The Relationship Between Children's Physical Fitness and Their Development of Locomotor Co-ordination

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Thesis presented for the degree of

Masters in Sports Science

at the

University of Stellenbosch

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December 2001

Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own work and that I have not previously, in its entirety or in part, submitted it to any university for a degree.

ABSTRACT

The purpose of this study was to determine if participation in a movement programme (FITKIDZ) designed by the author produced statistically significant improvements in the physical fitness and locomotor co-ordination of four and five year old children. The study also examined the relationship between post-intervention levels of physical fitness and locomotor co-ordination.

The subjects (N = 19), who all attended pre-primary school, were tested on physical fitness components and their execution of locomotor co-ordination using both quantitative and qualitative evaluation processes. The subjects were selected from a pre-primary school that volunteered to participate in the study. Due to the structure of the school and pressure from the parents, it was not possible to have a control group. The subjects underwent an eight-week movement programme (FITKIDZ), after which they were retested.

Results showed a statistically significant improvement in abdominal strength, Body Mass Index (BMI) and flexibility (Sit-and-reach scores and trunk lifts). Qualitative results also showed a statistically significant improvement in the children's performance of locomotor skills. Correlation matrices between the physical fitness components and locomotor skills indicated that the strongest straight-line relationship existed between strength and locomotor co-ordination. The other relationships between the physical fitness components and locomotor co-ordination were not significant.

It was concluded that the performance of locomotor skills improved, as did numerous components of physical fitness of the subjects over the duration of the designed movement programme. However, it was noted that this improvement may be partially due to normal maturation of the subject group and that the results from this study would be better supported if it were possible to include a control group.

OPSOMMING

Die doel van hierdie studie was om te bepaal of daar enige statistiese beduidende verskil was in die fisieke fiksheid en lokomotor-koördinasie van vier- en vyf-jaar oue kinders wat aan 'n bewegingsprogram (FITKIDZ) deelgeneem het, wat deur die outeur ontwerp was. Die studie het ook enige beduidende verhouding tussen pre-bemiddeling en post-bemiddeling uitslae van fisieke fiksheid en lokomotor-koördinasie ondersoek.

Die toetspersone (N = 19), almal kleuterskoolkinders, was in die fisieke fiksheidskomponente en uitvoering van lokomotor-koördinasie deur beide kwalitatiewe en kwantitatiewe waardebepalingstrategieë getoets. Die toetspersone was van 'n kleuterskool wat vrywillig aan die program deelgeneem het. Aangesien daar druk van die ouers was en die skool 'n sekere struktuur volg, was dit nie moontlik om 'n kontrole-groep te hê nie. Die toetspersone was op 'n agt-week bewegingsprogram (FITKIDZ) geplaas, waarna hulle weer getoets is.

Uitslae het 'n statistiese beduidende verbetering in abdominale krag, Liggaamsgewigindeks en lenigheid (Sit-en-reik tellings en romp ekstensie) gewys. Korrelasies tussen die fisieke fiksheidskomponente en lokomotor vaardighede dui aan dat die skerkste reguitlyn verhouding tussen krag en lokomotor-koördinasie bestaan het. Die ander verhoudings tussen die fisieke fiksheidskomponente en lokomotor-koördinasie was nie betekenisvol nie.

Daar is tot die gevolgtrekking gekom dat die uitvoering van die lokomotor vaardighede verbeter het, so ook veelvuldige fiksheidskomponente van die toetspersone oor die durasie van die bewegingsprogram. Daar is egter waargeneem dat hierdie verbeteringe gedeeltelik te danke mag wees aan die normale maturasie van die toetsgroep en dat die uitslae van hierdie studie beter ondersteun sou word as daar 'n kontrole-groep was.

Dedication

To my parents.

Table of Contents

List of Figures

Page

List of Tables

Acknowledgements

I wish to acknowledge my appreciation and gratitude to the following people for their support, assistance and patience:

- Keryn Foster
- Leila Goedhals
- Dr. Bressan
- The participants of the programme
- My Creator

I would also like to thank Cape Medical for providing the equipment and time to complete the intervention programme (FITKIDZ).

Chapter One

Setting the Problem

Instead of playing outside and exploring their environment through vigorous gross motor activities, it appears that increasing numbers of young children sit for hours in front of the television, computer or play station. Lack of physical activity throughout all age groups and especially in young children, is associated with a predicted decline in general health. Reduced activity can have a negative effect on health not only in terms of decreased fitness, but also in terms of increased weight, weaker bones, lower self-esteem and all the negative results of increasing cardiovascular and related diseases (Ganley & Sherman, 2000; Grund, Dilba, Forberger, Krause, Siewers, Rieckert & Muller, 2000). Research has documented decreasing levels of fitness in American children (Blair, 1992; Corbin & Pangrazi, 1992; Kuntzleman & Reif, 1992; Morrow, 1992; Nieman, 1998; Ganley & Sherman, 2000). Concern also can be directed to the fitness levels of South African youth especially with the possibility that regular physical education periods will be phased out of the school curriculum.

If physical education is not offered as part of the school curriculum, then the next-best option is to design and implement a programme to be offered at a nominal cost. There are model programmes available for teaching children the fundamental sport skills. Yet such programmes may not be suitable for very young children. It has been noted that many young children who are not yet competent in movement skills, have to deal with the psychological discomfort of competing with well co-ordinated children at school (Silva & Ross, 1980; Krombholz, 1997; Rose, Larkin & Berger, 1998). The child who is not physically fit may experience similar discomfort. It can be concluded that when dealing with pre-school children, a sound movement development programme should provide opportunities for the development of both perceptual-motor skills and physical fitness.

In looking for a starting point from which to design a movement programme that would address concerns of perceptual-motor development and physical fitness, it is important to establish a holistic approach. The activities included in the programme must be presented in a progressive fashion and require the children's active physical participation. Only if both these criteria are met can the programme claim improvements in gross perceptual- motor co-ordination and physical fitness as targeted outcomes.

Significance of the Study

The acquisition of fundamental motor skills is basic to motor development (Matney, 1999; Reeves, Broeder, Kennedy-Honeycutt, East & Matney, 1999). Children's motor development is related to their cognitive development. Magill (1988) highlighted Piaget's position that the intellectualising process was strongly influenced by the acquisition of movement capabilities. Piaget described the process as going through *assimilation* and *accommodation*, where assimilation involved the child trying to interpret the new experience, and accommodation involved the child trying to adjust all this new information into new thought processes. Clark and Whitall (1989) contended that if young children need to become cognitively aware of their own motor development, they will experience feelings of growing competence in movement.

Participation in vigorous physical activities is also beneficial to children's development (Rowland, 1990; Corbin & Pangrazi, 1992; Kuntzleman & Reiff, 1992). This is why exercise in a safe environment is recommended as an integral part of children's daily routine (ACSM Guidelines, 1995). In addition to the safety of the physical environment, there are a number of factors that must be considered when implementing a programme for children. For example, children have relative difficulty adapting to thermal stress. Children are more likely to suffer from insufficient thermoregulation than are adults. This is why children are encouraged to drink fluids whenever they are thirsty, rather than wait for scheduled "water breaks." Other factors are related to skeletal maturity. Children may be more prone to overuse injuries and damage to epiphyseal growth plates if weight bearing and/or endurance exercise is excessive.

Physical activity or exercise is well accepted as an effective medium for maintaining a healthy amount of body fat (Freedson & Rowland, 1992; www.mbmc.org). Parizkova's (Parizkova & Adamec, 1980) longitudinal studies showed that young children between the ages of three to six years who were participants in a regular exercise programme, had less subcutaneous fat than their peers who were sedentary. Many researchers believe that an active childhood provides the basis for a lifetime of fitness (Rowland, 1990; Reeves et al., 1999; Ganley & Sherman, 2000). As children's fitness levels improve, their risk for disease diminishes (Koch, Galioto, Vaccaro & Buckenmeyer, 1988; Kuntzleman & Reiff, 1992).

The positive relationship between the acquisition of skills and physical fitness is well documented. Motor development provides the base for acquiring motor control (www.center4success.com). The emerging ability to control movement supports the efficient use of energy and enables the young child to improve current performance and create new movement patterns. Without a continuous improvement in movement patterns, the child will be attracted to participate in more physical activities, which makes it more likely that he/she will be able to obtain and maintain a healthy level of fitness.

Reduced motor activity is a common characteristic among children classified in the overweight and obese population. Inactivity initially promotes obesity and that leads to a sedentary lifestyle. Inactivity is also associated with low levels of skilfulness. Logan, Reilly, Grant and Paton (2000) and Long (www.mbmc.org) ascertained that obesity often has its roots in the lifestyles of very young children, and that decreases in the amount of physical activity in the early years contributes to childhood obesity and the development of related diseases.

The importance of providing young children with movement programmes where they can be active and have fun mastering skills is clear. Not only will such programmes benefit their motor and cognitive development, but they will also make a contribution to their health in both the present and the future. The pre-school years have been identified as the optimal period for involving children in the systematic learning of co-ordination exercises (such as gymnastics), provided their nervous systems are mature enough to ensure successful gross motor learning (Borms, 1986). The significance of this research is its contribution to the literature on movement programmes for pre-school children that include a definite physical fitness component. The movement programme designed for this study may be useful in many situations for the following reasons:

- It requires very little equipment. That which is required can be adapted according to availability of equipment within the school.
- Very little space is required. One small open area or classroom is sufficient.
- It encourages movement exploration and enjoyment for each child.

- It provides opportunities to experience proprioceptive and kinaesthetic feedback through movement, which is critical for stimulating motor development.
- It provides a basis for children's education about movement, movement safety, fitness, health and social interaction.

Statement of the Problem

The purpose of this study was to determine whether or not a specifically designed movement skill and fitness programme could make a significant improvement in the fundamental locomotor skills and the health-related fitness of four and five year-old children. A secondary focus was to determine if there was a correlation between improvement in these children's fitness and improvement in their performance of locomotor skills.

The study included the use of the movement programme (FITKIDZ) as the intervention programme and was designed by the author of this study. It included aspects of fitness and perceptual motor development that could be incorporated into the every-day schooling of pre-primary school children. In order to determine the affect of the programme, the children who participated in the study were pre-tested and post-tested on measures of locomotor skill and physical fitness.

Research Questions

The following research questions guided this study:

1. Did the four and five year olds who participated in the FITKIDZ movement programme demonstrate an improvement in each of the fitness components: cardio-respiratory, strength, body composition and flexibility?
2. Did the four and five year old children who participated in the FITKIDZ programme demonstrate an improvement in their performance of locomotor skills?
3. Was there a relationship between the improvements in fitness components and improvements in the locomotor skills of the children who participated in the FITKIDZ programme?

Limitations

The following limitations must be acknowledged when considering the results of this study:

1. The programme for developing fitness and gross motor control was presented by the author and an assistant who both have a background in teaching movement to young children. The results of this study may not be generalisable to teachers.

2. The subjects were all aged four or five. The type of activities included in the programme may not be appropriate for children of different age groups.

3. The length of an activity session was 20 minutes. Longer sessions might produce different results.

4. The children who participated in this study were not accustomed to movement education or physical education instruction. This made participation in the various sessions inconsistent, in part due to children's problems with self-control/self-discipline, and control of attention. A longer programme may have produced different results.

5. Because of equipment shortages and space limitations, it was possible only to provide regular instruction and practice for the development of locomotor skills. It would have been preferable to include manipulative skills in a programme of this type. A more comprehensive programme might have yielded different results.

6. Due to time constraints available for working with the children, it was only possible to execute the test for the aerobic component of fitness (Modified Hoosier) in the third week of the programme. This may also have affected the outcome of the post-test result of the cardio-respiratory component, since it meant that there were only five weeks of the intervention programme between the pre- and post-test.

7. Due to the structure of the school and pressure from parents, it was not possible to include a control group in the study. It is noted that this may affect the reliability of the study. It is also acknowledged that children aged four and five will improve in their gross motor development if they are developing normally.

Definitions

The following definitions describe specific terminology that has been used in this study:

Motor Development

When used with terms such as *development, motor* refers to movement. *Motor development* thus refers to the changes that occur in motor behaviour throughout a lifespan and the processes that aid or bring about these changes (Clark & Whitall, 1989; Haywood, 1993).

Perceptual Motor Development

Perceptual-motor development refers to what a child learns by moving, incorporating information the senses of touch, hearing, vision, proprioception and the vestibular sense. It is the process of change in the nervous system that affects how the child gathers information through the senses, organises and interprets that information, then produces a movement response (www.center4success).

Summary

The importance of a holistic approach to development should be considered in order to promote a healthy community. In terms of young children, their educational programme should ensure that they develop both their fitness and their locomotor skills. Integrated movement/fitness programmes do not have to be expensive, but they do have to be well organised and presented, and they do require the regular participation of the children. There may be many new and exciting options to pursue in early childhood education, but that should not mean a de-emphasis on the developmental "basics" related to integrated motor, cognitive and physical development. As Borms (1986) summarised:

> Children grow up only once. How they grow depends on what we, the adults, do now. There is no second chance. They cannot vote but they do count (p.14).

Chapter Two

Review of Literature

Mastering the gross motor co-ordination of fundamental skills plays an important role in motor development. This learning process requires practice. Health-related physical fitness is possible to achieve through regular participation in physically vigorous movement activities. The physical participation required to develop skill requires a level of fitness. Although fitness can be developed through participating in very repetitive and simple movements, skill learning creates opportunities for participation in a wide variety of fitness development activities. A complimentary relationship between the development of skilfulness and the development of fitness occurs naturally when children participate in physically challenging practice sessions. Because it is an optimal relationship in children's motor development programmes, the contents of this chapter reviews present literature with the emphasis on the basics underlying physical fitness and gross locomotor co-ordination and development.

Physical Fitness

Physical fitness is a multi-faceted concept comprised of various components. Each of the components has its own distinct characteristics, which is why a person who is "fit" in terms of one component may not be "fit" in terms of another component. Fitness can be highly specific to certain parts of the body, or to certain sports. Haywood (1993) identified four components of physical fitness that are generally accepted as essential to basic health. They are usually referred to as the components of health-related fitness:

- Body composition.
- Flexibility.
- Cardio-respiratory endurance.
- Strength.

It is noted that researchers often consider there to be additional components of fitness, such as agility and power, but for the purpose of this study we will concentrate on the factors as highlighted by Haywood (1993).

Body Composition

Not all authors agree that body composition is a component of fitness. This is because when measuring body composition, the child must be still rather than moving/active. However, because body composition provides important information about the child's ability to perform physical activities, it is usually included as a component of physical fitness (Gutin, Manos & Strong, 1992).

The body can be divided into two types of tissue – lean body mass (LBM) and fat. LBM includes muscle tissue, bones and organ tissue. Fat consists of adipose tissue. The measurement of these two tissue types is the measurement of body composition (Maud & Foster, 1995; Badenhorst, 2001). When comparing the two, it is important that the fat percentage is not too high. As soon as the fat percentage gets too high the child's health is "at-risk" due to obesity. As Ganley and Sherman (2000) explained, obesity can be very detrimental to a child's health. For both children and adults obesity can be the basis for various chronic diseases. The pre-school years are considered to be a "critical period" in terms of the future development of obesity (Logan et al. 2000).

Lohman (1992) emphasised that children are not "small adults". They are "chemically different" than adults and thus any estimation of their fat percentage using adult equations will tend to over estimate their fat percentage. To overcome this problem, Slaughter, Lohman, Boileau, Horswill, Stillman, Van Loan and Bemben (1988) devised an equation using the sum of the right-side tricep and calf skin folds. The sum of these skin folds are then converted into fat percentages using the following equations for children with a sum of $\leq$ 35mm:

$$\text{Boys' Percent body fat} = 0.735\ (\Sigma \text{ skin folds}) + 1.0$$

$$\text{Girls' Percent body fat} = 0.610\ (\Sigma \text{ skin folds}) + 5.0$$

There are many factors that can influence body composition. Examples of these factors identified by Rowland (1996) are race, culture and habitual activity. When making gender comparisons, Rowland (1996) stated that at a young age, boys and girls have similar body composition, but after the age of approximately 3-4 years, there seems to be an increase in the female fat percentage that continues to be greater than males throughout life. This change is partly accounted for by Heyward and Stolarczyk (1996) who explained that as the child develops, there is a change in the density of LBM. This results in a decrease in body water content and an increase in bone minerals during growth and development, the changes naturally occurring to prepare the separate sexes for puberty.

Body Mass Index (BMI) is another way to scrutinise body composition. It compares weight (in kilograms), to height (in metres) squared.

$$\text{BMI} = \text{weight (kg)/ height}^2\ (\text{m}^2)$$

Maud and Foster (1995) mentioned that there might be an area of concern when using BMI since it lacks the ability to compare the leanness-fatness component. Thus it is important to use both methods of comparing body composition in order to assess a healthy body composition.

Flexibility

Flexibility is a controversial topic especially when it comes to children. Borms (1986) remarked that it is commonly believed that young children are very flexible, and that they gradually lose this flexibility as they grow older. This belief had contributed to the line of thought that there is very little need for flexibility development at a pre-school age because of the natural tendency for children to play using their "natural flexibility" (www.gambetta.com). However, there are questions about the physical demands of the play activities of the "modern child". To avoid problems associated with inactivity, Long (www.mbmc.org) suggests that physically challenging activities for children must be made appealing so that they are able to reap the benefits of participation. It has been documented that decreased flexibility characterises the ageing process. A temporary loss of flexibility may occur, for example, during growth when the bones increase in length thus stimulating muscle development (Haywood, 1993).

Traditionally, flexibility is defined as the range of motion available at a specific joint and depends very much on the anatomical structure of the joint (Haywood, 1993). Gambetta (www.gambetta.com) added that it is essential to remember that flexibility has both an anatomical quality and a physical ability. Anatomically, the shape of the joint determines how much flexibility is possible. Physically, there is the current ability to execute a movement through a specific range or amplitude.

The sit-and-reach test is a static test used to assess the flexibility of the spine and hamstring muscles. Cornbleet and Woolsey (1996) found that this test was useful in measuring flexibility in young children, but emphasised the proper execution of the test.

Cardio-respiratory Endurance

There are two types of physiological responses to exercise. One mechanism responds to short bursts of energy and the other to long-term energy expenditure. If the body is put under strenuous demands to perform briefly, the body will respond by depleting available stores of oxygen and phosphate compounds. In addition to using glycogen stores, these responses result in a build up of lactic acid. This, in turn, causes an oxygen deficit that must be replenished. This system thus operates without oxygen and is termed *anaerobic*. Further exercising demands will require more energy stores. With the completion of anaerobic sources, the body will compensate by depending on the respiratory and circulatory systems to supply oxygen to the working muscles. This is termed *aerobic performance*. Energy needs lasting less than 10 seconds are anaerobic. Those lasting approximately 90 seconds are equally aided by the anaerobic and aerobic systems. After three minutes it is the aerobic system that supplies the body with its needs. Cardio-respiratory endurance is aerobic endurance. (Powers & Howley, 1997)

Cardio-respiratory endurance is the ability to perform large muscle, dynamic activities at moderate-to-high intensity for sustained periods (ACSM Guidelines, 1995). In order to achieve a healthy level of cardiovascular endurance, the respiratory, cardiovascular and skeletal muscle systems must be in functional order (ACSM Guidelines, 1995). In the child of age four to five years, these systems are not completely mature. This explains why young children are not capable of maintaining moderate-to-high intensity exercise for prolonged periods of time.

The accepted method of measuring cardio-respiratory endurance is through VO_2 max. VO_2 max is defined as the maximal amount of oxygen uptake in the exercising muscles. There is a correlation between the VO_2 max and the relative cardiovascular function. Thus, the greater the VO_2 max value, the greater the cardiovascular fitness (Rowland, 1990).

Studies have shown that there are quite a few differences between the VO_2 max values in children and adults. This may be due to the immature body systems in the child. It also has been suggested that the wide variations in the body composition of children may also lead to misleading VO_2 max values. In other words, it may be the manner in which VO_2 max is expressed that may lead to the confusion (VO_2 max/kg) (Rowland, 1990).

What is clear is that maximal oxygen uptake increases as children age, and this is mostly due to the to the development of the VO_2 –dependant organs, namely: the heart, lungs, blood volume and skeletal muscle. There is not much difference between the mean values of VO_2 max among young children, although the values for boys tend to consistently be greater than those for girls (Rowland, 1996). Nieman (1998) cited research that supported an increase in children' s aerobic fitness after training, but that this increase was less than that achieved by adults receiving training. Borms (1986) agreed with these findings. Above all the components of fitness, cardio-respiratory endurance has been identified as the one that can have the greatest impact on adult health. This development begins in the young child and is very important for health throughout the life cycle (Ganley & Sherman, 2000).

Strength

Strength can be defined as the "ability to exert muscular force against resistance" (Webb, 1990: 1187). Muscles contract differently in order to allow the body to work appropriately by exerting this force against a resistance. Kraemer and Fleck (1993) stated that strength training for children is frequently misunderstood, resulting in a fear of the unknown and possible injuries. There is often a concern that children executing eccentric movements may harm muscle tendons because tension in the muscle tendon units increases as the muscle lengthens. However, eccentric and concentric contractions are part of many of the movements children perform when running, jumping and throwing a ball (Webb, 1990). Concern seems to be focussed on the use of artificial weights, such as dumbbells, medicine balls, etc. It is recommended that ballistic movements should be avoided until the skeletal system has matured and children should refrain from attempting to lift maximum weights as this may lead to severe injury (Ganley & Sherman, 2000).

The American College of Sport Medicine guidelines (1995) stated that children can safely participate in a resistance-training programme if it is correctly structured. Current evidence indicates that if a resistance programme is closely supervised and includes a basis of concentric muscle actions including high repetitions and a relatively low resistance, then the exercise will improve the child's muscle strength (Rowland, 1990). In fact, it will have no adverse effects on the development of the connective tissue, muscle or bones of the growing child. Ganley and Sherman (2000) stated that proper body awareness and training are imperative for safe and healthy development in children. They explained that initially it was not certain if children could actually improve their muscular strength through training. This was because early studies done by Vrigens (in Kraemer & Fleck, 1993) reflected no significant gains in strength in children who completed a resistance-training programme. These failures have been blamed on ineffective programmes and testing regimes.

Recent studies have shown that it is possible to improve strength in children, even in prepubescent youth (Committee on Sports Medicine, 1990). How is this possible? Evidence points towards the influence of the nervous system. It is believed that strength gains in the prepubescent child are probably primarily the result of enhanced neuromuscular activation (motor learning) rather than hypertrophy (muscular adaptation) (Borms, 1986; Webb, 1990; Kraemer and Fleck, 1993). It is thought that the improvements in nerve and muscle cell co-ordination are manifested as strength improvements (Borms, 1986; Nieman, 1998). Researchers make it clear that even though muscle size will not increase dramatically, or at all, in prepubescent children, there is still much to be gained from strength training. Strength training improves and enhances muscular function, which in turn improves physical fitness (Borms, 1986; Webb, 1990; Kraemer & Fleck, 1993; Katzmarzk, Malina & Beunen, 1997).

Physical Fitness Testing

The value of testing physical fitness is that it allows teachers or parents to monitor children's progress and thus determine which aspects of fitness needs to be focused upon in order to improve their overall health-related fitness. Physical fitness testing also acts as a means of motivation for some children and encourages them to become more fit (Safrit, 1995). Health-related fitness tests for children initially were developed in the 1950's, and later revised in the 1970's, e.g. the AAHPER Youth Fitness Test. These tests were not only based on health related fitness, but also athletic fitness. The current trend in general fitness testing has become more focused on health-related components of fitness (Corbin & Pangrazi, 1992). Interpretation of scores has also changed. Children were originally compared to norm-referenced standards, but now criterion-referenced standards are used that compare children's scores to optimal levels of health (Corbin & Pangrazi, 1992; Morrow, Jackson, Disch, & Mood, 1995).

According to Safrit (1995), there are many fitness batteries currently available including:

- AAHPERD Physical Best Program.
- Chrysler Fund/AAU Physical Fitness Program.
- Prudential FITNESSGRAM.
- President's Challenge Physical Fitness Program.
- YMCA Youth Fitness Test.
- National Youth Physical Fitness Program.

Many fitness tests done on young children show that the results obtained in the studies can be influenced by biological, social, and physiological factors (Lehnhard, Lehnhard, Butterfield, Beckwith & Marion, 1992). Freedson and Thomas (1992) mentioned their concern for the general failure of fitness tests to consider the maturational age of the child rather than the chronological age.

When examining the test items and procedures that these fitness tests are trying to analyse, it appears that very little is known about testing children younger than the age of five years old. The Prudential FITNESSGRAM (Institute for Aerobics Research in Safrit, 1995) is a fitness test that is designed to test fitness levels in the ages from five years to 17 years of age and above. Blair (1992), in his studies of American children and their fitness levels, stated that the use of the FITNESSGRAM was a reasonable tool for assessing fitness levels. This specific test battery considers aerobic capacity, body composition, and muscle strength, endurance, and flexibility to be the components of physical fitness (see Table 1).

Table 1.

Test battery for the Prudential FITNESSGRAM (Safrit, 1995).

Item	**Component of fitness**
One mile walk/run	Aerobic fitness
The PACER	Aerobic fitness
Curl-ups	Abdominal strength
90-degree push-ups	Upper-body strength
Pull-ups	Upper-body strength
Flexed arm hang	Upper-body strength
Modified pull-ups	Upper-body strength
Trunk lift	Trunk extensor strength & flexibility
Back saver sit-and-reach	Flexibility
Shoulder stretch	Flexibility
Skinfold measurements	Body composition
Body Mass Index	Body composition

For the purpose of this study, the Prudential FITNESSGRAM was selected as the basis for designing the physical fitness testing protocol because it allows for modification of the test battery according to the needs and requirements of a specific group. The support material also encourages customising the test battery to the needs of the group to be tested.

The Improvement of Gross Motor Skills

Helping children improve their fundamental movement skills is the best way to support their efforts to specialise in a particular sport when they get older (www.gambetta.com). The development of gross motor co-ordination depends largely on participation in physical activity (ici2.umn.edu/ceed (b)) and a broad experience of movement (Ledebt, Bril, & Breniere, 1998). Although movement can be used simply to rid active children of excess energy by "letting off steam", Wade (ici2.umn.edu/ceed (b)) believed it was better to channel this energy into activities that would promote both cognitive and physical development. Gross motor skill development programmes can fulfil this purpose by helping children become more both more skilful and more physically fit.

Motor Skill Development

Developmentalists contend that there is a predictable sequence of developmental steps or stages through which a child will progress, although the rate of development will vary tremendously from child to child (Haywood, 1993). This developmental sequence is reflected in a hierarchy of the development of motor skills (ici2.umn.edu/ceed (a)). The reflexes and reactions present at birth, for example, provide a base from which the young child learns to differentiate between the actions of completing a specific task effectively and efficiently. By the time children begin to ambulate, they have developed reflexes and have been able to move about in rudimentary ways.

From the later infancy up to and including the ages of six/seven, children progressively acquire the fundamental skills of movement. It has been noted that between the ages of 2.5 and 5.5 years, normal children's development follows similar and orderly sequences. These sequences are referred to as intraskill sequences, and they lead up to the formation of fundamental skills. The "whole body" or gross motor skills of object manipulation, e.g. throwing, catching, and locomotion are referred to as fundamental skills because they are the foundation of the subsequent learning of more specific motor skills (Ulrich, 1987).

Ulrich (1987) described motor skill development as a hierarchy (see Figure 1).

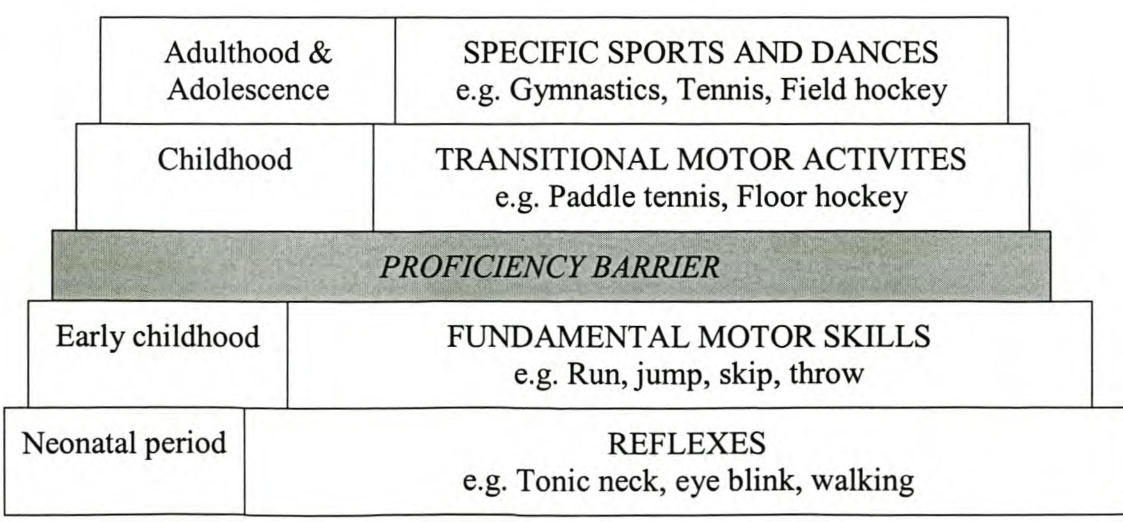

Figure 1.

Sequential acquisition of motor skills (adapted from Ulrich, 1987: 168)

The rate at which these gross motor skills develop depends on how each child matures with regards to his/her body size and physical growth, strength relative to body mass and the level of maturity of the nervous system (ici2.umn.edu/ceed (a)). It is for this reason that Silva and Ross (1980) concluded through their study of gross motor development and delays in development in early childhood (ages three to six years) that not too much emphasis should be put the rate of gross motor development at this young age. However, by age 6, most children should be capable of performing these skills and they should be ready to improve their base of movement by progressing on to the transitional skills that enable them to play traditionally popular games (Cratty, 1979; Ulrich, 1987).

Locomotor skills are those "travelling" skills that allow the body to move through space, changing location in the environment. Haywood (1993) identified seven fundamental locomotor skills:

- Walking.
- Running.
- Jumping.
- Hopping.
- Galloping.
- Sliding.
- Skipping.

The developmental sequences that characterise these skills are described in Appendix A. Locomotor skills were selected as the focus of this study because young children generally are able to acquire these skills earlier in their development than they are able to acquire the manipulative skills.

Motor Skill Learning

Seefeldt (1988) considered *readiness* an important factor in child motor skill learning. Readiness implies that a child is particularly receptive to learning to acquire more information; skills or values and these are mostly determined by tradition. Seefeldt (1988) stated that the basic diagonal patterns of movement form the basis of all subsequent movement learning. Once a child reaches the stage of maturation where he/she can control these patterns, new skills are possible through varying these patterns in temporal-spatial relationships. This is the concept of readiness. When a child's nervous system matures past a certain stage, he/she may suddenly be able to perform a more complicated movement resulting from the formation of larger and more complex co-ordinated units of action (ici2.umn.edu/ceed (a)).

Magill (1988) also examined readiness in terms of critical periods in motor skill learning. He used the framework of McGraw's study of the twins in 1935. McGraw is acknowledged as being the first person to identify the phenomenon of critical periods in early childhood. It was her study of the twins Jimmy and Johnny that gave the study of motor development a new perspective. She pointed out that for certain skills such as cycling and walking, practice at an early age was not beneficial to learning/retention. This led to the conclusion that there are different critical periods for the learning of various activities, and that providing practice opportunities before those periods occur, will not accelerate the learning process. Magill defined critical periods for learning in the following way:

1. The child must have reached maturation of the neuro-muscular mechanisms.
2. The child must be able to adapt to the demands of the environment and should be able to intellectualise that adjustment.

There are other factors that determine whether or not a child is optimally ready to learn a new skill. These factors include the motivation of the child to learn the new skill, prior experiences of the child in relation to those of the skill being learned, and the maturational level of the child. It is important to note that chronological age does not equal maturational age (Magill, 1988).

Perceptual Development

The improvement in children's motor skill performance is also related to their perceptual development. According to Haywood (1993), perception is the capacity to understand and interpret objects and events. Perception includes the selection, processing, organisation, and integration of sensory information. As children learn to organise, select, process and integrate new perceptual information together with previous experiences, their motor skill performance often will improve (Haywood, 1993).

A child's perceptual processes differ from adult processes. This is one reason why children's movements are less fluid than those of adults (Thomas, 2000). The visual, auditory and kinaesthetic senses, for example, develop at a rapid rate up to five to six years of age, after which the rate of development is much slower until full maturation is reached (Assaiante, 1998). As sensory capabilities improve, accuracy and speed in perceptual judgements increase. For example, as a child's vision improves, the ability to estimate distance improves and anticipation becomes less variable and more accurate (Bressan, 1998). The ability to anticipate is an important factor in improving skill in many performance contexts.

Haywood (1993) and Collier (2000) provide an overview of some of the key areas in which perception affects motor skill learning:

- As visual perception develops, children learn to match visual shapes with movement. They learn to distinguish between a moving object and its background. Providing the child with a solid coloured ball and background, for example initially encourages this process, progressing onto a more complex background to improve their figure-and-ground perception. Refining their distance and depth perception entails improving the child's ability to recognise forms and shapes regardless of their orientation, size, colour, etc. Judgements about space also rely on visual stimuli. This can be encouraged by presenting the child with visual-kinaesthetic tasks such as providing the child with a space and asking them to climb through it.

- Improvements in kinaesthetic perception enable the development of body awareness and the relationships among body parts. Body awareness is crucial to defining a left and a right side of the body. Exercises such as hopping aid this improvement of awareness. The ability to cross the midline when performing tasks also forms an integral part of body awareness (Screws, Eason & Surburg, 1998). Many tasks include movements on both sides of the body (skipping) and can effectively be included in a movement programme. Effort must also be made not to exclude up-down and back-front movements as these complete the range of movement for activities developing spatial dimensions.

- Connected to laterality is directionality, the body's ability to project itself into the spatial dimensions of a surrounding space. Often children need assistance in developing this aspect and can be aided by cues or instructions. Giving young children an appropriate label of sorts to remind them of their left and right will also aid this development.
- Regarding lateral dominance, it is usually accepted to allow the child to first learn a skill by using their dominant side after which they are encouraged to use their less dominant side to execute the movement (Iteya, Gabbard & Hart, 1995).
- Improvements in tactile discrimination contribute to body awareness by allowing children to differentiate between varied surfaces and multiple touches. It is essential to provide the young child with as much variation in tactile information as possible to enhance this area of development.
- Improvements in auditory perception help to encourage the differentiation and identification of sounds and improve the awareness of sound location.
- As balance control (vestibular perception) develops, locomotion improves.

Attention

The amount of attention a child can access is finite. This means that when the information load is too great, some information simply will not be processed. Information load is the interaction between the complexity of the information and how quickly it must be processed. Children cannot handle as great an information load as adults can. However, if the complexity of the information and the demands for speed in processing are not too great, children can operate as well as adults (Bressan, 1998). Manipulating information load to optimal levels is one way of supporting the learning of motor skills.

Information load is not the only limiting factor on children's processing. The young child has immature scanning strategies and his/her focus of attention may shift unpredictably from over-inclusive to selective attention. This is why children are more easily distracted. Difficulty in controlling attention also affects their recall. At this young age they have still not learnt to use task relevant cues on which to focus their attention (Bressan, 1998; Thomas, 2000). The filtering process in young children seems less capable of identifying and attending to relevant visual stimuli. Studies show that five and six year old children displayed difficulty in focusing on only relevant visual stimuli and shared their focus with that of the non-relevant stimuli. This effect, however, diminished as the children got older. Another consideration was auditory stimulation. It was found that children up to the age of 12 years disregarded relevant visual stimulation if supplied with auditory cues (Haywood, 1993).

When designing any fitness or movement education programme for children, it must be remembered that children of four and five years old often find it difficult to maintain their concentration on one specific activity for longer than a few minutes. This is in part because they have difficulty in accommodating large amounts of information in their memory processes (Bressan, 1998). To ensure that they remain interested in the activities provided, it is important to provide them with stimulating and exciting new activities. At this age it is possible to include the imagination into playing in order to make the exercises fun. Emphasis should be made on making learning something that the children enjoy.

Memory Processes

How a child processes information determines whether or not the information is stored or lost. The processing of information during motor skill learning opportunities can be influenced by many factors, including the type of skill (discrete or continuous) and the meaningfulness of the movement situation (Magill, 1989). Continuous tasks are repetitive, more over-learned and more meaningful when compared to discrete skills that have many components that can be interfered with, resulting in forgetfulness (Sage, 1984). Locomotor skills, for example, tend to be continuous, therefore “easier” to learn/retain in the memory.

Children’s memory processes appear to differ from adult processes. There are several characteristics of children’s memory processes that need to be taken into account when implementing programmes:

- When encoding (storing information in the memory), younger children do not label movements (give them a name/word or associate them with an image). This can make recall of the information difficult because the memory is biased toward concepts or symbols. Younger children may not be able to "find" something in their memories because it has not been stored in a "user-friendly" system. Older children may use visual images, whereas adults use verbal symbols to encode information into the memory, making the process more efficient. Poor quality encoding can result in a slower retrieval of information from the long-term memory (LTM) or a situation where only part of the information needed was retrieved (Thomas, 2000). This is why teachers of young children try to encourage improved memory storage by using words and images consistently, as well as by asking children to describe or draw what the skills they are trying to learn.

- Children do not use mental rehearsal the way that adults do, which also affects the quality of their memory. Young children only think about the end point of a movement, whereas adults think about the endpoint of a movement pattern, then recall/rehearse the movement sequence that leads up to that endpoint. Verbal rehearsal in children under the age of five years does not work effectively as a learning tool since the young child does not realise that this verbal repetition is a form of recalling the desired task. However, instructors are able to encourage correct movement by using verbal cues such as "jump" (Haywood, 1993). Children can be helped to improve their movement memory by being taught rehearsal strategies, such as visualisation at a slightly older age (Thomas, 2000). By the age of 11, children who have learned to label and rehearse information in some movement situations will be able to transfer these memory strategies to learning or performing in new situations (Haywood, 1993).

- Children also appear to have difficulty organising information so that it relates to other relevant information stored in the memory. This is known as *grouping* and *recoding* information. *Grouping* is the term used to chunk information together in the LTM for storage. Adults use certain characteristics to group new movements together into meaningful combinations, but children attempt to remember each individual movement by itself. This makes it difficult for children to mix and match movements and movement combinations since they do not easily experience the relationships among them (Bressan, 1998). However, studies showed that children older than seven years of age, when taught how to use adult grouping strategies, improved their performance (Haywood, 1993). *Recoding* is the term used when two individual pieces of information already stored separately in the LTM are combined into related information. When children do recode/combine things in their memory, they tend to so by colour, size, or some other physical characteristic. When adults recode, they can combine based on more abstract qualities, such as purpose or intention. The movement education approach, which encourages children to think about their movement in terms of space, effort and relationships, is designed to encourage children to use more adult-like strategies for storing movement information in their LTM (Bressan, 1998).

It is clear from the above-mentioned information that the ineffective use of control processes plays a large part in many performance deficits found in young children's movements. Another aspect that needs to be considered is the lack of sufficient knowledge. Studies have shown that children with larger amounts of task-related knowledge can perform as well or better than adults with less knowledge of the same situation (Thomas, French, Thomas & Gallager, 1988).

Three types of knowledge are defined by Chi (1981 in Haywood, 1993):

- Declarative knowledge which is knowledge of factual information,
- Procedural knowledge is knowledge of how to do something according to specific rules, and
- Strategic knowledge is knowledge of general rules or strategies that apply to numerous topics.

In many ways, young children can be compared to novices because they lack knowledge of movement. Both declarative and procedural knowledge are specific to a certain topic and are often lacking in the young child. Strategic knowledge develops last and requires experience from numerous movements to allow children to generalise across many topics (Thomas et al. 1988).

Motor Programmes and Feedback

Children show more variability and less consistency than adults in motor performance. This can be attributed not only to the quality of their perception and memory processes, but also the quantity of the content in their long-term memory (LTM). They simply have less experience of movement information stored in their LTM. The more experience children have, the more opportunity they have to improve both the quality and quantity of their LTM (Clifton, 1985; Ledebt et al. 1998). It is possible to use Schmidt's schema theory to explain the relationship between memory and motor skill performance (Magill, 1989).

Motor development depends greatly on feedback in order to make continuous corrections to achieve the desired movement execution. There are different theories that attempt to explain the processes involved. One such theory is the closed-loop theory that has undergone much scrutiny. A closed-loop theory including feedback, error detection and correction was proposed by Adams (in Schmidt & Lee, 1999). However, this theory did not allow any explanation for open-loop correction of movements and thus Schmidt expanded upon this theory.

Schmidt's theory is known as the Schema Theory and has a strong open-loop dependency (Schmidt & Lee, 1999). An open-loop system is a control system with pre-programmed instructions to an effector. Performance is not dependent upon feedback information and error-detection processes. Schema theory identifies two states of memory. Within this model, "recall memory" is responsible for the production of movement and the "recognition memory" is responsible for movement evaluation. Recall memory provides established information for rapid movements whereas the recognition memory provides information about the executed movement after completion. Recall memory is thus informative in terms of enlightening the mover of errors in execution (Schmidt & Lee, 1999).

According to Schmidt (in Kelso & Norman, 1978), the schema is based on information regarding four types of movement in a stored relationship. This information includes the initial conditions, the response parameters for the motor programme, sensory consequences of the movement and the outcome of the movement. With movement experience, then, the child is able to abstract the relationship between the information received to construct a schema. It is interesting to note that it is this abstraction of information that is stored and not the individual sources of information input.

Schmidt (Schmidt & Lee, 1999) described a generalised motor programme as a kind of memory structure for a movement that identifies the invariant characteristics for performance. Associated with the general programme is the recall schema, a memory structure which provides detail and conditions that are applied to the generalised programme. A beginner learns a generalised programme with a very specific recall schema. The recall schema expands with practice, which means the programme can be applied successfully in a variety of contexts. This explains why children can perform in simple and familiar contexts, but appear to "lose" their skilfulness in complicated and unfamiliar contexts. They may not have had the opportunity to develop a flexible recall schema to support variety in performance. In order to broaden their experience base of movement, children should be exposed to the most applicable forms of stimuli that will result in an improvement of the full range of their perceptual motor skills (Haywood, 1993). Studies done by Williams and Werner (1985) support the importance of relevant forms of stimuli by showing that the amount of practice done in order to develop a movement schema involved in gross motor skills may be just as important as the type of practice done.

Newell and Kennedy (1978) stated that: "perhaps the single most important variable governing the learning of motor skills is knowledge of results (KR)" (p. 531). Knowledge of results is the feedback given to the mover informing them of whether or not they selected the correct motor programme and schema to execute the movement. In their study, Newell and Kennedy (1978) found that the more specific the KR was, the faster the rate of learning. Thomas (2000) discovered that young children make use of general KR to improve motor performance. However, it is the older children that benefit more from precise KR. Younger children also appear to benefit if there is a delay between when a performance ends and when KR is given. Sage (1984) mentioned that learners can also benefit by receiving feedback about the quality of their execution of the movement i.e. knowledge of performance (KP).

Feedback naturally occurs as part of any movement performance, even if there is no coach or teacher to provide information. In Corbetta and Vereijken's (1999) approach to instruction, they emphasise participation in varied and novel environments. Children are encouraged to discover new movements in familiar environments as well as discover new ways of moving under circumstances that are new and challenging. In this way, children interpret the intrinsic feedback from their performance to learn new skills as well as how to adapt previously acquired skills.

Feedback is collected through the senses and after being perceived, it must either be recognised or interpreted. This processing demands time. If the movement being executed is slow enough, it is possible to use a closed loop feedback control system. However, quick movements would require the use of open loop feedback thus allowing the following movement performance to be modified (Bressan, 1995).

Guidelines for Teaching Children

The following are some practical implications when working with young children (Bressan, 1998):

- Young children require more time to process information. It helps to provide few new movements to allow experimentation and adaptation.
- Immature performers have not yet formed the perceptual sensitivity of mature movers. Limiting the amount of information that needs to be remembered and providing cues is recommended.
- Progressing from closed skills to open skills also encourages effective and efficient development. This progression is illustrated in Figure 2.

Closed skill
↓
Stationary closed skill with no change in environment
↓
Moving closed skill with no change in environment
↓
Stationary closed skill with changes in environment
↓
Moving closed skill with changes in environment
↓
Open skills

Figure 2.

Description of progression in skill development from closed skills to open skills

Recent research on children's physical activity has given rise to characteristic guidelines that differentiate children from adults (Welk, Corbin & Dale, 2000). The characteristics identified by the Council for Physical Education for Children (in Welk et al. 2000) are presented in Table 2.

Table 2.

Characteristics that differentiate children from adults in physical activity

Type	Characteristic	Implication
Biological	Need for high level of central nervous system arousal	• High volume of physical activity is typical • Low tolerance for total inactivity • Spontaneous activity is common
Cognitive Functioning	More concrete (less abstract) thought process Less developed cognition	• Relatively short attention span on any given task • Less interest in continuous activity • Failure to see long-term benefits of activity (e.g. health benefits) • Less accurate recall • Inability to accurately estimate time
Physiological	Limited tolerance for vigorous activity Weak relationship between cardiovascular physical fitness and physical activity	• Activity typically intermittent in nature • Effort (active behaviour) does not necessarily result in increases in cardiovascular fitness thus positive feedback for active behaviour is lacking
Biomechanical	Poorer economy and efficiency of movement	• Quicker onset of fatigue, and need for frequent rest • Less interest in continuous activity
Psychological: (the "kid" factor)	More available free time Natural curiosity and desire for pursuing new tasks	• More time to try new activities • Interest in exploring new activities

Children's Programmes

There are a huge variety of programmes that have been designed to promote the perceptual motor skill development of young children. All these programmes encourage children to learn from experiences guided by a structured curriculum. Anne White's "Center4success" programme, for example, emphasised the need to give children a chance to combine their movement skills together with all their other skills in order to enable them to succeed in all aspects of life (www.center4success.com). Research by Schaney, Brekke, Landry and Burke (1976) emphasised the significant improvement of perceptual-motor skills of kindergarten children participating in a perceptual-motor training programme. Recent research reveals that expressive movement programmes promote significant enhancement of gross motor co-ordination in pre-school children (Baard, 1998).

Existing programmes that incorporate both aspects of physical fitness and perceptual-motor developing in pre-school children involve similar structure to one another. Some of these programmes set the standard for American pre-school curriculum (www.mde.k12.ms.us; www.usd458.k12.ks.us). When designing a movement programme that incorporates activities that will enhance fitness and perceptual-motor development in young children, it is essential to consider the equipment used and if all the demands of development are met. Burton (ici2.umn.edu/ceed (a)) mentioned some practical implications for working with young children. He suggests all activities and equipment used should be scaled to the child's body size. Ulrich (1987) agreed with this.

A particularly attractive piece of equipment, the Swiss ball, has many uses in a children's programme. Swiss balls are large vinyl balls that come in a variety of colours and are popular for use in the fields of biokinetics, physiotherapy, physical education and personal training. These balls originated in Italy, but it was a Swiss physiotherapist, Dr. Susan Klein-Vogelbach, who introduced them into the therapeutic environment. These balls can be used for any age group by selecting the correct size (Sutton, 2001). Sutton (2001) explains that the Swiss ball provides a three dimensionally unstable environment that aids dramatic increases in core muscular strength and development. Working with the ball will also develop other major stabiliser and neutraliser muscles of the body.

The following are benefits that can also be achieved by regular training with the Swiss ball:

- Improved circulation
- Muscle flexibility
- Joint mobility
- Strength
- Endurance
- Muscle size
- Aerobic fitness
- Balance
- Agility
- Inter-muscular coordination
- Sensory perception
- Joint stability
- Posture (Sutton, 2001).

Referring back to the key areas in which perception affects motor skill learning, it is clear that working with the Swiss balls meets these demands. These advantages include:

- The size and bright colour of the balls are an important source of visual stimuli, and can be used to encourage development of figure-ground perception, depth perception, pattern and form perception and spatial awareness.

- Areas of kinaesthetic perception are well addressed through the use of Swiss balls. Body contact with the ball in numerous forms allows for the development of tactile discrimination, spatial dimensions and body awareness. Exercises described by Posner-Mayer (1995) provide activities that will initiate awareness of laterality, lateral dominance, directionality and crossing the body's midline.

- Development of auditory perception can be applied by introducing cues and various sounds created by clapping, talking or stamping the feet, etc.

- Balance development is an important aspect of using the Swiss balls as it provides instability in a three-dimensional environment (Sutton, 2001). Balance is an integral part of most skill performance and is thus essential to development (Haywood, 1993).

The Swiss balls also provide a sound basis for each aspect of physical fitness development and can be adapted to the needs of each age group. However, it is essential to use the Swiss balls with caution and under supervision with young children in order to prevent injury.

It is noted that a wide variety of experience provides the young child with a larger base of movement knowledge and thus it is important to make use of other equipment as well to ensure this for both perceptual motor development and physical fitness (Ulrich, 1987; ici2.umn.edu/ceed (a); ici2.umn.edu/ceed (b); Haywood, 1993).

The Relationship Between Fitness and Locomotor Skills

As previously mentioned, there are numerous aspects of physical fitness, including cardio-respiratory endurance, muscular strength, flexibility, and body composition (Rowland, 1990; Haywood, 1993; Powers & Howley, 1997). Locomotor skills are among the first fundamental skills to develop. As the child becomes more skilful in locomotion, other motor skills are also developed (Ulrich, 1985). Reeves et al. (1989) suggest that if motor co-ordination does not improve, that a lack of motor co-ordination may result in the child not being able to reach his/her fullest potential in becoming physically fit.

"Co-ordination is of particular importance in developing fundamental skills" (Reeves et al. 1989: 745). It is a necessity that the young child experiences good motor development, as this will provide the base for perceptual skill development (Ledebt et al. 1998; www.center4success.com). Without this, the child will not be able to succeed on the sports field or in the playground and this may have detrimental effects on other areas of development (www.center4success.com).

It is also possible to consider the relationship between fitness and motor skill development from another view. Studies show that size, physique and motor ability are related (Borms, 1986) and that an increase in strength is associated with an improvement of performance (Reeves et al. 1989). Negative fitness attributes, such as a high body fat percentage, may possibly result in a sedentary life style that leads to an unfit individual who is unable to improve his/her motor development (Ganley & Sherman, 2000).

Summary

The relationship between the variables of physical fitness and the development of gross motor co-ordination appear to be interdependent. As the child matures, a programme that combines fitness with motor skill development is crucial. For the younger children, including those who live in limited environments, a fitness programme that also focuses specifically locomotor skill development could lay the foundation for future skill development programmes.

It is known that children are not miniature adults in terms of their physiological composition (Lohman, 1992; ACSM Guidelines, 1995; Sherry & Wilson, 1998). A child's motor learning processes can be inefficient and ineffective if their neuromuscular system is not prepared for it. Thus it is important to assess each child as an individual and consider each child's physiological and perceptual-motor development accordingly. For this reason, it is recommended that early childhood movement programmes compare each child to himself/herself, rather than to others. This is the approach taken in this study.

Chapter Three

Methodology

This study explored the potential for a specifically designed movement programme to improve both the fitness and gross motor co-ordination of locomotor skills in four and five year old children. The data gathered presented information regarding each specific fitness variable and the performance of gross locomotor movements pre- and post an intervention programme. The data gathered also presented information regarding correlations between the components of physical fitness and gross locomotor skill development. This chapter includes a description of the study design, the procedures followed and of data analysis.

Design

This investigation followed an experimental research design. It involved pre- and post-intervention test of an experimental group. Due to the availability of subjects and the school structure of the subjects available for the study, it was not possible to have a control group.

Testing criteria for the physical fitness components were quantitative. However, since there are not many norms available for children of less than five years of age, the author elected to compare pre- and post-intervention results rather than comparing scores to any given norms. The test used as the base for the quantitative analysis was the *Prudential FITNESSGRAM*, which was designed to evaluate health-related physical fitness (Safrit, 1995). The *Prudential FITNESSGRAM* is targeted at ages five to 17 years and allows for modifications for special populations. Researchers are constantly searching to find better methods of assessing physical fitness in children. However, Blair (1992) states that he "believes that our current standards in the FITNESSGRAM are reasonable".

Qualitative checklists and rating of skills are often used in the field of motor development. The test used in this study is *The Test of Gross Motor Development* (Ulrich, 1985). This test provides a method for verifying the presence of selected criteria in children's performance of motor skills. In their study, Suomi and Suomi (1997) found the *Test of Gross Motor Development* to be an effective, user-friendly and accurate assessment of children's gross motor development.

Procedures

The following sections provide a description of the procedures followed in the experimental (data collection) portion of this study.

Subjects

Subjects were recruited from Barkley House Pre-Primary in Claremont, Cape Town. Permission was received from the school Head Master to work with the children and all parents of the subjects involved were requested to give their consent for allowing their child/children to participate in the program. Parents received a letter explaining the program that enabled them to return a "yes" or "no" response to the program (see Appendix B). The parents, on behalf of the subjects, completed and signed indemnity forms (see Appendix C).

The movement programme designed by the author and used as the intervention study was called "FITKIDZ" and shall from now on be referred to under that name. Because of their young age (ages four and five) and the set up of the classes within the school, it was decided to work with an entire class (N= 23) instead of selecting a few children specifically to work with. The subjects were a mixed group of boys (n= 15) and girls (n= 8).

Pre-test

To ensure that the data was properly collected, two testing days were assigned. Day One was designated for collecting physical fitness components (quantitative data collection) and Day Two for the qualitative evaluation of locomotor skills. On each of these days, the class was split into two groups to ensure an organised testing setting. In order to make the testing environment non-invasive but still interesting for the children, the physical fitness component stations were arranged in an organised and visually stimulating fashion for children aged four and five. The same effort was made to facilitate the environment for the locomotor skills testing.

Fitness Testing

The *Prudential FITNESSGRAM* (revised) was used to evaluate physical fitness components (Safrit, 1995). The various components were examined using the following tests as per revised description of the *Prudential FITNESSGRAM* unless stated otherwise:

- Body composition – body fat percentage and Body Mass Index (BMI).
- Strength – curl ups.
- Flexibility – Sit-and-reach and trunk lift.
- Aerobic – Modified Hoosier (modification made).

All tests were slightly revised to enable testing with children of ages four to five within a limited testing environment. The Modified Hoosier replaced the one –mile walk of the *Prudential FITNESSGRAM.* Description of these tests can be found in Appendix D.

Because of the young age of the children, and not being able to leave the school grounds to perform the standard one-mile test due to safety regulations, it was essential to formulate a modified test to measure aerobic fitness. Considering that recent studies show that the one-mile run performance may not serve as a strong indicator of cardiovascular fitness (Rowland et al. 1999) it made sense to explore the validity of other recognised aerobic fitness tests. Energy needs lasting less than ten seconds are anaerobic. Those lasting approximately 90 seconds are equally aided by the anaerobic and aerobic systems, and after three minutes it is the aerobic system that supplies the body with its needs (Powers & Howley, 1997). The Hoosier Endurance Shuttle Run (Safrit, 1995) was identified as being the closest test available to meet the demands of the testing environment. Bearing in mind that the aerobic system "kicks in" at three minutes (Powers & Howley, 1997) and that the children would find difficulty in remaining focused on the given task for six minutes (time prescribed for testing in six to eleven year olds), it was decided to modify the Hoosier to three and a half minutes in duration. The rest of the test followed the same protocol as the Hoosier Endurance Shuttle Run and is given in Appendix D.

Locomotor Skills Testing

The *Test of Gross Motor Development* (Ulrich, 1985) was used to evaluate the gross locomotor skills of the subjects. The tester (author of this study) divided subjects into small groups to ensure clear observation of their movements. The assistant gave instructions to the subjects verbally and visually after which they were required to execute the movements. The tester rated the movements as per specification of the *Test of Gross Motor Development* and each subject was given a score at the end of the evaluation. An evaluation sheet for this test is given in Appendix E.

Intervention Programme

The intervention programme for the subjects consisted of an eight-week movement programme. Sessions were twice a week for 20 minutes (entire time with children = 2 x 20 minute sessions). Groups were randomly split on the day of the movement session in order to allow for the subject to work with different class mates and to provide a more controlled environment. The group splits followed the same programme for the day and one group directly followed the other. While the one group was exercising, the other group continued with the every day programme as given by their class teacher.

Each session was held in the same indoor facility on the school premises. Before splitting into the two groups for the session, all the subjects were brought together in a circle formation together with the class teacher, programme organiser (author of this study) and the programme assistant. During this time the subjects spent time discussing personal discoveries and playing/singing educational games/songs. Hereafter, subjects were split into two movement groups.

Sessions were devoted to movement experimentation allowing the subjects to develop each aspect of fitness and gross locomotor co-ordination. Emphasis was made on the sessions being fun. Equipment used throughout the programme included bright orange 55cm Swiss balls, Reebok adjustable steps, bright yellow light resistance Therabands, and a skipping rope.

Continuous education was given to the subjects during the programme regarding muscles, heart rate, safety during exercise and the importance of exercise in a manner suitable for four and five year olds. Attendance records were kept for each session. An outline of session content is given in Appendix F.

Post-test

The procedures followed in the pre-test were again followed in the post-test and included:

- Body composition – body fat percentage and Body Mass Index (BMI)
- Strength – curl ups
- Flexibility – sit-and-reach and trunk lift
- Aerobic – Modified Hoosier (modification made)

for the physical fitness components, and the *Test of Gross Motor Development* for the gross locomotor evaluation.

A post-intervention report was given to each parent (see Appendix G), discussing each child's progress over the eight weeks and each child received a certificate to indicate that they had completed the programme.

Data Analysis

Quantitative data were analysed using the Statsoft analysis program, *Statistica*. Descriptive statistics of the experimental group were calculated. Due to unforeseen circumstances four of the subjects were not able to complete all the required tests. This resulted in the experimental group having 19 subjects (N= 19) with six girls (n= 6) and 13 boys (n= 13). A *t-test* for matched pairs was done to investigate whether there was a significant improvement in fitness in the post-intervention results compared to the pre-intervention testing using the before-mentioned procedures. A MANOVA was considered for this investigation. However, because it was necessary to test whether one population mean exceeded the other, it was essential to use the t-test for matched pairs (Keller & Warrack, 1997; Off & Longnecker, 2001).

Comparing pre- and post- intervention scores on the *Test of Gross Motor Development* did an analysis of qualitative data. A Wilcoxon Sum Rank test for matched pairs of non-parametric value was used to test whether there was a significant improvement in gross locomotor co-ordination after the intervention programme.

In order to see if there was any correlation between the fitness components and the gross locomotor co-ordination, a Spearman Rank Order Correlation was calculated. Significance was established at $p < 0.05$.

Summary

This study was driven by a concern that many modern-age children are becoming less and less able to participate in physical activity because they are less fit and therefore may be less skilful. Research has shown that this reduction in activity levels is leading to a less fit generation. This not only has a negative effect on general health, but may also have consequences on motor skills. To ensure that this does not happen, it is essential to develop structured programmes that stimulate children's desire to be active. Exposing four and five year olds to a programme such as the FITKIDZ programme, was an attempt to test whether their fitness and locomotor motor co-ordination could be improved within a limited time period. It was also an attempt to determine if there is a correlation between improvements in fitness and improvements in the performance of locomotor skills.

Chapter Four

Results

The research questions that provided the foundation for this study are used as a guide to present the results of this study. Research question one was answered using the quantitative results collected through the fitness tests for each fitness component. Research question two was answered using the qualitative data determined from the rating scales of the Test of Gross Motor Development. Research question three was answered by correlating the results of the fitness tests to the results of the gross locomotor co-ordination post intervention.

Research Question One

> Will four and five year olds who participated in the FITKIDZ movement programme demonstrate an improvement in each of the fitness components: cardio-respiratory, strength, body composition and flexibility?

Presentation of the Data

Table 3 presents the statistics that describe pre- and post-test performances of the experimental group. Pre-intervention testing indicates the following for each fitness component:

- The mean for the cardio-respiratory component was 31.7 laps (SD 6.0).
- The mean for the strength component was 5.4 curl-ups (SD 2.5).
- The mean for body composition (fat percentage) was 18.2 (SD 3.3) and body composition (Body Mass Index) was 17.4 (SD 1.5).
- The mean for flexibility (sit-and-reach) was 3.0 cm (SD 2.9) and flexibility (trunk lift) was 27.0 cm (SD 7.5).

Table 3

Results of the pre-and post-test performances of the experimental group on the physical fitness tests for each fitness component

	Fitness Components					
	Cardio-respiratory Component (laps)	**Strength (Curl-ups)**	**Fat Percentage (%)**	**BMI**	**Sit-and-reach (cm)**	**Trunk lifts (cm)**
Mean Pre-test	31.7	5.4	18.2	17.4	3.0	27.0
Mean Post-test	32.6	8.7	18.3	17.0	5.8	32.1
SD Pre-test	6.0	2.5	3.3	1.5	2.9	7.5
SD Post-test	5.5	3.8	3.9	1.8	4.2	5.0
Minimum Pre-test	20	3	12.2	15.2	-2	7
Maximum Pre-test	42	13	26	20.3	8	42
Minimum Post-test	22	3	12	14.5	0	25
Maximum Post-test	43	17	25.5	21.1	12	45
p-Value	0.20	0.00047*	0.40	0.020*	0.0018*	0.00071*

* = $p < 0.05$

The standard deviations (SD) for these scores indicate that there was greatest variation amongst the group's abilities pre-intervention in trunk lift flexibility. The second highest variation in the group was in the cardio-respiratory test. However, SD from the other tests show there was much less variance amongst the group pre-intervention.

Post-intervention testing showed the following results:

- The mean for the cardio-respiratory component was 32.6 laps (SD 5.5).
- The mean for the strength component was 8.7 curl-ups (SD 3.8).

- The mean for the body composition component (fat percentage) was 18.3 (SD 3.9).
- The mean for the body composition (Body Mass Index) was 17.0 (SD 1.8).
- The mean for the flexibility component (sit-and-reach) was 5.8 cm (SD 4.1).
- The mean for the flexibility component (trunk lift) was 32.1 cm (SD 5.0).

There was very little change in the SD post-test in the experimental group except in the trunk lift flexibility. This indicates that those subjects with less trunk lift flexibility pre-test improved significantly to ensure that there is very little deviation amongst the whole group.

Response to Research Question One

In order to determine whether there was a statistically significant difference in the scores of the fitness components pre- and post-intervention, a paired t-test for matched pairs was performed for each component using an Alpha value of 0.05 for all components (Appendix H).

Table 3 shows the p-value for each fitness component. The p-values marked with (*) indicate that statistically significant improvements were shown. Those without (*) remained unchanged. The paired t-test revealed no statistically significant difference between the pre- and post-intervention scores for the cardio-respiratory component. This, however, was not unexpected as the subjects are still very young and the amount of cardiovascular activity that they were exposed to during the programme was not intensive. Further reasons for this result will be discussed in Chapter Five.

Results from the paired t-test show that there was a statistically significant improvement in the strength component. This indicates an improvement in the level of strength post-intervention. Strength, in this case, is an indication of abdominal strength and suggests that the programme facilitated the strengthening of the abdominal muscles. Researchers make it very clear that even though muscle size will not increase dramatically, or at all, in prepubescent children, there is still much to be gained from exercising. Resistance training does not only improve and enhance muscular function, but in doing so, also improves performance and physical fitness (Borms, 1986; Webb, 1990; Kraemer & Fleck, 1993).

In order to determine whether or not there was an improvement in the level of flexibility, it is important to consider the sit-and-reach as well as the trunk lift execution. Examining the sit-and-reach and the trunk lift, there is also a statistically significant difference in the post-intervention results. From this it can be concluded that there was a significant improvement in both hamstring and lower back flexibility.

When considering body composition, it is essential to take both fat percentage and BMI values into account. In the case of the fat percentage, there is not a statically significant difference in the post-intervention results. However, there is a statistically significant difference in the BMI post-intervention results. This means that even though the average fat percentage of the subjects increased, their average BMI decreased. Although reasons for this are not understood, it is possible to speculate that some degree of error was included in the measurement of the fat percentage. Heyward and Stolarczyk (1996) have reported standard errors of the estimate for the equations used in the study to range between 3.6% and 3.9%.

From the above, the first research question can be answered as follows:

> The four and five year old children who participated in the FITKIDZ movement programme demonstrated an improvement in the fitness components of strength, flexibility and the Body Mass Index variable of body composition.
>
> They did not show improvements in the cardiovascular aspect of fitness, or in the fat percentage variable of body composition.

Research Question Two

> Did the four and five year old children who participated in the FITKIDZ programme demonstrate an improvement in their performance of locomotor skills?

Presentation of the Data

Each subject's test performance was analysed by the author as per description of *The Test of Gross Motor Development*. If a performance criterion was present in the performance of a gross locomotor movement, one point was awarded to the subject for that criterion. No points were allocated if the evaluation criterion was not fulfilled. The maximum score possible was 26. This gave a reasonably large range of values possible in conveying a score for each correct movement. The mean for the pre-intervention analysis was 14.3 (SD 5.4) and for post-intervention, was 24.5 (SD2.2) indicating a vast improvement in the execution of gross locomotor skills post-intervention and minimal deviation amongst these results. Table 3 presents the descriptive statistics of the results of this pre- and post-intervention qualitative analysis. Considering the post-test value of 20 for the minimum score in comparison to the pre-test value of 6, it is apparent that there is a great improvement in gross locomotor co-ordination.

Table 4

Results of the pre- and post-test qualitative assessment of the performance of locomotor skills

	Pre-test (N=19)	**Post-test (N=19)**
Mean	14.3	24.5
SD	5.4	2.2
Minimum	6	20
Maximum	22	26

Figure 3 presents the results of pre- and post-testing of performance of locomotor co-ordination. Pre-test results showed a mean of 14.3 (SD 5.4) and post-test results showed a mean of 24.5 (SD 2.2).

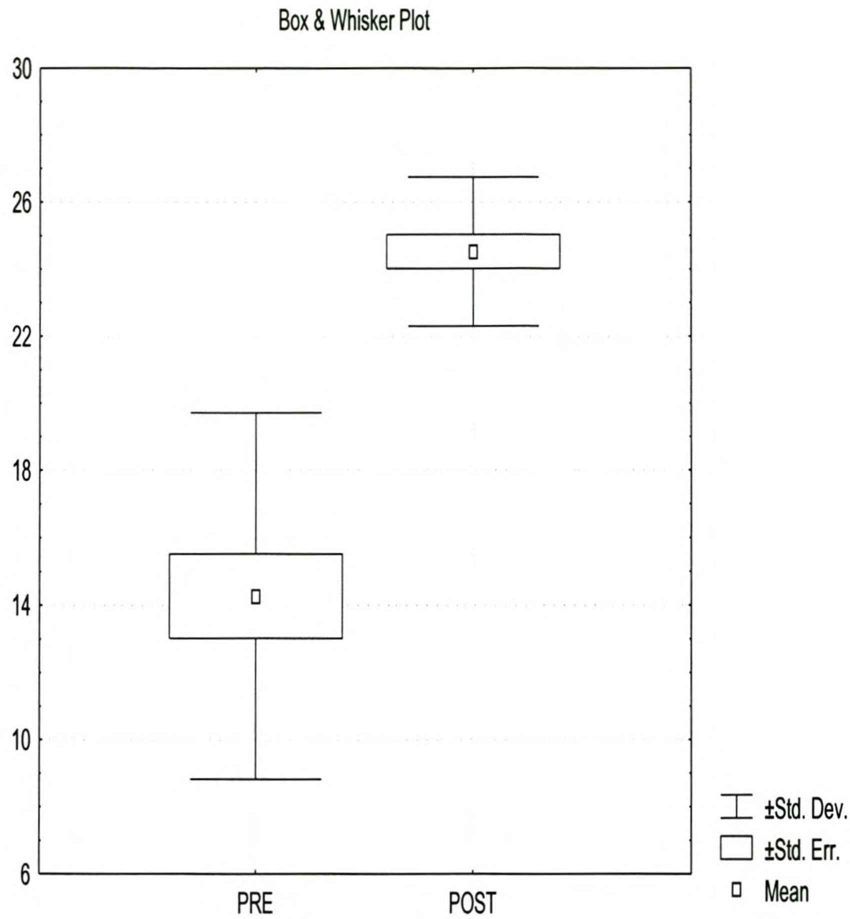

Figure 3.

A Box-and-Whisker plot for pre- and post-test results of locomotor skill performance

Response to Research Question Two

Due to the non-parametric nature of the qualitative data, a Wilcoxon Sum Rank test for matched pairs was used to determine whether or not there was a statistically significant post-test improvement in gross locomotor co-ordination (Appendix I).

Results showed the difference was significant in the improvement of locomotor skills performance, p =0.000132. This provides a positive response to the second research question:

Participation in a structured movement programme (FITKIDZ) by four and five year olds demonstrated a significant improvement in their performance of locomotor skills, keeping in mind that a single total score was recorded for the performance of all individual locomotor skills.

Research Question Three

Was there a relationship between the improvements in fitness components and improvements in the locomotor skills of the children who participated in the FITKIDZ programme?

Presentation of the Data

Correlation coefficients were calculated between post-test results of each of the physical fitness components and the post-test results of locomotor skill performance. Table 5 presents the statistics that describe the results of the Spearman Rank Order Correlations generated between locomotor scores and each aspect of fitness. These results will be elaborated upon in the response to question three.

Table 5

Results of the Spearman Rank Order Correlation between locomotor scores and results for each individual aspect of fitness (r = correlation co-efficient)

	Cardio respiratory	**Strength**	**Fat %**	**BMI**	**Sit-and-reach**	**Trunk Lifts**
Locomotor	-0.04	0.36	-0.29	-0.26	-0.18	-0.08

Response to Research Question Three

In order to determine if there was a significant difference in the correlation between the post-intervention scores of gross locomotor co-ordination and each component of fitness, a Spearman Rank Order Correlation was performed. From Table 5 it can be concluded that:

- The coefficient of correlation (r) between locomotor skill performance and the cardio-respiratory component was slightly negative. The correlation r was 0.04 and therefore means that no straight-line relationship existed.

- The r = 0. 36 between strength and locomotor performance indicated that although there was not a strong correlation between them, it was the highest correlation shown in the model. Thus there was a weak linear relationship between locomotor skills and strength. This result was analogous to previous research supporting the existence of a significant relationship between strength and motor performance (Reeves et al. 1999).

- There was also a negative correlation of 0.29 between locomotor performance and fat percentage. This again implied a weak negative linear relationship between the variables. There was a negative correlation of 0.26 between Body Mass Index and locomotor performance. This indicated that there was a weak negative linear relationship between locomotor skills and Body Mass Index.

- There was also a negative correlation between locomotor performance and the sit-and-reach and trunk lifts. It was, however also very weak, with r = 0.18 and r = 0.08 respectively. Thus no linear relationship exited between the components.

Research question three can thus be answered in the negative, as follows:

There does not appear to be any significant correlations between any of the fitness components and locomotor skills performance. However, it should be noted with a larger group of subjects, a positive linear correlation may exist between strength and locomotor skills.

Examining Individual Improvements

Cardio-respiratory Endurance

Even though the group statistics revealed that there was no statistically significant improvement in the cardio-respiratory component of fitness, four of the five subjects with the lowest pre-test scores appeared to benefit from the movement programme.

In Figure 4 it can be seen that Subjects 1, 3, 4 and 5 showed improvements in their cardio-respiratory scores. Subject 1's score improved by four, Subject 3 by four, Subject 4 by four and Subject 5 by nine. Subject 2's score, however, decreased by two.

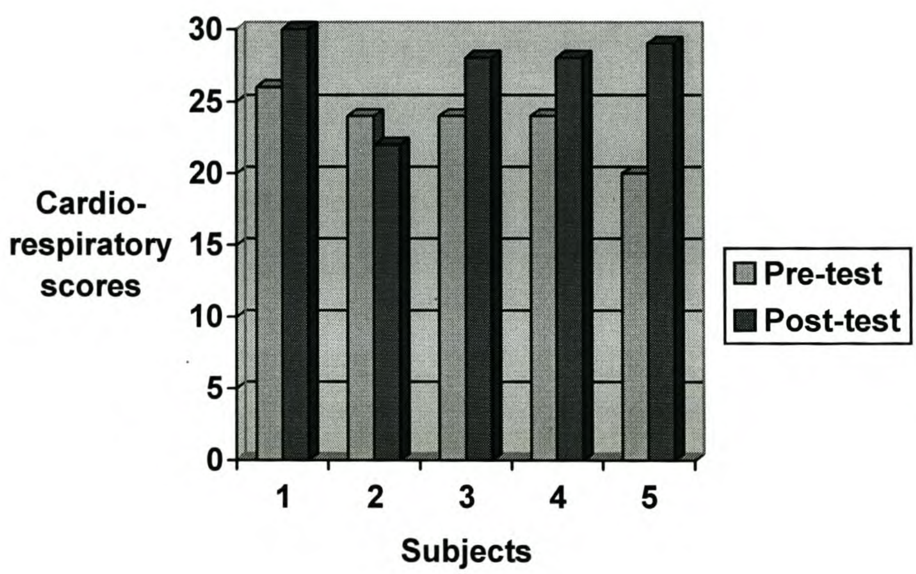

Figure 4.

Graphical presentation of the five lowest pre-test scores and the subsequent post-test scores on the cardio-respiratory component

Strength

A p-value of $p < 0.05$ indicated that there was a statistically significant improvement in the strength component which was based upon abdominal strength. Investigating the individual results revealed that amongst the lowest seven pre-test scores, six improved and one decreased. In Figure 5 it can be seen that Subjects 2 –7 improved on their score and Subject 1, decreased on the score of the number of curl-ups completed.

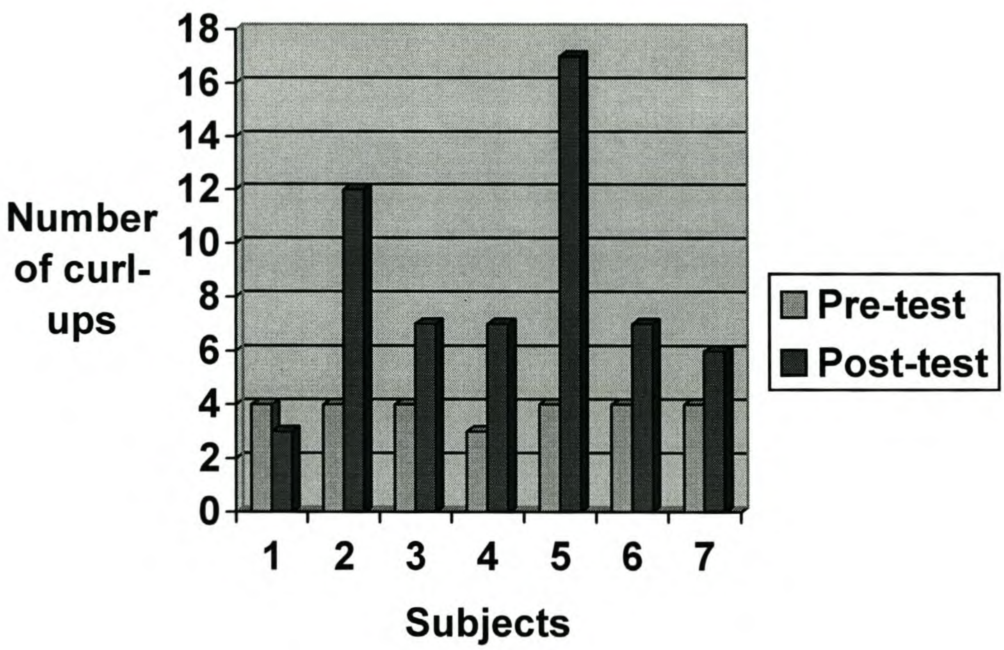

Figure 5.

Graphical presentation of the seven lowest scores on the strength test and subsequent post-test scores

Body Fat Percentage

Although it must be acknowledged that the group statistics were not supportive of the movement programme with regards to any statistically significant improvement in fat percentage, three of the five highest pre-test scores showed a drop in post-test values. Figure 6 indicates that Subjects 3, 4 and 5 experienced a reduction in fat percentage throughout the duration of the movement programme. Subjects 1 and 2 experienced an increase in fat percentage.

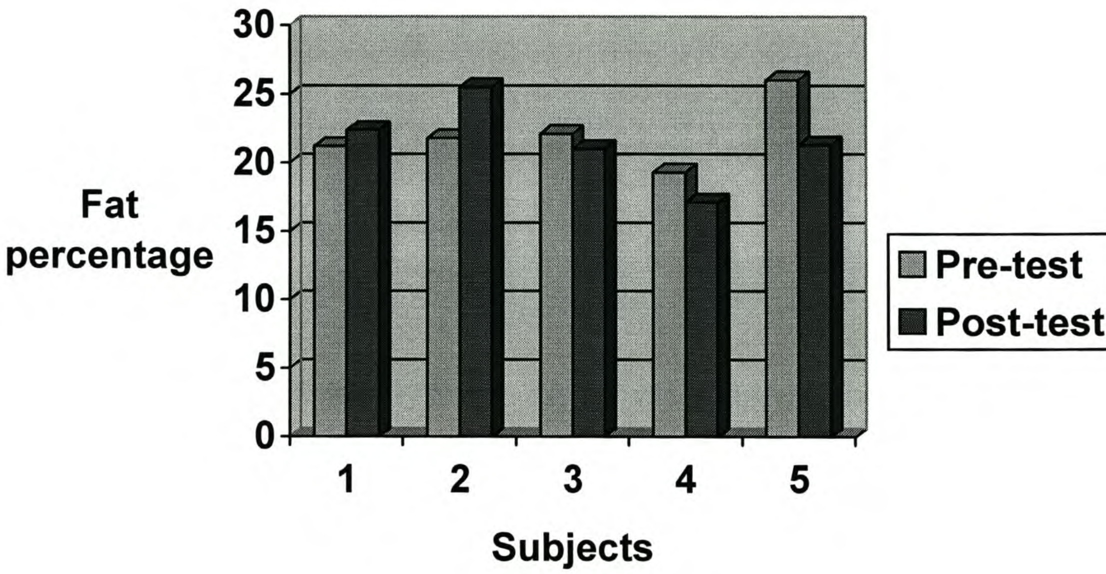

Figure 6.

Graphical presentation of the five highest pre-test values and subsequent post-test values for fat percentage

Body Mass Index

A p-value of $p < 0.05$ revealed that there was a statistically significant improvement in BMI. Four of the five highest BMI scores showed a reduction in post-test scores. The remaining score revealed an increase in BMI. Figure 7 shows that Subjects 2, 3, 4 and 5 experienced a reduction in BMI whereas Subject 1 experienced an increase in BMI throughout the duration of the movement programme.

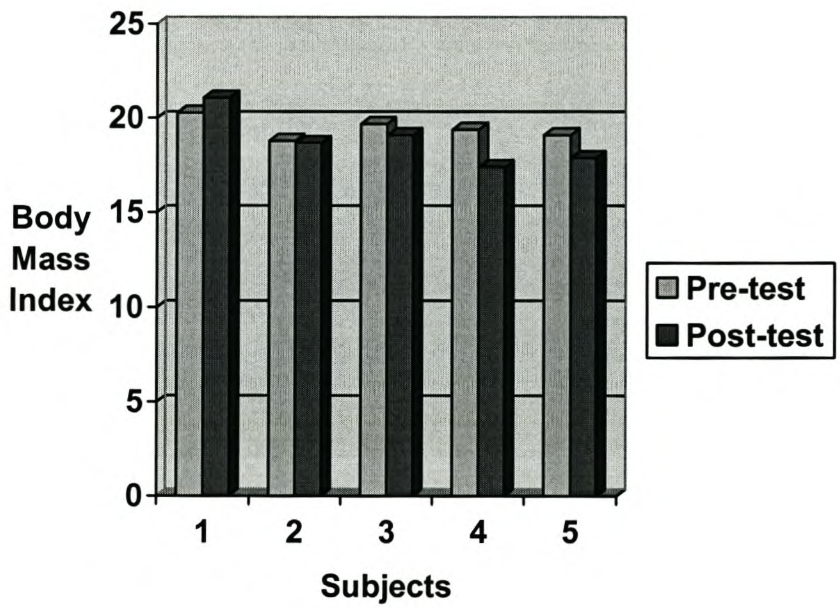

Figure 7.

Graphical presentation of the pre-test and subsequent post-test values for the five highest scores for the pre-testing of Body Mass Index

Flexibility

A statistically significant improvement in the sit-and-reach execution, $p < 0.05$, reveals the following about the individual responses to the movement programme: of the 6 lowest pre-test scores, only one subject did not improve. Figure 8 presents the relevant scores. Subjects 1, 2, 3, 4, and 5 are shown to have improved at completion of the movement programme. Subject 6 is the only one of the six lowest pre-test scores not to have improved.

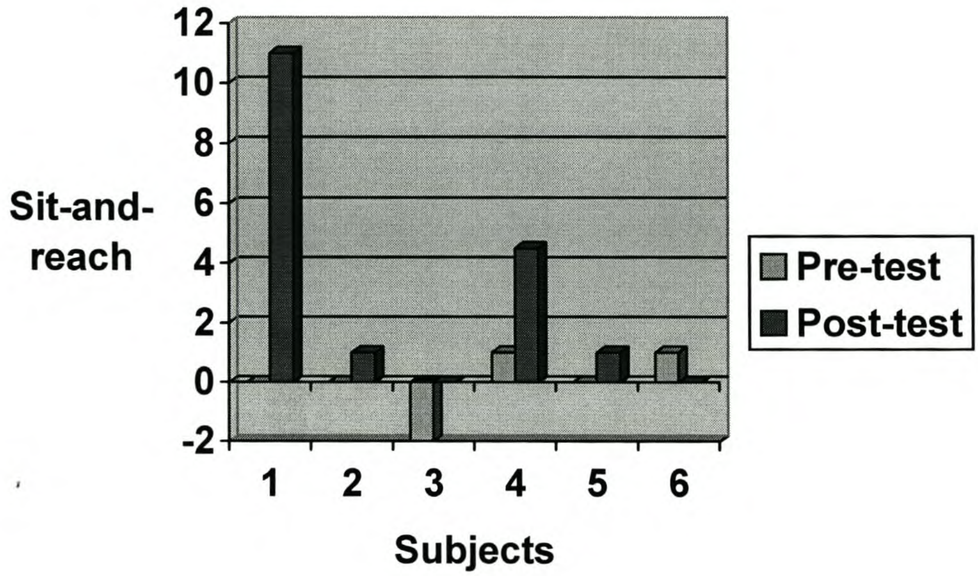

Figure 8.

Graphical presentation of the six lowest pre-test scores for the sit-and-reach execution along with the resulting post-test scores

A statistically significant improvement was discovered in the trunk lifts, $p<0.05$. For this test it was found that all 5 of the lowest pre-test scores resulted in an improvement on post-test scores.

Figure 9 reveals this improvement in all 5 of the subjects whose scores were lowest on the pre-test.

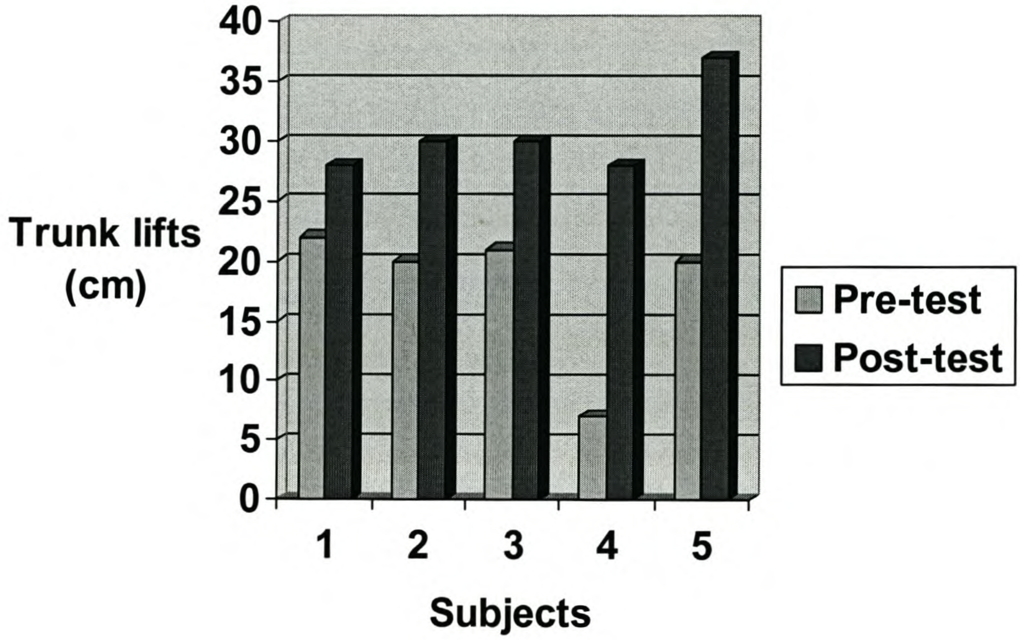

Figure 9.

Graphical presentation of the pre- and post-test results of the trunk lift execution

Locomotor Skills Performance

Considering the qualitative data, the results indicate that there is a statistically significant improvement in gross locomotor co-ordination following the completion of the movement programme, $p<0.05$. Taking a closer look discloses all five of the subjects who attained the lowest pre-test scores, improved their gross locomotor co-ordination. This is presented in Figure 10.

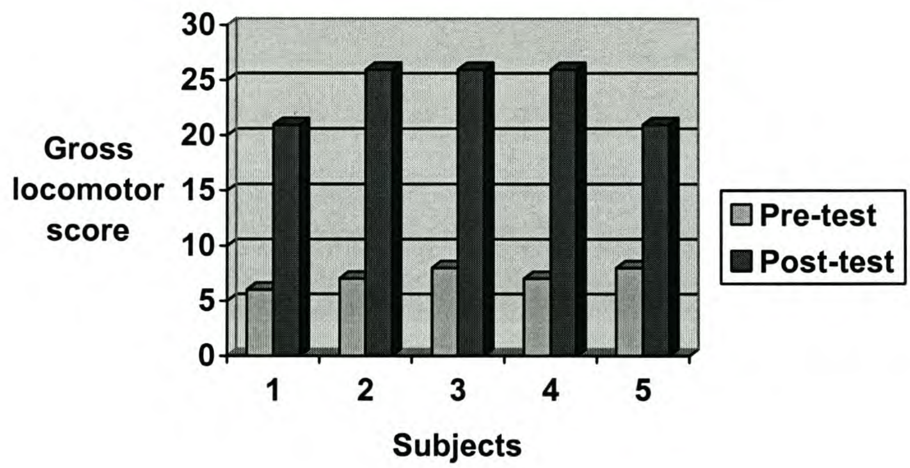

Figure 10.

Graphical presentation of the five lowest pre-test scores on the five lowest pre-test scores on the test of locomotor skills along with the corresponding post-test value

Summary

Considering the above-mentioned individual responses to the movement programme it is evident that even though there was not a statistically significant improvement for every fitness component within the group results, the movement programme did facilitate individual development. This suggests that a programme of this type may be beneficial to all young children with regards to some aspect of physical fitness as well as locomotor development. However, it is essential to keep in mind that each child is an individual and that the varying needs of each child should be duly addressed (Ulrich, 1987; Haywood, 1993).

Chapter Five

Conclusions and Recommendations

With the increasing concern of South African youth becoming more sedentary due to escalating numbers of children sitting for hours in front of the television, computer or play station, it is appropriate that the adult population supports the effort to keep the country's youth fit and healthy. Necessity to keep up with technological advancement should not interfere with the concerns of perceptual-motor development and physical fitness within the younger population.

A dynamic fitness-oriented movement programme (FITKIDZ) was designed to enable non-expert teachers/trainers to address various aspects of physical fitness and perceptual-motor development at nominal expense with the ability to adjust the programme for the specific needs of different child populations.

The movement programme (FITKIDZ) was designed by the author and tested in an experimental study to determine whether such a movement programme could enhance the learning of locomotor skills and improve general physical fitness in four and five year olds. In addition to this, an exploration was made into the possible relationships among locomotor skill development and the various components of physical fitness. Quantitative and qualitative analysis were used to determine the changes pre- and post-intervention of the experimental group. Results of analysis of the quantitative physical fitness tests revealed the following:

- The scores for the cardio-respiratory component went from 31.7 laps (SD 6.0) to 32.6 laps (SD 5.5).
- The scores for the strength component went from 5.4 curl-ups (SD 2.5) to 8.7 curl-ups (SD 3.8).
- Scores for the body composition tests went from 18.2 (SD 3.3) to 18.3 (SD 3.9) and from 17.4 (SD 1.5) to 17.0 (SD 1.5) for fat percentage and BMI scores, respectively.

- Scores for the flexibility component went from 3.0 cm (SD 2.9) to 5.8 cm (SD 4.1) for the sit-and-reach, and from 27.0 cm (SD 7.5) to 32.1 cm (SD 5.0) for trunk lifts.
- On the qualitative level of analysis (determined by the author with a background of Human Movement Science and Biokinetics), the mean scores showed a significant improvement following the intervention period, improving from 14.3 (SD 5.4) to 24.5 (SD 2.2).

A paired t-test for matched pairs was used as a tool for analysis between pre- and post-intervention scores and showed that there was a statistically significant improvement in:

- The strength component, $p = 0.00047$.
- BMI, $p = 0.020$.
- Flexibility as measured by the Sit-and-reach, $p = 0.0018$.
- Abdominal strength as measured by trunk lifts, $p = 0.00071$.
- Scores for the cardio-respiratory component and for fat percentage, however, showed no statistically significant improvement.

Determining whether or not there was a statistically significant post-test improvement in locomotor skills performance required the use of the Wilcoxon Sum Rank test for matched pairs. Results revealed that there was a significant improvement of locomotor co-ordination, $p = 0.000132$.

A Spearman Rank Order Correlation was performed in order to determine if there was a significant difference in the correlation between the post-intervention scores of locomotor co-ordination and each component of fitness. Results showed that the only significant linear relationship was between locomotor performance and strength, $r = 0.356$.

Conclusions

Researchers make it very clear that even though muscle size will not increase dramatically, or at all, in prepubescent children, there is still much to be gained from exercising. Resistance training does not only improve and enhance muscular function, but in doing so, also improves performance and physical fitness (Borms, 1986; Webb, 1990; Kraemer & Fleck, 1993). Within this study, strength refers to abdominal strength. Thus, the results support that a movement programme of this design allows for the improvement of abdominal strength.

As mentioned in Chapter Two, Maud and Foster (1995) voice that there may be an area of concern when using Body Mass Index (BMI) since it lacks the ability to compare the leanness-fatness component. It is thus important to use both methods of comparing body composition, namely, fat percentage and BMI, in order to assess a healthy body composition. This study showed that there was a significant improvement in BMI and yet there was no significant difference in fat percentage. Although reasons for this are not understood, it is possible to speculate that some degree of error was included in the measurement of the fat percentage. Heyward and Stolarczyk (1996) have reported standard errors of the estimate for the equations used in the study to range between 3.6% and 3.9%. The subjects were not given a specific diet to follow during the study either; therefore the fact that there was no improvement in fat percentage is not a great disappointment in discovery.

Traditionally, flexibility is defined as the range of motion available at a specific joint and depends very much on the anatomical structure of the joint (Haywood, 1993). Gambetta (www.gambetta.com) adds that it is essential to remember that flexibility has both an anatomical quality and a physical ability. Taking into consideration that both forms of flexibility tested in the study (hamstring and lower back) showed a significant improvement following the intervention programme, it follows that the designed programme provides for enhancement in flexibility.

Above all the aspects of fitness, cardio-respiratory fitness stands out to be the one component that can have the greatest impact on adult life. This development instigates in the young child and is essential to healthy maturity throughout the life cycle (Ganley & Sherman, 2000). However, fitness should be viewed as a composition of various units that enhance the performance of each variable (Haywood, 1993). At first, it may appear that the designed programme did not contribute to an improvement in cardio-respiratory fitness. However, recent studies show that the one-mile run performance may not serve as a strong indicator of cardiovascular fitness (Rowland et al. 1999). It would follow that a modified test for cardio-respiratory fitness may equally not be an indication of fitness. It is also of note that, due to time constraints and availability of subjects, the initial Modified Hoosier was only performed in the third week of the programme, leaving only five weeks before post-testing. This time span is limited and it would thus not be expected to find any significant improvements in cardio-respiratory fitness.

It is widely agreed that the development of gross motor co-ordination at an early age depends largely on physical activity (ici2.umn.edu/ceed (b)) and experience of movement (Ledebt et al. 1998). The speed at which these skills develop depends on how the child is maturing with regards to his/her body size and physical growth, strength relative to body mass and the level of maturity of the nervous system. This means that if the child's nervous system matures past a certain stage, he/she may suddenly be able to perform a more complicated movement resulting from the formation of larger and more complex coordinated units of action (ici2.umn.edu/ceed (a)). A partial purpose of the designed programme was to provide opportunity for the subjects to experience and master new movements. It appears successful in this regard.

Considering Magill's (1988) concept of readiness and the results of the study, it is possible to conclude that the designed programme provided a proficient basis of motivation for the subjects to master new skills resulting from a substantial base of movement experience. It is important to note that the subjects had developed to a sufficient level of maturity in order to achieve this.

It is clear that perceptual-motor development is also enhanced though such a programme. The use of the Swiss ball is of great value for perceptual-motor development as it tends to the requirements of the key areas in which perceptual development affects motor skill learning described by Haywood (1993) and Collier (2000) in Chapter Two. However, it is important to include other equipment to ensure that a larger base of movement knowledge is supplied to allow for both perceptual-motor development and physical fitness (Ulrich, 1987; ici2.umn.edu/ceed (b); Haywood, 1993). The designed programme provided for such needs.

Literature emphasises the many differences between the young child and an adult in terms of attention, memory processes, motor programmes and feedback in regards to each aspect of locomotor development. From earlier discussion in Chapter Two it is apparent that each one of these aspects needs a different approach in order to supplement development in the young child. This approach was taken in this study.

It is believed that strength gains in the prepubescent child are probably primarily the result of enhanced neuromuscular activation (motor learning) rather than hypertrophy (muscular adaptation) (Borms, 1986; Webb, 1990; Kraemer & Fleck, 1993). It is thought that the improvements in nerve and muscle cell interactions leads to strength augmentation (Nieman, 1998). This understanding would support the findings of this study in view of the correlation results between locomotor skill development and strength.

The relationship between the variables of physical fitness and the development of motor co-ordination appear to be interdependent. As the child matures it is crucial to incorporate a programme that combines fitness with motor skill development. However, it must be remembered that each child's physiological and perceptual-motor development is unique in its progress. Consequently, it is advised that movement programmes for young children compare each child to himself/herself, rather than to others.

From the outcomes resulting from this study it is possible to conclude that a movement programme of such design may be an effective medium of improving the locomotor skills and numerous fitness components in children aged four and five years, especially those children who are somewhat unfit or unskilled in their locomotor performance.

Recommendations

In view of the conclusions drawn as a result of the investigation, the following recommendations are made.

1. Normal development of children aged four and five years includes a natural process of development that would result in possible improved fitness and gross motor co-

ordination. Thus, for further studies it would be recommended to include a control group in order to further substantiate possible findings.

2. Such a study would benefit greatly if the programme were of longer duration to allow for greater physiological adaptation with respect to the cardio-respiratory component and body fat percentage in order to investigate any significant changes of either fitness attribute.

3. It is noticeable from the study and from relevant research and paediatric literature that movement is an important source of both perceptual motor development and physical fitness. However, such knowledge of movement should not be limited to four and five year olds, but distributed to children of all ages. It is necessary that adults who are in contact with educating children be instructed in the benefits of physical fitness and perceptual motor development in order to help build a fit and healthy population of youth.

Appendix A

Developmental Sequences in Locomotor Skills

Locomotor skills are those used to change the location of the body and to move it through space. Haywood (1993) identifies the following locomotor skills as follows:

- Walking
- Running
- Jumping
- Hopping
- Galloping
- Sliding
- Skipping.

The following developmental sequences are taken from Haywood (1993) and describe the characteristics of proficient movement skills.

Walking

An infant's initial attempts to walk are qualitatively different than an adult's walking pattern. An adult's walking pattern reflects certain developmental changes:

- Absolute stride length must increase, reflecting greater application of force and greater leg extension at push-off. Also, as children grow, increased leg length contributes to a longer stride.
- Planting the foot on the ground must change to heel-then-forefoot pattern, which results from an increased range of leg motion.
- The individual must reduce out-toeing and narrow the base of support laterally to keep the forces exerted in the forward-backward plane.
- The skilled walker must adopt the double knee-lock pattern to assist the full range of leg motion. In this pattern the knee extends at the heel strike, flexes slightly as the body weight moves forward over this supporting leg, then extends once more at foot push-off. Because the knee extends twice in one step cycle, this pattern is termed the double knee-lock.
- The pelvis must rotate to allow the full range of leg motion and oppositional movement of the upper and lower body segments.
- Balance must improve and forward trunk inclination be reduced.
- The skilled walker must coordinate oppositional arm swing, with the legs. This is consistent with the principle of action and reaction; that is, the opposite arm and leg move forward and back in unison. The arm swing must become relaxed and move from the shoulders with a slight accompanying movement at the elbow.

The rhythm and coordination of a child's walk improves observably until age five or so, but beyond this age, pattern improvements are subtle and probably not detectable to the novice observer.

Running

As with walking, the movement patterns a child uses are qualitatively different than an adult's running pattern. To achieve a proficient running pattern the following changes must occur:

- Stride length must increase, indicating that the runner is applying greater force. As greater force is used, several characteristics of mature running emerge: The rear leg is fully extended at push-off; the heel is tucked close to the buttocks as the thigh swings forward with greater acceleration; and before the foot strike, the thigh has come parallel to the ground. When the recovery leg is swung forward in a tucked position, the runner's effort is conserve.
- The runner must eliminate lateral leg movements so that forces are kept in the forward-backward plane.
- For extended running, each foot must strike the ground heel first, then forefoot, or strike the ground in an approximately flat pattern.
- The runner must eliminate out-toeing and narrow the base of support.
- The runner's support leg must be allowed to flex at the knee as the body's weight comes over the leg.
- Trunk rotation must increase to allow for a longer stride and better arm-leg opposition. The trunk should lean slightly forward.
- The arm must swing forward and back, with the elbows approaching right angles, and move in opposition to the legs.

A child's running pattern improves as he/she grows. Increased body size, strength and coordination give rise to improvements in running speed and time in flight. Proficient running patterns are not necessarily achieved before adolescence and often, many adults may experience an inefficient running pattern.

Jumping

To execute proficient jumps, the following must be executed:

- Get into a preparatory crouch that will stretch the muscles and allow the legs to apply maximal force as they fully extend at the moment of lift-off.
- Take off for a horizontal jump with the heels coming off the ground and both feet leaving the ground at the same time.
- Extend the arms backward, then initiate the takeoff with a vigorous arm swing forward to a position overhead.

Jumping for height requires the following:

- Direct force down and extend the body throughout flight.
- Keep the trunk relatively upright throughout the jump.
- Flex the ankles, knees, and hips upon touchdown to allow the force of landing to be absorbed.

Jumping for distance requires the following:

- Direct force down and back by beginning the takeoff with the heels leaving the ground before the knees extend. The trunk appears to tip forward.
- Flex the knees during flight, then bring the thighs forward to a position parallel with the ground.
- Swing the lower legs forward for a two-footed landing.
- Let the trunk come forward in reaction to the thighs flexing, putting the body in a jack knife position.
- Flex the ankles and knees when the heels touch the ground to absorb the momentum of the body over distance as the body continues to move forward.

Children are capable of refining these movements with practice. However, many children may fail to achieve this, even into their adult years.

Hopping

Adults rarely use hopping as a mode of movement. However, in order to become a skilful mover, it is better to develop these skills during childhood.

To become proficient hoppers, children need to make the following improvements:

- The swing leg must lead the hop.
- The support leg must extend fully.
- The hopper must use the arms, which should move in opposition to the legs.
- The hopper must flex the support leg at landing to absorb the force of the landing and to prepare for extension at the next takeoff.

Few children under the age of three can hop repeatedly. Hopping is believed to continue in its proficiency long after age five.

Galloping, sliding and skipping

Galloping, sliding, and skipping all involve the fundamental movements of stepping, hopping or leaping. Galloping and sliding consist of a step on one foot, then a leap-step of the other foot. The same leg always leads with the step. The difference between galloping and sliding is the direction of movement. In galloping, the individual moves forward; in sliding, the movement is sideways. Skipping is a step and a hop on the same foot, with alternating feet: step-hop (on right foot), step-hop (on left foot), step-hop (on right foot), and so on. Movement is usually forward.

Proficiency in these skills includes the following characteristics:

- The arms are no longer needed for balance.
- In skipping, arms swing rhythmically in opposition to the legs and provide momentum.
- The child can use the arms for another purpose during galloping and sliding, such as clapping.
- Heel-forefoot or forefoot landings prevail.
- The knees “give” on landing, remaining flexed while they support the body’s weight, and then extend at takeoff, especially when the child is travelling quickly.

Galloping is the first asymmetrical locomotor pattern a child learns. Sliding develops next and then skipping which is usually last and develops between age four and seven.

Appendix B

FITKIDZ Response Form

FITKIDZ is a programme aimed at improving your child's fitness and locomotor co-ordination. By doing this, your child will benefit all the riches of boosted development including improved muscle tone, locomotor co-ordination, self-esteem and general fitness.

The programme is part of a Master's study (University of Stellenbosch) and will consist of a pre- and post -assessment of fitness and locomotor co-ordination. It is an 8-week programme during which the children will work with Physioballs, Therabands (low resistance elastics) and other basic equipment. Activities will be supervised by a biokineticist.

Motivational techniques such as the use of a journal and challenging games will be used to inspire the child's movement.

Parents will receive a report of their child's progress.

Frequency: 2 x per week
Duration: 2 x 20 minute sessions (each child having only 20 minutes per session)
Ages: 4 and 5 years

....

FITKIDZ response form

Please tick one:

☐	Yes, I am interested in allowing my child to join the programme. Age of child interested...........
☐	No, I am not interested in allowing my child to join the programme.

Appendix C

Indemnity Form

CAPE MEDICAL REHABILITATION CENTRE
GROUND FLOOR ________HOSPITAL
_________ MEDICAL VILLAGE

TEL: ___________ FAX:_________

I, ________________________________, Guardian/Parent of______________________(child's name), give full permission for my child to participate in the FITKIDZ programme and shall not hold the Cape Medical Rehabilitation Centre or the programme supervisor responsible for any possible injury resulting from the programme.

This document was signed on the _____day of __________2000

At____

And was witnessed by_________________________________

Signed____

Appendix D

Description of Revised Physical Fitness Tests of the Prudential FITNESSGRAM and of the Modified Hoosier

Sit-and-reach

Objective:
Measure hamstring flexibility

Protocol:
Equipment
This test requires a standard sit-and-reach box with the measuring stick positioned on top of the box so that the zero is at the near end of the box, with negative numbers leading towards the subject on the stick and positive numbers leading away from the subject along the box surface.

Starting position
After removing shoes, the subject sits with both feet flat against the front of the box with the heels touching the ground. Hips should be parallel to the box and the legs straight.

Performance
The subject places one hand on top of the other, palms down, and reaches as far as possible three times, moving the across the top of the box. On the third try the position is held for at least two seconds.

Scoring:
One score is recorded. The score is recorded in centimetres. The score is positive if the subject reaches past the toes, zero if the subject reaches the toes along the top of the box, and negative if the subject cannot reach as far as the toes along the box.

Trunk lifts

Objective:
Measure trunk extensor flexibility.

Protocol:
Equipment
A measuring ruler and a floor mat.

Starting position
The subject being tested lies face down on the mat with the hands under the thighs and toes pointed.

Performance
The subject lifts the head and upper body and holds that position briefly so it can be measured. The tester measures the distance from the floor to the ruler. The participant then lowers the upper body down. Two trials are made, with the highest score recorded.

Scoring:
The score is the height to which the student was able to lift the upper body, measured from the chin to the floor. Measurement is in centimetres (cm).

Skinfold measurements

Objective:
Measure fat percentage for body composition.

Protocol:
Equipment
A skinfold calliper is required to take skinfold measurement.

Performance
Skinfold thickness measures are taken at the triceps and the calf on the right hand side of the body. Sights for these measures are as described for anthropometric testing. The tester pinches the skinfold slightly above the midpoint of the sight, placing the calliper at the midpoint. The tester holds the calliper for three seconds and records the measurement. Each site is measured three times.

Scoring
Skinfold thickness is measured in millimetres (dial calibration). Each skinfold is measured three times but the highest and lowest scores are discarded, recording the middle value.

Body Mass Index (BMI)

Objective:
Measure body composition.

Protocol:
Equipment
A measuring stick and a scale are required to measure height and weight.

Performance
Height is measured in metres (m) and weight is measured in kilograms (kg).

Scoring
Body mass index is calculated by dividing weight (kg) by height^2 (m^2).

$$BMI = kg / m^2$$

Curl-ups

Objective:
Measure abdominal muscle strength and endurance.

Protocol:
Equipment
This test requires a floor mat.

Starting position
The subject lies on the mat, with knees bent and feet flat on the floor. Arms and hands are held straight at the sides, with palms in contact with the mat.

Performance
The subject curls up until the shoulder blades are off the floor and then lowers the body until the head touches on the mat. Repetitions are performed approximately one curl-up every three seconds. Subjects continue until technique is no longer correct or the subject experiences pain or discomfort.

Scoring:
The score is the number of curl-ups performed with correct form. Heels must remain on the mat during the curl, and the subject must curl from the spine up. A curl is counted when the subject's head touches the mat.

Modified Hoosier Endurance Shuttle Run

Objective:
Measure cardio-respiratory endurance.

Protocol:
Equipment
Each subject has 12 tennis balls, 2 chairs, 2 buckets for collecting/transferring balls and a partner. The test administrator needs a stopwatch and a large supply of balls.

Starting position
Two subjects perform the test at the same time. Each subject has a partner. Two chairs are placed side by side for each subject. Each chair holds a bucket. One bucket holds 12 balls, the other one is empty. The partner for each subject sits on the floor 5 m away.

Performance
The subject collects a ball from the full bucket, runs to, and around their partner and back to the chairs to put the ball into the empty bucket. This continues for three and a half minutes. If the first bucket empties, the test administrator refills the first bucket. Subjects must try to collect as many balls as possible. Subjects may run or walk, but are informed of the aim of the test.

Scoring:
The score is the number of balls placed into the second bucket during the test resulting in an equivalent number of laps. (Safrit, 1995)

Appendix E

Scorecard for the Test of Gross Motor Development

LOCOMOTOR SKILLS					
Skill	**Equipment**	**Directions**	**Performance Criteria**	**1st**	**2nd**
RUN	50 feet of clear space, coloured tape, chalk or other marking device	Mark off two lines 50 feet apart Instruct student to "run fast" from one line to another	1. Brief period where both feet are off the ground		
			2. Arms in opposition to legs, elbows bent		
			3. Foot placement near or on a line (not flat footed)		
			4. Nonsupport leg bent approximately 90 degrees (close to buttocks)		

All locomotor skills are scored in a similar fashion (Ulrich, 1985).

Appendix F

Session Outline For the FITKIDZ Programme

Week one: Lesson one

Apparatus: 55cm Swiss balls

Goals:
- To introduce the new apparatus, allowing the children to get used to the feel of the ball by following example
- Body awareness and spatial awareness
- Movement exploration and balance (movement development)
- Flexibility and cardio-respiratory activity

Session structure:
Three groups, 15 min each
Single (each with own ball)

Activities:
Seated/Bouncing
- bounce as high as you can
- small bounces
- open and close the legs whilst bouncing
- clap your hands
- arms on your head
- roll your hips from side to side on a stationary ball

Standing
- bounce the ball with your hands
- lift the ball up to the sky
- give the ball a huge bear hug
- roll the ball to a partner
- throw the ball to a partner standing nearby

Moving
- carry the ball and move around without touching anyone
- roll the ball in front of you; forwards and backwards
- draw a house on the floor while rolling the ball

Lying over the ball
- make like a see-saw and roll forwards and backwards over the ball
- roll on the ball on your tummy and draw a big tree with the ball on the ground

Stretching (standing)
- Make a big circle with your arms in front of you
- Lift your arms up to the ceiling

- Arms at your side and let the one side flop like a rag-doll
- Make a small ball with your body
- Hold onto the wall and lift your one foot to the bottom to look like a flamingo

Stretching (sitting/lying)

- Sit with one leg straight and the other bent. Walk your fingers like a spider towards your toes on your straight leg. Change legs.
- Lying on your back, make yourself as long as you can

Lesson Two

Apparatus: Light resistance Therabands

Goals:

- To introduce the new apparatus, experimenting with movement (movement development)
- Allowing the children to adjust to the feel of the elastic resistance
- Resistance activities
- Laterality awareness and body awareness

Session structure:
Two groups, 20 minutes each
Single (each with own elastic)

Activities:
Arms (alternating between left and right; one side of elastic under the foot on the same side as arm used)

- Lift your arm at your side and make yourself as wide as you can
- Lift your arm at your side and make yourself as tall as a giraffe
- Lift your arm in front of you
- Experimentation and improvisation using the elastic. What movements can you make? What do you look like?

Arms and legs - seated (put the elastic around the feet and hold the elastic in the hands)

- Row, row, row your boat…
- Point the toes

Legs (seated, tie the elastic in a knot and put the elastic around the ankles)

- Open and close the legs like scissors
- Lift one leg up to the sky
- Turn the feet out and touch the little toe to the floor

Let's do the Hokey-Pokey…(Using right and left sides of the body)

Week two: Session One

Apparatus: 55cm Swiss balls

Goals:

- To experience activities working in pairs
- Focus on arm and leg strength
- Body awareness and movement development
- Flexibility and cardio-respiratory endurance

Session structure:
Two groups, 20 minutes each
Pairs, sharing a ball

Activities:
Tell your partner what to do

Seated/Bouncing

- bounce as high as you can
- small bounces
- open and close the legs
- clap your hands
- arms on your head
- roll your hips from side to side
- both of you sit on the ball
- experimentation

Standing

- bounce the ball with your hands
- lift the ball up to the sky
- give the ball a huge bear hug
- roll the ball to a partner
- throw the ball to a partner standing nearby
- lift the ball up above your head and pass it to your partner behind you; in front of you
- stand back to back and pass the ball to your partner round the side of the "house"

Moving

- carry the ball and move around without touching anyone
- roll the ball in front of you; forwards and backwards
- draw a house on the floor while rolling the ball

Lying over the ball

- make like a see-saw and roll forwards and backwards over the ball
- roll on the ball and draw a big tree, cloud, etc.

Stretching (same as before)

Session Two

Class outing to the fire station.

Week 3: Session One

Modified Hoosier Evaluation

Apparatus: four buckets, 24 balls, four small chairs

Goal:
- To execute the Modified Hoosier correctly working in pairs. Test description given clearly in Appendix D.

Activity:
Measuring aerobic capacity.

Session Two

No session due to painting of school.

Week 4: Session One

Apparatus: Reebok Steps, light resistance Therabands

Goals:
- experimenting with fundamental locomotor skills (movement development)
- introducing obstacles and changing the environment (movement development)
- cardio-respiratory and strength (arms and legs) activities
- body awareness

Session Structure:
Two groups, 20 minutes each

Activities:
Jumps – let's see who can jump on the spot:
- with arms out like an aeroplane
- marching like a soldier
- with feet wide apart
- with arms hugging yourself tightly

Basic locomotor movements– let's see who can:
- walk like a crab
- walk like a spider
- walk like a fairy
- skip around the room
- skip with a friend
- turn around while skipping
- gallop like a horse
- slide with your back against the wall all around the room
- hop on the spot
- hop sideways

Jumps/hops on the steps (steps set out alongside each other)– let's see who can jump/hop:

- from 1 leg to the same leg
- from 1 leg to the opposite leg
- sideways from 1 step to another
- with 2 legs
- over the steps
- and turn in the air
- off the steps

These activities are done with one child following the other in a line. Start off slowly and then speed it up.

Therabands (Pairs):
Sitting on steps across from each other. Elastic in each hand, both children pull backwards. Arms at side pulling elbows back past waist.

- Row, row, row your boat…

<u>Session Two</u>

Apparatus: Stethoscopes

Goals:

- To allow children to listen to his/her own heart beat before and after aerobic exercise
- Exercise education
- Body awareness and gross motor skills (movement development)
- Cardio-respiratory activity
- Flexibility

Class structure:
Two groups, 20 minutes each

Activities:
Education – the heart and exercise

- What does the heart do?
- Can you hear your heart beat (using the stethoscope)?
- What happens to my heartbeat if I jump around?
- Can you feel your heart beat?

"Aerobics"

- Run around without touching anyone
- Move backwards without touching anyone
- Make yourself as tall as a giraffe; as thin as a pin (Jumping jacks with intermittent intervals in changing positions)
- Take 2 big steps to the right; and two to the left
- Cross-country skiing
- Let's do the "can-can"
- Stuck-in-the-mud

Stretching (standing)

- Make a big circle with your arms in front of you
- Lift your arms up to the ceiling
- Arms at your side and let the one side flop like a rag-doll
- Make a small ball with your body
- Hold onto the wall and lift your one foot to the bottom to look like a flamingo

Stretching (sitting/lying)

- Sit with one leg straight and the other bent. Reach for the toes of the straight leg. Change legs.
- Lying on your back, make yourself as long as you can

Week 5: Lesson One

Apparatus: 55 cm Swiss balls

Goals:

- To encourage creativity in movement whilst working in small groups or pairs (movement development)
- Flexibility
- Strength
- Balance

Class structure:
2 groups, 20 minute session
Small sub-groups

Activities:

- Who can balance with their tummy on the ball?
- Which group can fit with three children sitting on the ball?
- What can you build with the ball? E.g. one child sitting with the ball between the feet, another lying over the ball, and the third lying on the ground with their feet on the ball.
- How can you balance on the ball? BE CAREFUL!
- How can the ball balance on you?
- In pairs, both children lying on the floor on opposite sides of the ball with their feet up on the ball, knees bent. Roll legs from side to side.

Session Two

Apparatus: High resistance Therabands

Goals:

- To allow children to experiment in a small group set up and in pairs using new apparatus/activities
- Body awareness
- Strength

Class structure:
2 groups, 20 minute session
Small sub –groups

Activities:
- "Human chairs" – Children divide into groups of 3. Two children cross their arms and hold hands. The third child sits on the "chair" created.
- "Wheelbarrows"- Children work in pairs. The one child lies face down on the floor. The other child takes his partner's ankles and lifts his partner's body off the ground. The child lying face down is thus lifted up onto his hands and moves forward in a "wheelbarrow" fashion.
- How does the wheelbarrow move? Can I move slowly or quickly? Can I move forwards and backwards?
- "Elastic slings" – children work in groups of 4. 2 children hold the high resistance elastic tightly. 1 child leans back into the elastic and relaxes. The fourth child stands behind the 1 resting on the elastic to make sure he/she doesn't fall. BE CAREFUL!

Stretching:
Same as before

<u>Week 6: Session One</u>

Apparatus: 55 cm Swiss balls

Goals:
- Body awareness and spatial awareness (movement development)
- Flexibility
- Strength

Class structure:
Two groups, 20 minute per session
Pairs

Activities:
Standing: Let's see who can-
- Throw the ball to their partner
- Catch the ball from their partner
- Bounce the ball to their partner
- Bounce the ball off the wall to their partner
- Pass the ball to their partner over their head
- Stand back-to-back and pass the ball around the side of the house
- Stand face-to-face and lift the ball above their heads

Seated: Let's see who can-
- Roll the ball to their partner (close and far) with their hands
- Roll the ball to their partner with their legs
- Throw the ball to their partner
- Catch the ball from their partner

Moving (child on either side of the ball): Let's see who can-

- Roll the ball to the side and move like crabs
- Roll the ball in a zig-zag pattern
- Roll the ball moving forwards and backwards
- Roll over the ball so that arms and legs go over the ball (partner helps)

Session Two

Apparatus: Light and heavy resistance Therabands, small soft balls.

Goals:

- to experience resisted and "limited" movement (movement development)
- body awareness and lateral awareness

Class structure:
2 groups, 20 minute sessions
Pairs and small groups

Activities:

- "3-legged walk". Children stand side-by-side and tie their touching legs with an elastic thus creating a "3-legged" structure
- Who can walk with 3 legs?
- Who can move sideways like a crab with 3 legs?
- Who can move slowly backwards with 3 legs?
- Who can walk in a circle with 3 legs?

- "Joint-legged walk" (3 +). The above-mentioned exercise is repeated attempting to tie as many children together as possible.
- How many legs can you use to walk?
- Who can walk slowly backwards?
- Who can walk in a circle?

- Resisted-elastic run. Children are divided into pairs. An elastic is placed around the waist of one child and he/she attempts to run away from the other child holding the elastic.
- Who can run away in a zig-zag pattern?
- Who can move backwards slowly?

In pairs, one child has the elastic tied around his/her right arm. The partner gives instructions on how to move to the left or right.

- Take 4 big steps to the right
- Turn your body in circles and move to the left, etc.

Week 7: Session One

Apparatus: Steps – various heights

Goals:
- Gross motor movement (movement development)
- Spatial awareness
- Strength and cardio-respiratory
- Creativity and experimentation

Class structure:
2 groups, 20 minutes

Activities on steps of various heights:
Jumping: Let's see who can jump/hop from one step to another –
- On two feet
- From one foot to the opposite foot
- From one foot to the same foot
- And turn on the step
- And open their legs as wide as the steps
- And jump of the step and land on two feet
- And jump off the step and land on one foot

Let's see who can-
- Jump over the steps
- Jump sideways over the steps

Let's see who can-
- Wriggle like a worm under the steps on their tummies
- Wriggle like a worm under the steps on their sides
- Who can change the order of the steps so the course changes

One child follows the next through the course. Start off slowly and then speed it up.
- Let's see who can skip/slide sideways/hop from the last step to the back of the line

<u>Session Two</u>

Apparatus: Rope

Goals:
- Concentration
- Gross motor movement (movement development)
- Cardio-respiratory

Class structure:
2 groups, 20 minutes

Activities:
- "Snaky". The programme administrator stands in the middle of the group and rotates in a clockwise direction holding the rope on the ground. The children attempt to jump over the moving rope. Once a complete 360 degree rotation has been made, the

programme administrator rotates in an anti-clockwise direction dragging the rope along the floor for the children to jump over.

- Let's see who can jump over the rope
- Let's see if we can get the rope to make a full circle

- Stationary rope jumps – various heights. The rope is held between two people providing various heights for the children to jump over move under.

Let's see who can-

- Jump over the rope
- Jump sideways over the rope
- Turn around and jump the other way over the rope
- Crawl under the rope
- Climb over the rope like a dog on all four legs

- Moving rope jumps – various heights. The rope is held between two people providing various heights for the children to jump over whilst the rope is moving in various patterns

Let's see who can-

- Jump over the rope
- Jump sideways over the rope
- Turn around and jump the other way over the rope

Week 8: Session One

Apparatus: Steps – various heights

Goals:

- Gross motor movement (movement development)
- Spatial awareness
- Strength and cardio respiratory
- Creativity and experimentation

Class structure:
2 groups, 20 minutes

Activities on steps of various heights:
Jumping: Let's see who can jump/hop from one step to another –

- On two feet
- From one foot to the opposite foot
- From one foot to the same foot
- And turn on the step
- And open their legs as wide as the steps
- And jump of the step and land on two feet
- And jump off the step and land on one foot

Let's see who can-

- Jump over the steps
- Jump sideways over the steps

Let's see who can-
- Wriggle like a worm under the steps on their tummies
- Wriggle like a worm under the steps on their sides
- Who can change the order of the steps so the course changes

One child follows the next through the course. Start off slowly and then speed it up.

Session Two

Apparatus: 55cm Swiss Balls

Goals:
- Concentration
- Gross motor movement (movement development)
- Cardio-respiratory
- Flexibility
- Balance

Class structure:
2 groups, 20 minutes

Activities:
- "Snaky". The programme administrator stands in the middle of the group and rotates in a clockwise direction holding the rope on the ground. The children attempt to jump over the moving rope. Once a complete 360 degree rotation has been made, the programme administrator rotates in an anti-clockwise direction dragging the rope along the floor for the children to jump over.
- Let's see who can jump over the rope
- Let's see if we can get the rope to make a full circle

- Stationary rope jumps – various heights. The rope is held between two people providing various heights for the children to jump over move under.

Let's see who can-
- Jump over the rope
- Jump sideways over the rope
- Turn around and jump the other way over the rope
- Crawl under the rope
- Climb over the rope like a dog on all four legs

- Moving rope jumps – various heights. The rope is held between two people providing various heights for the children to jump over whilst the rope is moving in various patterns

Let's see who can-
- Jump over the rope
- Jump sideways over the rope

Turn around and jump the other way over the rope

- Tug-of-war. Children are divided into two groups. The two groups stand facing each other holding the rope with one metre distance between the front people in each group. A marker is place on the floor between the two people in the front of the groups. When instructed to, the groups pull as hard as they can to pull their opponents across the demarcated area.

Balls
Seated/Bouncing
- bounce as high as you can
- small bounces
- open and close the legs while bouncing
- clap your hands
- arms on your head
- roll your hips from side to side without bouncing
- roll over the ball on your tummy
- experimentation

Stretching (standing)
- Make a big circle with your arms in front of you
- Lift your arms up to the ceiling
- Arms at your side and let the one side flop like a rag-doll
- Make a small ball with your body
- Hold onto the wall and lift your one foot to the bottom to look like a flamingo

Stretching (sitting/lying)
- Sit with one leg straight and the other bent. Walk your fingers forward like a spider to the toes of the straight leg. Change legs.
- Lying on your back, make yourself as long as you can

Appendix G

FITKIDZ Progress Report

Child's name: ____

Physical evaluation	Child (pre-test)	Child (post-test)	Class average (post testing)
Height			
Weight			

Comments: ____
____
____
____
____
____

Fitness components	Child's response to programme	Class average response to programme
Aerobic: Modified Hoosier Shuttle		
Abdominal Strength: Curl-ups		
Flexibility: Trunk lifts		
Flexibility: Sit-and-reach		
Body composition: Body Mass Index		
Body composition: Fat percentage		

Comments: ____
____
____
____
____
____

Gross motor/movement analysis:

Comments: ____
____
____
____

Dear Parent/Guardian

It has been a busy couple of months for your children, Keryn and myself. Tuesday and Thursday mornings have been full of activity and learning. It has been our goal to expose your child/children to a new form of movement so as to include them in my study.

For my thesis I am looking at the relationships between fitness and locomotor co-ordination. I have included a general breakdown of your child's progress in the form of an individual report.

If we look at fitness, it is clear to see that it is a product of many factors. These include the following components: flexibility, aerobic fitness, strength and body composition. During the programme we have included activities that have allowed each of these to possibly develop.

Locomotor co-ordination (how one moves from place to place) evolves from a basic skill and it is essential that these skills be learnt at a young age. Without these fundamental skills, any progression towards more skilled movement becomes more difficult. However, there is also a natural path of progression that the young body will need to follow before achieving such skilled movement. At times it is necessary to allow the child to mature before expecting them to attain such ability.

It has been a pleasure to work with this group of children and I appreciate being given the opportunity to spend time with them.

If you would like to ask any questions, please contact me on _____________.

On behalf of Keryn and myself, I wish you and your children a very happy, healthy and fit summer.

Kind regards,

Stephanie Goedhals
(Programme Organiser)

Appendix H

Quantitative Statistics

FITNESS COMPONENTS

CARDIO-RESPIRATORY
Ho: There has been no improvement in the cardio-respiratory performance.
Ha: There has been an improvement in the cardio-respiratory performance.
Alpha: 5%
Test statistic: t
t-Test: Paired Two Sample for Means

	pre	*post*
Mean	31.68421	32.63158
Variance	36.45029	30.24561
Observations	19	19
Pearson Correlation	0.662232	
Hypothesized Mean Difference	0	
Degrees of freedom	18	
t Stat	-0.86636	
P(T<=t) one-tail	0.198847	
t Critical one-tail	1.734063	

<u>Conclusion:</u>
The value of the test statistic is t= -0.866, and its p-value is 19.9% and is therefore bigger than the alpha of 5%. Thus we do not reject the null hypothesis and there has been no improvement in the cardio-respiratory performance after the programme.

STRENGTH
Ho: There has been no improvement in the level of strength.
Ha: There has been an improvement in the level of strength.
Alpha: 5%
Test statistic: t

t-Test: Paired Two Sample for Means

	pre	*post*
Mean	5.421053	8.684211
Variance	6.035088	14.33918
Observations	19	19
Pearson Correlation	0.397299	
Hypothesized Mean Difference	0	
df	18	
t Stat	-3.94763	
P(T<=t) one-tail	0.000472	
t Critical one-tail	1.734063	

Conclusion:
The value of the test statistic is t =1.734 and its p-value is 0%. The p-value is therefore smaller than the alpha of 5% and thus we reject the null hypothesis. There has been an improvement in the level of strength.

FLEXIBILITY

Ho: There has been no improvement in the level of flexibility.
Ha: There has been an improvement in the level of flexibility.
Alpha: 5%
Test statistic: t

SIT AND REACH

t-Test: Paired Two Sample for Means

	pre	*post*
Mean	3.026316	5.789474
Variance	8.513158	16.98099
Observations	19	19
Pearson Correlation	0.524927	
Hypothesized Mean Difference	0	
df	18	
t Stat	-3.35715	
P(T<=t) one-tail	0.001755	
t Critical one-tail	1.734063	

TRUNK LIFT

t-Test: Paired Two Sample for Means

	pre	*post*
Mean	26.94737	32.13158
Variance	55.7193	24.60673
Observations	19	19
Pearson Correlation	0.598094	
Hypothesized Mean Difference	0	
df	18	
t Stat	-3.76448	
P(T<=t) one-tail	0.00071	
t Critical one-tail	1.734063	

Conclusion:
In order to determine whether or not there was an improvement in the level of flexibility, it is important to consider the sit and reach as well as the trunk lift exercises. In the case of the sit and reach, the test statistic is t = -3.357 and the p-value is 0.00%. The p-value is therefore smaller than the alpha of 5% and thus we reject the null hypothesis. In the case of the trunk lifts, the test statistic is t = -3.764 and the p-value is 0.00%. The p-value is therefore smaller than the alpha of 5% and thus we reject the null hypothesis. Thus we can conclude that there has been an improvement in the level of flexibility.

BODY COMPOSITION

Ho: There has been no improvement in the body composition.
Ha: There has been an improvement in the body composition.
Alpha: 5%
Test statistic:

FAT %

t-Test: Paired Two Sample for Means

	Pre	*Post*
Mean	18.15263	18.28947
Variance	10.84819	15.24433
Observations	19	19
Pearson Correlation	0.792181	
Hypothesized Mean Difference	0	
Degrees of freedom	18	
t Stat	-0.24944	
P(T<=t) one-tail	0.402921	
t Critical one-tail	1.734063	

BODY MASS INDEX

t-Test: Paired Two Sample for Means

	Pre	*Post*
Mean	17.44703	16.97549
Variance	2.241974	3.203997
Observations	19	19
Pearson Correlation	0.856698	
Hypothesized Mean Difference	0	
Degrees of freedom	18	
t Stat	2.224434	
P(T<=t) one-tail	0.019576	
t Critical one-tail	1.734063	

Conclusion:

In order to determine whether or not there was an improvement in the body composition it is important to consider the fat percentage as well as the body mass index. In the case of the fat percentage, the test statistic is $t = 1.734$ and the p-value is 40.3%. The p-value is therefore bigger than the alpha of 5% and thus we do not reject the null hypothesis. In the case of the body mass index, the test statistic is $t = 1.734$ and the p-value is 1.96%. The p-value is therefore smaller than the alpha of 5% and thus we reject the null hypothesis. Thus we can conclude that there has been an improvement in the body mass index, but no improvement in the fat percentage of the children. This therefore means that the body mass index of the children decreased.

	Cardio respiratory Component	Strength	Fat Percentage	BMI	Sit-and-reach	Trunk lifts
p-Value	0.19884	0.00047*	0.40292	0.01957*	0.00175*	0.00071*

Conclusion:
The p-values marked with the (*) indicate that statistically significant improvements were shown. Those without the (*) remained unchanged.

Appendix I

Qualitative Statistics

LOCOMOTOR CO-ORDINATION

Ho: There has been no improvement in the locomotor co-ordination.
Ha: There has been an improvement in the locomotor co-ordination.
Alpha: 5%
Test statistic: T

```
   STAT.           Wilcoxon Matched Pairs Test (gross motor.sta)
   NONPARAMETRIC
   STATS
```

Pair of Variables	Valid N	T	Z	p-level
PRE & POST	19	0.00	3.823007	.000132

Conclusion:
The value of the test statistic is T = 0.00 and its p-value is 0.000132. If this is converted to a percentage, it is equal to 0.00%, which is smaller than the alpha of 5%. Therefore we reject the null hypothesis. There is sufficient evidence to state that there has been an improvement in the locomotor co-ordination.

```
   STAT.           Descriptive Statistics (locomotor.sta)
   NONPARAMETRIC
   STATS
```

variable	mean	valid N	median	mode	freq-cy of mode	minimum	maximum	
PRE	14.2631	19	15.00	17.00	3	6.00	22.00	POST
	24.5263	19	26.00	26.00	11	20.00	26.00	

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