.

	50 metre shuttle run (sec.)	50 metre dash (sec.)	Medicine Ball Put (cm.)	Shot Put (cm.)	Pull-ups (No.)	Sit-ups (No.)	250 metre Shuttle run (sec.)	12-minute run/walk test (m.)
MEAN	12,92	8,96	626,22	619,82	9,35	59,99	96,40	2178,4
STANDARD DEVIATION	1,92	1,63	130,70	136,23	6,57	12,01	27,56	354,59

N = 100

Table 4.3 indicates the arithmetic mean and standard deviation for each of the tests for the age group 15,7 – 16,6 years (16 year olds).

TABLE 4.4: MEANS AND STANDARD DEVIATION OF FITNESS SCORES OF 17-YEAR-OLD BOYS.

	50 metre shuttle run (sec.)	50 metre dash (sec.)	Medicine Ball Put (cm.)	Shot Put (cm.)	Pull-ups (No.)	Sit-ups (No.)	250 metre Shuttle run (sec.)	12-minute run/walk test (m.)
MEAN	13,21	8,77	764,25	751,62	5,63	63,53	88,16	2240,80
STANDARD DEVIATION	1,60	1,64	115,44	109,46	4,91	8,76	22,92	392,15

N = 100

Table 4.4 indicates the arithmetic mean and standard deviation for each of the tests for the age group 16,7 – 17,6 years (17 year olds).

TABLE 4.5: MEANS AND STANDARD DEVIATION OF FITNESS SCORES OF 18-YEAR-OLD BOYS.

	50 metre shuttle run (sec.)	50 metre dash (sec.)	Medicine Ball Put (cm.)	Shot Put (cm.)	Pull-ups (No.)	Sit-ups (No.)	250 metre Shuttle run (sec.)	12-minute run/walk test (m.)
MEAN	13,39	9,8	638,28	636,14	5,36	58,87	103,02	2086,8
STANDARD DEVIATION	2,57	1,7	105,08	105,96	5,14	7,59	33,92	216,05

N = 100

Table 4.5 indicates the arithmetic mean and standard deviation for each of the tests for the age group 17,7 – 18,6 years (18 year olds).

TABLE 4.6: MEAN COMPARATIVE SCORES OF 1997 AND 1977 FOR 15-YEAR-OLD BOYS

TEST ITEM	PRESENT STUDY'S MEAN PERFORMANCE	NORMATIVE DATA OF COOPOO 1978	T test	Significant/ not significant	P value
50 METRE SHUTTLE RUN (sec.)	12,32	-	-	-	-
50 METRE DASH (sec.)	9,13	8,18	6,59	Y	P<0.05
MEDICINE BALL PUT (cm.)	590,79	573,6	0,97	NS	P>0.05
SHOT – PUT (cm.)	559,12	493,3	4,02	Y	P<0.05
PULL – UPS (No.)	8,42	6,36	3,05	Y	P<0.05
SIT – UPS (No.)	55,46	44,63	5,22	Y	P<0.05
250 METRE SHUTTLE RUN (sec.)	91,85	84,62	3,71	Y	P<0.05
COOPER'S TEST (m.)	2065,8	2451,8	6,80	Y	P<0.05

N=100

The above table shows the student t-test of significance between means of boys 15 years on the various parameters selected. Significant differences in favour of the 1977 study are shown on the 50 m dash, 250 m shuttle run and the Cooper's test. The 1997 sample of 15 year olds performed significantly better in the, shot put, pull-up and sit-ups. T-test comparisons show no significant difference between the two samples on Medicine Ball Put. The 50m shuttle run test cannot be compared, as the method of the test done in 1977 and 1997 were different.

TABLE 4.7 : MEAN COMPARATIVE SCORES OF 1997 AND 1977 FOR 16-YEAR-OLD BOYS

TEST ITEM	PRESENT STUDY'S MEAN PERFORMANCE	NORMATIVE DATA OF COOPOO 1978	T test	Significant/ not significant	P value
50 METRE SHUTTLE RUN (sec.)	12,9	-	-	-	-
50 METRE DASH (sec.)	8,96	7,75	6,89	Y	P<0.05
MEDICINE BALL PUT (cm.)	626,22	643,48	0,98	NS	P>0.05
SHOT – PUT (cm .)	619,8	569,7	2,94	Y	P<0.05
PULL – UPS (No.)	9,35	7,53	2,44	Y	P<0.05
SIT – UPS (No.)	59,99	46,66	7,43	Y	P<0.05
250 METRE SHUTTLE RUN (sec.)	96,40	81,69	5,20	Y	P<0.05
COOPER'S TEST (m .)	2178,4	2517,7	7,37	Y	P<0.05

N=100

The table reflects the T-test comparison of means between the 1977 sample and 1997 sample. The results show that the 1977 sample performed significantly better on 50m dash, 250m shuttle run and Cooper's test ($p < 0.05$). The 1997 sample performed better on shot put, pull-ups and sit-ups ($p < 0.05$). No significant difference in means of both samples was found for the Medicine ball put. The 50 m shuttle run test cannot be compared, as the method of the test done in 1977 and 1997 were different.

TABLE 4.8: MEAN COMPARATIVE SCORES OF 1997 AND 1977 FOR 17-YEAR-OLD BOYS

TEST ITEM	PRESENT STUDY'S MEAN PERFORMANCE	NORMATIVE DATA OF COOPOO 1978	T test	Significant/ not significant	P value
50 METRE SHUTTLE RUN (sec.)	13,21	-	-	-	-
50 METRE DASH (sec.)	8,77	7,56	6,50	Y	P<0.05
MEDICINE BALL PUT (cm.)	764,25	673,1	5,80	Y	P<0.05
SHOT – PUT (cm .)	751,62	599,74	10,16	Y	P<0.05
PULL – UPS (No.)	5,63	7,82	3,61	Y	P<0.05
SIT – UPS (No.)	63,53	49,31	9,92	Y	P<0.05
250 METRE SHUTTLE RUN (sec.)	88,16	83,57	1,91	Y	P<0.05
COOPER'S TEST (m.)	2240,80	2467,2	4,60	Y	P<0.05

N = 100

The results show that the 1977 sample performed significantly better on the 50 m dash, pull-ups, 250m shuttle run and Cooper's test for boys 17 years ($p < 0.05$). The 1997 sample, performed better on the medicine ball put, shot put and sit-ups ($p < 0.05$). The results also show that the 1977 sample are better on tests relating to cardiovascular endurance. The 50 m shuttle run test cannot be compared, as the method of the test done in 1977 and 1997 were different.

TABLE 4.9: MEAN COMPARATIVE SCORES OF 1997 AND 1977 FOR 18-YEAR-OLD BOYS

TEST ITEM	PRESENT STUDY'S MEAN PERFORMANCE	NORMATIVE DATA OF COOPOO 1978	T test	Significant/ not significant	P value
50 METRE SHUTTLE RUN (sec.)	13,39	-	-	-	-
50 METRE DASH (sec.)	9,8	7,52	12,69	Y	P<0.05
MEDICINE BALL PUT (cm .)	638,28	702,95	4,30	Y	P<0.05
SHOT – PUT (cm.)	636,14	631,49	0,33	NS	P>0.05
PULL – UPS (No.)	5,36	8,35	4,92	Y	P<0.05
SIT – UPS (No.)	58,87	46,09	9,34	Y	P<0.05
250 METRE SHUTTLE RUN (sec.)	103,02	82,11	6,08	Y	P<0.05
COOPER'S TEST (m.)	2086,8	2480,3	9,99	Y	P<0.05

N = 100

The t-test comparisons of means for the 1997 and 1977 sample show that the 1977 sample performed significantly better ($p<0.05$) on all tests selected except for the sit-up test, the boys of the 1997 study did much better. No difference was found on the shot-put test. The 50m shuttle run test cannot be compared, as the method of the test done in 1977 and 1997 were different.

4.3 DEVELOPMENTAL CURVES

Figure 4.11 to 4.18 indicate the differences in the arithmetic mean between the 1997 and 1977 sample for each age group, for each test.

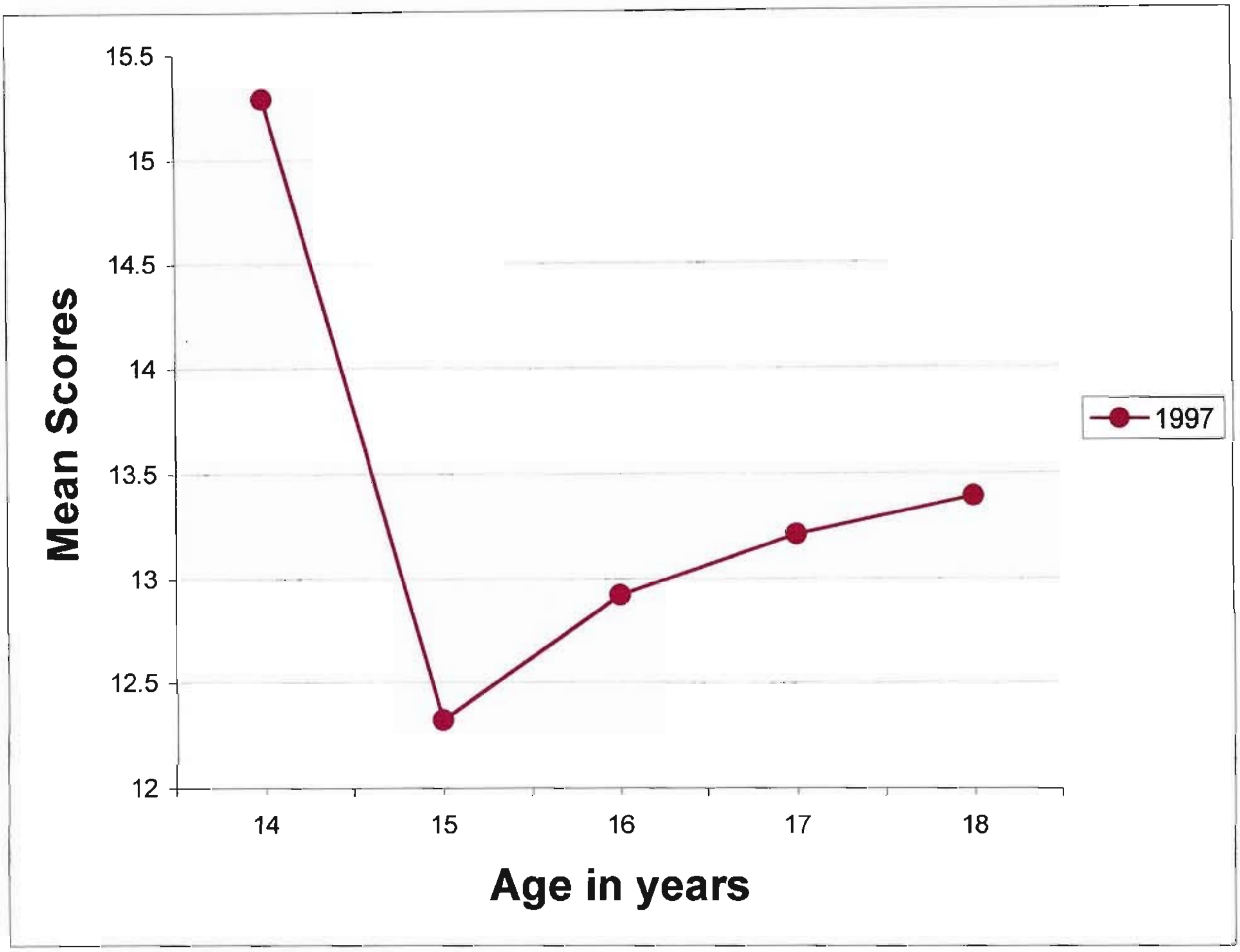


FIGURE 4.11: DEVELOPMENTAL CURVE FOR THE 50 METRE SHUTTLE RUN

In the 1997 study, the 50 metre shuttle run measuring explosive strength there is a significant improvement of scores from 14 years to 15 years and a slight deterioration of scores from 15 to 16 years and a marked deterioration in explosive strength from 16 years through to 18 years. The 1977 scores appear to be better than the 1997 study, except for 15 years olds. There were no comparisons for the 1977 study as the methodology used differed.

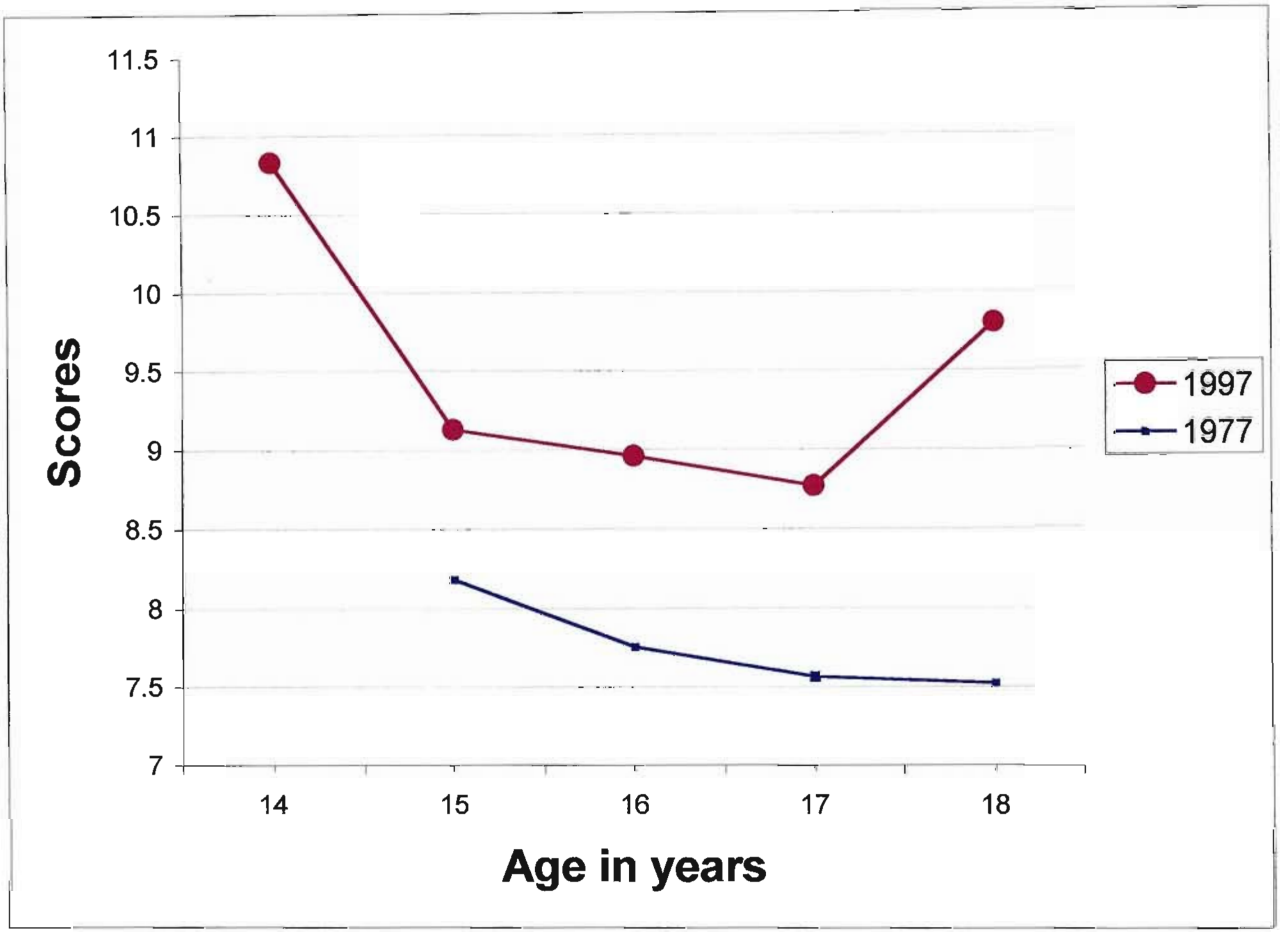


FIGURE 4.12: DEVELOPMENTAL CURVE FOR 50 METRE DASH

The above graph represents the mean scores for 50-metre dash for the selected age groups tested showing the mean difference in age groups between the 1997 study and the 1977 study. The developmental curve indicates that the 1977 results were faster than the 1997 results in all year groups.

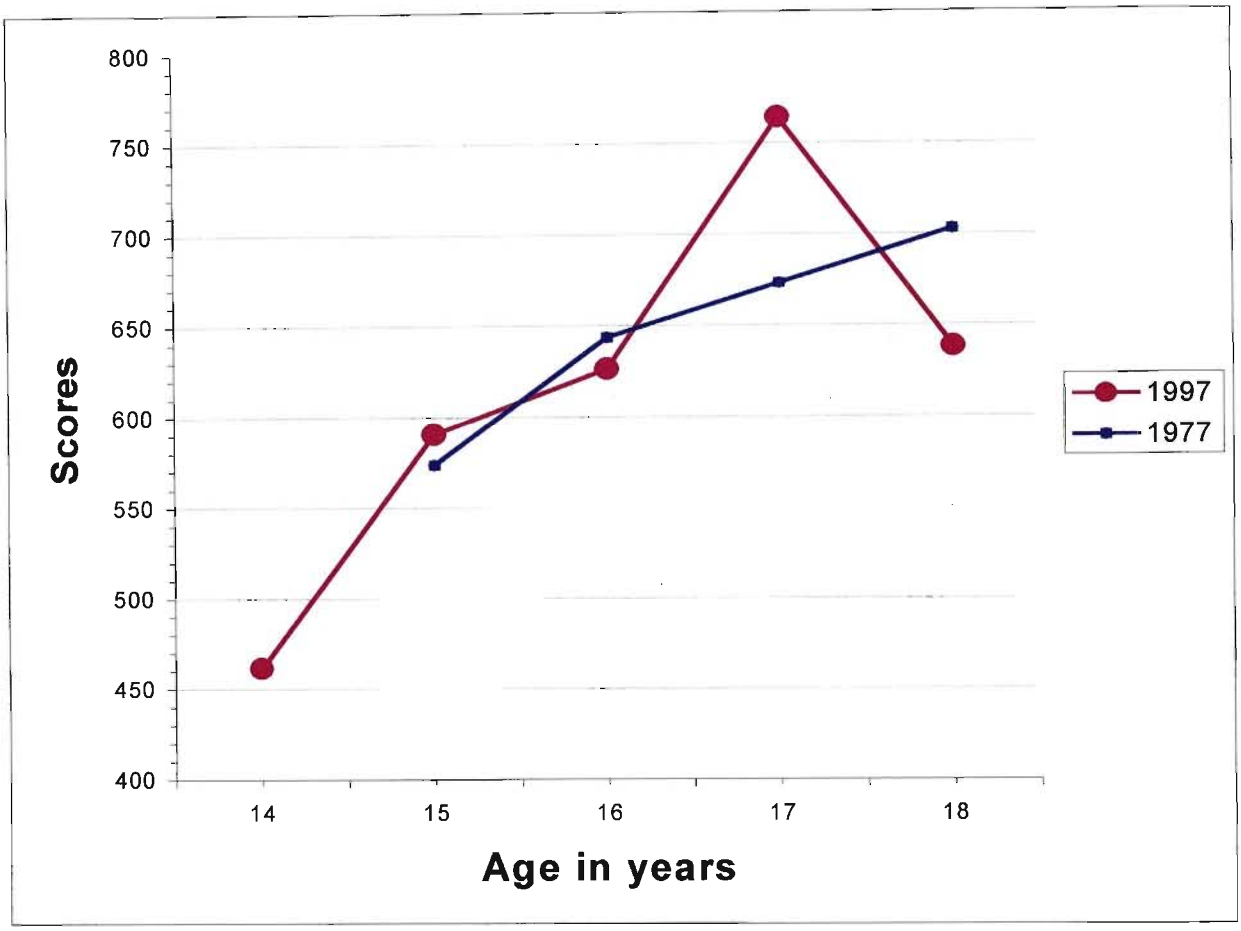


FIGURE 4.13: DEVELOPMENTAL CURVE FOR THE MEDICINE BALL PUT

The above developmental curve represents the mean scores for medicine ball put for the selected age groups showing mean differences across the age groups for the 1997 study and 1977 study. There seems to be little difference between the 15 and 16-year-old groups over the two time periods, with a better score being reflected by the 17 year olds in the 1997 study. The 18-year-old group in 1977 had better scores for medicine ball put.

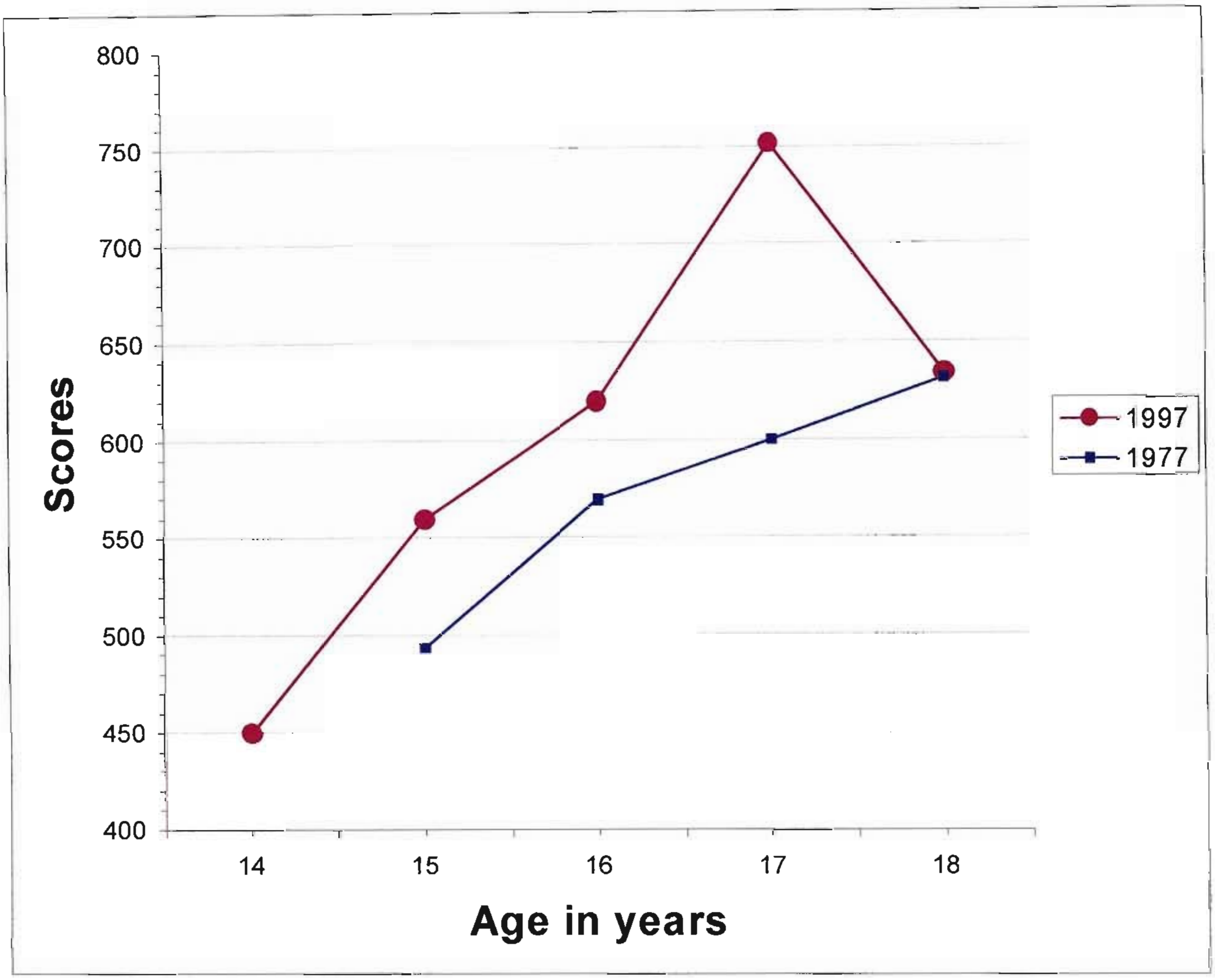


FIGURE 4.14: DEVELOPMENTAL CURVE FOR SHOT PUT

The above developmental curve represents the mean scores for shot put for the selected age groups showing mean differences across the age groups for the 1997 study and 1977 study. This curve indicates that static strength improved significantly from 1977 to 1997 in the 14, 15, 16 and 17 year old groups, however, no difference between the 18 years of age between the time periods.

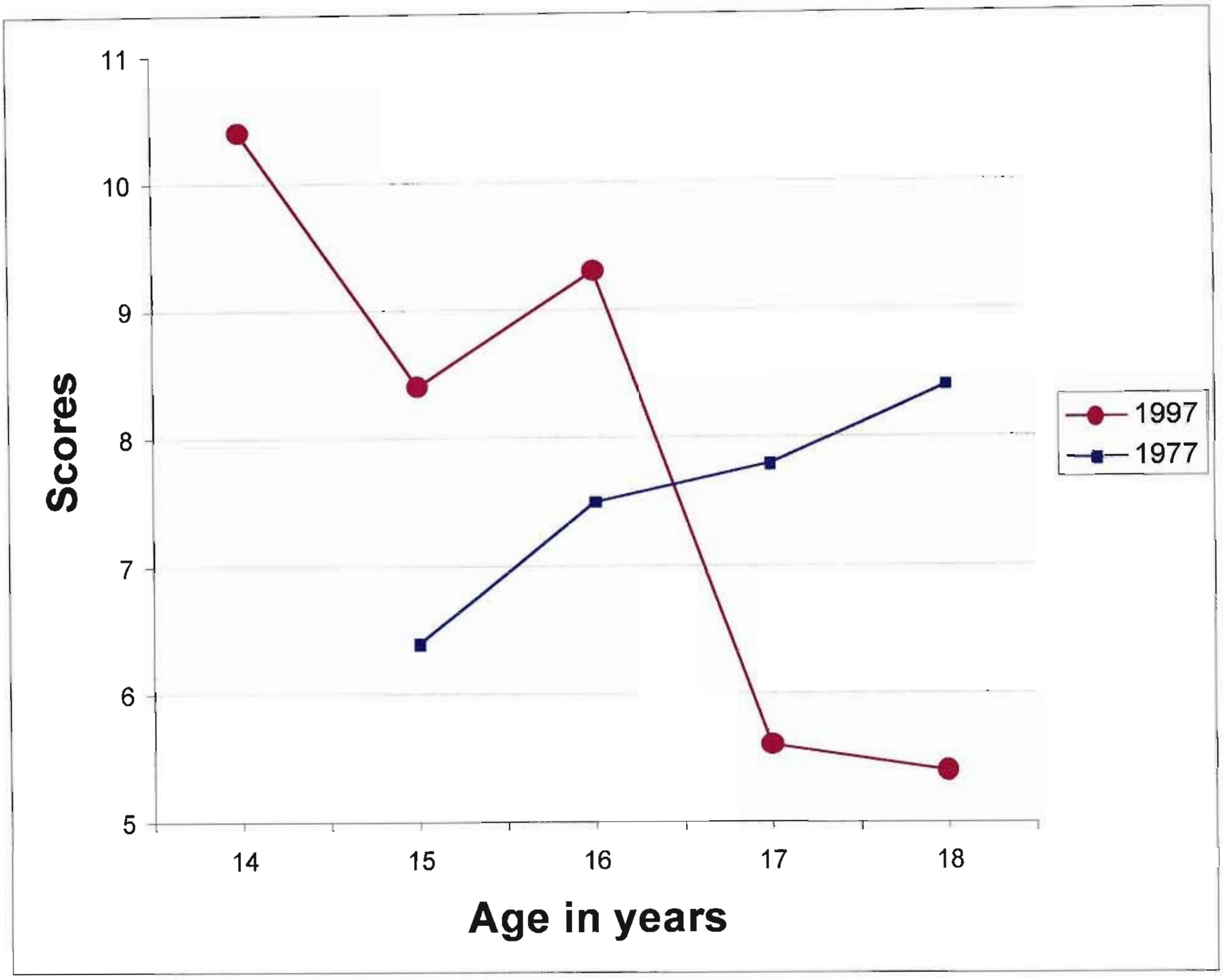


FIGURE 4.15: DEVELOPMENTAL CURVE FOR PULL – UPS

The above curve represents the mean difference in pull – ups for the different age groups showing a difference in mean scores across the age groups for the 1997 study and 1977 study. These scores show a significant increase in the mean pull – up scores for 14, 15 and 16 year olds compared to 1977. However, there is a drastic reduction in the mean pull – up scores for the 17 and 18 year old group in the present study compared to 1977 results.

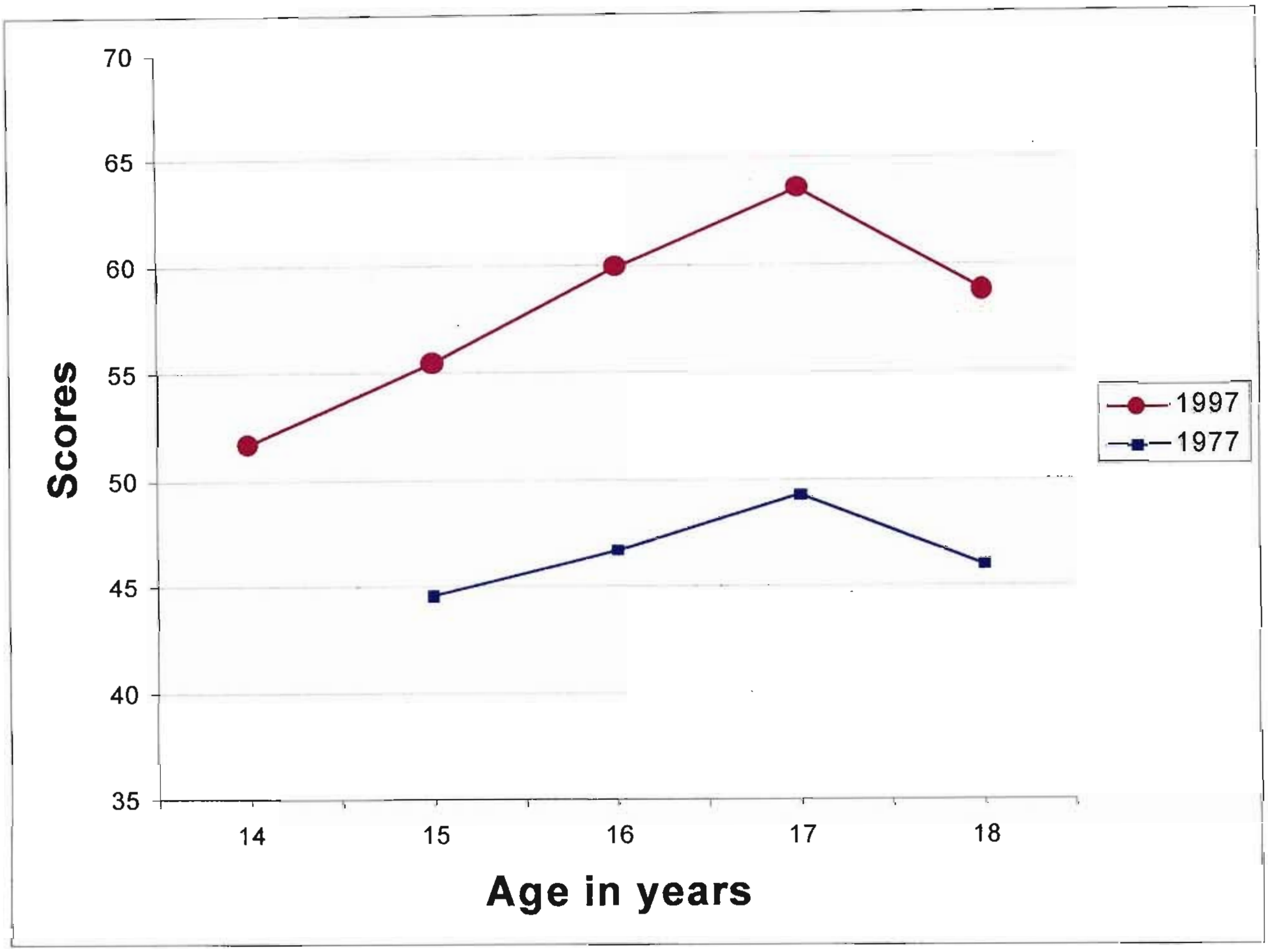


FIGURE 4.16: DEVELOPMENTAL CURVE FOR SIT – UPS

These results reflect the developmental curves for the different age groups over the two time frames. These scores indicate a definite difference favouring the 1997 results. However, there is still a drop in fitness from the 17 to 18 year olds.

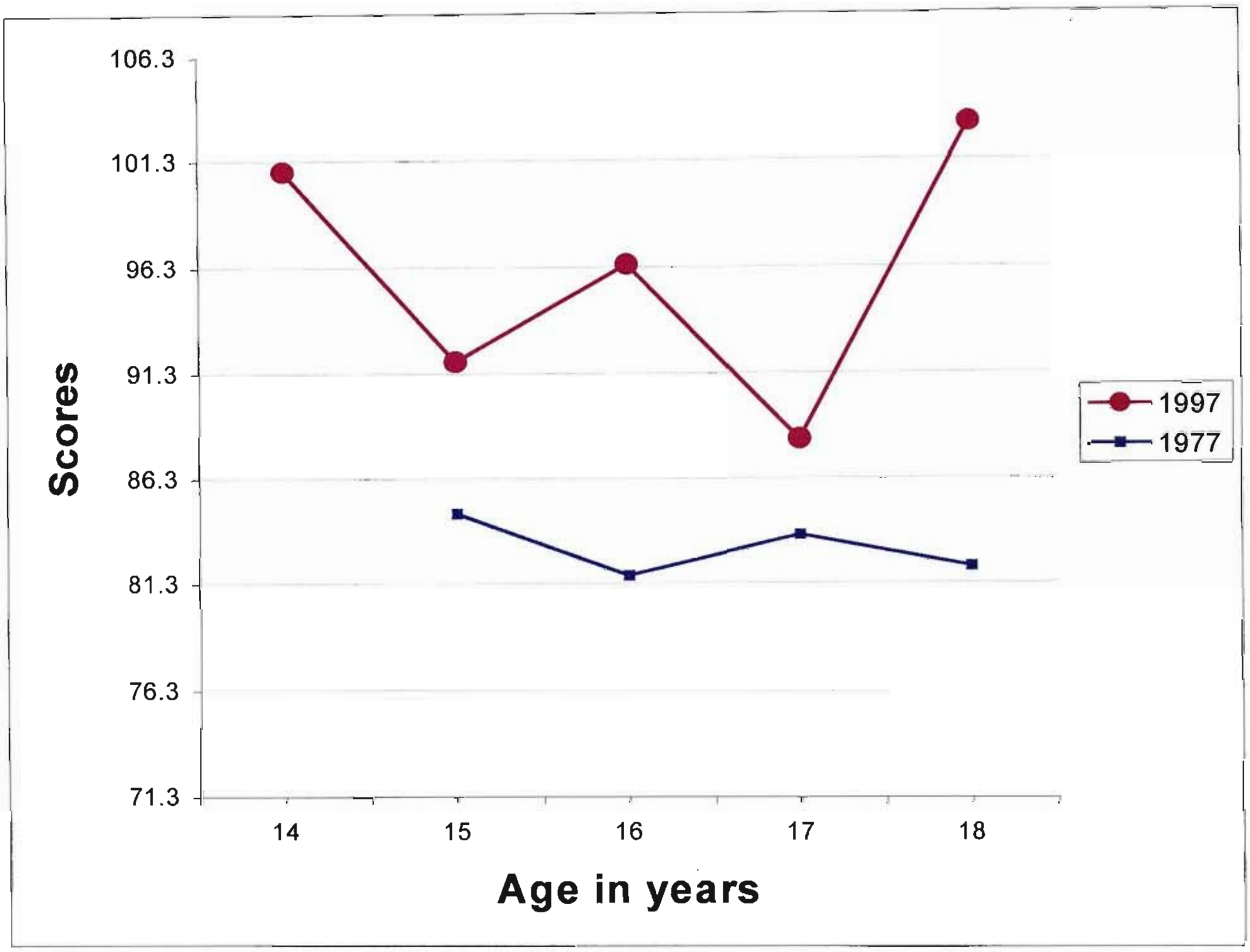


FIGURE 4.17 : DEVELOPMENTAL CURVE FOR THE 250 METRE SHUTTLE RUN

This developmental curve indicates the difference between 1977 and 1997 results for the 250-metre shuttle run. The 1977 scores were statistically significantly better than the 1997 scores. The 1997 scores show that the 18-year-old fitness dropped significantly as compared to the 17 year old groups.

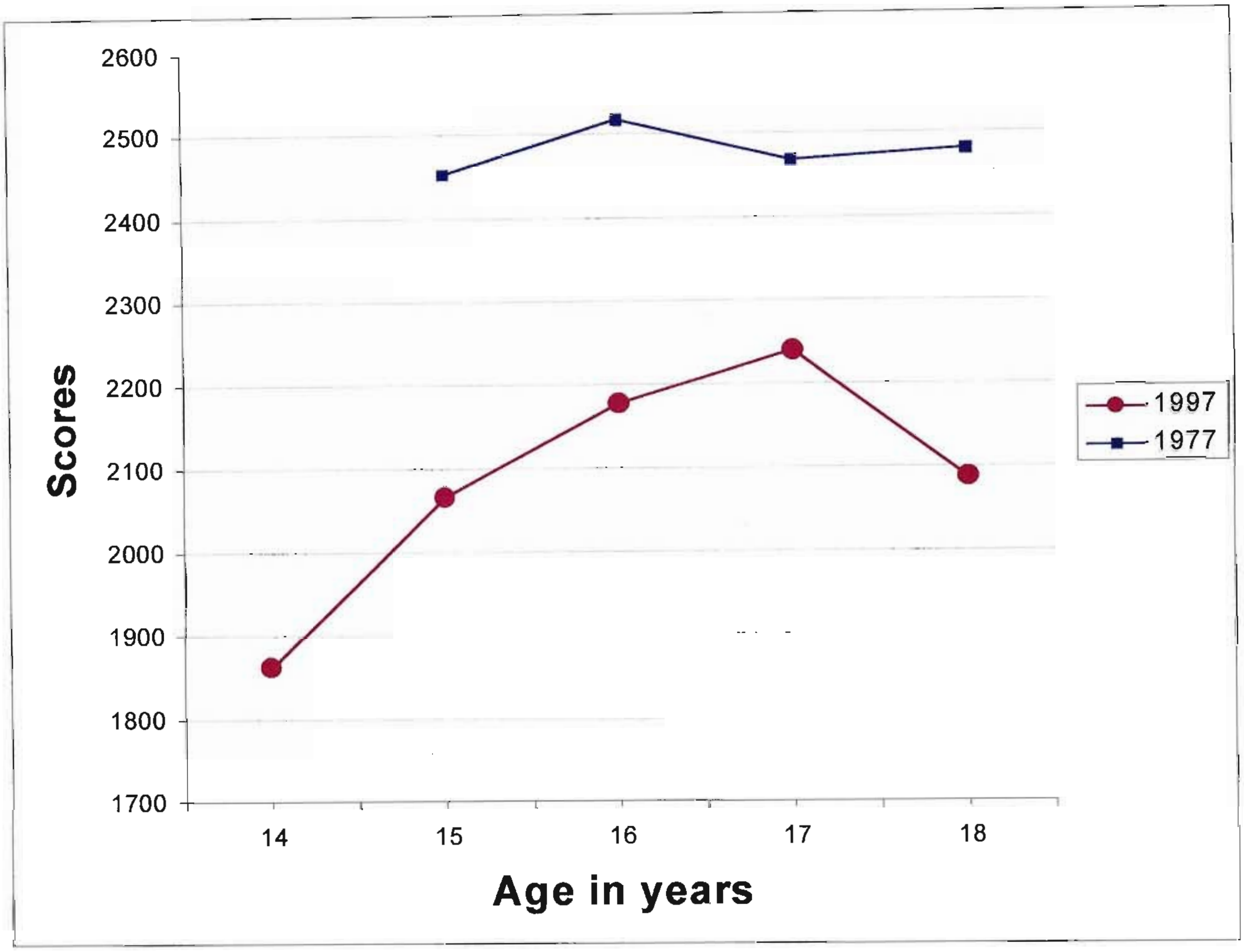


FIGURE 4.18: DEVELOPMENTAL CURVE FOR 12-MINUTE RUN/WALK TEST

These scores reflect the aerobic component across the age groups for the two different time periods. These data indicate that the 1977 mean scores were significantly better across the age groups for all ages.

A study on the developmental curves presented in figures 4.11 to 4.18 reveals the fact that each curve depends on the component tested. Both studies endorse similar sentiments where fitness or performance levels seem to decline in the more senior age groups, more so for tests measuring endurance, which show a marked decline in performance from the 17 years to the 18 years.

4.4 T - TEST

TABLE 4.10: MEAN DIFFERENCE BETWEEN THE AGE GROUPS ON 50 METRE DASH:

AGE GROUP	MEAN DIFFERECNE	SIGNIFICANT / NOT SIGNIFICANT	P VALUE
14 – 15 YEARS	1.69	Y	P < 0.05
15 – 16 YEARS	0.17	NS	P > 0.05
16 – 17 YEARS	0.19	NS	P > 0.05
17 – 18 YEARS	-1.03	Y	P < 0.05

In the 50 m dash there is a statistically significant difference between the 14 and 15 year olds ($p < 0.05$) showing a significant improvement in scores from 14 years to 15 years. There is a significant decrement in performance between the 17 and 18 year olds. No significant difference is to be found between the 15 and 16-year age groups and between 16 and 17 years ($p > 0.05$).

TABLE 4.11: MEAN DIFFERENCE BETWEEN THE AGE GROUPS ON 50 METRE SHUTTLE RUN:

AGE GROUP	MEAN DIFFERECNE	SIGNIFICANT / NOT SIGNIFICANT	P VALUE
14 – 15 YEARS	2.96	Y	P < 0.05
15 – 16 YEARS	-0.60	NS	P > 0.05
16 – 17 YEARS	-0.28	NS	P > 0.05
17 – 18 YEARS	-0.18	NS	P > 0.05

In the 50 m shuttle run measuring explosive strength there is an improvement of scores from 14 to 15 years and a slight deterioration of scores from 15 to 16 years and a deterioration in explosive strength from 16 years through to 18 years. There is no significant difference in scores between the 15 and 16 year olds, 16 and 17 year olds and 17 and 18 year olds ($p > 0.05$). The performance increment is significant at the 5% level from 14 years to 15 years ($p < 0.05$).

TABLE 4.12: MEAN DIFFERENCE BETWEEN THE AGE GROUPS ON PULL – UPS:

AGE GROUP	MEAN DIFFERECNE	SIGNIFICANT / NOT SIGNIFICANT	P VALUE
14 – 15 YEARS	2.07	Y	P < 0.05
15 – 16 YEARS	-0.93	NS	P > 0.05
16 – 17 YEARS	3.72	Y	P < 0.05
17 – 18 YEARS	0.27	NS	P > 0.05

The Pull – up test to limit measuring upper body muscular strength and muscular endurance shows a performance decrement, which is statistically significant ($p < 0.05$) between the 14 – 15 years and 16 – 17 years. No significant difference ($p > 0.05$) was found for 15 – 16 and 17 – 18 years. A marked improvement of performance at 15 and 16 years is noted in the present sample. However, a deterioration of performance on the pull-up test is noted in the later ages 17 and 18 years.

TABLE 4.13: MEAN DIFFERENCE BETWEEN THE AGE GROUPS ON SIT– UPS:

AGE GROUP	MEAN DIFFERENCE	SIGNIFICANT / NOT SIGNIFICANT	P VALUE
14 – 15 YEARS	-3.39	Y	P < 0.05
15 – 16 YEARS	-4.53	Y	P < 0.05
16 – 17 YEARS	-3.54	Y	P < 0.05
17 – 18 YEARS	4.66	Y	P < 0.05

The sit-up test show statistically significant differences in performance for all age groups ($p < 0.05$). However, significant improvement occurred from 14 to 15 years, 15 to 16 years. The performance decrement of the 18-year age group was significant ($p < 0.05$).

TABLE 4.14: MEAN DIFFERENCE BETWEEN THE AGE GROUPS ON MEDICINE BALL PUT:

AGE GROUP	MEAN DIFFERENCE	SIGNIFICANT / NOT SIGNIFICANT	P VALUE
14 – 15 YEARS	-129.03	Y	P < 0.05
15 – 16 YEARS	-35.43	Y	P < 0.05
16 – 17 YEARS	-138.03	Y	P < 0.05
17 – 18 YEARS	125.97	Y	P < 0.05

There is a significant improvement in performance on static strength for 15 years ($t = 0.97$; $p > 0.05$) and 17 years ($t = 5,80$; $p < 0.05$).

TABLE 4.15: MEAN DIFFERENCE BETWEEN THE AGE GROUPS ON SHOT PUT:

AGE GROUP	MEAN DIFFERECNE	SIGNIFICANT / NOT SIGNIFICANT	P VALUE
14 – 15 YEARS	-109.56	Y	P < 0.05
15 – 16 YEARS	-60.70	Y	P < 0.05
16 – 17 YEARS	-131.80	Y	P < 0.05
17 – 18 YEARS	115.48	Y	P < 0.05

The above results reveal statistically significant differences ($p < 0.05$) on the static strength factor for all age groups. A marked improvement has been noted from 14 years through to 17 years with a slight decrease in performance at 18 years.

TABLE 4.16: MEAN DIFFERENCE BETWEEN THE AGE GROUPS ON 250 METRE SHUTTLE RUN:

AGE GROUP	MEAN DIFFERENCE	SIGNIFICANT / NOT SIGNIFICANT	P VALUE
14 – 15 YEARS	0.15	Y	P < 0.05
15 – 16 YEARS	-7.58	NS	P > 0.05
16 – 17 YEARS	0.14	Y	P < 0.05
17 – 18 YEARS	-0.25	Y	P < 0.05

The 250-metre shuttle run test as a measure of cardio respiratory endurance revealed statistically significant differences ($p < 0.05$) for the age groups of 14 to 15 years, 16 to 17 years and 17 to 18 years. No significant difference was found between the 15 and 16 year olds ($p > 0.05$). The performance in this test fluctuated at the different age levels. Both the 1997 and 1977 studies showed a deterioration of performance between the 17 and 18 year olds.

TABLE 4.17: MEAN DIFFERENCE BETWEEN THE AGE GROUPS ON 12 MINUTE RUN / WALK TEST:

AGE GROUP	MEAN DIFFERENCE	SIGNIFICANT / NOT SIGNIFICANT	P VALUE
14 – 15 YEARS	-204.60	Y	P < 0.05
15 – 16 YEARS	-112.60	Y	P < 0.05
16 – 17 YEARS	-62.40	NS	P > 0.05
17 – 18 YEARS	154.00	Y	P < 0.05

In the 12-minute run/walk test significant differences ($p < 0.05$) were observed for the age group 14 to 15 years, 15 to 16 years and 17 to 18 years. It has been noted that there is a steady improvement of performance from age 14 through to 17 years followed by a deterioration of performance at 18 years old. No significant difference was found between 16 and 17 year olds ($p > 0.05$).

4.5 STANDARD SCORE TABLES

The standard scores for each of the eight tests for boys between the ages 13,7 to 18,6 years are presented in Tables 4.18 to 4.22. The mean and standard deviation of scores for each test are given at the foot of the respective columns. By establishing normative tables for adolescence by age group, individuals will be able to measure their own fitness profiles against established norms. This would serve to indicate both strengths and weaknesses and would encourage one to exercise regularly and thereby enhance fitness levels.

TABLE 4.18: Selected fitness Standard Score Tables for 14 year olds (13,7 to 14,6 years)

Explosive Strength		Static Strength		Dynamic Strength		Endurance		Standard Score
50 m shuttle /run (sec)	50 m dash (sec)	Medicine ball put (cm)	Shot put throw (cm)	Pull-ups (No)	Sit-ups (No)	250m shuttle /run (sec)	12 min run/walk test (m)	
4,3	5,00	771	769	30	89	20	2620	100
5,4	5,58	740	737	28	87	28	2545	95
6,5	6,16	709	705	26	83	36	2469	90
7,6	6,74	678	673	24	79	44	2393	85
8,7	7,32	647	641	22	75	52	2317	80
9,8	7,9	616	609	20	71	60	2241	75
10,9	8,48	585	577	18	67	68	2165	70
12,0	9,06	554	545	16	63	76	2089	65
13,1	9,64	523	513	14	59	84	2013	60
14.2	10,22	492	481	12	55	92	1937	55
15.3	**10,8**	**461**	**449**	**10**	**51**	**100**	**1861**	**50**
16.4	11,41	430	417	8	47	108	1785	45
17,5	11,99	399	385	6	43	116	1709	40
18,6	12,57	368	353	4	39	124	1633	35
19,7	13,15	337	321	2	35	132	1557	30
20,8	13,73	306	289	0	31	140	1481	25
21,9	14,31	275	257	0	27	148	1405	20
23,0	14,89	244	225	0	23	156	1329	15
24,1	15,47	213	193	0	19	164	1253	10
25,2	16,05	182	161	0	15	172	1177	5
26,3	16,63	151	129	0	11	180	1101	0
15,3	**10,83**	**461,76**	**449,56**	**10,49**	**51,67**	**100,78**	**1861,2**	**$\bar{X}$**
3,8	**1,92**	**104,84**	**106,59**	**7,29**	**12,77**	**25,89**	**252,4**	**S.D.**

TABLE 4.19: Selected Standard Score Tables for 15 year olds(14,7 to 15,6 years)

Explosive Strength		Static Strength		Dynamic Strength		Endurance		Standard Score
50 m shuttle /run (sec)	50 m dash (sec)	Medicine ball put (cm)	Shot put throw (cm)	Pull-ups (No)	Sit-ups (No)	250m shuttle /run (sec)	12 min run/walk test (m)	
6.50	5.4	1020	949	28	105	42	3465	100
7.08	5.77	977	910	26	100	47	3325	95
7.66	6.14	934	871	24	95	52	3185	90
8.24	6.51	891	832	22	90	57	3045	85
8.82	6.88	848	793	20	85	62	2905	80
9.40	7.25	805	754	18	80	67	2765	75
9.98	7.62	762	715	16	75	72	2625	70
10.56	7.99	719	676	14	70	77	2485	65
11.14	8.36	676	637	12	65	82	2345	60
11.72	8.73	633	598	10	60	87	2205	55
12.3	**9.1**	**590**	**559**	**8**	**55**	**92**	**2065**	**50**
12.88	9.47	547	520	6	50	97	1925	45
13.46	9.84	504	481	4	45	102	1785	40
14.04	10.21	461	442	2	40	107	1645	35
14.62	10.58	418	403	0	35	112	1505	30
15.2	10.95	375	364	0	30	117	1365	25
15.78	11.32	332	325	0	25	122	1225	20
16.36	11.69	289	286	0	20	127	1085	15
16.94	12.06	246	247	0	15	132	945	10
17.52	12.43	203	208	0	10	137	805	5
18.10	12.80	160	169	0	5	142	665	0
12.32	**9.13**	**590.7**	**559.12**	**8.42**	**55.46**	**91,85**	**2065.8**	$\bar{x}$
1.94	**1.26**	**142.85**	**130.18**	**5.88**	**16.48**	**18,53**	**464.87**	**S.D.**

TABLE 4.20: Selected fitness Standard Score Tables for 16 year olds (15,7 to 16,6 years)

Explosive Strength		Static Strength		Dynamic Strength		Endurance		Standard Score
50 m shuttle /run (sec)	50 m dash (sec)	Medicine ball put (cm)	Shot put throw (cm)	Pull-ups (No)	Sit-ups (No)	250m shuttle/ run (sec)	12 min run/walk test (m)	
7.2	4.0	1016	1029	29	100	16	3238	100
7.7	4.5	977	988	27	96	24	3132	95
8.3	5.0	938	947	25	92	32	3026	90
8.9	5.5	899	906	23	88	40	2920	85
9.5	6.0	860	865	21	84	48	2814	80
10.0	6.4	821	824	19	80	56	2708	75
10.6	6.9	782	783	17	76	64	2602	70
11.2	7.4	743	742	15	72	72	2496	65
11.8	7.9	704	701	13	68	80	2390	60
12.3	8.4	665	660	11	64	88	2284	55
12.9	**8.9**	**626**	**619**	**9**	**60**	**96**	**2178**	**50**
13.47	9.4	587	578	7	56	104	2072	45
14.0	9.8	548	537	5	52	112	1966	40
14.6	10.4	509	496	3	48	120	1860	35
15.1	10.9	470	455	1	44	128	1754	30
15.7	11.4	431	414	0	40	136	1648	25
16.3	11.8	392	373	0	36	144	1542	20
16.9	12.3	353	332	0	32	152	1436	15
17.5	12.8	314	291	0	28	160	1330	10
18.0	13.3	275	250	0	24	168	1224	5
18.6	13.8	236	209	0	20	176	1118	0
12.92	**8.96**	**626.22**	**619.82**	**9.35**	**59.99**	**96,40**	**2178.4**	**$\bar{X}$**
1.92	**1.63**	**130.70**	**136.23**	**6.57**	**12.01**	**27,56**	**354.59**	**S.D.**

TABLE 4.21: Selected fitness Standard Score Tables for 17 year olds (16,7 to 17,6 years)

Explosive Strength		Static Strength		Dynamic Strength		Endurance		Standard Score
50 m shuttle /run (sec)	50 m dash (sec)	Medicine ball put (cm)	Shot put throw (cm)	Pull-ups (No)	Sit-ups (No)	250m shuttle/ run (sec)	12 min run/walk test (m)	
8,40	3,8	1104	1071	16	83	18	3410	100
8,88	4,3	1070	1039	15	81	25	3293	95
9,36	4,8	1036	1007	14	79	32	3176	90
9,84	5,3	1002	975	13	77	39	3059	85
10,32	5,7	968	943	12	75	46	2942	80
10,8	6,2	934	911	11	73	53	2825	75
11,28	6,7	900	879	10	71	60	2708	70
11,76	7,2	866	847	9	69	67	2591	65
12,24	7,7	832	815	8	67	74	2474	60
12,72	8,2	798	783	7	65	81	2357	55
13,2	**8,7**	**764**	**751**	**6**	**63**	**88**	**2240**	**50**
13,68	9,19	730	719	5	61	95	2123	45
14,16	9,68	696	687	4	59	102	2006	40
14,64	10,17	662	655	3	57	109	1889	35
15,12	10,66	628	623	2	55	116	1772	30
15,60	11,15	594	591	1	53	123	1655	25
16,08	11,64	560	559	0	51	130	1538	20
16,56	12,13	526	527	0	49	137	1421	15
17,04	12,62	492	495	0	47	144	1304	10
17,52	13,11	458	463	0	45	151	1187	5
18,00	13,60	424	431	0	43	158	1070	0
13,21	**8,77**	**764,25**	**751,62**	**5,63**	**63,57**	**88,16**	**2240,80**	$\bar{x}$
1,60	**1,64**	**115,44**	**109,46**	**4,91**	**8,76**	**22,92**	**392,15**	S.D.

TABLE 4.22: **Selected fitness Standard Score Tables for 18 year olds**
(17,7 to 18,6 years)

Explosive Strength		Static Strength		Dynamic Strength		Endurance		Standard Score
50 m shuttle /run (sec)	50 m dash (sec)	Medicine ball put (cm)	Shot put throw (cm)	Pull-ups (No)	Sit-ups (No)	250m shuttle/ run (sec)	12 min run/walk test (m)	
5,4	4,8	948	945	15	79	3	2736	100
6,2	5,3	917	913	14	77	13	2671	95
7,0	5,8	886	882	13	75	23	2606	90
7,8	6,3	855	851	12	73	33	2541	85
8,6	6,8	824	820	11	71	43	2476	80
9,4	7,3	793	789	10	69	53	2411	75
10,2	7,8	762	758	9	67	63	2346	70
11,0	8,3	731	727	8	65	73	2281	65
11,8	8,8	700	696	7	63	83	2216	60
12,6	9,3	669	665	6	61	93	2151	55
13,4	**9,8**	**638**	**634**	**5**	**59**	**103**	**2086**	**50**
14,2	10,3	639	603	4	57	113	2021	45
15,0	10,8	608	572	3	55	123	1956	40
15,8	11,3	577	541	2	53	133	1891	35
16,6	11,8	546	510	1	51	143	1826	30
17,4	12,3	515	479	0	49	153	1761	25
18,2	12,8	484	448	0	47	163	1696	20
19,0	13,3	453	417	0	45	173	1631	15
19,8	13,8	422	386	0	43	183	1566	10
20,6	14,3	391	355	0	41	193	1501	5
21,4	14,8	360	324	0	39	203	1436	0
13,39	**9,8**	**638,26**	**634,14**	**5,36**	**58,87**	**103,02**	**2086,8**	$\bar{x}$
2,57	**1,7**	**105,08**	**105,96**	**5,14**	**7,59**	**33,92**	**216,05**	**S.D.**

In the following chapter, a detailed discussion will follow, based on the results presented.

CHAPTER FIVE

DISCUSSION OF RESULTS

The main purpose of this study was to compare youth fitness levels of a cohort of Indian high school boys in 1997 with those of 1977, using the results obtained from the ***Coopoo (1978)*** study as well as the establishment of norms for this cohort. The important aims of this study were met by this research project. The results will now be discussed under the following headings, namely, developmental curves, comparison between groups and possible explanations for these results.

5.1 DEVELOPMENTAL CURVES

The following observations were made after the mean scores for the various age groups had been examined: -

The fifty-metre shuttle run measuring explosive strength was the only test that differed from the battery in 1977, as the exact equipment for the testing procedure could not be replicated. The 1997 study reflects a marked improvement of performance on the shuttle run test from 14 to 15 years, followed by a decrement from 15 to 16 years, 16 to 17 years and 17 to 18 years. However, the trend of this component (explosive strength) follows a similar pattern to that of ***Coopoo (1978).***

The results of ***Coopoo (1978)*** showed a 1% significant difference between the 15 and 16 year olds and similar trends could be observed from the 16 to 18 year olds. The comparison of the two sample means 1997 and 1977 show a significant difference at the 5 % level for all age groups. The 15 year age group indicated a significant difference in favour of the 1997 sample t= 2,69 and ($p < 0.05$) on the 50m shuttle test. However, the highest mean scores in the Coopoo study was found in the 16, 17 and 18 years. This trend that was established in 1977 appear to be a normal developmental one, as the boys become stronger and faster as they mature. In the current study the best scores were obtained for the 14 year olds and a large decline was noted in the 15 years with a steady increase till 18 years. However, this increase was still significantly less as compared to the recorded 14 year olds. This appears to show that there is a significant decrease in physical activity levels, especially those related to speed, such as a game of soccer in schools as compared to the 1977 study. If one has to examine the age at which the interest dwindles in physical education and sport is around 15 to 16 years of age.

There is a severe problem currently in schools with respect to the teaching and implementation of physical education in Indian schools in Kwazulu Natal. Many qualified physical education teachers are being retrenched and non-specialists are being requested to teach physical education. In the opinion of the author the marked decrease in speed may be attributed to poor teaching methods and knowledge of the unskilled teachers.

In the fifty-metre dash the 1997 study shows a marked improvement in performance from 14 – 15 years, a progressive improvement from 15 – 16 years and 16 – 17 years. However, there is a decline in performance from 17 – 18 years. ***Coopoo (1978)*** also observed similar trends between the 16 and 17 year age group where there was no significant difference found. This study showed a progressive improvement of performance for explosive strength from 15 years through to 18 years. ***Coopoo (1978)*** reports that explosive strength improves with age. ***McMullen (1982)*** found similar trends to the present study showing a linear increase in performance with age from 15 to 17 and a decline at age 18. The developmental curve indicates that the 1977 results were faster than the 1997 results in all age groups. This noted decrease in the 50-metre dash after age 16-17 years is directly attributable to the reduced physical education periods in grade 11 and 12. This trend existed in 1977 as well. So thus, the trend with the general reduction of fitness from about grade 10 still exists, however, the fitness levels have dropped even in the earlier grades (grades 8 and 9).

The developmental curve for medicine ball put shows little difference in mean scores between the 15 and 16 year old group over the two time periods, with the 17 year olds performing better in the 1997 study. The 18-year-old group in 1977 had better scores for medicine ball put (See Figure 4.13).

There is a progressive improvement of the static strength factor with age and body mass from 14 years through to 17 years on both the 1997 and 1977 study. This shows that mass is positively related to static strength. ***Fleishman (1964)*** gives a loading of 0,70 for mass on the static strength factor. With the exception of the score for 18 years age group, this study is therefore in accord with the findings of ***Coopoo (1978),*** that there is a progressive static strength improvement with age. According to ***Coopoo (1978)*** the increase in static strength is attributed to the increase in body mass. ***McMullen (1982)*** also endorse similar trends showing a linear increase in performance with age. These findings are similar to those of ***Fleishman (1964)*** who performed a factor analytic study that yielded a factor labeled "static strength." In Fleishman's analysis body weight loads positively on static strength. The increase of the mean weight of the cohort in 1997 compared to 1977, could also explain this slight increase in the 16-year-old group in the 1997 study.

The second test conducted as a measure of static strength was the Shot put. Results indicate statistically significant differences ($p < 0.05$) on the static strength factor for all age groups. A marked improvement has been noted from 14 years through to 17 years with a slight decrease in performance at 18 years. ***Coopoo (1978)*** showed similar trends with significant differences being found at the 5 % confidence interval between the mean scores of 15 – 16 years, 16 – 17 years and 17 – 18 year olds. The developmental curve indicates that static strength improved significantly from 1977 to 1997 in the 14,15,16 and 17-year-old groups, however, no difference between the 18 years of age between the time periods (See Figure 4.14). There were better strength scores example the shot put in 1997 as compared to 1977, appears to be that the children today, are more dietary conscious, because of the media, television, published sportspersons diets, as well as the cheaper and better protein available for purchase. The media image that is advocated in magazines, books, films and television may have influenced these boys to concentrate on strength activities. Many boys at this age may attend a gymnasium only do weight training, hence the improvement in strength. This improvement in strength is definitely not being achieved through the physical education lessons in schools.

The developmental curve for 2-minute sit-ups of the 1997 study show an improvement of performance on abdominal strength from 14 to 15 years, 15 to 16 years and 16 to 17 years. However, there is a decline in fitness from 17 to 18 year olds. ***Coopoo (1978)*** notes a steady improvement of scores from 15 year olds through to 17 year olds. This study also showed a decline in performance of the 18 year olds, and a significant difference at the 5 % level of confidence. " The possible reason for this decline in dynamic strength of the trunk, in this senior age group, may be attributed to the reduced amount of physical activity undertaken by this age group during the physical education period" ***(Coopoo, 1978).*** An individual's physical status, such as leg strength and training could affect performance on this test.

The comparison of two sample means using the t – test for this purpose showed this component to be statistically significant between means in all age groups ($p < 0.05$). The result of this test shows an improvement in the 1997 performance for all age groups across the decades. This finding is supported by ***Updyke (1992)*** who reported an improvement of scores for sit-up test for boys across the decade (1980 – 1989). This may appear to be that our boys are growing stronger due to better medial support, better nutrition and the effects of society's image with respect to strength. Sit-ups feature in almost all fitness competitions.

The Pull – up test to limit measuring upper body muscular strength and muscular endurance shows an improvement in performance between the 15 and 16 year olds and a drastic decline in performance between the 16 – 17 and 17 – 18 years. ***Coopoo (1978)*** revealed a steady improvement in scores from 15 year olds to the 17 year olds after which scores leveled off. The present study is in contradiction to the findings of ***Coopoo (1978).*** A small % of zero scores were found between ages 14 and 15 years with a slight increase with the frequency of zero scores at age 16 years and 17 years, followed by a marked increase in frequency of zero scores at age 18 years. The results of this study indicate that body weight is a major confounder to performance on the pull – up test. The confounding effect of body weight as observed in this study is consistent with results from previously published studies with young adult males ***(Fleishman, 1964).***

Pate et al. (1993) reports relatively large % of zero scores using the traditional pull – up test. **Cotton (1990)** reports that as many as 30 % of 16 to 18 year old boys cannot perform one pull – up. The results of the 1997 study indicate that muscular strength decreases significantly with age. The literature supports this finding and attributes declines in muscular strength to decrease muscle mass, muscle fibers and reduction in the number of functional motor units, due to reduced physical activity, and is assumed to be the result of increased academic emphasis in schools at this age ***(Cotton, 1990).***

Updyke (1992) reports that the pull-up performance among boys appears to reflect the effects of weight gain. In this study over the ten-year period, the 14 – 17 year olds demonstrated a flattened W-shaped curve finishing about 9 pull-ups. However, the pull-up performance of boys 18 years declined gradually across the decade
(1980 – 1989). The present study also shows a decline in pull-up performance of Indian boys across two decades (1977 – 1997) (See Figure 4.15).

The 250 metre shuttle run test as a measure of cardio respiratory endurance for young children revealed decline in performance between 15 and 16 year olds, an improvement between 16 to 17 years and a drastic decline in performance at 18 years. Both the studies showed a fluctuation of performance at the different age levels. The results of the study indicate that there is a deterioration in performance in this parameter of fitness over a twenty-year time period. The results of these tests reflect the neglect of aerobic and anaerobic training in schools, as well as during leisure time. Another development that has occurred over the last number of years is the increased number of schoolboys involved in part time work over weekends, thus reducing their effective activity time. It does appear that the number of youth soccer, volleyball and cricket has dwindled in the Indian community.

Comparison of means scores on the 12-minute run/walk test show statistically significant difference between means at all age groups ($p < 0.05$) on this component of fitness (cardiovascular endurance). There seems to be a marked deterioration in performance in the 1997 sample. The 1977 performance scores were better across the age groups for all ages. Similar trends have been observed in the study conducted by ***Updyke (1992)*** who showed that mile run/walk times decreased for boys 14 –17 years. It took 14-17 year old boys 66 seconds longer to cover 1mile distance in 1989 than it did in 1980, resulting in a dramatic decline in endurance performance over a ten year time period ***(Updyke, 1992).***

Research on Peak Vo_2 max in boys during the developmental years has shown that the average Peak Vo_2 max across the age range remains quite constant in boys to age 16. Increased body fatness decreases Peak Vo_2 max expressed relative to body weight because it adds to the body weight but not to the body's ability to utilize O_2 during exercise ***(Cureton & Warren, 1990).***

Zhu (1997) reported that as children matured, they increased their running performance or decreased their running time. Thus it can be concluded that the aerobic capacity of an individual is related in part to body weight and in part to age. Once again, the aerobic component decreased considerably from 1997 cohort to the 1977 cohort. It is assumed that many factors may contribute to this situation. Transport to schools by parents on a daily basis has become more frequent today than 20 years ago. The reduced and in some cases non-existent physical education classes in many schools may contribute to this decay in aerobic fitness. The increased emphasis on academic standards, with almost every second child in high school going to extra academic tuition in the afternoons, in order to improve their grades, may affect the status of their physical activity, thus aerobic fitness. In many cases both parents work, leaving the children at home in the afternoon without supervision. The excellent television programmes, computer games and Internet facilities may keep the boys indoors for most of the afternoons. This detracts from physical activity.

The author is not making a case for the poor fitness, but merely paints a picture that may explain such drastic deterioration. Some measure must be taken at school, during physical education or extra curricular activities to remedy this.

5.2 THE DIFFERENCE IN PHYSICAL FITNESS BETWEEN AGE GROUPS

The following observations were made after the mean scores for the various age groups had been examined:

1. The greatest difference in physical ability is to be found between the 14 and 15 year olds. Statistically significant differences were found for all tests: the tests for dynamic arm strength, dynamic trunk strength, explosive strength, static strength and endurance. In each test better performance was produced at age 15.

2. Significant improvement between age groups was also found between the 16 and 17 year olds. Statistically significant differences were found for six out of eight tests. The 17 year olds performed better than the 16 year old on the sit-ups test, medicine ball put, shot put, 250m shuttle run and 12-minute run/walk test. However, the 16 year olds had better pull-up scores. No significant difference was found between the means for the fifty-metre shuttle run and 50-metre dash.

3. A comparison of mean scores across the age groups reveal that the 17-year age group obtained the highest mean scores for six out of eight tests. However, the mean score for the pull-up test fell below that of the 14, 15 and 16 year olds. The mean score for 50 m shuttle run was also greater than the 15 and 16 year olds.

4. The results of this study clearly indicate that there was a deterioration of fitness at 18 years. The 18 year olds showed a deterioration in fitness in seven out of eight tests. On three tests, 50m shuttle run, pull-ups and 250 m shuttle run the 18 year age group's mean score was below that of the 14 year age group. The results also indicate that the 16 year age group as well as the 17 year age group performed significantly better than the 18 year olds on tests of explosive strength, dynamic strength and endurance. On the static strength factor the 16 year olds mean scores were lower than 18 year olds.

5. Cardiovascular endurance does not seem to be related to age because t-test comparisons show that there were no significant difference for the 250 m shuttle run between the age groups 14 years – 18 years, 15 years and 17 years and 16 years and 18 years. For this parameter of fitness the mean scores for the 14 year olds was 100 seconds and the mean score for the 18 year olds was 103 seconds. On the 12-minute run/walk test no significant difference was found for the age groups 15 years and 18 years, 16 years and 17 years and 16 years and 18 years. The 15-year mean score on this parameter was 2065 metres and the 18-year mean score was 2086 metres.

6. In examining the mean scores of the different age groups in the ***Coopoo (1978)*** study, it has been observed that physical ability improves with age from 15 to 18 years. In contrary to the present study, which found a deterioration of fitness from 17 to 18 years old, ***Coopoo (1978)*** results show an improvement from 17 years through to 18 years. However, the mean score for dynamic strength of the trunk for 18 year olds dropped below that of the 17 year olds. Coopoo attributes this decline to the reduced amount of physical activity by this age group during the physical education period. The results of ***Coopoo (1978)*** also indicates that cardiovascular endurance, static strength and upper arm and shoulder strength improves with age. ***Coopoo (1978)*** also indicates that the 16 years old group obtained the best mean scores for tests relating to cardiovascular endurance.

7. The greatest difference in physical ability in the 1978 study is to be found between the ages 15 and 16 years. Statistically significant differences were found in six of the eight tests. The 16 year olds produced better performance scores.

5.3 CONCLUSIONS

The results of the 1977 cohort as compared to the 1997 cohort, compares favourably in some cases, better in others and completely poor in some. The strength components such as shot put, medicine ball put and sit-ups are slightly better in the 1997 cohort compared to the 1977. However, this is not significantly different through all age ranges. The speed components were superior in the 1977 cohort with poor performances registered in the 1997 group. Aerobically, the 1977 cohort was far superior to the present study. However, an important conclusion is that the same trends occurred, that is the decline of fitness results from Grade 10 to 12 in both cohorts. This is related to the increased academic emphasis in these years of development. The author postulates a number of assumptions that may impinge of these results. They are:

- With subject advisors of Physical Education being eliminated from schools and supervising educators since 1990, the teaching and practice of Physical Education has suffered much. To a large extent, Physical Education lessons at schools has been reduced to playing of games, that is, soccer and netball (for boys and girls at elementary school). At secondary school level rationalization of teacher has resulted in pressures on school administrators to do away with "frills," non-examination subjects that has inevitably resulted in de-emphasis of physical education classes.

- With the marginalisation of Physical Education at schools contributing to a lack in fitness levels, the problem is compounded with the gaining popularity of television and computer games. Children and adolescents are lured to watch television in their spare time. To most children, recreation takes the form of sitting before a screen and pressing buttons. Besides improving in hand-eye co-ordination and basic motor skills, very little physical activity is promoted.

- The reasons for the involvement of teenagers in part-time employment, though many fold, include supplementing the family income and the desire for financial independence. But coupled with part-time employment is the lack of free time for the teenager. With little or no time for any physical fitness programme or exercise, or due to tiredness, the fitness level is bound to nose dive.

- In most households, very often both parents are working and the children are left to care for themselves. Usually the responsibility of looking after the children rests with the eldest in the family, in most cases this is the teenager in the high school. This responsibility does not allow for the teenager to leave home engaging in any type of vigorous participation in sport or exercise programme, thus contributing to a drop in fitness level.

- Most aerobic activities such as running and swimming laps are not perceived to be pleasurable, and it is extremely difficult to motivate children to begin a lifelong habit of maintaining a high degree of physical fitness if it involves repeated endurance physical activities.

- Another possible explanation includes changes in lifestyle, especially more abundant food and incorrect selection of food coupled with lack of exercise owing to increased use of the automobile. The author ascribes the difference in physical fitness between these two groups to the fact that in the previous cohort children did not live in such a highly mechanized society. The use of cars was minimum. Children walked everywhere, even to school, frequently a long distance. Nowadays physical activity in daily life is extremely limited, more children engage in recreation as spectators.

- Many competitive sports programs favor the better athletes to the exclusion of those that are less skilled. As children grow older drop out rates to these programs increase.

- Lack of motivation from high school boys because of change of interest.

Corbin (1987) points out that children are engaged in community sports and activity programs outside the school environment but there is a dramatic dropout rate in these programs, as children grow older.

5.4 RECOMMENDATIONS

In order to contribute further to the area of physical fitness levels of South African youth the following recommendations appear warranted.

- It is hoped that this study has provided useful information about the status of fitness of today's Indian youth. There is dire need for greater emphasis of physical education in schools, both in the curriculum as well as extra curricular activity.
- Normative scales should be redrawn on a regular basis in order to develop greater confidence in their reliability. These norms should be made available to the Department of Education and Culture, filtering down to schools and also to Sporting Clubs and Gymnasiums.
- These norms could serve as a form of motivation and encouragement in order to maintain or improve performance on the various components of fitness.
- Other testing items may be added to the test battery, for example flexibility and skinfold measurement.
- The analysis of the results of this study provides direction for future studies. It could be used in inter-racial studies based on scientific grounds.
- To be active, it is recommended that children should engage in both regular cardiovascular aerobic exercise at least 30 minute a day, three times a week and muscular strength training at least twice a week. Appropriate frequencies, intensity and duration of exercise for obtaining acceptable levels of fitness. Exercise should be intense enough to provide a training effect.
- Parents should play a significant role in influencing sport involvement of their children. Family encouragement and the actual involvement of parents in sport activities seem to be instrumental in the sport involvement of children. Parents and the community should be educated on the value of physical activity for future health. Emphasis should be placed on the carryover value into adulthood.
- There is a pressing need for additional research to identify the desired levels of fitness for this age group so that more definite statements can be made about youth fitness. The time is ripe for implementing sound health-related physical fitness programs in the schools. This type of fitness should be promoted locally,

regionally and nationally. A strong body should be formed to reintroduce physical education in all standards at school.

- School governing bodies and school administrators should be made aware of the state of fitness of the children.
- The fitness status of children should be better assessed by studies of the general population and sub-groupings, example, by race/ethnicity, gender and socio-economic status.

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APPENDIX A

SCORE CARD

NAME :________________________________

SCHOOL:________________________________

AGE	DATE OF BIRTH	HEIGHT	WEIGHT

TYPE OF TESTS	SCORE	PERCENTAGE
PULSE (RESTING)		
50 METRE DASH		
50 METRE SHUTTLE RUN		
PULL - UPS		
SIT - UPS (2 MINUTE)		
MEDICINE BALL PUT		
SHOT PUT (5.4 KG)		
250 METRE SHUTTLE RUN		
12 MINUTE RUN /WALK TEST		
REMARKS		
RECOMMENDATION		

APPENDIX B

University of Durban-Westville

DEPARTMENT OF HUMAN MOVEMENT STUDIES

UNIVERSITY OF DURBAN-WESTVILLE
HUMAN PERFORMANCE RESEARCH LABORATARY
INFORMED CONSENT AND INDEMNITY
INFORMED CONSENT

PART 1

In order to assess cardiovascular function, body composition, and other physical fitness components, the undersigned hereby voluntary consents to engage in one or more of the following tests:

12 minute run/walk test
2 minute speed sit-ups
pull ups to limit
medicine ball put

50 m shuttle run
50 m dash
250m shuttle run
shot put

1. EXPLANATION OF TESTS

The 12 minute run walk test is performed on a 400 metre track. The subject is required to walk or walk/run for 12 minutes. The subject may stop the test at any time because of fatigue or discomfort.

For muscle fitness testing, the medicine ball put and shot put and pull ups will be used. These tests assess the strength and endurance of the major muscle groups in the body. The sit-up test assesses the strength of the abdominal muscles of the trunk.

A pulse measurement, height and weight will be taken by trained personnel in order to determine various biochemical parameters.

2. RISKS AND DISCOMFORTS

During the 12 minute run-walk test, certain changes may occur. These changes include fainting, irregularities in heartbeat, fatigue, etc. Every effort is made to minimize these occurrences.

There is a slight possibility of pulling a muscle or spraining a ligament during the muscle fitness testing. In addition, you may experience muscle soreness 24-48 hours after testing. These risks and discomforts will also apply to your prescribed exercise programmes.

3. EXPECTED BENEFITS FROM TESTING

These tests allow us to assess your physical working capacity scientifically and to appraise your physical fitness status clinically. The results are used to prescribe a safe, sound exercise program for you. Records are kept strictly confidential unless you consent to release this information.

4. ENQUIRIES

Questions about the procedures used in the physical fitness tests are encouraged. If you have any questions or need additional information, please ask us to explain further.

5. FREEDOM OF CONSENT

Your permission to perform these tests is strictly voluntary. You are free to deny consent if you so desire.

INDEMINITY

PART 2

I, the undersigned, on my own behalf and on behalf of my heirs, executors, administrators, successors and assigns and on behalf of my dependants and next of kin, do hereby-

i) waive and release any and all claims whatsoever that I or they may have against the (Masters Student Krishnaveni Naidoo of the University of Durban Westville), whilst I am participating in the fitness test, and any activities related thereto or connected or associated therewith, including traveling to and from the destination of testing, and including but not limited to any and all medical and legal costs, fees and expenses of any such act of omission, whether reasonably incurred or not.

ii) indemnify and hold harmless the Masters student of the University of Durban Westville and its postgraduate students against any such claim that I or my heirs, executors, administrators, successors or assigns, my dependants or next of kin may institute or assert against them and any claim in respect of any costs, including legal costs, fees and expenses necessary or incidental thereto.

I have read this form carefully and fully understand the test procedures. I consent to participate in these tests.

______________________________ ______________________________

SIGNATURE OF PARTICIPANT **DATE**

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WITNESS