# EFFECTS OF AEROBIC AND PROGRESSIVE RESISTANCE EXERCISE TRAININGS ON GROSS MOTOR SKILLS AND PHYSIOLOGICAL PARAMETERS OF PRIMARY SCHOOL PUPILS IN IBADAN, NIGERIA

**BY**

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**DOCTOR OF PHILOSOPHY**
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# CERTIFICATION

I certify that this research was carried out by **Monday Omoniyi MOSES** under my supervision in the Department of Human Kinetics and Health Education, Faculty of Education, University of Ibadan, Ibadan, Nigeria.

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## DEDICATION

This Doctoral thesis is dedicated to
**GOD THE FATHER, GOD THE SON AND GOD THE HOLY SPIRIT**
*Who said "though my beginning be small, my latter end shall be greatly increased".*

It is also dedicated to
my grandmother, (Madam Abigeal Monone ODEBATA),
my mother, (Mrs Omolara Elizabeth MOSES) and
my late father, (Mr Iwamotigha MOSES).

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# ABSTRACT

Gross Motor Skills (GMSs) ability in children begins to emerge and mature during the preschool and elementary years. Lack of Aerobic Exercise (AE) and Progressive Resistance Exercise (PRE) may impede qualitative patterns of GMSs and expose pupils to unhealthy lifestyle in future. Studies are available on the utilisation of AE and PRE to improve physical-physiological profiles of secondary school students in Nigeria, but gross motor skills and physiological parameters of primary school pupils have not been addressed. The study, therefore, investigated the effects of AE and PRE trainings on the GMSs, Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Heart Rate (HR), Percent Body Fat (%BF) and Body Mass Index (BMI) of primary school pupils in Ibadan, Nigeria.

The pretest-posttest, control group experimental research design was adopted. Participants were 180 (93 from public and 87 from private schools) pupils purposively drawn from primaries 3, 4 and 5 of each of the two public and private primary schools used. Systematic random sampling technique was used to assign the participants into experimental groups (AE, PRE) and control group. Each of the experimental groups was exposed to a 12-week interval training programme. Pretest-posttest data were collected using Test of Gross Motor Development (TGMD-2) (r=0.91), height meter (r=0.99), weighing scale (r=0.96), Sphygmomanometer (r=0.97), Stethoscope (r=0.98) and Skin-fold Caliper (r=0.89). Three research questions were answered and six hypotheses tested at 0.05 level of significance. Data were analysed using analysis of covariance, Scheffe post hoc test and t-test.

Primary school pupils had normal systolic and diastolic blood pressure and heart rate but were underfat, underweight and very poor in GMSs levels. There were significant effects of treatments on GMSs ($F_{(3,176)} = 257.75$, $p<0.05$), SBP ($F_{(3,176)} = 6.86$, $p<0.05$), heart rate ($F_{(3,176)} = 9.57$, $p<0.05$) and BMI ($F_{(3,176)} = 6.375$, $p<0.05$). However, there was no significant effect of treatments between the GMSs of public and private primary schools pupils as well as between the GMSs of boys and girls in primary schools. Scheffe post hoc test shows that there was a significant mean difference in GMSs among the three groups (PRE and AE, $\bar{x} = 6.4$; PRE and control, $\bar{x} = 20.0$). It further showed that the significant mean difference in SPB was between PRE and control ($\bar{x}$ = 8.0); HR was between AE and control ($\bar{x}$ = 8.7); BMI was between PRE and control ($\bar{x}$ = 1.27).

AE and PRE enhanced GMSs, SBP, DBP, HR, %BF and BMI in primary school pupils in Nigeria. Therefore AE and PRE should be emphasised in the physical education programme of primary school pupils in order to improve qualitative GMSs, body fat and body weight.

**Key words**: Gross motor skills, Physiological parameters, Aerobic exercise, Progressive resistance exercise, Nigeria primary school pupils.

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# CHAPTER ONE

# INTRODUCTION

## Background of the study

Elementary school-aged pupils typically engage in free play, running, chasing games, rope jumping and age-appropriate sporting activities that are aligned with the development of fundamental motor skills. Ferguson, etal, (1999) defined fundamental movement / motor skills (FMSs) as common motor activities with specific patterns and that they are the general skills that form the basis for the more advanced and specific motor activities, such as sport skills. According to the Movement Skill Classification System (MSCS) formulated by Burton and Miller (1998), FMSs are related to specialised and context-specific movements. The classifications of FMSs, according to Gambetta (1996), consist of locomotor skills, non-locomotor (stability) skills, movement awareness and body awareness. Gambetta (1996) further classified locomotor skills into walking, running, leaping, hopping and jumping; stability skills consist of movements like turning, twisting, swinging and balancing; movement awareness includes those abilities needed to conceptualise and form an effective response to sensory information; and body awareness is the knowledge of one's own body parts and their movement capabilities which include spatial awareness, rhythmic awareness, directional awareness, vestibular awareness (the basis for balance and body position), temporal awareness (timing mechanism in the body), and visual awareness (Houwen, Visscher, Lemmink and Hartman, 2009).

Motor skills are acts or tasks dependent on practice and experience for their execution (Payne and Isaacs, 2002). The term motor refers to underlying biological and mechanical factors that influence movement (or observable action); however, the terms ‘movement’ and ‘motor’ are frequently used interchangeably (Hui-Ching, Chien-Chih, Chih-Yun and Chih-Wei, 2005). FMSs are specifically grouped into gross motor skills and fine motor skills (Kurtz, 2007). Gross motor skills (GMSs), identified as aspect of FMSs by Ulrich (2000), are defined as motor skills that involve the large, force-producing muscles of the head, trunk, arms and legs and are used to achieve a movement task or goal such as throwing a ball to a friend or jumping over a puddle.

Haywood and Getchell (2005) and Ulrich (2000) supported the idea of Kurtz but placed emphasis on gross motor skills (GMSs) which they further grouped into locomotor and object control skills. They coined locomotor skills that include running, galloping, leaping, horizontal jumping, sliding, and hopping as those that are used to transport the body from one location to another and can be found in most games, sports, and recreational activities. Object control skills according to them refer to skills including projecting (striking a stationary ball, stationary dribbling, kicking, overhand throwing, and underhand rolling) and receiving objects (catching). Kalaja, Jaakkola, Liukkonen and Watt (2010) established that motor manipulation or object control skills involve movements that give force to objects or receive force from objects which includes throwing, catching, kicking, trapping, striking, volleying, bouncing, ball rolling and punting.

Participation in structured exercise ensures that the body systems work properly. People who do not have an exercise routine have greater risk to suffer from different ailments and diseases as they are getting older. Likewise, the development of GMSs stimulates all other domains of human development such as physiological parameters (PPs) as it involves physical activities. Gallahue and Ozmun (1998) affirmed that physical activities are forms of movement which stimulate bone mineralisation and muscle development ability of the lungs and heart to take in and transport adequate amount of oxygen to working muscles (Watson, 1993) and modify percent body fat (%BF) and body mass index (BMI)(Adeyanju, Venkateswarlu and Dikki, 2005). Blood pressure is affected by exercise in that it rises during performance as a result of increase in stroke volume and heart rate brought about by nervous and hormonal influences (Heyward, 1991). Amusa, Sohi, and Adelabu, (1988); Agbonjinmi and Amusa, (1990); and Muritala (2004) confirmed that PPs comprises of blood pressures, blood lipids and lipoproteins, heart rate, vital capacity, body composition, bone characteristic and colon functions. But this study only considered blood pressure (systolic and diastolic), heart rate and body composition (%BF and BMI).

Wilmore and Costill (1994) submitted that obesity and low initial levels of fitness reduce physiological efficiency and combining these biomechanical and physiological limitations, lead to a reduced running economy, though this seems to improve with age from 8 to 20 years. Heyward (1991) was of the idea that although pupils are biomechanically and physiologically inefficient, they rely heavily on aerobic metabolism for exercise. Nevertheless, pupils have less glycogen stored per gram of muscle along with less phosphofructokinase, an important glycolytic enzyme. They also have lower creatine phosphate stores per gram of muscle (Sharp and Reed, 1992). Pupils are thus unable to generate the low blood pH or high blood lactate values that are associated with anaerobic work (Malina, 1991).

Participation in programmed exercise activities is dynamic in nature and can be quite demanding to the point of creating changes in body systems. Watts, Jones, Davis and Green (2005) posited that majority of studies in overweight or obese pupils and adolescents have focused on Aerobic Exercise (AE) which is a long duration exercise that relies on the presence of oxygen for the production of energy; it may be used to control body weight, reduce the percentage of body fat, improve the circulatory function, and reduce blood pressure. AE may decrease body fat, attenuate the loss of lean body mass normally seen during dietary energy restriction and mediate the accumulation of visceral adipose tissue but the latter is associated with cardiovascular risk in the paediatric population (Owens, Humpel, Salmon and Oja, 2004). Gabbard (2000) emphasised that as pupils are naturally more aerobic, it would be useful to know if aerobic capacity is trainable in them. Improvements in aerobic capacity rely on the development of anaerobic metabolism, since anaerobic glycolysis is the starting point for aerobic glycolysis.

Progressive Resistance Exercise (PRE) is a form of strength training in which each effort is performed against a specific opposing force generated by resistance. PRE is used to develop the strength and size of skeletal muscles. Properly performed, PRE can provide significant functional benefits and improvement in overall health and well-being. The goal of PRE, according to the DeMello-Meirelles and Gomes (2004) is to gradually and progressively overload the musculoskeletal system for it to get stronger. Campos, Luecke and Wendeln (2002) showed that regular resistance training will strengthen and tone muscles and increase bone mass. Resistance training should not be confused with weightlifting, powerlifting or bodybuilding, which are competitive sports involving different types of strength training with non-elastic forces such as gravity of weight training or plyometrics and an immovable resistance such as isometrics, usually the body's own muscles or a structural feature such as a doorframe (Abass, 2005; Kraemer, William, Zatsiorsky and Vladimir, 2006).

Structured Aerobic and progressive resistance exercises programmes for pupils from walking to six years that incorporate fundamental skills provide the foundation for all sports as well as for an active and healthy future. Such programmes provide a broad range of ideas and activities that are specifically designed to help young pupils enjoy physical activity. The study conducted by Wiese-Bjornstal (2004) recommended that those planning physical activity for pupils should greatly de-emphasize competition with others during the early childhood years. Instead, emphasis should be placed on skill development, teamwork, personal improvement, and social interaction skills and on the positive effect associated with participation.

From observation, it was noted that primary school pupils in Ibadan like to exhibit what the knowledge acquired. Also physical education professionals are not readily available in primary schools. Where they are available, they are made to teaching all subjects without giving priority to their profession so that they would be able to teach the mechanisms of movements. When exposed to structured AE and PRE training programmes, they should be able to incorporate basic defensive and offensive strategies in racket games (table-tennis, tennis, badminton) and ball games (football, volleyball, basketball); combine skills to participate in a different individual, team and dual sports (soccer, tennis, track and field, team handball, hockey and tumbling); and demonstrate one or more of the following dance or rhythmic activities: folk, social, creative, aerobic, modern, jazz, rhythmic activities such as rope jumping. Hence, the study investigated “Effects of Aerobic Exercise and

Progressive Resistance Exercise trainings on Gross Motor Skills and Physiological Parameters of Primary School Pupils in Ibadan, Nigeria".

**Statement of the Problem**

Many of the physical/sporting activities (where performed) in primary schools are based on product assessment, "who is the best?" devoid of "how to" whereas concern for the proper movement (process) skills must come before focussing on the product in order to prevent movement deficits. Physical activities of pupils during recess and break times no not challenge some of the gifted pupils and also denying them the ability to perform a lot of organised physical activity. It is noted that many pupils have interest in physical activities but the school timetable does not give enough time for exercise trainings that may help in their general well-being and GMSs development with those in Ibadan take no exception.

Many affluent parents are not giving enough opportunities for pupils to explore and practice locomotor skills and do not usually allow their pupils to take as many risks as of previous generations leading to the fact that too many pupils are getting fatter rather than fitter. Heads of schools would not let their pupils take part in a long walking exercise because of time wasting rather they ask students to only walk one lap around the track or available space in the school environment.

Hohepa, Schofield and Kolt (2004) emphasised inculcating exercise habits in pupils and adolescents as the starting point of a life-style of regular exercise that will continue through adulthood. Early participation in quality physical activity will not only increase healthy blood pressure, heart rate, %BF, BMI and well-being in the short term but also increase the likelihood of pupils living active lifestyles and reaching their sporting potential, as they grow into adulthood.

Taking into consideration the importance of physical activities in general well-being, not much has been done on qualitative assessments of GMSs among pupils that are apparently without disabilities in physical education books and journals locally though few are available internationally. It is unclear how successful efforts have been to increase the physical activity levels of pupils but Van-Sluijs**,** McMinn and Griffin (2007) reiterated that involvement in Aerobic and progressive resistance exercises trainings can serve as a way to help pupils develop the knowledge, attitudes, gross motor skills, behavioural skills and confidence needed to maintain fundamental movement skills for physically active lifestyles.

Pupils should be taught the gross motor skills and confidence through structured exercises so that they can actually enjoy taking part in physical activity, rather than trying to avoid it at every opportunity. Observation show that pupils in primary schools in Ibadan, Nigeria were not been taught the techniques of gross motor skills as a result of unavailable physical education teachers. Studies are available on the utilisation of aerobic exercise (AE) and progressive resistance exercise (PRE) to improve physical-physiological profiles of secondary school students in Nigeria but gross motor skills and physiological parameters of primary school pupils in Ibadan, Nigeria have not been addressed. Hence, the study investigated effects of aerobic exercise and progressive resistance exercise trainings on gross motor skills and physiological parameters of primary school pupils in Ibadan, Nigeria.

**Research Questions**

The research questions answered in this study were:

1. What is the level of gross motor skills of primary school pupils in Ibadan?
2. What is the cardiovascular (systolic blood pressure, diastolic blood pressure and heart rate) level of primary school pupils in Ibadan?
3. What is the level of body composition (percent body fat and body mass index) of primary school pupils in Ibadan?

**Hypotheses**

The six hypotheses tested in this study were shown below:

1. There will be no significant difference in locomotor skills (Run, Gallop, Hop, Leap, Horizontal Jump and Slide) of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.
2. There will be no significant difference in object control skills (Striking a stationary ball, Stationary dribble, Catch, Kick, Overhand throw and Underhand roll) of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.
3. There will be no significant difference in physiological parameters (Blood pressure, Heart rate, Percent body fat and Body mass index) of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.
4. There will be no significant difference in gross motor skills of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.
5. Gender will not significantly influence gross motor skills of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.
6. Types of school will not significantly influence gross motor skills of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Delimitations of the Study**

This study was delimited to the following:

1. The randomised classic pretest - posttest quasi-experimental research design of two experimental comparison groups and one control group.
2. One hundred and eighty (180) pupils drawn from classes 3-5 of both private and public primary schools in Ibadan, Oyo State, Nigeria.
3. A 12-week aerobic and progressive resistance exercises training programme.
4. Pupils of private schools (Adem Nursery and Primary, Foko, Alaadorin, Ibadan and Sacred Heart Nursery and Primary, Oke-bola, Ibadan) and public schools (Christ Gospel School 11, Foko, Alaadorin, Ibadan and Progressive Day School 1, Foko, Alaadorin, Ibadan) in Ibadan, Nigeria.
5. Fifteen (15) trained research assistants for trainings and data collection.
6. Locomotor Skills (Running, Galloping, Hopping, Leaping, Horizontal jump and Sliding).
7. Object Control Skills (Striking a stationary ball, Stationary dribble, Catch, Kick, Overhand throw and Underhand roll).
8. Physiological parameters of resting blood pressure, resting heart rate, percent body fat (using seven site skinfold: chest, triceps, subscapular, axilla, suprailiac, abdomen and thigh), and body mass index.
9. The following instruments:
    - Test of Gross Motor Development -2 (TGMD-2) developed by Ulrich (2000)
    - Measuring Tape
    - Stethoscope
    - Sphygmomanometer
    - Skinfold calliper
    - Stop watch
10. The following measurements:
    - Total body weight using bathroom weighing scale
    - Resting heart rate using stethoscope and stop watch

- Systolic and diastolic blood pressure using stethoscope and sphygmomanometer
- Percent body fat using skinfold calliper

13. Descriptive statistics of mean and standard deviation
14. Test of Gross Motor Development -2 and Pediatrics Physiological Parameters Norms.
15. Inferential statistics of Analysis of Covariance (ANCOVA) and independent t-test were used to analyse data collected for the study. Where significant differences occurred, Scheffé post hoc test was applied, all at the 0.05 level of significance.

**Limitations of the Study**

The limitations encountered in the course of this study were:

1. The participants were volunteers and thus were not randomly chosen and their motivational levels were not totally controlled.
2. Public holidays and industrial actions embarked upon by public schools also stood as constraint to this study as two days training were carried out instead of three on the two occasions where disturbances were experienced within two non-consecutive weeks during the trainings which affected the sample size and might influence the performance of the public school pupils that participated in the study.

**Significance of the Study**

This study investigated the improvement that manifested in the gross motor skills and physiological parameters of primary school pupils following aerobic exercise and progressive resistance exercise trainings. The outcome of the study established the level of gross motor skills (GMSs) of primary school pupils in Ibadan qualitatively. It also showed the level of blood pressure, HR, %BF and BMI of primary school pupils in Ibadan.

The study is significant in that it proved that PRE better improved GMSs and physiological parameters (PPs) of pupils which would assist primary school physical education teachers to plan their training programmes. The outcomes of this study showed that primary school pupils involved have very poor GMSs thereby illuminate the directions physical education professionals should follow in order to help pupils.

In order to plan qualitative and quantitative movement programme for pupils in the wider community, it is important to gather information about the GMSs and PPs level of pupils, hence, this study bridged the wide gap by bringing into being local baseline information on pupils gross motor skills and physiological parameters.

**Operational Definition of Terms**

**Aerobic exercise** – a continuously low intensity exercise that relies on the presence of oxygen for the production of energy; it may be used to control body weight, reduce the percentage of body fat, improve the circulatory function, and reduce blood pressure.

**Progressive resistance exercise**- exercise in which the workload is increased in predetermined steps/intervals. The increments are sufficient to stimulate improvements but not great enough to cause damage or injury.

**Gross motor skills** – gross motor quotient obtained from locomotor skills and object control skills conversion

**Locomotor skill test**- it measures skills involved in moving the centre of gravity from one point to another.

**Object control test**- it measures skills involved in projecting and receiving objects.

**Gross motor quotient**- a numeric representation of an examinee's overall performance on the particular abilities measured by the TGMD-2 of locomotor and objects control tests.

**Physiological parameters**- some of the features needed by the systems of the body for efficient participation in physical activities e.g. Blood pressure, heart rate, percent body fat and body mass index.

**Primary school pupils:** Pupils ranges from ages 7-12 in public and private primary schools in Ibadan.

**Underfat:** level of fat in the body that is less than normal requirement in the body fat charts for boys and girls 7-18 years

**Underweight:** weight value that is less than the 5$^{th}$ percentile level in the Pupils BMI-For-Age Weight Status Categories in Corresponding Percentiles ranking

# CHAPTER TWO

# LITERATURE REVIEW

The literature review carried out in this study was on the under-listed sub-topics:

1. Exercise Prescription
2. Aerobic Exercise and Child Development
3. Progressive Resistance Exercise and Child Development
4. Introduction to Motor Development
5. Theoretical Framework of Gross Motor Skills
6. The Development of Movement Skills
7. Pupils' Physical Development and Gross Motor Skills
8. Factors Affecting Gross Motor Skill Learning
9. Gross Motor Development Patterns in Pupils
10. Basic Gross Motor Skills
11. Movement Assessment Methods in Pupils
12. Physiological Importance of Physical Activity to Pupils
13. Appraisal of the Reviewed of Literature

## EXERCISE PRESCRIPTION

One of the most challenging aspects of preventive health / health care is how exercise prescription experts approach a sedentary lifestyle and attempt to recommend and prescribe an exercise programme. Clearly, not all of sedentary individuals are willing to accept expert's advice to start exercising while others may desire to exercise yet lack the knowledge or motivation (www.PACEproject.org, 2005). Utilizing a single counseling session to implement an exercise prescription is difficult. Prior to the initial prescription of exercise, individuals are asked to complete an exercise assessment form. This form serves several purposes. First, it identifies an individual's physical activity status. Secondly, the form assesses cardiovascular risk and potential necessity for pre-exercise testing. Thirdly, the form determines the individual's performance goals. The first counseling session entail a review of the assessment form, a focused history and physical examination and a discussion of the individual's performance goals. The second session is utilized to review the individualized exercise prescription.

Exercise assessment form identifies three levels of physical activity: pre-contemplator, contemplator and active individuals (www.PACEproject.org, 2005). The pre-contemplator does not exercise nor intends to start in the near future. The contemplator either has considered starting an exercise program or is doing so infrequently and the active individual is near or achieves physical activity standards. Although PACE scores will vary with practices, approximately 10% (1 out of 10 patient visits) is pre-contemplators, 50% (5 out of 10 patient visits) are contemplators and 40% (4 out of 10 patient visits) are actives (desirable levels). The reporting bias by patients (tendency of patients to report doing more intense or frequent activity than they are actually doing) can influence the actual numbers when assessing levels of physical activity.

This patient may present roadblocks to justify their inactivity. The goal is to encourage the individual into the contemplator category (Patrick, Sallis, Long and Calfas, 1994). Contemplators are patients who do little or no regular physical activity, yet are interested in becoming more active. These individuals are ready for change, but may require additional knowledge, skill, or encouragement. Counseling goals should be directed at reinforcing benefits of exercise, addressing barriers and changing patient behavior. Contracting and setting realistic goals is an effective counseling method designed to increase activity in this group. Actives are patients already participating in physical activity at various levels of intensity. This group should be praised for their self-motivation and encouraged to continue an active lifestyle. Benefits of exercise, pitfalls in their current exercise program, and short-term goals should be reviewed and established. When an individual has decided to incorporate physical activity within their lifestyle, a personal goals analysis should briefly be performed. Recommendations for activity depend on the specific health, fitness and performance goals of the individual. A recommended model is outlined in figure 2.1.

**Fig.2.1: Model for Physical Activity Recommendations**

| | Individual's goals based on current level of fitness | Recommendations |
|---|---|---|
| 1. | Sedentary Individual | |
| | Flexibility | Initiate conditioning exercises/stretching |
| | Health benefits | Initiate low to moderate intensity leisure exercise |
| | Physical fitness | Initiate moderate intensity exercise (aerobic fitness) |
| 2. | Moderately Active Individual | |
| | Flexibility | Continue conditioning exercises/stretching |
| | Health benefits | Continue low to moderate intensity exercise |
| | Physical fitness | Continue moderate intensity exercise (aerobic fitness) |
| | Muscle strength and endurance | Initiate/continue weight training program |
| 3. | Vigorously Active Individual | |
| | Flexibility | Continue conditioning exercises/stretching |
| | Health benefits | Goal already achieved |
| | Physical fitness | Continue vigorous intensity exercise (aerobic fitness) |
| | Muscle strength and endurance | Continue weight training program |
| | Elite performance | Competitive organized sports league |

It has been shown that if exercise prescription experts take the time to write an exercise prescription, individuals are more likely to comply with the doctor's orders. A pharmacological prescription has the drug, dose, route and frequency, likewise an exercise prescription provides the clients instructions regarding exercise goals. The following sections present important components of the exercise prescription

**Physical Activity Selection**

The choice of physical activity should be based on the individual's fitness level and interest. The most effective exercises for aerobic training employ large-muscle groups that are maintained in continuous and rhythmic motion. Examples include walking, jogging, running, cycling, swimming, rope skipping, rowing and stair climbing. The most popular activity is walking. This activity requires no specialized equipment or facility. Activity selection also depends on availability of specialized facilities such as gymnasiums, pools and fitness centers. Cardiovascular goals can be established by modifying frequency, duration and intensity. Other training options, which can be used for conditioning of sedentary adults as well as children, include calisthenics, arm exercises and weight training. The latter is particularly important, since traditional aerobic conditioning regimens often fail to accommodate participants who have an interest in improving muscular strength and endurance.

It would be impractical to recommend jogging to a patient with severe osteoarthritis. For obese, elderly or arthritic individuals, it may be more practical to offer low-impact exercises designed to decrease injuries and increase compliance. Examples of low-impact activities are cycling, walking and swimming. Each exercise prescription should give specific guidance as to what activity benefit the individuals most.

**Training Frequency**

The optimal training frequency appears to be 3 to 4 sessions per week. The amount of improvement in $VO_2max$ tends to plateau when frequency of training is greater than three times per week, whereas the incidence of overall injuries increases significantly. Although improvement in cardiorespiratory fitness can occur in de-conditioned individuals exercising only 1 to 2 times per week, such regimens evoke little weight loss, stamina or endurance. Conditioned individuals, who are training less than 2 days per week, improve minimally in cardiorespiratory fitness (Wilmore and Knuttgen, 2003).

**Training Duration**

The duration of exercise required for cardiorespiratory fitness and improvement in $VO_2max$ varies inversely with the intensity. The greater the intensity the shorter the duration of exercises necessary to achieve improvement in cardiorespiratory fitness. Exercise programmes of low intensity but long duration can yield results similar to those of higher intensity and shorter duration. Current recommendations are to engage in 20 to 60 minutes of aerobic exercise excluding warm-up and cool-down. As with frequency, duration of exercise in excess of 45 minutes is associated with increasing incidence of orthopedic injury. To avoid acute injury, trainers should gradually increase frequency, duration and intensity of activity over a period of several weeks to months.

**Training Intensity**

The final and most difficult aspect of the exercise prescription is intensity. The intensity should be specifically tailored to the individual's performance goals. The optimal intensity for aerobic exercise training occurs between 50% to 85% of the functional aerobic capacity ($VO_2$max) of an individual. Deconditioned individuals should start at 20% to 40% of their $VO_2$max.$VO_2$max represents the amount of oxygen transported and used in cellular metabolism during maximal exercise.

Exercise intensity can be prescribed by several methods, the most popular of which are utilization of the target heart rate; calculated $VO_2$max or category-ratio scales for rating of perceived exertion (Fletcher, Balady and Froelicher, 1995). In most cases, it is not feasible to directly measure oxygen uptake in patients. Study showed that heart rate and oxygen uptake are linearly related during peak exercise (Fletcher, Balady and Froelicher, 1995). Thus, heart rate monitoring has become widely accepted as an indicator of exercise intensity. The recommended target heart rate (THR) should be 65% to 90% of maximum heart rate (MHR). This heart rate range is for improvement/maintenance of $VO_2$max. This method of calculating THR has come under some scrutiny because the variability of age-predicted heart rate maximums.

Furthermore, recent data suggest the use of the 220 minus specific age. Formula significantly underestimates the MHR, especially in the elderly population (Fletcher, Balady and Froelicher, 1995). The alternate method to calculate THR employs the use of heart rate reserve (HRR) - the Karvonen equation. First, calculate the MHR. Women subtract their age from 220 and men subtract one-half their age from 205. The second step is to determine the resting heart rate (RHR). Third, calculate the HRR. The HRR is MHR minus RHR. Lastly, the THR is the product of training intensity (TI), generally 40% to 60% (moderate intensity), multiplied by the HRR then adding the RHR [THR = (MHR - RHR) x %TI + RHR]. When a THR is calculated, the patient should be taught to monitor their heart rate at various stages of exercise. The easiest pulse to press is the carotid artery. It is expected that older individuals should not palpate hard when counting their pulse.

In order to calculate beats per minute an individual counts their pulse for 15 seconds and then multiplies this figure by 4. Alternatively, the radial artery can be utilized. Commercial heart rate monitors are available for interested individuals. Intensity can also be judged as a rating of perceived exertion (RPE), which can be equated to desirable heart rate during individual activities. The original scale introduced by Borg in the early 1960s is a 15 grade category scale ranging from 6 to 20, with a verbal description at every odd number that is an important adjunct to heart rate monitoring during training.

The RPE scale provides valuable information related to the amount of strain or fatigue the individual is experiencing during exercise. The original scale was actually validated in a young population to represent the actual heart rate at a given level of work. Unfortunately, heart rate maximums decline with age and therefore actual heart rates and RPE do not match. The linear relationship between heart rate and work intensity remains for individuals at all ages. The following rating of perceived exertion values should be followed: less than 12 ( light), 40% to 60% of maximal heart rate (MHR) 12 to 13 - somewhat hard (moderate), 60% to 75% of MHR 14 to 16 (hard /heavy), 75% to 90% of MHR The RPE can be a very powerful tool, particularly in populations who are uncomfortable in measuring pulse, those with arrhythmias (e.g., atrial fibrillation, atrial flutter), and patients on drugs that slow the heart rate (e.g., beta-blockers, certain calcium channel blockers). The RPE can be performed safely, efficiently and accurately without interfering aerobic activity.

Another method is to use the Rating of Perceived Exertion Scale (RPE). This is to rate perception of overall effort, according to a scale ranging from 7 - "very, very light", through 13 - "somewhat hard", to 19 - "very, very hard". This involves starting from low on the scale, and work up to a higher level. However, the RPE scale should not be used alone for regulating exercise intensity in older persons; it should be supplemented by checking pulse at intervals to see that the individuals are still within target range.

### The Exercise Session

A typical exercise session includes a warm-up period, a cardiorespiratory phase and a cool-down period. Warm-up should last five to ten minutes and is designed to prepare the body for transition from rest to the cardiorespiratory phase. A preliminary warm-up serves to stretch muscles, increase flexibility and gradually increases heart rate and circulation. An appropriate warm-up decreases the incidence of both orthopedic injury and the potential for adverse ischemic responses. Thus warm-up has musculoskeletal and cardiovascular preventive value. An ideal warm-up for the endurance phase of training should be the same activity only at a lower intensity. The cardiorespiratory phase of exercise should last 20 to 60 minutes at the individual have predetermined heart rate range or rating of perceived exertion. This phase serves to stimulate oxygen transport and maximize caloric expenditure. There appears to be little additional cardiovascular benefit beyond 30 minutes of the endurance phase. Longer exercise sessions are also associated with a disproportionate incidence of musculoskeletal injuries.

Improvement in VO2max increases linearly with increasing intensity of exercise to a peak of 80% VO2max with little additional cardiorespiratory benefit thereafter. The cool-down period follows the cardiorespiratory phase and should last 5 to 10 minutes. The cool-down period again may be the same exercise only at a much lower intensity. Exercises of a muscle stretching or muscle lengthening nature are likewise encouraged. Specific muscle groups should include extensor muscle of the back, lower leg and upper extremity. These activities will gradually decrease the heart rate and blood pressure to near resting values.

### Rate of Progression

Fitness provider's first goal should be to engage the client in a regular exercise programme at an acceptable minimum frequency. Thereafter, emphasis is placed first on increasing frequency, second on increasing duration, and lastly, on increasing intensity. It is best to maximize the preceding variable prior to increasing subsequent variables. The rates of progression can be separated into 3 phases: initial conditioning phase; improvement conditioning phase; and maintenance conditioning phase. The benefits derived from each of these phases depend on the client's age, current level of fitness, intensity of their physical activity programme and individual goals. In general, the benefits of physical activity represent a dose-response curve. The initial conditioning phase lasts approximately 4 to 6 weeks. During this phase, training effects should be appreciated. These are a decrease in resting heart rate, more rapid recovery of resting heart rate following physical activity, and the ability to increase duration and intensity without increasing fatigue. The improvement-conditioning phase lasts approximately 4 to 6 months. Clients can be progressed to reach target heart rates or desired duration of physical activity.

It is best to first increase the duration of activity to the desired length and then increase the intensity. The client will continue to enhance cardiorespiratory fitness resulting in improved endurance and resistance to early fatigue.

Most clients enter the maintenance-conditioning phase after 6 months of regular exercise. Individuals will have obtained the desired level of cardiorespiratory fitness and do not need to increase their duration or intensity of exercise. Emphasis may be refocused from an exercise programme involving primarily fitness activities to one that includes a more diverse array of enjoyable activities. Clients should be advised that different forms of exercise or activities of similar intensity can be employed to maintain interest in exercise. The use of a structured exercise programme can facilitate clients through the phases of conditioning. Three fitness levels are assigned: beginner, intermediate and advanced. The clients should be assigned to one of these levels based on their level of fitness. Prior to initiating an exercise programme, stress the importance of maintaining a training log.

Pupils and older people are repeatedly told about the benefits of physical exercise - how it can help in losing weight, lower blood pressure, improve cholesterol levels, lower blood sugar and slow down osteoporosis. To begin with, people often wonder if it's safe to start exercising at an advanced age. In fact, there are few health reasons to discourage the elderly from exercising. In particular, chronic diseases, such as diabetes or even heart failure, need not be a barrier so long as they are under control. Exercise can actually improve such conditions, when done correctly with the full approval of your physician (http://weboflife.ksc.nasa.gov/exerciseandaging/chapter2.html, 2005). There is a helpful list of checkpoints client can use to see if he/she needs to contact physician before continuing with exercise programme. Any man over 40 or woman over 50 should talk to their physician before starting any vigorous physical activity, whether it is endurance or resistance training.

**Muscle Conditioning**

A comprehensive exercise prescription should contain instructions on muscular endurance and muscular strengthening. Muscular endurance is best developed by utilizing lighter weights with greater number of repetitions, while muscular strengthening, which uses heavier weights with fewer repetitions. Muscle conditioning can be accomplished best by means of static (isometric) or dynamic (isotonic or isokinetic) exercises. Resistance training for the average individual should be performed at rhythmical, slow to moderate speed through a full range of motion utilizing the major muscle groups. In resistance training, 8 to 10 repetitions of each exercise should be performed or until volitional fatigue (if prior to minimum number of repetitions). Different muscle groups should be used and exercises performed 2 to 3 times per week. Small hand-held weights or wrist/ankle weights can be utilized as a means of resistance training.

Quite often, carrying out simple activities like making beds, dressing or undressing may use 50% of an elderly person's maximal physical capability. In other words, their cardiovascular ability (or aerobic capacity) has declined with age, so that exertion beyond a certain level causes a lack of adequate oxygen circulation. Aerobic capability can be increased by different types of aerobic exercise, thereby greatly improving functional ability, maintaining independence and the quality of life. To be really effective, aerobic exercises must be sustained for 15 to 20 minutes at a time; this should build up to gradually starting with 5 minutes of endurance activity. The goal should be a total of at least 30 minutes of endurance exercise, on most or all days of the week (Exercise: A guide from the National Institute on Aging, 2005).

A new client starts gradually, proceeding from moderate to vigorous exercise, if their physician approves. Moderate types of aerobic exercise include recreational sports like swimming, cycling and tennis, as well as some energetic activities around the house - mowing or raking the lawn, or scrubbing floors. More vigorous types of aerobic exercises are climbing hills (or stairs), hiking and jogging. Whatever the activity, client should incorporate adequate warm-up and stretching routines before starting, and ensure a cool-down and stretching period afterwards. It's important to do enough aerobic exercises, but not to overdo it. There are several ways to "dose" the right amount of endurance exercise. The best makes use of calculated target heart rate (THR).

A simple additional check is the talk-sing test. If individual can't talk comfortably during exercise, he/she is probably exercising in the vigorous range. On the other hand, if he/she can sing a song, he/she is not really exerting enough. Initially, people should start their exercise program in a supervised setting. He /she should stop endurance exercising promptly if any chest pain, dizziness, severe shortness of breath, extreme fatigue, or pain in your legs. Take ample fluids, and avoid extremes of heat or cold are noticed when exercising.

**Strength Exercise**

Strength training is increasingly recognized as playing an important role in the health of the elderly. People lose 20% to 40% of their muscle tissue, as they get older. Strength or resistance exercises help restore this muscle tissue, and improve flexibility, coordination and balance. They can also help with weight control (though not to the same extent as most types of aerobic exercise). Increased muscle strength can protect vulnerable joints and the lower back, and resistance training can slow the loss of bone that occurs in osteoporosis. Most strength exercises involve lifting or pushing a weight against gravity, repeated a number of times (reps); the weight and the number of repetitions determine the effort expended. Usually two or three "sets" of 8 to 15 reps are done for each muscle group.

Participants should do resistance training on two or more days a week, but they should not exercise the same muscle group on any two days in a row. Starting with a minimum weight, 8 reps /set initially are increased gradually to 15 reps / set. Then the weight is increased slightly, with a drop back to 8 reps / set. The effort should feel hard to very hard (15 to 17 on the RPE scale). One should breathe out during the main effort part of the lift (or push), and breathe in during the return movement. Slow movements are better than fast - e.g. 3 seconds for the lift/exhale, 1 second hold, 3 seconds for the lower/exhale. (Exercise: A guide from the National Institute on Aging, 2005).

As with aerobic exercise, warm-up and stretching routines before, and stretching after the training session are important. Don't exercise if it produces pain anywhere. Increasing weights and repetitions slowly, and emphasizing correct breathing can usually avoid difficulties.

**Balance Exercises**

Falls in pupils are common causes of hospitalisation and disability. Balancing exercises, which are often modified leg and hip strength exercises, can help prevent falls. One goes through the leg and hip exercises, gradually releasing the hand holds (Exercise: A guide from the National Institute on Aging, 2005). In recent years, Tai Chi, a gentle form of ancient Chinese martial arts, has gained acceptance as a program that is especially beneficial in improving balance in the elderly. Tai Chi should only be started if your physician finds that you are healthy enough to undertake a regular exercise program, and you train with an approved instructor.

**Stretching Exercises**

Stretching routines may often seem to be an unnecessary, boring preliminary to the real exercise you are going to do. In fact, they are very important. Muscles tend to shorten during exercise, and stretching reduces the risk of muscle cramps.

Each stretch should be held for at least 10 seconds (just beyond what is comfortable) and there should be no "bouncing", which only increases the muscle tension by stimulating the "opposite" muscles (Exercise: A guide from the National Institute on Aging, 2005).

If client can't do endurance or strength exercises for some reason, stretching exercises offer an alternative. Again, client should secure physician's approval first. Certain conditions (e.g. after hip replacement, or osteoporosis) demand great care in designing such exercises. They should be done at least 3 times a week, for about 20 minutes each session. Prior warm-up is then necessary - walking or arm-pumping. To start with, a stretch exercise programme must be supervised, until you are sufficiently experienced to do it at home.

**AEROBIC EXERCISE AND CHILD DEVELOPMENT**

The review reported by Raphael (1997) referred to aerobic exercise as the one that is of moderate intensity, undertaken for a long duration. Aerobic means "with oxygen" and refers to the use of oxygen in a muscle’s energy-generating process. Many types of exercise are aerobic, and by definition are performed at moderate levels of intensity for extended periods of time. An effective aerobic exercise should involve 5-10 minutes of warming up at an intensity of 50-60% of maximum heart rate, followed by at least 20 minutes of exercise at an intensity of 70-80% of maximum heart rate, ending with 5-10 minutes of cooling down at an intensity of 50-60% of maximum heart rate (Cooper, 1968). As pupils are naturally more aerobic (Gabbard. 2000), it would be useful to know if aerobic capacity is trainable in them.

Gabbard (2000) confirmed that few studies have shown that aerobic capacity in pupils improves with aerobic training. However, Rowlands, Ingledew and Eston, (2000) argued that no study has been done that included all the following criteria: at least 12 weeks training, three times a week training, heart rate at least 160 bpm for at least 20 minutes, and using a large group plus matched controls. This would be the equivalent of an adult aerobic training programme in a well-controlled study. Rowlands et al found in their study of pupils that, when adult-type training in terms of intensity was performed, V02max improved between 7 and 26%. This suggests that pupils can improve their aerobic fitness from a training programme of adult-like intensity.

Rowlands, Ingledew and Eston, (2000) showed that because of lower lactate production, the anaerobic threshold for pupils is normally at pulse rates around 165 to 170 bpm, similar to that of trained endurance adults. With sedentary adults, the anaerobic threshold will vary from 120 to 150 bpm. Thus the optimal heart-rate-training stimulus may be relatively higher for sedentary pupils than for sedentary adults. Other evidence supporting the high-intensity stimulus theory is the fact that activity levels in pupils are not related to $V0_2$max (Rowlands, Ingledew and Eston, 2000). While pupils may not be as active now as they were in the past, they are still as aerobically fit (Armstrong and Welsman, 1994). This shows that general activity does not provide a training stimulus, and suggests that pupils have a natural fitness. Thus, to improve on their natural fitness, a reasonably tough training programme is required. One of the major physiological differences between adults and pupils is that between aerobic and anaerobic metabolism. Pupils have limited anaerobic glycolysis capabilities until post-puberty because they have much lower glycolytic enzyme activity.

To aid this, pupils have greater aerobic enzyme activity than adults and burn a greater proportion of fats during aerobic exercise. Because pupils are naturally aerobic and are good fat-burners, it thus makes sense that higher intensity training which taxes the glycolitic system, rather than the fatty acid system, would be more useful, since this is the physiological area in which pupils are limited. Eriksson et al showed that high-intensity endurance training can significantly increase the PFK enzyme activity and the peak lactate response to exercise in pupils, which suggests that the anaerobic glycolysis function can improve with training.

Arguably, improvements in aerobic capacity rely on the development of anaerobic metabolism, since anaerobic glycolysis is the starting point for aerobic glycolysis. Glycogen is first broken down into pyruvate via anaerobic glycolysis and then, with sufficient oxygen present, the pyruvate enters the Kreb's cycle to be burned in the mitochondria. In this way, anaerobic and aerobic metabolism is inextricably linked and the aerobic metabolism of glycogen, which is the most efficient and important fuel for endurance performance, cannot improve until anaerobic glycolysis develops. To support this argument, research shows that in pre-pubertal pupils anaerobic powers, measured on the Wingate tests, and aerobic power, measured with a $VO_2$max test, are highly correlated. This suggests that, at a young age, the two systems are related and possibly dependent on each other.

**Aerobic versus anaerobic exercise**

Fox and Haskell’s (1970) formula showed the split between aerobic (light orange) and anaerobic (dark orange) exercise and heart rate (shown in the figure 2.2). Aerobic exercise and fitness can be contrasted with anaerobic exercise, of which strength training and weight training are the most salient examples. The two types of exercise differ by the duration and intensity of muscular contractions involved, as well as by how energy is generated within the muscle. Initially during aerobic exercise, glycogen is broken down to produce glucose, but in its absence, fat metabolism is initiated instead. The latter is a slow process, and is accompanied by a decline in performance level.

**Fig.2.2: Aerobic versus anaerobic exercise zones**

EXERCISE ZONES

| BEATS PER MINUTE / AGE | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 65 | 70 |
|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 200 | 195 | 190 | 185 | 180 | 175 | 170 | 165 | 155 | 150 |
| VO2 Max (Maximum effort) | | | | | | | | | | |
| 90% | 180 | 176 | 171 | 167 | 162 | 158 | 153 | 149 | 140 | 135 |
| Anaerobic (Hardcore training) | | | | | | | | | | |
| 80% | 160 | 156 | 152 | 148 | 144 | 140 | 136 | 132 | 124 | 120 |
| Aerobic (Cardio training / Endurance) | | | | | | | | | | |
| 70% | 140 | 137 | 133 | 130 | 126 | 123 | 119 | 116 | 109 | 105 |
| Weight control (Fitness / Fat burn) | | | | | | | | | | |
| 60% | 120 | 117 | 114 | 111 | 108 | 105 | 102 | 99 | 93 | 90 |
| Moderate activity (Maintenance / Warm up) | | | | | | | | | | |
| 50% | 100 | 98 | 95 | 93 | 90 | 88 | 85 | 83 | 78 | 75 |

The free encyclopedia Wikipedia reported Fox and Haskell (1970)

The switch to fat as fuel is a major cause of what marathon runners’ call "hitting the wall". Anaerobic exercise, in contrast, refers to the initial phase of exercise, or any short burst of intense exertion, in which the glycogen or sugar is consumed without oxygen, and is a far less efficient process.

Operating anaerobically, an untrained 400 meter sprinter may "hit the wall" short of the full distance. There are various types of aerobic exercise. In general, aerobic exercise is one performed at a low to moderate level of intensity over a long period of time. For example, running a long distance at a moderate pace is an aerobic exercise, but sprinting is not. Playing singles tennis, with near-continuous motion, is generally considered aerobic activity, while doubles tennis, with their brief bursts of activity punctuated by more frequent breaks, may not be predominantly aerobic.

Cardio-respiratory function develops throughout childhood. Lung volume and peak- flow rates steadily increase until full growth. For example, maximum ventilation increases from 40 l/min at five years to more than 110 l/min as an adult (Wilmore and Costill, 1994). This means that pupils have higher respiratory rates than adults, 60 breaths/min compared to 40 breaths/min for the equivalent level of exercise (Sharp and Reed, 1992).

The ventilatory equivalent for oxygen is also higher in pupils, $VE/V0_2$=40 for an eight-year-old compared to 28 for an 18 year-old. This means that pupils have inferior pulmonary functions to adults. Cardiovascular function is also different for pupils. They have a smaller heart chamber and lower volume than adults. This results in a lower stroke volume than adults, both at rest and during exercise. Chamber size and blood volume gradually increase to adult values with growth. Pupils compensate for the smaller stroke volume by having higher maximal heart rates than adults have. For a mid-teenager, max heart rate could be more than 215 beats/min compared to a 20 year-old whose max heart rate will be around 195-200 bpm (Sharp and Reed, 1992). However, the higher heart rates cannot fully compensate for the lower stroke volume and so pupils' cardiac output, measured in L/min, is lower than adults (Wilmore and Costill, 1994).

Pupils can compensate a little again, as their arterial venous oxygen difference is greater. This suggests that a greater percentage of the cardiac output goes to the working muscles than in adults (Wilmore and Costill, 1994). Because of the fact that lung and heart capacity increase with age, one would expect aerobic capacity to increase accordingly. This is true in absolute terms. $V0_2$max, measured in L/min, increases from 6 to 18 years for boys and from 6 to 14 for girls. However, when $V0_2$max is normalised by bodyweight, little change is observed with age in boys, and in girls there is a slight decline after puberty. Therefore, relative to bodyweight, pupils have a Cardio-respiratory system for effective aerobic exercise. This is demonstrated by the fact that pupils can run quite well compared to adults. Indeed 10 year olds have completed marathons in very respectable times.

For the pupil, an inferior $V0_2$max, expressed in l/kg/min does not limit running endurance performance. In fact, young pre-pubescent girls have an advantage before their relative body fat increases. Instead, endurance performance is limited by poor running economy. This means that for a given pace a child requires higher oxygen consumption than an adult. Pupils have shorter limbs and a smaller muscle mass, resulting in a lower mechanical power. They have disproportionately long legs, meaning that they are biomechanically out of balance and potentially less coordinated. In addition, they have a greater surface area to mass ratio. All these factors reduce biomechanical efficiency.

Physiologically, pupils have inferior cooling mechanisms, due to low blood volume and high skin temperature. They also expend more energy per kilogram of body weight. Pupils have a higher $VE/V0_2$ ratio due to their inferior lung function and they rely more on fat metabolism because of a lack of muscle glycogen and glycolytic enzymes. Wilmore and Costill (1994) ascertained that all these factors reduce physiological efficiency. Combined, these biomechanical and physiological limitations lead to a reduced running economy, though this seems to improve with age from 8 to 20 years.

Although they are biomechanically and physiologically inefficient, pupils rely heavily on aerobic metabolism for exercise, describe them as aerobic animals. The anaerobic capacity for both boys and girls increases with age, but is not fully developed until around 20 years. The main reason for this is probably the lack of muscle mass. However, pupils also have less glycogen stored per gram of muscle along with less phosphofructokinase (PFK), an important glycolytic enzyme. They also have lower creatine phosphate stores per gram of muscle (Sharp and Reed, 1992). Pupils are thus unable to generate the low blood pH or high blood lactate values that are associated with anaerobic work (Malina, 1991). This means that the natural fatigue mechanisms from intense work that adults possess do not exist with pupils. This, along with the fact that they tend to overheat more than adults, are the major risk factors that coaches need to be aware of when training young athletes at high intensities. For instance, on sprint interval training, while they may appear to be able to keep going in that they have not developed high acidosis, their muscles will still be fatigued and they may be hot if it is warm weather or indoors

Strengthening the muscles involved in respiration, to facilitate the flow of air in and out of the lungs Strengthening and enlarging the heart muscle, to improve its pumping efficiency and reduce the resting heart rate. Toning muscles throughout the body, this can improve overall circulation and reduce blood pressure. Increasing the total number of red blood cells in the body facilitates transport of oxygen throughout the body. As a result, aerobic exercise can reduce the risk of death due to cardiovascular problems. In addition, high-impact aerobic activities (such as jogging or jumping rope) can stimulate bone growth, as well as reducing the risk of osteoporosis for both men and women.

In addition to the health benefits of aerobic exercise, there are numerous performance benefits: Increased storage of energy molecules such as fats and carbohydrates within the muscles, allowing for increased endurance. Neovascularization of the muscle sarcomeres increases blood flow through the muscles. Increasing speed at which aerobic metabolism is activated within muscles, allowing a greater portion of energy for intense exercise to be generated aerobically. Enhancing the speed at which muscles recover from high intensity exercise.

**Aerobic capacity**

Aerobic capacity describes the functional status of the cardiorespiratory system, (the heart, lungs and blood vessels). Aerobic capacity is defined as the maximum volume of oxygen that can be consumed by one's muscles during exercise. It is a function both of one's cardiorespiratory performance and of the ability of the muscles to extract the oxygen and fuel delivered to them. To measure maximal aerobic capacity, an exercise physiologist or physician will perform a $VO_2$ max test, in which a subject will undergo progressively more strenuous exercise on a treadmill, from an easy walk through to exhaustion. The individual is typically hooked up to a respirometer to measure oxygen, and the speed is increased incrementally over a fixed duration of time.

The higher a cardiorespiratory endurance level, the more oxygen transported to exercising muscles, the longer exercise can be maintained without exhaustion and accordingly the faster they are able to run. The higher the aerobic capacity of an individual the higher the level of aerobic fitness. The cooper and multi-stage fitness tests can also be used to functionally assess aerobic capacity. In most people, aerobic capacity can be improved through a variety of means, including Fartlek training.

The degree to which aerobic capacity can be improved by exercise varies widely in the human population: while the mean response to training is an approximately 17% increase in $VO_2$max, in any population there are "high responders" who may as much as double their capacity, and "low responders" who will see little or no benefit from training (Kolata, 2002). Studies indicate that approximately 10% of otherwise healthy individuals cannot improve their aerobic capacity with exercise at all (Bouchard, Claude, An, Rice, Skinner, Wilmore, Gagnon, Perusse, Leon and Rao, 1999). The degree of an individual's responsiveness is highly heritable and this trait is genetically determined according to Bouchard, etal (1999). Some older adults, especially those who have been inactive for a long time, will need to work up to these activities gradually (Kolata, 2002).

**Moderate exercises:** Swimming, Bicycling, Cycling on a stationary bicycle, Gardening (mowing, raking), Walking briskly on a level surface, Mopping or scrubbing floor, Golf, without a cart, Tennis (doubles), Volleyball, Rowing, and Dancing.

**Vigorous exercises:** Climbing stairs or hills, Shoveling, Brisk bicycling up hills, Digging holes, Tennis (singles), Swimming laps, Cross-country skiing, downhill skiing, Hiking and Jogging. The key to successful weight control and improved overall health is making physical activity a part of once daily routine. Any type of physical activity chosen to do either strenuous activities such as running or aerobic dancing or moderate-intensity activities such as walking or household work will increase the number of calories your body uses. It's easier than one thinks to perform numerous aerobic activities throughout the day.

**Mild to moderate aerobic exercises:** Short walk around the block, rake leaves, play actively with the kids, walk up the stairs instead of taking the elevator, mow the lawn, take an activity break--get up and stretch or walk around, and park your car a little farther away from your destination.

**Higher intensity aerobic exercises:** Brisk walking, jogging, bicycling, swimming, aerobic dancing, racket sports, rowing, ice or roller-skating, cross-country or downhill skiing and using aerobic equipment (i.e., treadmill, stationary bike). Aerobic activity is often coined either High Impact or Low Impact. The basic difference is that one foot always stays on the floor and supports the weight of the body in low-impact aerobics. High-impact aerobics include actions that take both feet off the floor, thus causing more jarring of the joints when the body weight hits the floor again. An example of Low Impact is walking while High Impact is jogging or jumping up and down. The point is not to make physical activity an unwelcome chore, but to make the most of the opportunities you have to be active.

It is important to start at a low intensity and increase this over the following few weeks as the exercise feels easier. For example, 20 minutes of walking, jogging or a combination of walking/jogging may be sufficient to leave you rather breathless and fairly tired at the start of your program, but as the weeks go by, you may need to increase the pace or introduce jogging up some shallow hills to achieve a further increase in fitness. To continue to increase your fitness level, you will have to increase the time spent exercising aerobically to 30 minutes per session for up to five sessions per week.

The average adult model for endurance training involves an intensity of 75% of max heart rate maintained for 20-30 minutes. If this is performed 3-5 times a week, then the average adult can expect a 25% improvement in $VO_2$max. This improvement in fitness is caused by both an increase in stroke volume and an improvement in $O_2$ respiration and metabolism in the working muscles due to increased capillaries, mitochondria and enzyme activity.

**PROGRESSIVE RESISTANCE EXERCISE AND CHILD DEVELOPMENT**

The principles of progressive resistance exercise (PRE) for increasing force production in muscles have remained virtually unchanged since they were described by DeLorme and Watkins (1948) almost 60 years ago. These principles are (1) to perform a small number of repetitions until fatigue, (2) to allow sufficient rest between exercises for recovery, and (3) to increase the resistance as the ability to generate force increases. These principles are detailed in the guidelines of the American College of Sports Medicine (ACSM, 2002), where it is recommended that loads corresponding to an 8- to 12-repetition maximum (RM) be lifted in 1 to 3 sets, training 2 or 3 days each week. An 8RM to 12RM load is the amount of weight that can be lifted through the available range of motion 8 to 12 times before needing a rest.

Traditionally, PRE has been used by young adults who are healthy to improve athletic performance. However, recent reviews have emphasized the potential health benefits of including PRE as part of the promotion of physical activity in the community (Winnett and Carpinelli, 2001; Kraemer, Ratamess and French, 2006). The potential health benefits of incorporating PRE into an overall fitness program include helping to reduce risk factors associated with osteoporosis as well as diseases such as cardiovascular disease and diabetes.

The health benefits associated with PRE also may make it a useful intervention in physical therapy. A reduced ability of muscles to generate force, due to injury, pathology, or disuse, is a common impairment in clients seen by physical therapists. If a lack of force generation by muscles is an impairment contributing to an inability to perform everyday activities, then this provides a rationale for physical therapists to apply the principles of PRE when designing treatment programmes. Despite the prevalence of impairment in the ability to exert adequate muscle force, the extent to which PRE has been used in physical therapy is not well known because of the variable use of the term "strengthening." The term "strengthening" has been criticized because of its vagueness, as it could be misinterpreted as referring to any type of muscle training exercise (Mayhew and Rothstein, 1985).

It was reported in a survey of physical therapy treatment choices for musculoskeletal impairments that between 52% and 69% of physical therapy treatments for spinal impairment included “strengthening” exercises and that up to 87% of treatments for knee impairments included “strengthening” exercises (Jette and Delitto, 1997). However, a difficulty in interpreting data such as these is the inconsistent use and perhaps overuse of the term “strengthening” and, when used, whether the exercise regimens were consistent with the principles of PRE. Therefore, the extent to which PRE has been used or is appropriate for physical therapy remains unclear. Concerns have been raised about the possible negative effects and safety of PRE. Traditionally (eg. in the area of neuromuscular physical therapy), there have been concerns that training muscles to increase force production could have a negative effect by increasing muscle spasticity (Jette and Delitto, 1997).

**Strength training**

Strength training is the use of resistance to muscular contraction to build the strength, anaerobic endurance and size of skeletal muscles. There are many different methods of strength training, the most common being the use of gravity or elastic/hydraulic forces to oppose muscle contraction. When properly performed, strength training can provide significant functional benefits and improvement in overall health and well-being including increased bone, muscle, tendon and ligament strength and toughness, improved joint function, reduced potential for injury, increased bone density, a temporary increase in metabolism, improved cardiac function and elevated good cholesterol.

Training commonly uses the technique of progressively increasing the force output of the muscle through incremental increases of weight, elastic tension or other resistance, and uses a variety of exercises and types of equipment to target specific muscle groups. Strength training is primarily an anaerobic activity, although some proponents have adapted it to provide the benefits of aerobic exercise through circuit training. Until the 20th century, the history of strength training was essentially a history of weight training. With the advent of modern technology, materials and knowledge, the methods that can be used for strength training have multiplied significantly (Coffey, 2009).

**Types of strength training**

Weight and resistance training are popular methods of strength training that use gravity (through weight stacks, plates or dumbbells) or elastic/hydraulic resistance respectively to oppose muscle contraction. Each method provides a different challenge to the muscle relating to the position where the resistance to muscle contraction peaks. Weight training provides the majority of the resistance at the initiating joint angle when the movement begins, when the muscle must overcome the inertia of the weight's mass (however, if repetitions are performed extremely slowly, inertia is never overcome and resistance remains constant). In contrast, elastic resistance provides the greatest opposition to contraction at the end of the movement when the material experiences the greatest tension while hydraulic resistance varies depending on the speed of the submerged limb, with greater resistance at higher speeds. In addition to the equipment used, joint angles can alter the force output of the muscles due to leverage and the relative overlap of actin and myosin contractile proteins.

**Resistance training**

Resistance training is a form of strength training in which each effort is performed against a specific opposing force generated by resistance (i.e. resistance to being pushed, squeezed, stretched or bent). Resistance exercise is used to develop the strength and size of skeletal muscles. Properly performed, resistance training can provide significant functional benefits and improvement in overall health and well-being. The goal of resistance training, according to the DeMello-Meirelles, and Gomes, (2004) is to "gradually and progressively overload the musculoskeletal system so it gets stronger." Research shows that regular resistance training will strengthen and tone muscles and increase bone mass (Campos, Luecke and Wendeln, 2002). Resistance training should not be confused with weightlifting, power-lifting or bodybuilding, which are competitive sports involving different types of strength training with non-elastic forces such as gravity (weight training or plyometrics) an immovable resistance (isometrics, usually the body's own muscles or a structural feature such as a doorframe)(Kraemer, William, Zatsiorsky and Vladimir, 2006).

Resistance training has two different, sometimes confused meanings - a more broad meaning that refers to any training that uses a resistance to the force of muscular contraction (better termed strength training), and elastic or hydraulic resistance, which refers to a specific type of strength training that uses elastic or hydraulic tension to provide this resistance (Ormsbee and Thyfault, 2007). Full range of motion is important in resistance training because muscle overload occurs only at the specific joint angles where the muscle is worked.

**Isometric training**

Isometric exercise, or "isometrics", is a type of strength training in which the joint angle and muscle length do not change during contraction. Isometric exercises are opposed by a force equal to the force output of the muscle and there is no net movement. This mainly strengthens the muscle at the specific joint angle at which the isometric exercise occurs, with some increases in strength at joint angles up to 20° in either direction depending on the joint trained (Kitai and Sale, 2004). In comparison, isotonic exercises strengthen the muscle throughout the entire range of motion of the exercise used.

The basic principles of strength training involve a manipulation of the number of repetitions (reps), sets, tempo, exercises and force to cause desired changes in strength, endurance, size or shape by overloading of a group of muscles. The specific combinations of reps, sets, exercises, resistance and force depend on the purpose of the individual performing the exercise: sets with fewer reps can be performed using more force, but have a reduced impact on endurance.

Strength training also requires the use of 'good form', performing the movements with the appropriate muscle group(s), and not transferring the weight to different body parts in order to move greater weight/resistance (called 'cheating').

Failure to use good form during a training set can result in injury or an inability to meet training goals - since the desired muscle group is not challenged sufficiently, the threshold of overload is never reached and the muscle does not gain in strength (Kitai and Sale, 2004). The benefits of strength training include increased muscle, tendon and ligament strength, bone density, flexibility, tone, metabolic rate and postural support. Strength training has a variety of specialized terms used to describe parameters of strength training:

- **Exercise** - different exercises involve moving joints in specific patterns to challenge muscles in different ways
- **Form** - each exercise has a specific form, a topography of movement designed to maximize safety and muscle strength gains
- **Rep** - short for repetition, a rep is a single cycle of lifting and lowering a weight in a controlled manner, moving through the form of the exercise
- **Set** - a set consists of several repetitions performed one after another with no break between them with the number of reps per set and sets per exercise depending on the goal of the individual. The number of repetitions one can perform at a certain weight is called the Rep Maximum (RM). For example, if one could perform ten reps at 75 lbs, then their RM for that weight would be 10RM. 1RM is therefore the maximum weight that someone can lift in a given exercise - i.e. a weight that they can only lift once without a break.
- **Tempo** - the speed with which an exercise is performed; the tempo of a movement has implications for the weight that can be moved and the effects on the muscle.

Feigenbaum and Pollock (1997) presented the following as the protocol that must be in a standard training schedule.

- Sets of one to five repetitions primarily develop strength; with less impact on muscle size none on endurance.
- Sets of six to twelve repetitions develop a balance of strength, muscle size and endurance.

- Sets of thirteen to twenty repetitions develop endurance, with some increases to muscle size and limited impact on strength.
- Sets of more than twenty repetitions are considered to be focused on aerobic exercise. They still use the anaerobic system, but usually at a rate through which it can consistently remove the lactic acid generated from it (see figure 2.3).

Individuals typically perform one to six sets per exercise, and one to three exercises per muscle group, with short breaks between each set - the specific combinations of reps, exercises, sets and break duration depends on the goals of the individual program. The duration of these breaks determines which energy system the body utilizes. Performing a series of exercises with little or no rest between them is referred to as circuit training which draws energy mostly from the aerobic energy system. Brief bursts of exercise, separated by breaks, are fuelled by anaerobic systems, which use either phosphagens or glycolysis.

For developing endurance, gradual increases in volume and gradual decreases in intensity is the most effective program (Rhea, Phillips and Burkett, 2003). It has been shown that for beginners, multiple-set training offers minimal benefits over single-set training with respect to either strength gain or muscle mass increase, but for the experienced athlete multiple-set systems are required for optimal progress. However, one study shows that for leg muscles, three sets are more effective than one set (Rønnestad, Egeland, Kvamme, Refsnes, Kadi and Raastad, 2007).

Beginning weight-trainers are in the process of training the neurological aspects of strength, the ability of the brain to generate a rate of neuronal action potential that will produce a muscular contraction that is close to the maximum of the muscles' potential.

**Fig. 2.3: Progressive Resistance Exercise Training Principles**

| Variable | Training goal | | | |
|---|---|---|---|---|
| | **Strength** | **Power** | **Hypertrophy** | **Endurance** |
| Load (% of 1RM) | 80-100 | 70-100 | 60-80 | 40-60 |
| Reps per set | 1-5 | 1-5 | 8-15 | 25-60 |
| Sets per exercise | 4-7 | 3-5 | 4-8 | 2-4 |
| Rest between sets (mins) | 2-6 | 2-6 | 2-5 | 1-2 |
| Duration (seconds per set) | 5-10 | 4-8 | 20-60 | 80-150 |
| Speed per rep (% of max) | 60-100 | 90-100 | 60-90 | 60-80 |
| Training sessions per week | 3-6 | 3-6 | 5-7 | 8-14 |

(Source: Siff, 2003).

Weights for each exercise should be chosen so that the desired number of repetitions can just be achieved.

**Progressive overload**

In one common method, weight training uses the principle of progressive overload, in which the muscles are overloaded by attempting to lift at least as much weight as they are capable of. They respond by growing larger and stronger (Brooks, Fahey and White, 1996). This procedure is repeated with progressively heavier weights as the practitioner gains strength and endurance. However, performing exercises at the absolute limit of one's strength (known as one rep max lifts) is considered too risky for all but the most experienced practitioners. Moreover, most individuals wish to develop a combination of strength, endurance and muscle size. One repetition sets are not well suited to these aims. Practitioners therefore lift lighter (sub-maximal) weights, with more repetitions, to fatigue the muscle and all fibres within that muscle as required by the progressive overload principle.

Commonly, each exercise is continued to the point of momentary muscular failure. Contrary to widespread belief, this is not the point at which the individual thinks that he/she cannot complete any more repetitions, but rather the first repetition that fails due to inadequate muscular strength. Training to failure is a controversial topic with some advocating training to failure on all sets while others believe that this will lead to overtraining, and suggest training to failure only on the last set of an exercise (Stoppani, 2004). Some practitioners recommend finishing a set of repetitions just before the point of failure; e.g. if you can do a maximum of 12 reps with a given weight, only perform 11. Adrenaline and other hormones may promote additional intensity by stimulating the body to lift additional weight (as well as the neuro-muscular stimulations that happen when in "fight-or-flight" mode, as the body activates more muscle fibres), so getting "psyched up" before a workout can increase the maximum weight lifted.

Weight training can be a very effective form of strength training because exercises can be chosen, and weights precisely adjusted, to safely exhaust each individual muscle group after the specific numbers of sets and repetitions that have been found to be the most effective for the individual. Other strength training exercises lack the flexibility and precision that weights offer.

**Split training**

Split training involves working no more than two or three muscle groups or body parts per day, instead spreading the training of specific body parts throughout a training cycle of several days. It is commonly used by more advanced practitioners due to the logistics involved in training all muscle groups maximally. Training all the muscles in the body individually through their full range of motion in a single day, is generally not considered possible due to caloric and time constraints. Split training involves fully exhausting individual muscle groups during a workout, then allowing several days for the muscle to fully recover.

Muscles are worked roughly twice per week and allowed roughly 72 hours to recover. Recovery of certain muscle groups is usually achieved on days while training other groups. I.e. a 7 day week can consist of a practitioner training trapezious, side shoulders and upper shoulders to exhaustion on one day, the following day the arms to exhaustion, the day after that the rear, front shoulders and back, the day after that the chest. In this way all mentioned muscle groups are allowed the necessary recovery (Kraemer and Zatsiorsky, 2006).

**Fig. 2.4: Training Strategy**

| Type | Low | Medium | High |
|---|---|---|---|
| Intensity (% of 1RM) | 10-40% | 50-70% | 80-100% |
| Volume(per muscle) | 1 exercise | 2 exercises | 3+ exercises |
| Sets | 1 set | 2-3 sets | 4+ sets |
| Reps | 20+ reps | 8-15 reps | 1-6 reps |
| Session Frequency | 1 p/w | 2-3 p/w | 4+ p/w |

(Source: Siff, 2003).

A common training strategy as shown in figure 2.4 is to set the volume and frequency the same for each week (eg. training 3 times per week, with 2 sets of 12 reps each workout), and steadily increase the intensity (weight) on a weekly basis. However, to maximize progress to specific goals, individual programmes may require different manipulations, such as decreasing the weight, and increase volume or frequency (Campos, Luecke and Wendeln, 2002). Making program alterations on a daily basis (daily undulating periodisation) seems to be more efficient in eliciting strength gains than doing so every 4 weeks (linear periodisation) (Rhea, Ball, Phillips and Burkett, 2003) but for beginners there are no differences between different periodisation models (Buford, Rossi, Smith and Warren, 2007).

**Periodisation**

Periodisation is the modulating of volume and intensity over time, to both stimulate gains and allow recovery. Commonly, volume is decreased during a training cycle while intensity is increased. In this template, a lifter would begin a training cycle with a higher rep range than he will finish with. For example, a lifter might begin a training program performing sets with 8 reps (see figure 2.5). Throughout the course of his/her training program, the lifter will slowly increase the weight while slowly decreasing the reps., this is enough time for the neuromuscular system to adapt and become more efficient.

**Fig. 2.5: Periodisation of training intensity and weight increases**

| Week | Set 1 | Set 2 | Set 3 | Set 4 | Set 5 | Volume Lbs. | Peak Intensity (Last Set) | % of 1 Rep Max (Last Set) |
|---|---|---|---|---|---|---|---|---|
| 1 | 95 lb x 8reps | 100 lb x 8reps | 110 lb x 8reps | 115 lb x 8reps | 120 lb x 8reps | **4,320** | **73%** | **52.5%** |
| 2 | 105 lb x 8reps | 110 lb x 7reps | 115 lb x 7reps | 125 lb x 7reps | 130 lb x 7reps | **4,200** | **79%** | **57.75%** |
| 3 | 110 lb x 7reps | 120 lb x 7reps | 125 lb x 6reps | 135 lb x 6reps | 140 lb x 6reps | **4,010** | **84%** | **63%** |
| 4 | 125 lb x 6reps | 130 lb x 6reps | 140 lb x 6reps | 145 lb x 5reps | 155 lb x 5reps | **3,870** | **88%** | **68.25%** |
| 5 | 130 lb x 5reps | 140 lb x 5reps | 150 lb x 5reps | 155 lb x 5reps | 165 lb x 4reps | **3,535** | **94%** | **73.5%** |
| 6 | 140 lb x 4reps | 150 lb x 4reps | 160 lb x 4reps | 165 lb x 4reps | 175 lb x 4reps | **3,160** | **99%** | **79%** |

(Source: Siff, 2003).

This is an example of periodisation, where the volume decreases while the intensity and weight increases.

**Benefits of weight training**

The benefits of weight training include greater muscular strength, improved muscle tone and appearance, increased endurance, enhanced bone density, and improved cardiovascular fitness. Many people take up weight training to improve their physical attractiveness. Most men can develop substantial muscles; most women lack the testosterone to do this, but they can develop a firm, "toned" as in physique, and they can increase their strength by the same proportion as that achieved by men (but usually from a significantly lower starting point). Ultimately an individual's genetics dictate the response to weight training stimuli to some extent.

The body's basal metabolic rate increases with increases in muscle mass, which promotes long-term fat loss and helps dieters avoid yo-yo dieting. Moreover, intense workouts elevate the metabolism for several hours following the workout, which also promotes fat loss (DeMello- Meirelles and Gomes, 2004).Weight training also provides functional benefits. Stronger muscles improve posture, provide better support for joints, and reduce the risk of injury from everyday activities. Older people who take up weight training can prevent some of the loss of muscle tissue that normally accompanies aging—and even regain some functional strength—and by doing so become less frail. They may be able to avoid some types of physical disability. Weight-bearing exercise also helps to prevent osteoporosis. The benefits of weight training for older people have been confirmed by studies of people who began engaging in it even in their 80s and 90s.

The ability of the body to resist the stresses that can result from an injury can be increased by obtaining a greater amount of strength. That is true in the athletic world and it has its advantages in performing everyday activities, such as lifting or carrying objects. Strength contributes to the overall efficiency of the human body. Starting a strength training program, means you have started a new lifestyle because strength is reversible. It will decline if you do not continue to obtain a strength stimulus throughout your entire life. Stronger muscles improve performance in a variety of sports. Sport-specific training routines are used by many competitors. These often specify that the speed of muscle contraction during weight training should be the same as that of the particular sport.

Though weight training can stimulate the cardiovascular system, many exercise physiologists, based on their observation of maximal oxygen uptake, argue that aerobics training is a better cardiovascular stimulus. Central catheter monitoring during resistance training reveals increased cardiac output, suggesting that strength training shows potential for cardiovascular exercise. However, a 2007 meta-analysis found that, though aerobic training is an effective therapy for heart failure patients, combined aerobic and strength training is ineffective (Haykowsky, Liang, Pechter, Jones, McAlister and Clark, 2007).One side-effect of any intense exercise is increased levels of dopamine, serotonin and norepinephrine, which can help to improve mood and counter feelings of depression.

**Nutrition**

It is widely accepted that strength training must be matched by changes in diet in order to be effective. Adequate protein is generally believed to be required for building skeletal muscle with popular sources advising weight trainers to consume a high protein diet with from 1.4 to 3.3 g of protein per kg of body weight per day (0.6 to 1.5 g per pound) (Kleiner, 1997).

**Gender differences in mass gains**

Due to the androgenic hormonal differences between males and females, the latter are generally unable to develop large muscles regardless of the training program used (Freedson, 2000). Normally the most that can be achieved is a look similar to that of a fitness model. Muscle is denser than fat, so someone who builds muscle while keeping the same body weight will occupy less volume; if two people weigh the same but have different lean body mass percentages, the one with more muscle will appear thinner (Jensen, 1998).

The results obtained by female bodybuilders are extremely atypical: they are self-selected for their genetic ability to build muscle, perform enormous amounts of exercise, their musculature is exaggerated by very low body fat, and like many male bodybuilders their results may be enhanced by anabolic steroids (Mann, 2000). Unless a woman dedicates her life to bodybuilding, she will not achieve the same results as a professional male bodybuilder. In addition, though bodybuilding uses the same principles as strength training, it is with a goal of gaining muscle bulk. Strength trainers with different goals and programs will not gain the same mass as a male professional bodybuilder.

**Muscle toning**

Some weight trainers perform light, high-repetition exercises in an attempt to "tone" their muscles without increasing their size. The use of the word "tone" in this sense is inaccurate. Muscle tone correctly refers to the constant, low-frequency contractions that occur in all muscles, even at "rest", to prepare them for future activity. What muscle builders refer to as a toned physique is one that combines reasonable muscular size with moderate levels of body fat, qualities that may result from a combination of diet and exercise. High-repetition exercises indeed do cause hypertrophy of both slow-twitch and high-twitch muscle fibers, contributing to overall increased muscle bulk. Dieting has no effect on muscle hypertrophy of any type of muscle fiber. It may however decrease the thickness of the subcutaneous fat between muscle and skin, through an overall reduction in body fat, thus making muscle striations more visible.

**Safety concerns related to training of pupils**

Orthopaedic specialists recommend that pupils avoid weight training because the growth plates on their bones might be at risk. The very rare reports of growth plate fractures in pupils who trained with weights occurred as a result of inadequate supervision, improper form or excess weight, and there have been no reports of injuries to growth plates in youth training programs that followed established guidelines (Dowshen and Homeier, 2005; Faigenbaum, 2008).

The position of the National Strength and Conditioning Association is that strength training is safe for pupils if properly designed and supervised. Younger pupils are at greater risk of injury than adults should they drop a weight on themselves or perform an exercise incorrectly; further, they may lack understanding of, or ignore the safety precautions around weight training equipment. Safer alternatives for pupils include the use of sandbags or a lightly loaded weight vest. As a result, supervision of minors is considered vital to ensuring the safety of any youth engaging in strength training (Dowshen and Homeier, 2005; Faigenbaum, 2008).

Strength training can be a safe form of exercising, however each category has it advantages as well as disadvantages. Weight training can be one of the safest forms of exercise, especially when the movements are performed correctly. However, as with any form of exercise, improper execution can result in injury. When the trainee becomes fatigued, technique can break down. For example, the deadlift allows heavy weights to be lifted with correct technique. If the lower back fatigues and is allowed to round, the resulting uneven spinal loading can cause disk compression injuries.

A child is born with billions of neurons which need sensory stimulation in order to link together to form neural pathways. Every movement made makes connections in the mind/body systems. The development of these neural connections is vital for memory, sensory development, communication between the two sides of the brain, processing of information, participation in the arts and the later formal learning of reading, writing and mathematics (www.sparc.org.nz, 2004). Physical activity not only strengthens the connections within the brain, pupils also have an opportunity to understand concepts by exploring them physically. By experiencing concepts physically, pupils are empowered to understand them cognitively.

Physical activity increases relaxation that allows the brain to process more efficiently and assists retention and learning. Assists the brain to continue to grow and develop brain cells (neurons) and connecting pathways. Neural pathways are increased and strengthened with each new movement experience. The more connections, the more ways information can be processed. The environment and exploratory movement experiences influence how the brain wires itself up after birth. Physical activity increases oxygen and glucose (the fuels) to the brain. Quality childhood movement experiences prepare the brain for language, art, maths, science, movement, group abilities and intelligences. Physical activity triggers a transmitter that enhances learning by boosting the ability of the brain cells to communicate with each other (www.sparc.org.nz, 2004).

## INTRODUCTION TO MOTOR DEVELOPMENT

Motor refers to movements that involve large muscle groups and are generally more broad and energetic than fine motor movements (Mauro, 2008). These may include walking, kicking, jumping, and climbing stairs. Pupils with neurological problems, developmental delays, or disabilities that affect movement may receive physical therapy to help with gross motor skills, or may need modifications or assistive technology to keep up with mobility or athletics in spite of these delays.

At this age, toddler should be running, jumping, and climbing on age-appropriate playground equipment. His coordination is improving. He may begin to walk up and down stairs stepping on each step with one foot. He will enjoy playing games with running and kicking balls and climbing. Supervision is important at this age to prevent accidents. With his newfound skills, toddler may try to climb to reach objects that are not safe for pupils. Home assessment on a regular basis is needed to identify potential safety risks and to remove or secure them. Gross Motor Skills involve the large muscles of the body that enable such functions as walking, kicking, sitting upright, lifting, and throwing a ball.

Logsdon (2008) opined that gross motor skills are important for major movement functions such as walking, maintaining balance, jumping, reaching, and many others. Gross motor abilities share connections with other physical functions. A student's ability to maintain upper body support, for example, will affect his ability to write. Writing is a fine motor skill. Students with poor gross motor development, have difficulty with activities such as writing, sitting up in an alert position, watching classroom activity, and writing on a blackboard. For them, these activities can be physically draining.

FMSs establish and strengthen neural pathways. Learning the fundamental movement skills involves trying out new things, thinking, making decisions, evaluating and persisting. Pupils who have competent physical skills are more likely to have self-confidence and self-esteem. This can flow on into their approach to other aspects of their lives and also have a positive impact on their relationships with their peers. Pupils learn movement skills in a progressive order, for example from walking and hopping to skipping. Development usually begins with the head and upper body and then the feet. Baby will learn to push up with their arms and raise their head before they learn to crawl. Pupils also develop control over their body from the centre to more distant parts like feet and hands. Fundamental movement skill development is related to but doesn't depend on age and experience, as pupils learn holistically.

The prominent position of FMS is based upon the importance of motor development to pupils' physical, cognitive and social growth and development (Payne and Isaacs, 2002); the fact that the development of FMS is not automatic as a child grows and develops, but is largely influenced by environmental factors; and the understanding that FMS are the foundations of a physically active lifestyle (Gallahue and Ozmun, 2002).

These skills also appear to be related to the health of young people. For example, prior studies have shown that pupils and adolescents with greater fundamental movement skill proficiency tend to be more physically active (Okely et al., 2001b; Saakslahti et al., 1999; Ulrich, 1987); have higher levels of aerobic fitness (Okely et al., 2001a) and self-esteem (Ulrich, 1987); and are less likely to be overweight (Okely et al., 2004). Experimental studies have shown that if these skills can be well-delivered through appropriate professional development programs, teachers will respond positively and find it easy to integrate them into their teaching programme (McKenzie et al., 1998; Okely et al., 2003). Hence, the development of FMS may provide one of the better strategies for encouraging pupils' participation in physical activity.

In 1997, the New South Wales Schools Fitness and Physical Activity Survey assessed the fundamental movement skill proficiency of a representative sample of students in Years 4, 6, 8 and 10 (approximately 9.3, 11.3, 13.3 and 15.3 years of age, respectively). It found that, with the exception of one skill, the prevalence of mastery/ near-mastery did not exceed 40% for boys and girls in any one Year group (Booth, Okely et al., 1999). As a result of these findings, a recommendation was made to 'provide adequate support and resources to develop FMS among students in

New South Wales (NSW), with particular emphasis on primary school-aged pupils' (Booth et al., 1999).

In response to this recommendation, the New South Wales Department of Education and training (NSWDET, 2000) developed a resource (Get skilled: Get active) and a model of professional development, which have been widely disseminated since 1999, to enhance the teaching of FMS (NSWDET, 2000). They have also supported the evaluation of this resource through several studies, namely, the Gold Medal Fitness Program and the evaluation of the Get skilled: Get active resource (Okely and Booth, 2004; Okely et al., 2003). In addition, the two other education sectors in NSW (Catholic Education Commission, CEC; and Association of Independent Schools, AIS) promoted the resource and provided professional development workshops to support its implementation.

The development of FMS in also an integral part of the Prevention of obesity in pupils and young people: NSW Government Action Plan 2003-2007 under the 'Healthier Schools' priority area. The NSW SPANS 2004 is the first state-wide representative study of FMS among NSW pupils and adolescents since 1997. It provided the opportunity to gather data on the population mastery and socio-demographic distribution of FMS and, to examine trends in skill proficiency over the seven-year period 1997-2004.

After six weeks Motor Skills Programme carried out by Hui-Ching, Chien-Chih , Chih-Yun and Chih-Wei, , (2005) it was noticed that the experiment group had significantly improved in motor skills and cognition of movement concept. With compared the pre-test and post-test of experiment group and control group, experiment group had significantly better than control group in fundamental motor skills; but had no significant in cognition of movement concept.

After six weeks motor skills program, the experiment group had significantly correlation between fundamental motor skills and cognition of movement concept; but the control group had no significantly correlation between fundamental motor skills and cognition of movement concept. Therefore, through education motor skills will improve the ability of cognition learning, apprehension, and application. And, through meaningful motor skills experience will change the cognition learning behaviour forever. About learning motor skills, preschool pupils need an appropriate learning environment, induction and frequently exercise opportunity to develop, expert, fiddly all motor skills; not only with the maturational factor (Hsu and Hsu, 2001;Gallahue, 1997).

**Ways of Teaching a Motor Skill**

Depending on the type of skill, different methods and approaches may be used to teach a new motor skill. Massed practise involves a motor skill being practised consistently and continuously until the skill has been learned. It tends to be more suitable for highly skilled or highly motivated athletes. Boredom is the greatest disadvantage of massed practise. Distributed practise involves short, frequent practise sessions, interspersed with rest periods, or intervals of other skill learning. This tends to be more appropriate in the early stages of learning, when the energy demands of a skill are high; the learning task is complex or boring, and when motivation is low. Rest periods are valuable in providing opportunities for athletes to think about what they are doing, which may also enhance learning.

Motor skills may be taught in their entirety, whole learning, or broken down into parts, part learning. For example: a basketball lay-up shot may be taught as a whole, or broken down into the dribble, footwork, shot, and follow through, and a swimming stroke may also be taught as a whole, or swimmers may be taught the kick, arm movement and breathing separately. Whole learning may be best for simple skills and part learning for complex skills. Generally, it depends on the skill being taught and most coaches tend to combine the two as whole-part learning. Pupils learn the whole skill at times, and concentrate on parts of the skill at other times, like when they are having difficulty with a specific aspect. Whole learning increases the awareness of timing, pace, and rhythm of a complete skill, learning a skill in parts puts emphasis on learning each part correctly. It is important to teach skills correctly from the beginning, whether they are simple or complex skills.

Physical practise involves active participation in an activity, while mental practise involves the athletes visualising a performance in their minds (mental imagery) (Falola and Moses, 2010), viewing a video of their own or someone else's performance, and/or reading or listening to instructions. A combination of the two is most effective for learning: using mental practise initially, and then alternating with periods of physical activity.

**THEORETICAL FRAMEWORK IN GROSS MOTOR SKILLS**

The framework employed in the study was the dynamical systems theory (DST). Newell, (1984); Thelen and Ulrich, (1991); Magill, (2004); and Amui, (2006.) opined that dynamical systems theory is a framework that seeks to explain changes that occur during motor skill performance and the underlying factors that influence the skills. Movement, according to this theory, is considered as deriving from a complex and multifaceted interaction among the individual, the task, and the environment (Newell, 1984). Gross motor development is influenced by the interaction of cooperating sub-systems (Gallahue, 1987; Ulrich and Ulrich, 1993).

Dynamical systems theory considers the individual as a system comprising of multiple interacting subsystems such as the individuals' experience, abilities, strength, and motivation, resulting in a product that is the result of the interaction of these subsystems (Gallahue, 1991; Ulrich and Ulrich, 1993). A change in one subsystem could influence the outcome of overall performance. Factors such as difficulty of task, the size and weight of equipment, the nature of playing area, and the individuals' skill level are examples of subsystems that influence performance (Newell, 1984).

From the dynamical systems perspective, movement patterns do not develop in a series of highly predictable movements or levels, instead patterns may change over time with some probabilities (Clark and Philips, 1993; Garcia and Garcia, 2002). Human movement involves many potential movement patterns, degrees of freedom, and these variables within the system are free to vary as movement occurs. Specific patterns are involved in developing specific motor skills. Degrees of freedom within a task subsystem must be reduced to offer stability to the movement.

The stable pattern of behaviours that are observed across multiple trials and task conditions are called behavioural attractors (Clark and Philips, 1993; Langendorfer and Roberton, 2002).

Behavioural attractors are common patterns of movement occurring under specific conditions (Clark and Phillips, 1993). The resulting stable behaviour will be stable to the degree that the cooperating subsystems continue to act together (Thelen and Ulrich, 1991). Attractor pathways are the common patterns that change over time (Hamilton and Tate, 2002). Attractor states are not always stable and they may change with time due to changing relationships between subsystems or changes in constraints that also change with time (Hamilton and Tate, 2002). Dynamical systems theory suggests that cooperating subsystems are driven to self-organize and reduce the degrees of freedom that result in a more stable movement. When the individual is driven to a new attractor state or movement pattern, a control parameter initiates a perturbation that prompts the individual to move from an old inefficient movement pattern to a more stable and efficient movement form (Thelen and Ulrich, 1991).

Control parameters are physical variables within systems or subsystems. As these variables change with the system, the behaviour of the system also changes. Examples are motivation experience gained from practice and strength. Dynamical systems theorists refer to this process as a phase shift. Phase shifts are the result of gradual or sudden changes in variables or subsystems that make the body move from one pattern to another. During the process of a phase shift a lot of variability is observed in the individual's performance, but as the movement is stabilized into new patterns, performance changes (Garcia and Garcia, 2002). Sometimes a phase shift will bring about more efficient patterns of movement and in other situations phase shifts result in a regression in the movement pattern (Garcia and Garcia, 2002). For example, a child learning to catch may be scooping to catch balls tossed to him or her. But as the learner is continuously prompted to get the hand out in front, keep eyes on ball and catch with the hands; within a few trials the child starts to catch with the hands.

The control parameter in this instance is the act of the hand and tracking of the ball with the eyes. The child is now catching with the hands and this becomes the new attractor state. Control parameters are believed to be primarily responsible for the changes in movement performance. These could be variables, that when altered, allows the system to re-organize itself in a different way (Langendorfer and Roberton, 2002). Control parameters do not necessarily have to be task related but could be biomechanical or environmental factors. Parameters can be identified, by determining the essential variables of a skill or task (Southhard, 1998). Some examples are size and weight of equipment, degree of difficulty of task, and the environment in which the task will be performed. These may cause the individual to reorganize movement patterns when scaled to a critical value to achieve a stable movement pattern.

**THE DEVELOPMENT OF MOVEMENT SKILLS**

Burton (1998) established that the transformation of a helpless infant into a walking toddler in approximately one year is one of the miracles of childhood. Despite great variety in body size, degree of muscular strength, opportunity to move, and actual experience, walking is first observed in about 80 percent of all infants between 10 and 15 months after birth. The acquisition of new motor skills from birth through early childhood follows a remarkably consistent pathway allowing us as pupils, and later as adults, to interact competently with the environment.

The Center for Early Education and Development (CEED) according to Leitschuh, (2004) established that the interaction with one's environment in infancy through self-produced locomotion provides the foundation for the development of cognitive, perceptual, and social skills.

Thus, it is not surprising that the consistent sequence of early motor milestones is often used by early childhood professionals to evaluate the developmental status of skills in these three areas. All through childhood, pupils' movement competence continues to play a major role in their overall development and their ability to acquire the skills of life. Given the importance of the development of movement skills during early childhood, persons who work with young pupils should have a good understanding of: a) the developmental hierarchy of movement skills, and b) the factors which may affect the appearance and unfolding of these skills (Leitschuh, 2004).

**Developmental Hierarchy of Movement Skills**

Movement skills may be defined as identifiable movement patterns that are used to accomplish certain tasks. A better understanding of specific movement skills may be gained by categorizing them into a four-level developmental hierarchy (Leitschuh, 2004 and Burton, 1998).

**Level 1:** At the bottom of the hierarchy are reflexes, which dominate the motor behaviour of infants for the first three or four months after birth. Examples of primitive reflexes are the grasp reflex, elicited by placing an object in an infant's hand and the stepping reflex, elicited by holding an infant upright and gently bouncing his/her feet on a table or floor. Primitive reflexes afford infants their first opportunities to interact with their world, but by about four months these reflexes usually disappear. Although these responses are apparently not under the direct control of the infant, some experts believe they help to establish the frames of reference between the infant's eyes, head, trunk, and limbs necessary for successful voluntary motor behaviour.

**Level 2:** The early locomotor milestones--including rolling over, creeping, crawling, standing, walking with support, and walking independently--are at the next level up the hierarchy. These locomotor milestones usually appear between four to thirteen months, with the onset of independent walking marking the end of infancy and the beginning of toddlerhood. About 85-to- 90 percent of all infants demonstrate these skills in the same chronological order, with the others either skipping a skill (e.g., going directly from rolling over to standing) or showing alternate skills (e.g., scooting in a sitting position). In the 1950s and 1960s some theorists hypothesized that infants who do not show the "normal" sequence of early locomotor milestones are at greater risk for learning and/or speech problems, but there has been little evidence reported to support this notion.

**Level 3:** The third level comprised of what are usually called fundamental motor skills which emerge from the end of infancy to about six or seven years of age. These include locomotor skills such as running, jumping, hopping, galloping, and skipping, and object control skills such as throwing, catching, striking, kicking, and dribbling. Walking, the last early motor milestone might also be considered to be one of the fundamental motor skills. The term "fundamental" suggests that these skills provide the foundation for the learning of other more specialized movement skills. The movement skills at the first three levels of the hierarchy sometimes are referred to as phylogenetic (development of a species) skills, meaning they are common to all human beings.

**Level 4:** At the top level of the hierarchy are specialized movement skills sometimes referred to as ontogenetic (development of an individual) skills because they are not demonstrated by all persons, but are specific to the needs and interests of a particular person. There are many specialized movement skills, which are more specific forms of fundamental motor skills. They include such movements as the windmill pitch in softball or new skills created by combining fundamental motor skills, such as volleyball spike which combines jumping and striking. Although specialized movement skills are observed in earlier years, they are primarily learned after fundamental motor skills are intact, from about six-to-seven years and throughout a person's lifetime.

**PUPILS' PHYSICAL DEVELOPMENT AND GROSS MOTOR SKILLS**

Infant reflexes begin to fade as babies use their senses to learn to interact with the environment around them and as their bodies grow stronger and mature. One way babies learn to use their bodies is by learning to achieve large physical tasks, or gross motor skills, such as crawling and walking. Once again, it's important to remember that while the following section will discuss gross motor development milestones in general terms, every child is unique. Pupils will develop at their own speed and pace, and there is a wide range of healthy ages at which they can achieve these milestones. Milestones help organize and summarize this information easily and clearly.

Scientists have observed that motor skills generally develop from the center of the body outward and from head to tail. These developments do not just occur by instinct. The more chances babies have to practice these skills, the more they will be able to grow and strengthen. This means babies need time and space to explore and manipulate objects in their environment and use their muscles, having "tummy time." Caregivers can place babies on their belly on the floor so they have an opportunity to use those muscles. By around age 2 months, infants' backs continue to strengthen, and they are able to raise their head and chest up off the ground and rest their body on their elbows when they're lying on their stomachs. Around this time, they will also kick and bend their legs while lying on their stomachs; this helps prepare babies for crawling later. By around 3 months, babies continue to mature as they can hold themselves up for longer periods, up to several minutes, and begin to hold their bodies in symmetry. That means that the tonic neck reflex disappears, and they are able to hold each arm in the same position on both sides of their body while on their backs.

Babies continue to strengthen their muscles and improve control of their body parts as they grow. Around age 4 months, they can maintain control of their head and hold it steady while they're sitting up with help or lying on their belly. They begin to roll their body from their belly to their back on their own. About a month later, they will then be able to roll from their back to their belly. Also around age 5 months, babies will wiggle all their limbs while they lie on their belly; this strengthens their crawling muscles. As with all physical development, skills build one on top of another. Around age 6 months, most infants can sit up by themselves for brief periods and can begin to put some weight on their legs as they're held upright with some support.

As babies enter the second half of their first year, they become more mobile and can move themselves around their environment on their own. Caregivers need to be prepared to be more active as they follow the babies and to baby proof their home so that dangerous situations and substances can be avoided. Babies are eager to explore their newly expanded environment. Babies may begin to crawl around age 7 months. At around 8 months, babies can sit up by themselves for extended periods and can pull themselves to their feet while they hold onto something for leverage and support, such as a table or the edge of a couch. By the next month, age 9 months, babies can not only sit independently for a long time, but also reach and play with toys while maintaining their balance. At this time, babies can pull themselves up into a stand without support. This is a critical time for exercising these muscle groups. Research has found that the use of these devices prevents babies from developing the core torso strength necessary for walking (before developing leg strength), which can then lead to difficulty walking or running in the future. For this reason, walkers and other similar devices should not be used.

Babies continue to build on their physical abilities, and around age 10 months, they can stand on their own for extended periods. They are making progress toward walking, picking up and putting down their feet while they stand. They may make their first hesitant steps as they walk while holding onto something such as a crib rail. The ability to walk improves as infants walk while holding onto caregivers' hands around age 11 months, and begin making their own first toddling steps around age 12 months.

In the second year of life, toddlers continue to become more mobile and more agile. Around age 15 months, babies begin to climb stairs, high chairs, and furniture, but they will not yet be able to get back down once they reach the top. They begin to transition more smoothly from one position to another, such as from lying down to sitting up and from sitting up to standing up. By age 18 months, toddlers' balance becomes more stable as they can move more easily on their feet around objects and begin walking backwards, sideways, in circles, and even running. At this point, they can also begin walking up stairs using their feet and using their hands to hold onto a handrail.

Near the end of their second year, toddlers begin to develop complex gross motor skills such as throwing objects for distance and kicking. They continue to refine and to become more fluid in their movements. Their walking and running gaits become more natural and mature and less toddler-like as their feet turn inward while they move. By age 24 months, they can jump in place and balance on one foot for a short period and may begin peddling their first tricycle. They can go up stairs easily on their own, even though they may need some help climbing back down. At the end of the second year, toddlers are very mobile and can run and walk quickly from one place to another; however, they are still refining their ability to stop themselves once they get started. Around this time, they may run into a few walls or unintentionally walk into a dangerous situation, such as off the sidewalk curb and into the street, simply because their brain can't get the message to their feet fast enough to stop moving. It's even more important at this time that caregivers monitor their environment for safety and urge rules such as holding an adult's hand while crossing the street.

As toddler gets older and more agile, s/he will be more able to participate in simple ball games or running games with older siblings. Toddlers can also continue sand or water play and begin to use large crayons to create artistic masterpieces. Cognitively, this is a time that you can begin to reinforce simple concepts such as colours or numbers. Pupils of this age often enjoy simple pretend play.

Branta, Haubenstricker and Seefeldt (1984) revealed that reports dating back to the 1920s have unequivocally established that efficiency of movement improves during infancy and childhood, and generally through adolescence. The inclination from 1940 to 1960 to record movement in quantitative values has given way during the last two decades to a reemphasis of qualitative assessment. Investigators commonly agree that movement skills change in an orderly manner, but controversy continues over the degree of accuracy obtainable with the various descriptive forms, and over the utility of products resulting from such assessments.

Comparison of the quantitative changes in movement skills of pupils is difficult because standardized procedures of test administration have not been applied. When comparisons are possible because of similar or identical testing protocols, improvement in selected motor tests is evident in both boys and girls until adolescence. At approximately 13 years of age the performance of girls in some tests reaches a plateau, and may even decline thereafter, while boys continue to improve in skills requiring strength, power, and muscular endurance. Exceptions to these generalizations occurred in arm and shoulder girdle muscular endurance, as measured by the flexed-arm hang, where boys had superior performances beginning at age 7, and in flexibility, as measured by the sit and reach test, where girls excelled at age 5 and thereafter.

Stability of motor performance was greater for tasks that required all-out effort than for those emphasizing accuracy or total body coordination. Relationships between successive measures taken during early and middle childhood are likely to decline more rapidly than those taken after adolescence. Girls generally were more stable in motor performance than boys, except in the Motor Performance Study, where the values for boys across a range of 5 to 6 years were clearly more stable. This review underscores the need for careful documentation of the conditions under which data on motor performance are obtained. Numerous reports were examined and excluded by the authors because information that would have qualified the data for comparative analysis was not available. Essential ingredients in such reports are descriptions of the sampling techniques and the manner of calculating chronological ages, socioeconomic status, ethnic and racial characteristics, evidence of secular changes, geographic and environmental characteristics, and a detailed account of the testing procedures.

Deal (1993) used heart rate and log book recordings to compare daily activity patterns between pupils who attended day care and those enrolled in a developmental movement programme. The pupils in the study were largely sedentary with mean heart rates ranging from 109 beats per minute to 115 beats per minute while some pupils did not record a single reading above 130 beats per minute for four consecutive hours. Pupils involved in a directed movement program had significantly higher activity levels than those in care, however no difference between the groups existed during time spent at home. This supports other investigations of preschoolers in the home environment that have found little time is spent engaged in vigorous activity with the greatest portion of time devoted to sedentary or low level activity (Freedson, 1989). The positive effect of an outdoor environment on activity levels of pupils may have important implications because of the greater tendency for large muscle motor activity and higher levels of physical activity in comparison to indoor environments.

Taggart and Keegan (1997) investigated movement skills of five year old pupils in pre-primary centers during outdoor play time. Pupils in these centres rarely engaged in the fundamental movement skills of kicking, catching and striking while the dominant behaviours were climbing, jumping, and running. This is consistent with findings by Schiller and Broadhurst (2002) who found that only 18% of teachers and directors of early childhood centers provided balls and bean bags for throwing, striking, and kicking activities.

Taggart and Keegan (1997) also found that greater time spent outdoors together with efficient equipment set up and pack up times positively influenced the amount of gross motor physical activity pupils engaged in. Adult presence also influences the play patterns of pre-primary pupils during outdoor play (Taggart and Keegan, 1997). Pupils participate in fundamental movement skills for longer periods of time when an adult is present. Interaction and encouragement from adult careers precipitated greater engagement in the manipulative skills of catching, throwing, kicking, and hitting. Taggart and Keegan (1997) went on to suggest that play programs should have "balanced periods of teacher-initiated and child-initiated learning experiences. The extent to which pupils' activity behaviours are influenced by supervising caregivers is unknown at this time, although it could be assumed that as the length of time pupils spend in care increases so does the caregiver's influence. Centre design and equipment type influenced the movement choices of pupils while adult presence and interaction markedly influenced the length of active play and movement skill practice. Taggart and Keegan's (1997) data suggested that childcare settings that incorporated free play and directed play were best suited to developing fundamental movement skills.

Guidelines for physical activity during childhood are premised on the notion that physical activity levels decline with increasing age. Until recently, physical activity guidelines existed only for pupils of elementary school age and above (Corbin and Pangrazi, 1998). The National Association for Sport and Physical Education (2002) recently published physical activity guidelines for pupil's birth to five years of age. These guidelines provide parents and caregivers with some direction as to the quantity and quality of movement experiences that will meet the needs of pupils. These principles offer care administrators and providers some broad direction as to the physical activity needs of young pupils. Little however is known about the environmental and physical constraints that are placed on caregivers which in turn impact upon the physical activity opportunities of pupils in their care. It is evident that pupils who receive age appropriate movement skill instruction in activity stimulating environments are more likely to experience success in movement tasks and consequently seek further activity opportunities.

It is therefore necessary to ensure that day care environments, in which pupils can spend a large proportion of their time, provide the opportunities and the structure to engage pupils in meaningful movement experiences. Meaningful movement programmes are those that allow pupils to learn movement skills based on sound educational principles in an interesting and organized manner. Some evidence exists to support the positive impact of guided physical experiences on movement skill development, perceived competence and physical activity levels (Deal, 1993; Garcia, Garcia, Floyd and Lawson, 2002; Ignico, 1994; Weiss, Dziura and Burgert, 2004).

**Developing mind and body of pupils through physical activity and sport**

Wiese-Bjornstal (2004) is of the idea that movement and sport experiences are central not only to the physical development and maturation of youngsters but also to their psychological and social development. For example, through physical activity and sport, youngsters learn to feel competent and worthy, develop moral responsibility, feel joy and enthusiasm for their bodies and human movement, and learn cooperative and competitive skills essential for adulthood. Many of these benefits are often achieved without the benefit of adult guidance, through the natural play and movement intrinsic to pupils. However, the role of the adult is crucial in structuring situations to maximize opportunity for development and by providing guidance when "teachable moments" naturally occur.

**Perceived Competence**

It is essential for pupils to develop and maintain a positive view of themselves and their competencies. Through physical activity and sport experiences, the foundation is laid for the development of perceived competence (defined as domain-specific self-esteem) in the physical and social domains. Available research shows that within the physical achievement domain, the sources from which pupils derive information about their competence differ across age. Adult feedback is an important source of information in the early years, but such dependence often declines with age as pupils increasingly learn from their peers.

This general pattern varies depending on factors such as psychological characteristics. For example, Donald (2007) sport research has shown that pupils with low self-esteem, low perceived competence, and high anxiety about competition are more sensitive to adult evaluation of their physical competence than pupils with contrasting psychological characteristics. It has been found also that pupils who seriously underestimate their physical competence may be likely candidates for low levels of physical achievement, or worse, discontinued physical activity involvement altogether.

One major implication for adult leaders is to provide plenty of opportunity for success in physical activity experiences for all pupils at their current level of actual competence. In addition to experiencing success, pupils must perceive and believe their actions are responsible for that success and they can control skill improvement and successful outcomes. There can be a direct relationship between perceived competence and performance in the physical and social domains.

To develop positive self-perceptions about physical mastery attempts, Donald (2007) suggest: 1) provide contingent and appropriate praise and criticism. Give a specific, and earned reason for the praise, e.g., "You did a good job of catching the ball;" 2) Give frequent and qualitative skill-relevant feedback, such as, "Sally, you are stepping toward the ball nicely, but next time work on extending your arms out to meet the ball;" 3) Encourage pupils to evaluate their own performance realistically. If they did well because of skill, suggest they can say, "I'm proud!" or, "I did it!" rather than, "I was just lucky."

**Moral development**

The potential for youngsters to experience positive moral growth and development through physical activity and sport experiences is enormous. Concepts of fair play and sports-like behaviour can be gained through properly structured and guided movement experiences. Research examining purposeful introduction of moral dilemmas into physical activity and sport settings, along with guidance from adults about appropriate strategies to resolve dilemmas, indicates that pupils can learn skills which help them successfully negotiate conflict situations (Wiese-Bjornstal, 2004).

Time-outs can be taken from games and play activities to take advantage of meaningful learning opportunities as they arise. Issues and underlying values can be discussed, the desirable behaviour reinforced or alternative behaviours suggested, and play can resume. Pupils should be encouraged to discuss what other pupils do that makes them feel good or bad, how to help one another act out the values they have discussed, and how they can better work together so all kids can benefit equally from participation in the activity. Physical activity and sport offer excellent opportunities to learn respect for authority and rules, proper responses to winning and losing, sensitivity to others, and being the best you can be.

Adults should create environments that will foster good behaviour and an understanding of the reasoning behind it. Sports-like behaviour can be promoted by preventing conflicts from occurring as well as solving problems as they happen. The importance of adults modelling desirable and appropriate ethical behaviour cannot be overstated.

**Positive affect**

To a great extent, pupils participate in physical activity because it is "fun!" Looking at these feelings of positive effect, pupils say that fun includes excitement, challenge, winning, being with friends, improving skills, maintaining a positive relationship with a teacher or coach, and experiencing personal success. Unfortunately, the fun aspect is lost sight of in many programmes led by adults, particularly youth sport programmes. Given that fun is the prime motivator, it is essential that adults are careful not to undermine but, rather, take advantage of pupils's innate enthusiasm for movement and play and maximize the fun.

**Keeping Physical Activity Fun**

1. Provide lots of action and variety in the class, practice, or play setting. Make sure all pupils stay involved, and avoid the common practice of standing in long lines to await a turn. It takes creativity with limited space and equipment, but just do it!
2. Plan plenty of opportunity for social and interactive activities; rotate partners and teammates to encourage pupils to learn to interact with a wide variety of others. Making friends is an important aspect of fun.
3. Provide for skill learning, practice, and optimal challenges for a variety of skill levels.
4. Recognize and encourage effort and improvement in physical participation.
5. Provide time for pupils to experience the sheer joy of playful movement.

**Competitive skills**

Within the competitive structure of many physical activity and sport experiences are countless opportunities for teaching important social values. What better place than in the midst of a game to discuss the true meaning of such values as winning, losing, success, failure, anxiety, rejection, fair play, acceptance, friendship, and cooperation? Remember that competition is a developmental process that progresses through stages just as motor development. Types and levels of competition in physical activity and sport should be consistent with each stage of development.

Research suggests that pupils do not really understand "competition" until the later elementary school years (Wiese-Bjornstal, 2004). Pupils certainly compete with others much earlier and may have a rudimentary understanding of the concept; however, it is only after pupils have developed the cognitive ability to assume the role of the other person that they can truly appreciate what competition in sport really means. The primary implication for those planning physical activity and perhaps, more importantly, youth sport programs is to greatly de-emphasize competition with others during the early childhood years.

Instead, emphasis should be placed on skill development, teamwork, personal improvement, and social interaction skills, and on the positive affect associated with participation. For example, early in skill learning, pupils might "compete" only with themselves in trying to improve on their own performances. Elements of competition against opponents can be gradually introduced beginning in the mid-elementary school years. Teaching about competition must be planned and structured in the same ways as other concepts and skills. In the upper elementary grades pupils will appreciate more chances to test their skills against others in competitive contests.

**Cooperative Skills**

Competitive games can often be modified to be more cooperative and humanistic. The basic concept is to encourage pupils engaged in physical activity experiences to play with rather than against each other and to play to overcome physical challenges, not to overcome other pupils/ opponents.

Games should be designed to make cooperation among players necessary to achieve the objectives. Pupils can, in a fun way, learn to become more considerate of one another, more aware of the feelings of others, and more willing to cooperate for mutual benefit. Research findings in studies assessing the social impact of involving pupils in cooperative games programs have also shown an increase in cooperative behaviour in free play and in classroom situations. By designing more cooperative versions of traditional games, it is possible to create tremendous potential for enhancing social development through physical activity.

The development of personal values and social skills can be enhanced by participation in physical activity and sport. The role of adult leaders in the process is crucial to establish the proper environment in which they can develop. When afforded the opportunity to do so, adult leaders must carefully structure physical activity and sport situations to enhance the chances for pupils to experience positive personal and social growth. Within such structure, however, they should not lose sight of retaining the joy and enthusiasm associated with free participation in movement experiences and play activities.

**FACTORS AFFECTING GROSS MOTOR SKILLS LEARNING**

The exact timing of when a particular early locomotor milestone, fundamental motor skill, or specialized movement skill is first observed in a given individual may depend on one or more performer or environmental factors (Leitschuh, 2004). Performer factors, which are most likely to affect the emergence of particular movement skills, include body size and physical growth, strength relative to body weight, and the maturity of the nervous system. Research about body size shows that pupils with proportionately longer legs who are not overweight, tend to walk earlier than pupils with shorter legs (Houwen, Visscher, Lemmink and Hartman, 2009). Degree of strength is illustrated by jumping or hopping, which requires pupils to have at least enough strength to project their bodies off the ground.

Most motor development experts view the maturity of the nervous system as the primary factor in effective use of movement skills in pupils. The greatest problem for the developing nervous system is to control the many separate action units of the body. In one arm alone, excluding the hand, there are approximately 2,600 motor units, 26 muscles, and 4 joints. Through learning and maturation, independent action units become coordinated, reducing the need to control individual units. Instead of thinking about the actions at each joint in clumsily performing a new skill, a child may soon be able to smoothly coordinate the joint actions and simply think about performing a single action. For example, some pupils may be able to step and hop, the two basic components of the skip, but unless they are able to coordinate the timing of the two skills in both legs, they will not be able to perform this fundamental movement skill. However, a child suddenly may be able to skip as his/her maturing nervous system allows him/her to build larger and more complex coordinated units of action.

Environmental factors may also influence the emergence of movement skills. The motivation to move may be enhanced by exposing pupils to environmental features that invite action, such as interesting objects and toys, accommodating surfaces and terrains, playful siblings and friends, and attentive caregivers. Improving attractiveness and increasing opportunities to move may advance early locomotor milestones and in later years, may be the most important factor in a child becoming proficient at specialized movement skills. On the other hand, limited opportunities to actively explore the environment and participate in movement activities may delay or deny a child's acquisition of certain movement skills. Riddoch et al (2004) reported that infants who spent more than two hours a day in walkers crawled and crept significantly later than other infants. It should be emphasized, however, that the long-term effect of this type of experience is unknown.

There are many interrelated factors which affect motor skill learning. This section looked at some of the major ones and the implications they have for teaching and coaching motor skills.



**Individual Learning Styles**

Individual learning styles refers to the ways in which different individuals learn best. Some people need to hear instructions; others need to see a skill performed, while others learn by doing (I hear, I forge, I see, I remember and I do, I understand). Effective teaching and coaching provide opportunities for all pupils to learn in the manner which suits them best. In practise, this means that in order to cater for the needs of all learning styles you generally need to provide a good demonstration, an explanation of the key points, and plenty of time to practise. There are many skills that pupils must learn for themselves. It is important that you encourage pupils to be in control of their own learning. Self-direction, self-motivation, self-determination, and self-reliance are important qualities and characteristics of successful pupils.

**Motivation**

Motor skill learning is at its best when motivation is high. Skill acquisition requires pupils to spend time practising appropriate tasks. For practise to be effective for a pupil, it requires a high success rate over a period of time to motivate the pupil to continue practising. Thus, it is important that pupils can see or identify the results of how well they are improving through their practise or participation in competition. You can motivate pupils by ensuring practise activities appear to be both important and relevant to them, and helping them develop appropriate short and long-term goals.

**Feedback**

Feedback provides information and motivation to facilitate skill learning. It refers to all of the information a pupil receives about how a motor skill is performed and the results of the performance. Feedback is effective in changing immediate performance, reinforces learning, and is important in motivating pupils to make changes and continue learning. It is essential in the early stages of learning, where it is used for major adjustments in skill execution. In the later stages of learning, feedback is used to make fine corrections to performance. Feedback, and how well it is used, has a significant influence on the standard of performance a pupil is eventually able to achieve. It should be noted that an overload of information or feedback often results in learners failing to understand the most important points. Therefore, make feedback to be brief, positive, quick, specific, and appropriate to trainees.

## Receiving and Storing Information

Learning involves the perception of sensory information. Pupils can perceive and interpret the same information differently. This has implications for a coach, as trainee need to constantly monitor understanding of motor skill performance and relate this to their individual learning styles. Information received by trainees passes into their short-term memory, where it is retained for about 30 seconds. The information then either passes into long-term memory, or it is lost if it has not been repeated almost immediately. Trainees cannot remember too many instructions at once, or instructions that are given too quickly. Any interference or irrelevant information can distract a trainees' short-term memory.

It is important for trainer to achieve a balance between providing trainees with enough information to execute a new motor skill, and overloading them with unnecessary detail. Trainer should limit verbal instructions to not more than two or three key points upon which the pupil should focus. Trainer's instructions should be brief, to the point, make the demands of the skill clear and simple, and should be given when the pupil's attention is guaranteed. Trainer need to determine which cues to introduce at various stages of skill acquisition, and develop plans for progressively introducing additional instructional points.

For most pupils, a visual demonstration of a motor skill by a skilled performer greatly enhances their learning. This may be a video of an elite performer. All demonstrations need to be technically corrected and accompanied by good verbal instructions highlighting the key points. They should be available during practise as a reference to correct performance. An understanding of the mechanical and physical principles associated with a new motor skill is likely to aid learning for some Pupils in some sports.

## Selective Attention

Trainees are bombarded by sensory information from a huge range of stimuli both from the external environment (e.g. noise, movement, sights), and from within their own bodies (e.g. balance, muscle soreness, fatigue, hunger). Pupils do not pay attention to all of the available information; rather they disregard irrelevant information and select sensory cues to concentrate on. Trainer need to be aware of when trainees are paying attention to information that is essential to learning a new motor skill, or when they are listening to the cars going by. Overloading trainees with too many instructions at once causes confusion, as learners do not always know which stimuli they should respond to. Trainer needs to select relevant information and direct the trainees to attend to one or two key points at a time, so that they learn to identify the correct cues. Trainer also needs to be able to identify the cues trainees need to attend to in a competitive situation.

**Arousal and Anxiety**

A trainee's level of arousal and state of anxiety will influence their receptiveness to learning a new motor skill. An arousal level that is too low shows as over-relaxation or lack of interest. The trainees give insufficient energy and attention to practicing the new skill. Excessive tension and nervousness are signs of an arousal level that is too high. The trainees' attention may become too narrow to pick up all of the cues needed for a good performance. They are likely to fatigue more quickly than usual, which will reduce the time spent practising. Optimal levels of arousal vary for different skills and amongst different pupils.

**Classifications of Motor Skills**

The classification of motor skills has implications for the way in which motor skills are taught.

**Open and Closed Skills**

The classification of open and closed skills is based on the conditions and the environment in which the skills are performed.

**Open skills** are performed in conditions where:

• the surrounding environment is constantly changing and generally unpredictable,

• there is uncertainty about what to do and when to do it, and

• there is a limited time to make decisions and produce the actions required of a skilled performance. For example: a tennis player receiving a serve faces uncertainty about when the ball will be served, how fast it will travel, and to what corner of the service court the ball will be directed. The skills used in team sports, e.g. hockey, squash, volleyball, football and cricket are nearly always open skills.

**Closed skills** are performed in environments which are highly predictable, where:

• the pupil is able to plan what to do and how to do it in advance,

• the pupil does not have the same pressure of time that is associated with open skills,

• the demands and requirements of the activity are known in advance of the performance,

• the pupil's attention is directed totally towards the production of the desired movement pattern. For example: in a gymnastics floor routine, the gymnast aims to perform to perfection, movements which have been constantly repeated many times in practise. The skills involved in sports such as gymnastics, archery, shooting, bowling, and golf are largely closed skills. Closed skills may also be found within a sport where the skills are mostly open, e.g. softball pitch, tennis serve, rugby goal kick, basketball free throw.

**Skill Transfer**

Skill transfer involves the application of skills and knowledge learnt and experienced in one situation, to a different situation. Experience in similar sports is often beneficial, e.g. if an pupil is skilled at football, then some of the tactical skills will help in hockey; squash players are likely to find handball and racket ball relatively easy to pick up; and cricket players taking batting practise from a machine, will be able to transfer that learning to the game situation.

The Physical Education curriculum is based on the theory of transfer of learning. Students learn relatively simple skills first, and then use that knowledge to develop new skills, e.g. students learn to bat and throw before learning to play the games of softball and cricket. From the earliest stages of learning, parents understand that their pupils need to 'walk before they can run'! This concept applies to coaching as well. It is beneficial to teach basic skills first or more complex skills in a closed environment. For example, warm-up activities may include simple drills that will later be built on; aquatic skills may first be taught on dry land; harnesses are used to teach dangerous gymnastics moves; and ball pitching machines are used in the initial stages of teaching basic hitting skills. In each of these examples, either the skill is taught in a closed environment so that the learner may concentrate completely on just that skill, or the basic components of the skill are taught with the expectation that those basics will be easily developed to form the basis of the complete skill. It should be aware that the transfer of skills may be positive, negative, or neutral.

**Positive:** The previous learning and experience aid or facilitate the learning of the new skill, e.g. if a pupil is a skilled hockey player, that will help when learning a golf swing.

**Negative:** The previous learning and experience hinder or interfere with the learning of the new skill, e.g. an experienced vaulter in gymnastics may have difficulty with a one-footed take-off in long jump.

**Neutral:** The previous learning and experience have no effect on the learning of the new skill, e.g. a swimmer's ability in the pool is unlikely to benefit their skill performance on the tennis court. Where the previous learning may have resulted in incorrect technique, the faults need to be corrected before the new skill can be learned. This generally increases the time required to learn the new skill. There may also be negative transfer from 'sloppy' training practises to competition, e.g. a shot putter who walks out of the front of the circle during training, may well do so in the middle of a tense competition, and be disqualified.

**GROSS MOTOR DEVELOPMENT PATTERNS IN PUPILS**

From the moment of conception, the neurological apparatus that begins to develop in the embryo reflects the primacy of the motor cortex. The beginning structure of the brain in the embryo is the neural groove. This groove essentially closes in on itself, allowing the development of the cerebral cortex, or the two hemispheres that we commonly recognize when we see a picture of the brain. It should be noted that the first closing along this neural groove is the area that will ultimately develop into the motor cortex. From the earliest period of neural development, it is the motor cortex that leads the way and provides us with an evolutionary perspective that would suggest that movement would be the primary vehicle of discovery for the developing child.

A child is born with a series of basic reflexes and is entirely dependent on others for nutrition and sustenance. In a relatively short period of time, assuming normal nutrition and weight gain, the child quickly develops the capability to move around the environment and begins developing a repertoire of simple motor skills. These skills allow the child to discover the world via its perceptual systems the sensations of smell, touch, sound, and sight. Before long the child reaches a critical point in physical development, moving from a crawling position to maintaining upright posture.

From here on, as any parent will attest, there is a veritable explosion of motor activity, as walking, and then running follows the acquisition of control of upright posture. This milestone has implications for other developmental domains. Locomotion brings opportunities not only to explore the environment independently, but also to take advantage of opportunities to interact with other people and, consequently, acquire a whole range of social competencies. In the first two years, the child acquires a rapidly increasing repertoire of motor skills, such as reaching and grasping, walking and running, as well as a parallel set of motor skills imbedded in the speech apparatus which, don't forget, is also a motor skill. In these very early years the child's physical development may be the only domain in which one can assess general development.

The abilities demonstrated in movement provide a primary window into the status of the person. The child who is disabled physically from birth or has a damaged central nervous system, however subtle, usually exhibits deficits first in the motor domain, either by a failure or slowness to acquire locomotion, upright posture, or the ability to speak. Movement behaviour reflects the complete development of the growing child and provides a rich context for parents, teachers, and child development professionals to enrich the child's experience. One can capitalize on the motor skill and play behaviour that is intrinsic to the growing child. The point to be stressed is that movement and play should not be the part of the curriculum used to diffuse energy or to "let off steam" so that pupils can then return to the more serious elements of learning. Rather, motor skills and play are important precursors of the more formal and stylized elements of what is refer to as cognitive or intellectual development.

Movement experiences and play should be key elements in the curriculum and experience of pupils both at school and at home. Research suggests that the child seeks information--is naturally inquisitive. This inherent curiosity can best be addressed via movement and play behaviours, particularly in the preschool years. During this period intellectual and motor skills have not become formal and stereotyped. The child is developing an understanding of his or her own capacity for movement. Thus, for parents and professionals, understanding development of movement skills and play is fundamental to a complete understanding about child development. A lack of play experiences and opportunities to participate in vigorous physical activity and movement can slow both physical and intellectual growth. It must be recognized and understood that it is not enough to provide for play and physical activity by having "recess."

Adequate time and structured environments that reflect the developmental level of the child must be an integral part of the child's education. It is clear that pupils and adults who are physically active on a regular basis are healthier than those who are not active. It is also evident from research findings that many pupils and adults do not regularly take part in physical activities that contribute to a healthy lifestyle (Sanders, 1992).

There are many reasons for this lack of physical activity, the most evident being the lack of exposure at an early age to physical skill development activities (Sanders, 1992). If you do not possess the skills to strike a tennis ball you are probably not going to play tennis. If a child is not skilled in throwing or catching he will most likely not participate in games where those skills are needed. Over the past 20 years we have created a world of very young techno wizards who spend huge amounts of time watching TV, playing video games, or surfing the Internet instead of using and developing their physical skills during outdoor play. Have we created an entire generation of pupils who do not know how to throw and catch a ball? If pupils do not learn to throw, catch, jump and kick when they are young they will not possess the skills needed to participate in physical activities as adults and thus most will not get appropriate amounts of physical activity (Sanders, 1992).

Developmentally appropriate practice suggests that we as adults make educational decisions based on what is known from research and experience about how pupils learn and develop. For example, learning to strike a ball with a bat is not an easy task especially when we use a regulation baseball and a wooden bat. In schools today, pupils find themselves focused on learning basic concepts in math, reading and social studies (Goldman, 2006). Physical activity, in many schools and in many homes, does not have the level of importance it deserves. Pupils who do not develop physical skills are those who get left out of play with their friends and could be those who remain physically inactive throughout life (Goldman, 2006)

FMSs are commonly considered the building blocks to more advanced movement skills and specific sport skills (Gabbard, 2000; Haywood and Getchell, 2001; Payne and Isaacs, 2002; Seefeldt, 1980) and are included in the national content standards in physical education (National Association for Sport and Physical Education, 1995). In his model of the progression of motor skill proficiency, Seefeldt (1980) proposed that pupils must learn a certain level of competency in FMS if they are to break through a hypothetical "proficiency barrier" and successfully engage in sport specific skills later in life. Seefeldt (1980) suggested that early childhood was the time to best develop FMS. Motor development textbooks (Gabbard, 2000; Haywood and Getchell, 2001; Payne and Isaacs, 2002) support this view, indicating the importance of early childhood for motor skill development. However, these skills do not naturally "emerge" during early childhood; rather, they result from many factors influencing the child's motor skill development (Newell, 1984).

Thus, fundamental movement skills that share the same characteristics are placed in the same category of movement. For example, the fundamental movement skills of catching and striking are placed in the movement category of manipulation because both skills involve the manipulation of an object. Researchers agree in subdividing the domain of fundamental movement skill into three categories: stability, locomotor, and manipulation (Ferguson, Gutin, Le, Karp, Litaker, Humphries, Okuyama, Riggs and Owens, 1999). Once the rationale for dividing fundamental movement skills into different categories is to provide specific information concerning which one category can be addressed, stability skills are believed to form the basis for all locomotor and manipulative skill because all movement involves an element of stability (Gallahue and Donnelly, 2003).

This category can be subdivided even further into static balance, dynamic balance and non-locomotor movements. Although some text books in physical education place this last subcategory into the body awareness subdomain of movement concepts. Stability skills are dodging, walking on the beam balance, tripod and one-foot balance which require dynamic or static balance used to gain or maintain one’s equilibrium against the force of gravity (Gallahue and Donnelly, 2003). According to Gallahue and Ozmun (1998), it is important that individuals master fundamental aspects of stability before efficient forms of locomotion occur.

Newell (1984) suggested that motor skill development is based on the interaction between constraints from the task, the organism, and the environment. That is, FMS emerge within a dynamic system consisting of a specific task, performed by a learner with given characteristics, in a particular environment. In this dynamic systems theory perspective, factors (subsystems) within the organism (the learner) will influence motor skill development. For example, motivation, strength, and neurological development, are a few of these many factors. In addition, environmental considerations, such as the equipment used, previous experience, and instruction, may influence motor development. These two factors (organism and environment) are specific to the task being asked of the performer. Given this dynamic view of motor skill development, it may be hypothesized that certain populations of pupils will be influenced by constraints that retard the development of FMS in early childhood. Preschool pupils who are identified as disadvantaged may be one such group, as they present both environmental and biological (organismic) risk factors in the identification of their disadvantaged status.

A number of studies (Connor-Kuntz and Dummer, 1996; Goodway and Rudisill, 1997; Hamilton, Goodway, and Haubenstricker, 1999) have found that disadvantaged pupils demonstrated developmental delays in FMS. Goodway and Rudisill (1997) and Hamilton et al. (1999) further suggested that these delays indicated the lack of environmental support in which the pupils were raised. Given these data, it is important to examine the role of intervention programs in remediating developmental delays with this disadvantaged population, specifically in the motor development area.

The effectiveness of early intervention programs in achieving positive educational and social outcomes for disadvantaged pupils is documented (MacPhail and Kramer, 1995). MacPhail and Kramer, (1995) meta-analysis of 162 studies revealed that effect sizes for early intervention programs averaged half a standard deviation. The author concluded that more organized interventions or those with professional interveners reported greater gains in outcome measures than those with less structure and noncertified interveners. However, despite a substantial body of early intervention literature, limited evidence is available with respect to motor development outcomes for disadvantaged pupils.

Contemporary literature on the benefits of motor skill interventions for young pupils is limited (Connor-Kuntz and Dummer, 1996; Halverson, Roberton and Langendorfer, 1982; Hamilton, et al., 1999; Valentini, 1997; Zittel and McCubbin, 1996; Fisher, Reilly, Kelly, Montgomery, Williamson, Paton and Grant, 2005). Halverson, Roberton and Langendorfer, (1982) documented the positive influence of instruction on typical young pupils's throwing performance.

Fisher et al. (2005) reported that typical preschool pupils demonstrated qualitative performance gains in six fundamental motor skills from pre-test to post-test as a result of two 5-week instructional units consisting of direct instruction. In contrast, the control group, who engaged in well equipped free play, made no significant gains in motor skill development. A study by Connor-Kuntz and Dummer (1996) found significant pretest-posttest gains in FMS in typical preschool pupils, head start (disadvantaged) preschool pupils, and preschool pupils with disabilities, as a result of an 8-week intervention. Despite significant improvements, pupils in Head Start and Special Education were still below expected standard scores for their age at the post-test.

Hamilton et al (1999) found that prior to a motor intervention; disadvantaged preschool pupils demonstrated developmental delays in object control skills. Following an 8-week parent-assisted intervention, they found significant pre- to posttest gains in object control skills for the experimental group, as compared to a control group who did not demonstrate significant change in motor performance. Finally, Valentini (1997) found that a 12-week, student-centered instructional program resulted in significant gains in the FMS of developmentally delayed kindergarten pupils from pre- to post-intervention. What was interesting about this study was that the control group did not change from pre- to post-intervention, despite the fact both groups had received 30 mm of daily physical education per day throughout the intervention period. In contrast to the above studies, Zittel and McCubbin (1996) used a single-subject design to examine the influence of an 8-week motor skill intervention on the motor skill acquisition of 4 developmentally delayed preschool pupils.

Motor skills are deliberate and controlled movements requiring both muscle development and maturation of the central nervous system. In addition, the skeletal system must be strong enough to support the movement and weight involved in any new activity. Once these conditions are met, pupils learn new physical skills by practicing them until each skill is mastered.

Gross motor skills involve control of the extremities (arms, legs, hands, and feet) and torso. There is an orderly sequence for development of these muscles. Although norms for motor development have been charted in great detail by researchers and clinicians over the past 50 years, the pace of development varies considerably from one child to the next. As skills become more complex, the degree of variation increases among normal pupils. The normal age for learning to walk has a range of several months, while the age range for turning one's head, a simpler skill that occurs much earlier, is considerably shorter. In addition to variations among pupils, an individual child's rate of progress varies as well, often including rapid spurts of development and frustrating periods of delay.

Although rapid motor development in early childhood is often a good predictor of coordination and athletic ability later in life, no strong correlation has been demonstrated between a child's rate of motor development and intelligence. In most cases, a delay in mastering a specific motor skill is temporary and does not indicate a serious problem. However, medical advice should be sought when pupils lag significantly behind their peers in motor development or if they regress and lose previously acquired skills.

This is the ability of pupils to use two legs and walk and involves their whole body. The whole-body movements are described as gross motor. These terms have the same meaning and cover the stages a child goes through in developing control of the body: learning to support the head; rolling over; sitting; crawling; pulling to stand; walking; running; climbing stairs; hopping; playing football; skipping; riding a tricycle and a bicycle; standing on one leg; swimming; and climbing.

Gross motor skills develop over a relatively short period of time. Most development occurs during childhood. However, pupils and others, who engage in activities requiring high degrees of endurance, may spend years improving their level of muscle and body coordination and gross motor skills. The sequence of gross motor development is determined by two developmental principles that also govern physical growth. The cephalo-caudal pattern, or head-to-toe development, refers to the way the upper parts of the body, beginning with the head, develop before the lower ones. Thus, infants can lift their heads and shoulders before they can sit up, which, in turn, precedes standing and walking.

The other pattern of both development and maturation is proximo-distal, or trunk to extremities. One of the first things an infant achieves is head control. Although they are born with virtually no head or neck control, most infants can lift their heads to a 45-degree angle by the age of four to six weeks, and they can lift both their heads and chests at an average age of eight weeks. Most infants can turn their heads to both sides within 16 to 20 weeks and lift their heads while lying on their backs within 24 to 28 weeks. By about 36 to 42 weeks, or 9 to 10 months, most infants can sit up unassisted for substantial periods of time with both hands free for playing.

**School-age**

School-age pupils who are not going through the rapid, unsettling growth spurts of early childhood or adolescence are quite skilled at controlling their bodies and are generally good at a wide variety of physical activities, although the ability varies on the level of maturation and the physique of each child. Motor skills are approximately equal in boys and girls at this stage, except that boys have more forearm strength and girls have greater flexibility.

Five-year-olds can skip, jump rope, catch a bounced ball, walk on their tiptoes, balance on one foot for more than eight seconds, and engage in beginning acrobatics. Many can even ride a small two-wheeler bicycle. Eight- and nine-year-old typically can ride a bicycle, swim, roller-skate, ice-skate, jump rope, scale fences, use a saw, hammer, and garden tools, and play a variety of sports. However, many of the sports prized by adults, often scaled down for play by pupils; require higher levels of distance judgment and hand-eye coordination, as well as quicker reaction times, than are reasonable for middle childhood. Games that are well suited to the motor skills of elementary school-age pupils include kick ball, dodge ball, and team relay races.

In adolescence, pupils develop increasing coordination and motor ability. They also gain greater physical strength and prolonged endurance. Adolescents are able to develop better distance judgment and hand-eye coordination than their younger counterparts. With practice, they can master the skills necessary for adult sports. For some persons, the development of gross motor ability and endurance continues into adulthood. Pupils and members of the military routinely engage in activities designed to further enhance their gross motor development.

Complex motor skills take more time and effort to acquire because a number of different actions make up the skill. Complex skills can be simplified to make learning easier by:

• breaking the skill down into a series of steps or parts, teaching the individual parts separately, and progressively bringing them all together as learning occurs,

• making the action simpler, leaving out some parts to be added later,

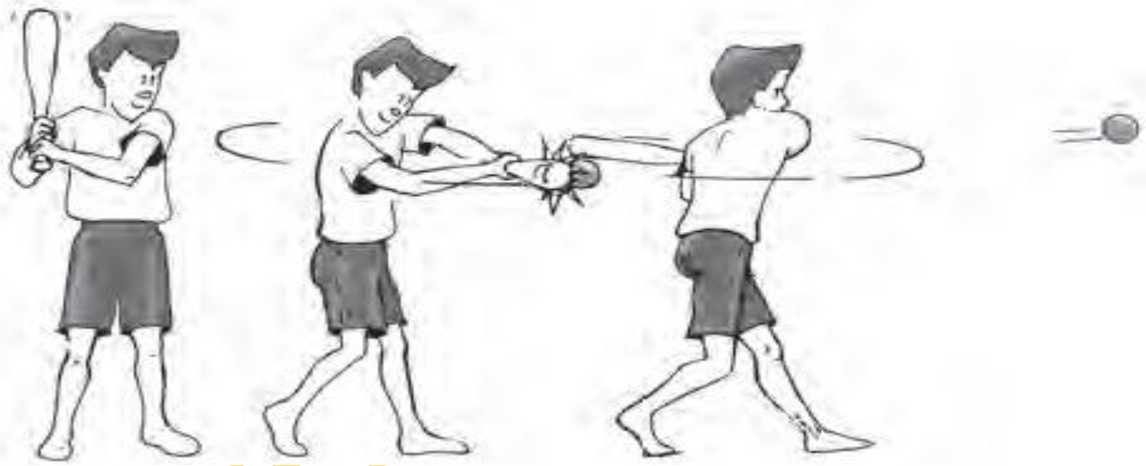
• practising the simplified action in a simple situation, with team mates, opposing players, and competition being added progressively, and

• slowing the action down to give your pupils time to think about what they are doing, and to make the appropriate responses.

## BASIC GROSS MOTOR SKILLS

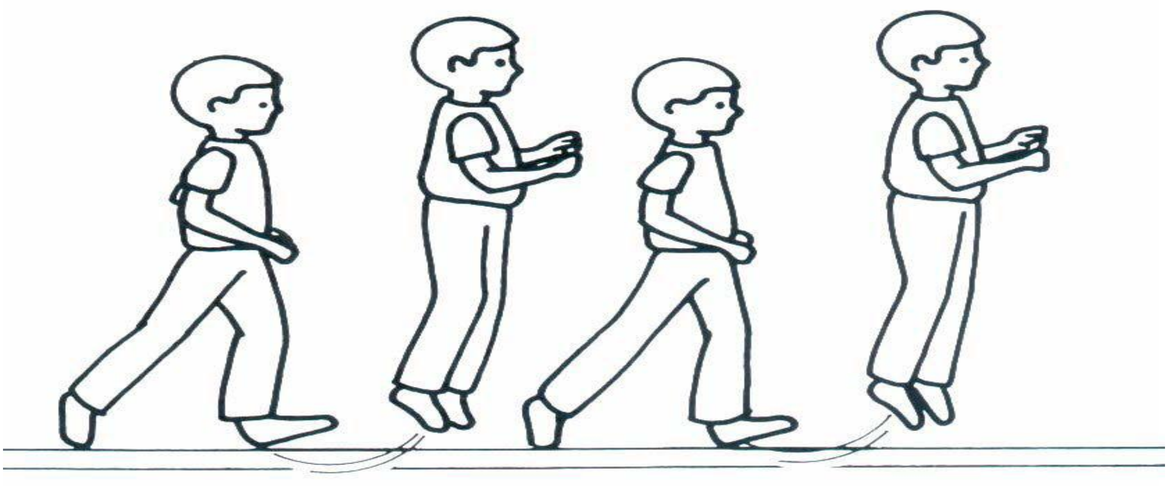
Fundamental motor skills, such as the run, leap, catch and overhand throw, form the building blocks which underpin the learning of more complicated sport and movement skills common to the community. Without fundamental motor skill competence, students are less likely to learn related sport and movement skills. Fundamental motor skill competence has been shown to influence students in many ways. Students who have achieved fundamental motor skill competence have been found to successfully participate in a range of sports and movement activities and maintain involvement during childhood and adolescence. Regular involvement in sport and movement activities leads to gains in health-related physical fitness.

**Striking a stationary ball**



This is an object control skill that involves applying a pushing force with a bat to propel an object into the air. This is the most difficult fundamental movement skill to achieve.Important for hand-eye-foot coordination.

**Galloping**



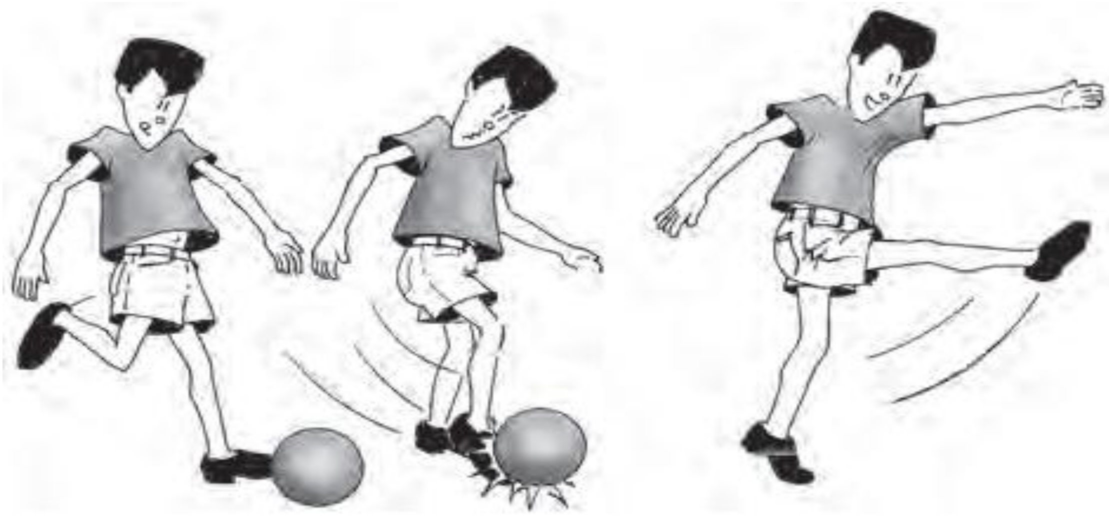
This is stepping off one foot then sliding with the other foot in a forward direction. Weight is transferred from the front foot to the back foot with a small lift, before the front foot takes the next step. The stepping foot is always the front foot. Four year old children can perform a basic gallop with a preferred leg emerging. Five year old children can gallop on either leg and alternate with another rhythmic pattern such as side sliding. Skipping ability also emerges at this age as children need to be able to hop with control on both legs prior to the development of this skill. Side gallop among boys, 13% in Year 2 displayed mastery, increasing to 62% in Year 10. Between 20% and 30% of boys in each Year showed near-mastery.

Among girls, 14% achieved mastery in Year 2, increasing to 68% in Year 10. Between 20% and 35% of girls displayed near-mastery. In all Years, girls demonstrated a higher prevalence of mastery and near-mastery than boys, although the differences were generally small. Leap less than 10% of boys in any Year mastered the leap, with near-mastery ranging from 7% to 17%. For girls, the proportion who mastered the leap ranged from 6% in Year 2 to just fewer than 30% in Year 10, with the increase linear from Year to Year. Near mastery levels ranged from 8% to 22% among girls.

**Leaping**

This is forward movement sustained throughout the leap, yes focused forward throughout the leap, take off from one foot and land on the opposite foot, during flight legs are straightened with the arms held in opposition to legs and controlled landing without losing balance more girls demonstrated proficiency in the leap with a fourfold to fivefold difference between boys and girls which increased with age. Well under half of the boys and girls in all Year groups except Year 10 girls displayed mastery and near-mastery of the leap.

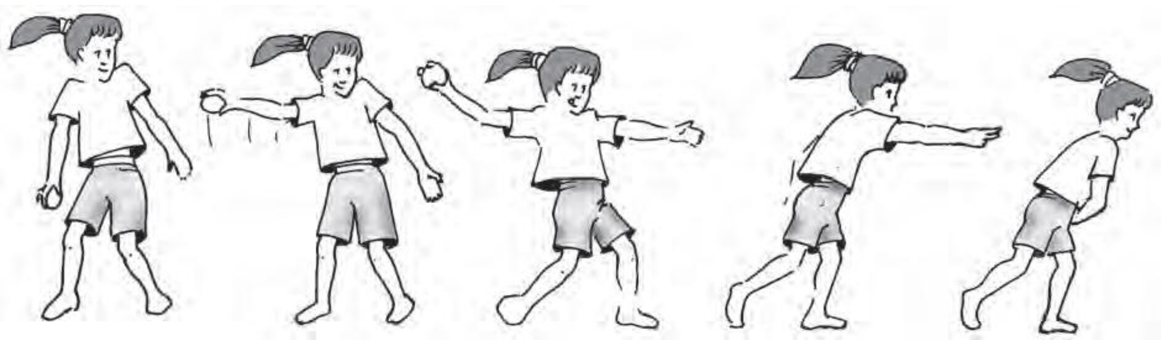
**Kicking**



Kicking is a manipulative skill that involves applying a pushing force to an object to propel it. By three years of age children can kick a stationary ball forcibly. Strength and direction of kick increases with age. Kick among boys, mastery of the kick increased from 9% in Year 2 to just fewer than 60% in Year 10, with the proportion achieving mastery doubling from Year 2 to year 4, and from Year 4 to Year 6. Between 10% and 20% of boys in all Year groups displayed near-mastery.

Among girls, the prevalence of mastery for the kick ranged from 2% in Year 2 to just fewer than 10% in Year 10, with about a 2% increase between each Year group. The prevalence of near-mastery showed the same pattern as mastery for girls. The most notable finding, as expected, was the large gender difference, with the prevalence of mastery being around five times higher among boys in each Year group.

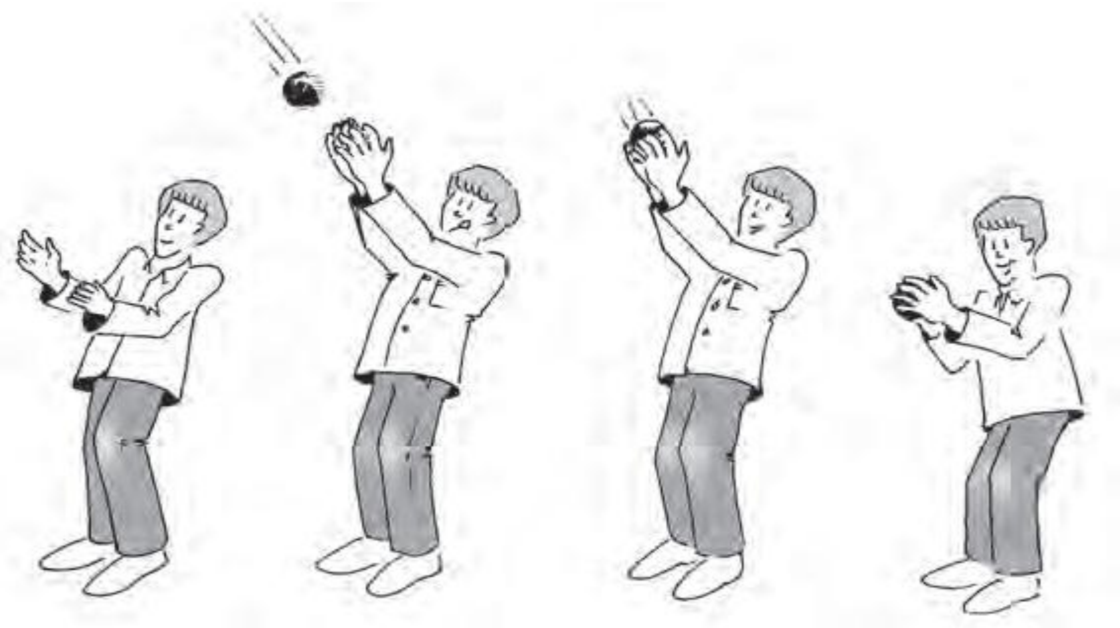
**Overhand Throwing**



Throwing and catching are complementary skills, yet are quite different in terms of their movement focus. Throwing and catching skills in this resource include: overarm throw, underarm throw and roll, as seen in cricket and softball games; and a variety of two-handed passes, like the chest, bounce, spiral pass that are prevalent in netball, basketball and rugby. Throwing and catching actions for small balls differ from those for large balls. Overhand throwing is what the young pupils are doing with anybody. It is the process of imparting force to an object, usually a ball, to another person or object using an overhand pattern. The pattern of movement varies according to the requirement (distance) of the movement task. Throwing involves propelling a ball away from the body and is a target skill

Among boys, mastery of the throw increased from 11% in Year 2 to 58% in Year 10, with between 13% and 26% of boys in each Year displaying near mastery. Among girls, 0.5% in Year 2 showed mastery, with this increasing by approximately 4% in each Year up to Year 8 where 14% of girls showed mastery of the throw. Between 6% and 20% of girls displayed near-mastery of the throw. A higher proportion of boys in all Years achieved mastery in the throw.

**Catching**



This is a visual task as well as a motor task because it requires sophisticated coordinated use of both processes. In catching or receiving, the body controls a ball or object, relying on the ability of the eyes to track the ball into the receiving part of the body. Catching is important for hand-eye coordination. Catching develops somewhat later than other fundamental movement skills in pupils. It involves making the fine visual-motor adjustments required to locate, anticipate initiate, and intercept a moving object. It also involves receiving force from object and retaining the object in the hands. Practice in catching can be facilitated by the use of objects of varying sizes, shapes, colour and firmness.

Pupils at initial stage typically experience greater success with catching a soft ball, brightly colour beanbag, yarn ball than with a hard ball of comparable size. They are able to grip a beanbag more securely than the ball and there is little fear of injury if a child is hit in the face or on a finger by a beanbag or a beach ball. Between 15% and 20% of boys achieved mastery in the catch, with the prevalence of near-mastery around 20% in each Year. Among girls, 10% in Year 2 achieved mastery, increasing to 50% in Year 10, with near-mastery between 15% and 25% in each Year. The prevalence of mastery was higher for boys in all Years and exceeded 50%

among boys in Years 6, 8 and 10. Mastery among girls also exceeded 50% among Year 10 girls. The prevalence of combined mastery and near-mastery was above 50% among Year 4 boys and for both boys and girls in Years 6, 8 and 10.

Catching is receiving and controlling an object by the body or its parts. As pupils learn to catch, they may first fear the ball and pull away to protect them. Pupils progress from catching a ball with their whole body, then with their arms and hands, and eventually with their hands alone. What are some basic activities that parents and teachers can introduce to pupils to assist them in learning how to catch? It is considered developmentally appropriate to select catching equipment that is matched to the size; confidence and skill level of pupils so that they are motivated to actively participate. Equipment must be modified to assist pupils in learning the skill. It would be inappropriate to use an official volleyball or basketball to initially learn how to catch.

More appropriate equipment would include scarves, balloons and beanbags. Inappropriate equipment leads pupils to frustration when they are unsuccessful and thus they do not develop the skill. Initial catching activities should involve the use of a large balloon called a punch ball balloon. The punch ball moves slowly through the air giving pupils time to track the balloon and get their arms in the position to catch. In order for pupils to catch the balloon they must first be able to throw it straight up into the air.

Parents and teachers can provide the following simple directions to assist pupils in throwing the ball into the air. Hold the balloon out in front of you with one hand on each side.

- Lower the balloon below your waist until it touches your knees.
- Raise both hands into the air and let go of the balloon as it passes your nose.
- Timing the release of the balloon is important. If the balloon is released too soon it may travel far out in front of the child where it is hard to catch. If the balloon is released too late it will travel behind the child and be almost impossible to catch.
- A progression of balloon catching activities might include:
- Drop the balloon, let it bounce, and then catch it.

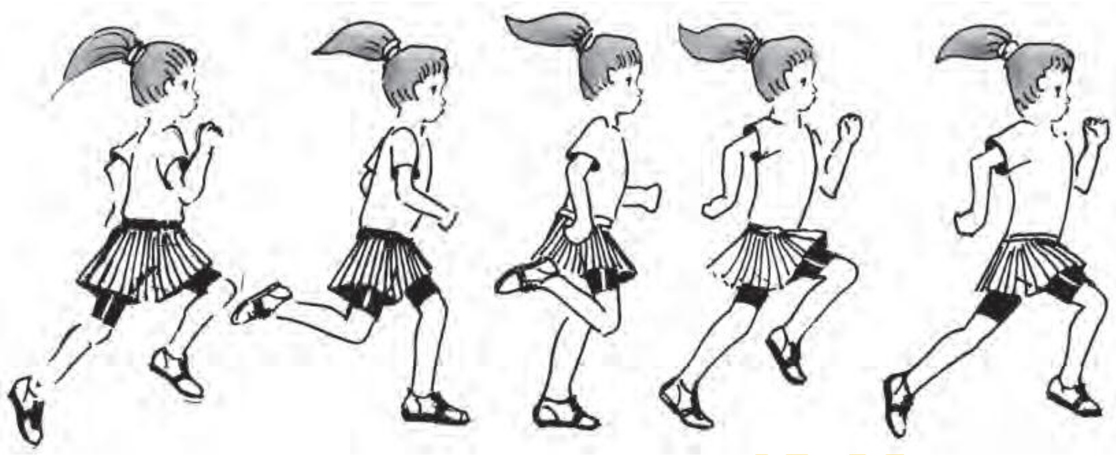
- Throw the balloon into the air and catch it.
- See how high you can throw the balloon and still catch it.
- Throw the balloon into the air and see how many times you can clap your hands before you catch it.
- Throw the balloon against the wall and catch it.
- Throw the balloon back and forth with a friend.

A launch board propels the ball into the air directly in front of the child and thus pupils do not need to be skilled at tossing the ball into the air. When a child steps on one end of the board, a ball or beanbag, placed on the other end, flies into the air directly in front of the child. Launch boards are easy to make. Use ¼" thick birch plywood cut 30" long and 5" wide. Seven inches from one end, attach a 5-inch-long, 1-1/2" diameter dowel stick with glue and screws.

Place a small ball or beanbag on the launch end of the board. If using a ball, drill a 2" hole in the end of the board to lay the ball in. A beanbag may be the best choice as it lays flat on the board and is easy for pupils to grab out of the air. Place your beanbag on the low end of the board. Go to the other end, get your hands ready to catch by holding them out in front of you, then raise your foot and stomp on the end of the board. As the beanbag flies into the air in front of you, clap your hands around the beanbag and catch it." The instructional emphasis for this activity should be to have pupils concentrate on getting their hands ready to catch the beanbag and to focus on watching the beanbag as it moves through the air. Pupils should first focus on attempting to catch the beanbag with both hands at the same time then with the right and the left hand alone.

As pupils get better at catching, other challenges can be added such as stomping on the board so the ball or beanbag goes higher, attempting to catch two beanbags at the same time, and launching and catching other items such as a child's favourite stuffed animal (Goldman, 2006).

**Running**



Running is like walking except there is a period of suspension when both feet are off the ground at the same time. The skill of running includes jogging, sprinting, chasing, dodging and evading. All of these are important to many games (e.g. tag), sports (e.g. athletics) and everyday activities (e.g. running to get to school on time). In running, the greater the force produced from the drive off the back leg, the greater the forward acceleration. That is, the more he pushes off the ground with the legs, the faster he will go. In running, the direction of force is achieved through a forward lean of the body. Knees move forwards, and arms move forwards and back, to minimize any lateral movements of the body. That is, child leans his body in the direction of the run. If he shortens his lever arm, the movement will be faster. That is, bending his knees and elbows shortens the lever to increase running speed.

Research states that blood flow is very important for brain development and with intense exercise like running you get increased blood flow to the brain (Wendt, 2001). Research also indicates that by exercising, you increase the production of neurotransmitters. Neurotransmitters are important for adequate communication between nerve cells. Without efficient communication between nerve cells behaviour and learning can break down. There is mounting research that outlines how exercise promotes the release of Dopamine, epinephrine and other body chemicals that will have a positive impact on learning (Wendt, 2001).

Wendt's (2001) research showed a positive impact from intense exercise over a period of six-weeks. Most behavioural changes were noticed around the two-week mark. "I designed the exercise to have a 10 minute warm-up and 10 minute cool down with 20 minutes of exercise at 50-75% $VO_2$ max. This roughly translates into a heart-rate zone of 135-175 beats per minute. The frequency of exercise was designed to be five out of seven days every week.

Wendt (2001) further said that they engage in various workouts during the week included a distance run. They extended the session and told pupils they could stop and rest whenever they were tired, but they must keep their heart rate in the designated zone of 135-175 beats per minute. Based on research, I determined this zone to be optimum for changing body chemistry, and as a result, produce a positive impact on behaviour. Surprisingly, we had many pupils run between two and five miles during that session. That included five and six-year olds left to their own devices. It was incredible, especially when I had a colleague recently tell me that kindergarten teachers would not let their pupils take part in a walking exercise because it was too much for them. They were asking the kindergarten pupils to only walk one lap around the track.

Running currently is undergoing a second boom, but if there is to be a third boom, it may be fuelled by youngsters. The first running boom began in the mid 1970s, mainly middle-aged Baby-Boomers, men who were looking to lose a few pounds and get in shape by running 10kilometer races. The second running boom started in the late 1990s, continuing today, fuelled by young women, seemingly the daughters of those Baby-Boomers. Their goals were the same as their fathers--weight control, good health--although they focused more on finishing marathons rather than running fast. The next running boom may feature kids, the grand-pupils of those Baby-Boomers. If so, the parents and grandparents will need to supply both motivation and opportunities.

Running has profited from increased participation in football. Football is a sport that features near continuous running, so it is easy to shift from that sport to pure running. While football programs sometimes drain participants away from track and cross-country at the high school level, experts agree that kids chasing after a ball, or after each other, promote health habits that can endure after they become adults. Nevertheless, Higdon (2002) agreed that the positive aspects of running so outweigh the negative risks that                                                 parents should do everything possible to inspire their pupils to take up running and other forms of exercise.

A child engaging in exercise training is probably going to be less tempted to experiment with cigarettes or drugs or to hang around with "friends" who climb into a car after downing a six-pack of beer. Higdon (2002) suggests that a healthy lifestyle that includes appropriate amounts of exercise can add six to nine years to your life and contribute greatly to the quality of that life. When it comes to converting pupils into runners--competitive or recreational, the running lifestyle you lead, may work better than lectures on fitness.



**Jumping**

Jumping is the transfer of weight from one or both feet to both feet. May be for height, take-off for distance, flight; or from a height. Fifteen per cent of Year 2 boys showed mastery of the vertical jump, increasing linearly by approximately 10% per Year to 52% of Year 10 boys. Between 20% and 30% of boys in each Year group displayed near mastery. Twenty per cent of Year 2 girls displayed mastery of the vertical jump, increasing to 52% of Year 10 girls. Mastery of the vertical jump increased by around 10% in each Year group from Year 2 to Year 8, but did not increase thereafter. Between 15% and 25% of girls in each Year group demonstrated near-mastery.

A jump can be divided into three parts: take-off, flight and landing. Landing safely is an important skill to focus on when learning to jump, leap or hop. For more details, please see the 'landing' activities in the 'stability' section of this resource. Jumping for distance (or horizontal jumping) is important in sports (e.g. athletics, long and triple jump) and in other games and activities (e.g. elastics). Jumping for height (or vertical jumping) is used in many sports (e.g. high jump, basketball rebound, rugby line-out, vaulting in gymnastics) and in many playground games and activities (e.g. using a skipping rope).

**Dodging**

Dodging involves quick, deceptive changes in direction to evade, chase or free from an opponent. When dodging, knees are bent and the body shifts rapidly in a sideways direction. As applied to sport, the skill of dodging is evident in moving the shoulders, head, eyes or other body parts to deceive or 'fake' the opposition as a way of: getting free to receive a pass (e.g. in football); 'getting around' your opponent (e.g. to score a basket in basketball); or avoiding being tagged in a tag game.

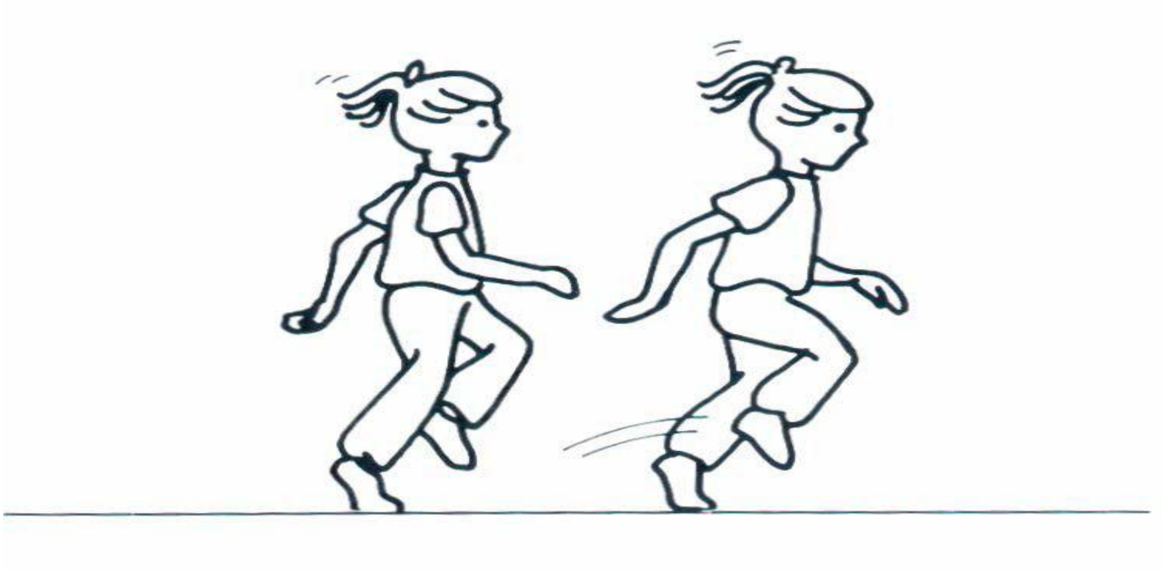
Center of gravity is low and close to the base of support. This is achieved by bending the knees for better balance. Dodging occurs as the body shifts rapidly to one side. To gain maximum force, knees need to be bent, with a low body position so that extension of the powerful muscles in the legs can be directed through the body in a sideways direction.

**Hopping**

Hopping is a springing action that involves taking off from one foot and landing on that same foot. It involves dynamic balance, with the non-hopping side adding counterbalance and force to assist with the continuous forwards and upwards movement.

Hopping is a component of many other fundamental skills, (e.g. in skipping and kicking for distance, in sports like athletics (component of triple jump) and in dance activities). They body is balanced when the center of gravity is over the base of support. The base of support is the hopping foot and, to achieve balance, the body leans towards the hopping foot while the non-hopping side provides the counterbalance and the arms assist. To achieve height or distance in the hop, a summation of force is required. This is achieved by extending the ankles, legs and arms forwards and upwards together.

**Skipping**



Skipping is a complex bilateral rhythmical activity involving coordinated alternate use of both sides of the body. Because of the neurological organization required, it is a real challenge for pupils who are not developmentally ready and an easy task for those who are (Gallahue and Donnelly, 2003). Skipping is a combination of a long step and a hop (step–hop), first on one foot and then on the other, and has an uneven rhythm. Skipping is a fundamental skill in a variety of games and dance activities (e.g. when moving to music or a beat in folk dancing).

Skipping involves shifting weight from one foot to the other with a narrow base of support. Therefore arms should extend to help maintain balance. Force should be applied upwards for the hop action to allow the opposite leg to swing forward freely. Before introducing skipping, it is advisable to give pupils opportunities to explore many movement variations of galloping, sliding and Kicking.

**MOVEMENT ASSESSMENT METHODS IN PUPILS**

There are a several ways to measure pupils' performance of FMSs, each with advantages and disadvantages. The assessor must take these into consideration when deciding what approach to take. The decision on how to measure pupils' FMS performance will be guided by the purpose of assessment. What information is needed and why? The purpose may be to appropriately group a class of pupils, to identify those at risk, to plan intervention or educational programmes, to monitor change over time, to provide feedback to the performer or to predict performance in the future (Burton and Miller, 1998).

In motor skill assessment, students are asked to demonstrate their current ability to perform a designated skills such as run, throw or jump and are assessed on the quantitative (product assessment) or qualitative (process assessment) merits of performance (Gallahue and Donnelly, 2003).

**Quantitative Assessment**

Quantitative assessment approaches involve measuring the product or outcome of the performance. The item score is a number or quantity, for example the time in seconds to run 50 meters, the distance in centimeters jumped or the number of successful bounce and catches in 20 seconds. The result is usually compared to the performance of a normative group. The scores are converted or transformed into relative scores such as standard scores or percentiles. Such information enables the comparison of a Measurement of Fundamental Movement Skills child's performance to their chronological peers and could be used to screen for pupils with movement difficulties or to select participants eligible for a movement program.

The Western Australian Department of Education (WADE, 2001) includes a four item screening test, Stay-in-Step, that teachers may use to identify pupils with poor coordination skills (Larkin and Revie, 1994). The objective nature of the measures generally ensures a high level of reliability over time and between assessors. Further most tests can be done quickly and are capable of testing large groups.

As the tester does not require an extensive understanding of movement competencies to administer the test, this approach is useful for generalist teachers or professionals without a background in human movement (Hands and Larkin, 1998). On the other hand, the test outcomes do not inform the intervention or teaching programme, as they do not provide direct information about the proficiency of the performance (Branta, Haubenstricker and Seefeldt, 1984). For example, if a child's 50 meter run time means they are performing below the 10th percentile for their age, the coach or teacher may not know why. When pupils are still mastering motor skills, their movement patterns are often extremely variable.

The information gathered through quantitative measurement techniques is not able to discern between levels of variability in movement patterns. Is the slow run time due to a short stride length, erratic arms, low knee lift or all of the above? Finally, the validity of the test results depends on the appropriateness of the normative group for the child or group being tested. Physical factors that impact on performance such as height, weight and body composition, and differing cultural expectations and interests are not taken into account when interpreting the scores. These measures are most often used for the assessment of FMS during school athletic or swimming carnivals. For example, pupils compete against others of their same age and usually gender to identify the fastest runner, fastest swimmer or highest jumper.

**Qualitative Assessment**

In recent years, the most frequently used FMS assessment tools with pupils employ qualitative measures that focus on the form or technique of the movement, in other words, how the skill is performed. Knudson and Morrison (1997) define qualitative assessment as "the systematic observation and introspective judgement of the quality of human movement for the purpose of providing the most appropriate intervention to improve performance." Observation records or checklists for each FMS are usually generated to facilitate FMS assessment. There are two schools of thought about how these observation records are structured. Each approach stems from a different theoretical approach to motor development. One is the Global or Whole Body approach and is associated with Seefeldt and Haubenstricker, (1982).

The levels or stages for skill development are global in that the movement of the arms, legs and trunk are described for each stage. All body components progress in unison towards greater levels of efficiency. An observation record based on this approach includes descriptors for each body part for each defined stage of learning (Seefeldt and Haubenstricker, 1982). On the other hand, Roberton (1977) developed the Component Stage Theory, which states that body components develop at their own rate, and therefore should be assessed independently. In the development of the overhand throw, for example, Roberton has shown that the arm action will develop independently of the leg and trunk actions and that the patterns will vary between pupils. Even within a body component, such as the arm, individual patterns for the upper and lower arm have been shown.

Generally, skill performances are described within phases of performance such as preparation, propulsion and follow through. Subsequent research has now identified component stages for a number of FMS (Clark and Phillips, 1993; Halverson and Williams, 1985). These studies have significantly contributed to our understanding of motor development, but have made assessment of FMS more complicated. A less complex approach to assessment using component stage theory is the 'mastery' or 'proficiency criteria' model which describes the key actions of the main body parts for the proficient form of the action, rather than patterns that may be observed during Measurement of Fundamental Movement Skills the learning of the skill.

These criteria do not represent a developmental sequence nor fully describe an instructional sequence but comprise certain key aspects for a proficient performance. This approach has been adopted for most Australian FMS teacher resource packages. The assessor records the key components of the skill being demonstrated by the performer. For example, do the arms move in opposition to the legs while running; is the head stable, are the knees lifting high? Those components not demonstrated become the focus for future interventions. Australian researchers have used qualitative techniques in several studies to report on FMS development in pupils. Walkley and colleagues (1993) qualitatively evaluated the FMS levels of proficiency of 1182 Victorian school pupils in Years 2, 4, 6, and 8 using skill components developed specifically for the project. They reported low levels of proficiency for all skills based on mastery of skill criteria. Mastery was defined as the demonstration of all, or all but one, of the skill criteria.

The Department of Education in Tasmania in conjunction with the University of Tasmania used the Test of Gross Motor Development (Ulrich, 1985) to measure FMS levels in 574 pupils aged 7 and 10 years (Cooley, Oakman, McNaughton and Ryska, 1997). This formal test provides qualitative performance criteria for 12 skills, and the scores are converted to standard scores and percentiles for pupils aged between 3 and 10 years. In the Tasmanian study, the 7-year-old pupils compared favourably to the American standards but 10-year-old pupils were categorized as below average.

The major advantages of qualitative assessment are the information can be used to inform the teacher or movement professional which specific components of a skill an individual needs to practice and the assessment can be undertaken in a more meaningful context than quantitative methods. Most quantitative test items need to be performed in controlled settings, for example a 50-metre times sprint must be measured on a marked track. An observation record for a child's run could easily be completed during a game or class activity, or even during school recess. The negative aspects of qualitative assessment include the difficulty of comparing results that have been gathered by different assessors.

Assessors may interpret components of Measurement of Fundamental Movement Skills movement differently unless intensive training has been undertaken. For example, how high is a high knee lift? Inter-rater reliability, therefore, is generally quite low. This approach can be very time intensive. The time required to assess a large number of pupils, for example a school class, is high. Further, it is difficult to interpret information gathered, as the results usually have no normative data.

**How many skill components are enough?**

FMS assessment tools involving observation records vary in complexity and number of skill criteria for any one skill. McIntyre (2000) analysed video footage of pupils performing the overarm throw using 3 different assessment tools. These were the Test of Gross Motor Development (Ulrich, 1985), the Fundamental Motor Skills-A Manual for Classroom teachers (Victorian Department of Education, 1996), and the Fundamental Motor Skills Assessment Manual (Western Australian Department of Education, 1997). McIntyre, (2000) noted that each tool had different skill criteria and used different assessment protocols.

The TGMD had 4 skill components, the Victorian package 6 components and the Western Australian package, 8 components. Mastery is evident if the component is demonstrated 2 out of 2 trials (TGMD), 4 out of 6 trials (Victorian Department of Education, 1996), or 3 out of 3 trials (Western Australian Department of Education, 1997). These differences prevent national comparisons between pupils. Greater complexity in the wording and number of components in the records increases the potential for disagreement between observers, reduces reliability and the chances of being rated as proficient.

The experience and skill level of the observer must also increase. However, the information gathered is more valuable. A compromise between complexity and depth of information and simplicity needs to be found. The NSW and Western Australian teacher resources provide several levels of observational complexity that assessors may choose according to their confidence in movement observation and purpose. These are the global check (overall the Measurement of Fundamental Movement Skills movement looks proficient), components for initial focus (2 or 3 components only are observed) and finally components for fine-tuning (all the remaining components).

**How to interpret observation records**

Several approaches can be used to interpret information collected using observation records. The skill components not demonstrated could be individually reported for individuals or whole samples (McIntyre, 2000; Booth et al, 1997). Performers could be grouped based on a specified formula.

Victorian Department of Education (1996) suggested pupils are grouped based on the skill component they most need to practice. In the Western Australian Department of Education (WADE, 2001), a 'rule of thumb' is recommended to categorise the performance of pupils on any one skill. Groupings based on this information facilitate the planning of learning experiences. Pupils are at the beginning level of achievement if they are unable to demonstrate any or only one of the skill criteria. They are at the developing level if they consistently demonstrate all of 2 or 3 initial focus criteria.

A child at the consolidating level has mastered all or nearly all criteria and at the generalising level consistently demonstrates all skill criteria across a range of contexts. The Get Skilled Get Active Resource (NSW Department of Education and Training, 2000) suggests teachers use their professional judgement to identify pupils whose FMS performance is progressing towards, achieved or working beyond their expected level. Within the progressing towards category pupils could be identified as beginning, developing or consolidating.

Walkey (1993) and the NSW Schools Fitness and Physical Activity Survey (Booth et al., 1997) rated pupils as achieving mastery of a skill if all components were demonstrated or near mastery if only one component was not observed. For all of these strategies, the impact of not taking into consideration the relative difficulty of a missing component is unknown. Performances rated as near mastery may vary significantly from child to child. For example, the overhand throw of a Measurement of Fundamental Movement Skills child who is not demonstrating a hip-shoulder rotation is more proficient than that of a child who is not stepping forward. Miller (2002) found that performance variation was greater for some skill components both within and between pupils for the two handed sidearm strike.

**Easiest skill components**

For some FMS this information is available. The NSW Fitness and Physical Activity Survey (Booth et al., 1997) reported the percentage of each age group that demonstrated mastery of each component. Most of the boys were focusing their eyes on the target; therefore this is the easiest component. On the other hand, very few boys showed a split hip-shoulder rotation, therefore this is the hardest component for them to master. McIntyre (2001) reported a similar pattern of component mastery for Western Australian pupils. Figure 3 reveals the percentage of mastery for each component of the throw among 7-year-old girls. In both studies, while the percentages varied a similar pattern of mastery was evident with this skill across all age groups studied.

A relatively new approach to psychometric measurement, the Rasch measurement model, is able to provide a different perspective when used to analyse FMS data. This technique, based on item response theory, is founded on the principles of fundamental measurement, order and objectivity (Wright and Masters, 1982). Computer programmes implementing this model RUMM, Andrich, Sheridan and Luo, 1997) test the fit of data to the model and position items and persons on a common unidimensional and additive scale.

In the development of the Victorian FMS package, Walkley and colleagues used the Rasch measurement model to scale the difficulty level of individual skill components for a range of FMS with pupils aged between 6 and 12 years, shown in Figure 4 (Victorian Department of Education, 1996). The difficulty levels for the skill components of the overhand were similar to those reported by Booth et al (1997) and McIntyre (2000). The eyes-focused forward was very easy for the pupils in the study to demonstrate and the sequential hip and shoulder rotation was the hardest. The question now remains is how best to integrate this information into assessment tools. In the first instance, if the mastery of Measurement of Fundamental Movement Skills components varies from the expected pattern it is highly likely that the child may have a motor learning disability and require additional support and intervention (Larkin and Hoare, 1991).

The relationship between qualitative and quantitative measures is useful when assessing FMS. In order to capture the inherent advantages of both approaches, some tests include both quantitative and qualitative test items. Wessel (1976) reported that "I CAN Fundamental Skills" comprise qualitative measures to assess pupils first learning a skill and product or outcome measures to assess the more proficient performers. The McCarron Assessment of Neuromuscular Development includes quantitative items, qualitative items and items that are measured using both approaches. The combination of approaches takes into account the more erratic and variable movement patterns of beginners compared to the more consistent patterns of skilled performers. With the latter group, quantitative measure better discriminate between performers.

Recent studies have compared qualitative and quantitative measures for the overarm throw (McIntyre, 2000; Roberton and Konczak, 2001) and the two handed strike (Miller, 2002). McIntyre (2000) reported a significant correlation of .754 ($p<.05$) between average distance thrown and quality of performance for pupils aged between 7 and 12 years. When calculated for each age groups, correlations ranged between .47 ($p = 0.14$) for 7-year-olds to .81 ($p<.00$) for 12-year-olds. These results suggest that as pupils become more proficient and more consistent in performance, the relationship between process and product becomes stronger (McIntyre, 2000).

Roberton and Konszak (2001) also reported significant correlations between quantitative (ball velocity) and qualitative (skill components) measures for primary school aged pupils. They correlated different body components to the velocity and found correlations varied with age. For example, the trunk action correlations were low (between 0.1 and 0.3) until 13 years of age (0.59) when stride length became more highly correlated (0.71) and stepping dropped to 0.27. Miller (2002) compared distance Measurement of Fundamental Movement Skills weighted for accuracy and process measures for the two handed strike and found a significant relationship. She found younger boys (6- 7 years) were more proficient than the older girls (9-10 years) but the older girls were able to hit the ball further. This difference could be due height and weight advantages evident in the older girls. Overall, variability in performance was highest for pupils who were younger, female and with poorer coordination. These studies show that while the relationship between process and product is strong the interrelationships between body components and outcome change over time.

**PHYSIOLOGICAL IMPORTANCE OF PHYSICAL ACTIVITY TO PUPILS**

It is important that pupils learn to move effectively, efficiently, and with control and enjoyment. The learning needs to be developmentally appropriate and challenging, extending pupils' competence through movement experiences which are fun and child focused. FMSs are the basic movements which underpin all that we do. There comes a point for all pupils when they need help, encouragement and guidance to develop FMSs. Their skills may be developed through involvement and practise in the many varied opportunities provided for them. Pupils need encouragement and instructive feedback from an adult, e.g. "watch the ball", which provides information to help them improve their skills.

O'connor and Temple (2005) published an article on constraints and facilitators of physical activity in family day care where they reported the review below "Regular" participation in physical activity has been well established as an integral part of a healthy lifestyle in adults (Pate et al., 1995). It has been recognized that most diseases affected by exercise (such as coronary heart disease, hypertension, obesity, and osteoporosis) are a result of life-long processes, usually surfacing clinically in the older adult years (Corbin et al., 1998; National Centre for Chronic Disease Prevention and Health Promotion, 2000). Clinical markers of hypokinetic disease have been observed in pupils (Boreham, Twisk, Savage, Cran and Strain, 1997; National Centre for Chronic Disease Prevention and Health Promotion, 2000). The increased prevalence of overweight and obesity may be attributed to decreasing activity, increasing inactivity, and a rising caloric intake (Magarey, Daniels and Boulton, 2001).

These results have placed an emphasis on promoting exercise habits in pupils and adolescents as the starting point of a life-style of regular exercise that will continue through adulthood (Corbin et al., 1998). While some evidence exists to support the tracking of cardiovascular disease risk factors into adulthood, data demonstrating the tracking of physical activity behaviours is more limited(Twisk, Kemper, Snel, 1995; Wang, Monteiro and Popkin, 2002). The lack of supporting evidence may be as much a problem of assessing physical activity in pupils as much as it is one of tracking (Kohl and Hobbs, 1998).

While there appears to be some support for the notion that activity tracks in pupils (Pate, Baranowski, Dowda and Trost, 1996) and that inactive pupils and youth are likely to become inactive adults (Corbin and Pangrazi, 1998), the lack of hard evidence for tracking physical activity has been substituted with a common sense argument. This argument is based on the belief that early positive physical activity experiences will predispose people to enjoy physical activity in later years (Okely, Booth and Patterson, 2001; Centers for Disease Control and Prevention, 1997; Corbin and Pangrazi, 1998). In addition to physiological and potential public health benefits, pupils who exercise regularly have higher self-esteem and may exhibit reduced risk taking behaviours (Brown and Brown, 1996; Dinubile, 1993).

Early childhood forms a unique period where pupils undergo significant social, intellectual, emotional, and physical development. Enhancement of movement skills is believed to play an important role in the development of pupils within the physical domain, with potential carry-over into the social and cognitive domains (Gabbard, 2004). Body management activities, manipulation opportunities with a variety of equipment, and both locomotor and non-locomotor activities should form the basis of a young child's pre-school movement experience (Carson, 1994; COPEC, 1994; Gallahue and Ozmun, 1998; Sanders, 1992). Fundamental movement skills are basic movement patterns that can be adapted, combined and refined serving to provide a foundation from which more complicated skills can be established and later applied to lifetime sporting, recreational, and physical activities (Carson, 1994; Gallahue and Ozmun, 1998).

Fundamental movement skill (catch, throw, kick and the like) competency amongst Australian primary school aged pupils is considered by some to be poor (Booth et al., 1997; Walkley, Holland, Treloar, and Probyn-Smith, 1993). Because success is a strong predictor of motivation to participate and persist in sport, it is essential that young pupils be provided with opportunities to establish appropriate movement skill competencies at an early age (Walkley et al., 1993; Weiss, Dziura and Burgert, 2004). Without those competencies pupils are less likely to participate in physical activity as they get older. Okley, Booth, and Patterson (2001) found fundamental movement skill proficiency among other things, to be significantly associated with adolescents' participation in organized physical activity. FMS are important because they: are the building blocks for more complex skills, are common threads for many sport skills, develop a wide range of motor skills, and help pupils to understand the structure and concepts of human movements.

## APPRAISAL OF REVIEWED LITERATURE

This review revealed vividly that pupils need to participate regularly in physical activity and that all concerned individuals must provide developmentally appropriate activities that will assist them in the development of physical skills. When adults assist pupils in development of specific physical skills, they empower them to learn about the importance of physical activity in their lives and to become physically active and healthy for a lifetime (Wilmore and Knuttgen, 2003). It is clear that pupils and adults who are physically active on a regular basis are healthier than those who are not active. It is also evident from research findings that many pupils and adults do not regularly take part in physical activities that contribute to a healthy lifestyle. There are many reasons for this lack of physical activity, the most evident being the lack of exposure at an early age to physical skill development activities. If an individual does not possess the skills to strike a tennis ball he is probably not going to play tennis. Likewise in the skills of throwing or catching, he will most likely not participate in games where those skills are needed.

There is also a consensus that if pupils do not learn to throw, catch, jump and kick when they are young they will not possess the skills needed to participate in physical activities as adults and thus most will not get appropriate amounts of physical activity. Developmentally appropriate practice suggests that adults make educated decisions based on what is known from research and experience about how pupils learn and develop. Using a plastic ball and bat is more developmentally appropriate and will initially better help the child learn the skill.

Another consensus is that in schools today, pupils find themselves focused on learning basic concepts in mathematics, reading, social studies etc. Physical activity, in many schools and in many homes, does not have the level of importance it deserves.

# CHAPTER THREE

## METHODOLOGY

The method and procedures employed in this study were discussed under the following sub-headings:

1. Research Design
2. Population of the study
3. Sample and Sampling Techniques
4. Research Instruments
5. Validity of the instruments
6. Reliability of the instruments
7. Test Location
8. Procedure for Data Collection
9. Order of Exercise Training
10. Pilot Study
11. Procedure for Data Analysis

**Research Design**

The randomised classic pre-test and post-test quasi-experimental research design of two experimental comparison groups and one control group devised by Isaac and Michael (1981) as shown below was employed in the study.

Public + Private schools [aerobic exercise (AE) in Experimental Group]

Public + Private schools [progressive resistance exercise (PRE) in Experimental comparison Group]

Public + Private schools [Pure Control]

The design has one experimental group and two control groups. One of the two control groups is actually an experimental comparison group because the trainings were not the same while the third group is a pure control group. The two experimental groups were designed to be different so as to enable the researcher confidently confirm that experimental manipulations were effective and that the results did not occur by chance. The main purpose of this design was to determine the amount of change produced by the treatment (Thomas, Nelson and Silverman, 2005).The design was appropriate given the fact that it provided the avenue through which differences can be checked frequently during study (Bryman, 2001).

**Population**

The population for this study comprised all public and private primary schools' pupils in Ibadan, Nigeria. Studies in physical, health education and sports had been conducted using this group of people (Awosika, 2005; Ogungbenro, 2005; Omolawon and Olajide, 2005; and Cools, DeMartelaer, Samaey and Andries, 2008) but none of them was on gross motor skills (GMSs) and physiological parameters (PPs) in relation to Aerobic and progressive resistance exercises.

**Sample and Sampling Techniques**

A total of one hundred and eighty (180) pupils were sampled for this study. The samples were volunteers drawn purposively from four (two public and two private) primary schools in Ibadan. Between thirteen (13) and ten (10) pupils of them were in primary three (3), twenty (20) and eighteen (18) were in primary four. In primary five (5) three schools had fifteen (15) pupils each while the fourth school had twelve (12) pupils. The selection of the number of participants from each class is by proportionate allocation (based on the population of each class in the schools chosen). Each of the schools had representation ranging from 40 to 48 pupils. Systematic random sampling technique was used for allocating participants into the three groups, namely: the aerobic exercise (AE), the progressive resistance exercise (PRE) and the control group.

**Table 3.1: Illustration of the Participants Sample Size based on Type of School and Class Representation**

| Class | Adem Nursery and Primary School | Sacred Heart Nursery and Primary School | Christ Gospel School 11 | Progressive Day School 1 | Total |
|---|---|---|---|---|---|
| Primary 5 | 15 | 12 | 15 | 15 | 57 |
| Primary 4 | 19 | 18 | 20 | 18 | 75 |
| Primary 3 | 13 | 10 | 13 | 12 | 48 |
| Total | 47 | 40 | 48 | 45 | 180 |

Between 15-20 volunteers, totalled 200, were recruited from each of the classes in the schools chosen before the commencement of the trainings but mortality inform of inability to meet up to one hundred percent training attendance as well as absence during post training measurements reduced the sample size to the representation illustrated on table 3.1.

## Research Instruments

The first five instruments below were used to measure physiological parameters while the last was used to measure gross motor skills of the participants in the study.

**Weighing scale**: Hana portable weight measuring scale (RA9012) made in England was used to measure the weight of the participants in kilogram.

**Sphygmomanometer:** The 2009 BOKANG Model of free style standing model sphygmomanometer calibrated from 0-300mmHg made in China by W.B.I.C.Wenzhou (CE0197) was used in conjunction with the stethoscope for measuring the participants' systolic and diastolic blood pressure.

**Stethoscope:** The Litman's stethoscope made in the United States of America (U.S.A.) was used to measure heart rate and blood pressure of the participants.

**Stopwatch:** The track star jewels digital stopwatch made in Switzerland was used in timing the participants' heart rate and related exercise measurement.

**Skinfold Calliper**: The large skinfold calliper (model 3003) made by Cambridge Scientific Industries Incoporated, U.S.A., was used to measure skinfold thickness of the participants. The calliper is graduated from 0mm to 67mm, with a constant pressure of 10g/mm.

**Test of Gross Motor Development 2 (TGMD-2):** The TGMD-2 developed by Ulrich (2000) is a well-constructed, criterion-referenced and norm-referenced, standardized test of gross motor skill development that includes locomotor and object control skills. It was used to measure how pupils coordinate their trunk and limbs during movement task performance in gross motor skills rather than assessing end products.

**Validity of Instruments**

The instruments used in this study had scientifically been proved to be standardised ones. However, the researcher cross-checked the PPs instruments to ensure that they were in proper working condition before usage.

**Reliability of Instruments**

All the instruments used in this study have been proved scientifically to be reliable. In line with this view, Evelyn (2004) established r = 0.90 for weekly frequency of participation in at least 30 min of Aerobic and progressive resistance exercises. Jackson, Pollock and Ward (1980) reported r = 0.89 for 7 sites skinfold. Freedman etal (1999) reported r = 0.9 for weight-height indices. Bourbonnais etal (2002) also found strong Pearson product-moment correlation coefficients of 0.97 for sphygmomanometer, stethoscope (r=0.98), stadiometer (r=0.99) and weighing scale (r=0.96). The TGMD-2 has three categories with coefficient ratings. The coefficient value for locomotor is .85; object control is .88 while gross motor skills is .91(Ulrich, 2000).

**Order of Exercise Trainings**

The Aerobic and progressive resistance exercise trainings involved twelve consecutive weeks interval trainings in which participants in the experimental groups were exposed to repeated periods of work, interspersed with rest periods. The AE group involved in low intensities (35–54%HRmax) work load while the PRE group took part in short moderate intensities (55–69%HRmax) workload with increment at scheduled interval (Marwick et al., 2009). The activities took place three times a week in line with the position of the American College of Sports Medicine (2007) on quality and quantity of exercise training. The control group did not partake in any organised training during the period. The under listed modalities were applied.

**Procedure for Data Collection**

To enhance the cooperation of the participants and the authority of the school used, the researcher collected a signed letter of introduction from the Head of the Department of Human Kinetics and Health Education, University of Ibadan, which was used for identification purpose. With this, awareness interaction on exercise and its benefits were given to the pupils after a discussion with their teachers that were well incorporated into the training. Finally, they all filled informed consent through their head teachers, teachers and parents. Data on the gross motor skills and Physiological parameters of the participants were collected before (pre) and after (post) training programmes that lasted for twelve (12) weeks by the researcher with the help of his trained assistants following the underlisted procedures.

**Age**: Participants supplied their Date of Birth and this was subtracted from date on which he or she was assessed. The obtained value was recorded in years.

**Body Weight:** Body weight of the participants was collected by standing on weighing scale dressed in a gymnastic cloth and was recorded in kilograms to the nearest line point.

**Height:** The participants stood on Stadiometer bare-footed, erect, feet together with heel, buttocks, proximo-posterior trunk position of arms and rear of the head in contact with the bar of the Stadiometer. While the participants looked straight forward, the height was recorded to the nearest line point in meters.

**Heart rate:** The resting heart rate of the participants was taken at the mitral area through auscultation in a sitting position. The researcher put on the headpiece of the stethoscope over the mitral area of the participants without too much pressure exerted and listened to the sound that was heard. The heart sounds of “lub-dub” that was heard was counted for ten (10) seconds. The counted numbers were multiplied by six (6) to make one (1) minute count and recorded.

**Systolic and diastolic blood pressure:** The cuff of the sphygmomanometer was wrapped evenly and snugly around the arm of the participants at 2.5cm above the site of brachial pulsation. The pressure at which the first sound (korotkoff) was heard was recorded as the systolic blood pressure. The researcher continued with the deflating of the cuff noting the point when the last sound was heard which was recorded as diastolic blood pressure both in mmHg. The researcher finally deflated the cuff and removed it from the participants' arm.

**Skinfold (Percent Body Fat)**: The researcher pinched the right side (for consistency) of the pupils' skin at the appropriate site to raise a double layer of skin and the underlying adipose tissue, but not the muscle. The calliper was then applied 1 cm below and at right angles to the pinched and a reading was taken two seconds later. The mean of two measurements was taken. Where the two measurements differ greatly, a third was done with the median value taken. The obtained score was used in the equation developed by Jackson and Pollock (1978) and Jackson, Pollock and Ward, (1980) for body density and percent body fat respectively.

Body Density =1.112 - (0.00043499 X Sum7) + (0.00000055 X Sum7$^2$) - (0.00028826 X Age).

Body Fat Percentage = [(4.95/Body Density) + 4.5] 100 (boys).

and

Body Density =1.097 - (0.00046971 X Sum7) + (0.00000056 X Sum7$^2$) - (0.00012828 X Age).

Body Fat Percentage = [(4.95/Body Density) + 4.5] 100 (girls).

**Note:** 'Sum7' is the sum of all the seven sites measurements in mm.

**Body Mass Index:** BMI was obtained using the Quetelet's Index of weight (kg)/square of height (m) reported by Eknoyan (2008).

**Gross Motor Skills (locomotor and object control skills)**: Each gross motor skill includes several behavioural components that are presented as performance criteria. In general, these behaviours represent a mature pattern of the skills**.** Where the participant performs a behavioral components correctly, '1' mark was awarded but if the participant does not perform a behavioural component correctly, '0' mark was awarded. After completing this procedure for each of two trials, the researcher totalled the scores of the two trials to obtain a raw skill ability score for each of the items which were converted to a standard score. Standard score was then converted to an overall gross motor quotient that Ulrich (2000) termed GMSs. The conversion tables are in appendixes 6-9.

To effectively use TGMD-2 the following considerations suggested by Ulrich (2000) were followed.

1. The researcher taught and developed competence in those who assisted with the data collection. The researcher has acquainted himself in utilizing the instrument which made him to give supervised practice to the research assistants to ensure adherence to test procedures.
2. Testing conditions were followed. There was prior arrangement of the setting to help minimize administration time and distractions. Materials were put at various designated spots.
3. Testing time was 12-20 minutes for each participant. To ensure the test was completed within the time frame, several balls were provided during the test to reduce time for retrieving balls.
4. Appropriate information was provided on the examiner record form for identification of participants. There was accurate demonstration preceding assessment. Participants had a practice trial to ensure that they knew what they were expected to do and a second demonstration was performed if a child did not understand after the first one on the day of measurement. Each participant had two trials for each locomotor and object control skills tested apart from training practices and the score for each trail was recorded.The specific materials, directions of movement and performance criteria in each of the skills are listed below.

**Table 3.2: LOCOMOTOR SKILLS PROCEDURES**

| Skill | Materials | Directions | Performance Criteria |
|---|---|---|---|
| Running | 60 feet of clear space, and two cones. | Place two cones 50 feet apart. Make sure there is at least 8 to 10 feet of space beyond the second cone for a safe stopping distance. Tell the child to run as fast as he or she can from one cone to the other when you say ″Go″. Repeat a second trial. | • Arms move in opposition to legs, elbows bent.<br>• Brief period where both feet are off the ground.<br>• Narrow foot placement landing on heel or toe (i.e., not flat footed).<br>• Non-support leg bent approximately 90 degrees (i.e., close to buttocks). |
| Galloping | 25 feet of clear space, and tape or two cones. | Mark off a distance of 25 feet with two cones or tape. Tell the child to gallop from one cone to the other. Repeat a second trial by galloping back to the original cone. | • Arms bent and lifted to waist level at takeoff.<br>• A step forward with the lead foot followed by a step with the trailing foot to position adjacent to or behind the lead foot.<br>• Brief period when both feet are off the floor.<br>• Maintains a rhythmic pattern for four consecutive gallops. |
| Hopping | A minimum of 15 feet of clear space | Tell the child to hop three times on his or her preferred foot (established before testing) and then three times on the other foot. Repeat a second trial. | • Non-support leg swings forward in pendular fashion to produce force.<br>• Foot of non-support leg remains behind body.<br>• Arms flexed and swing forward to produce force.<br>• Takes off and lands three consecutive times on preferred foot.<br>• Takes off and lands three consecutive times on non-preferred foot. |
| Leaping | A minimum of 20 feet of clear space, a beanbag, and tape | Place a beanbag on the floor. Attach a piece of tape on the floor so it is parallel to and 10 feet away from the beanbag. Have the child stand on the tape and run up and leap over the beanbag. Repeat a second trial. | • Take off on one foot and lead on the opposite foot.<br>• A period where both feet are off the ground longer than running.<br>• Forward reach with the arm opposite the lead foot. |
| Horizontal Jump | A minimum of 10 feet clear space of tape | Mark of a starting line on the floor. Have the child start behind the line. Tell the child to jump as far as he or she can. Repeat a second trial. | • Preparatory movement includes flexion of both knees with arms extended behind body.<br>• Arms extend forcefully forward and upward reaching full extension above the head.<br>• Take off and land on both feet simultaneously.<br>• Arms are thrust downward during landing. |
| Sliding | A minimum of 25 feet clear space, a straight line, and | Place the cones 25 feet apart on top of a line on the floor. Tell the child to slide from one cone to the other and back. | • Body turned sideways so shoulders are aligned with the line on the floor.<br>• A step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot. |

| | | | |
|---|---|---|---|
| | two cones. | Repeat a second trial. | • A minimum of four continuous step-slide cycles to the right.<br>• A minimum of four continuous step-slides to the left. |

**Table 3.3: OBJECT CONTROL SKILL PROCEDURES**

| Skill | Materials | Directions | Performance Criteria |
|---|---|---|---|
| Striking a stationary Ball | A 4-inch lightweight ball, a plastic bat, and a batting tee. | Place the ball on the batting tee at the child's belt level. Tell the child to hit the ball hard. Repeat a second trial. | • Dominant hand grips bat above non- dominant hand.<br>• Non-preferred side of body faces the imaginary tosser with feet parallel.<br>• Hip and shoulder rotation during swing.<br>• Transfers body weight to front foot.<br>• Bat contacts ball. |
| Stationary Dribble | An 8- to 10-inch playground ball for pupils ages 3 to 5; a basketball for pupils ages 6 to; and a flat, hard surface. | Tell the child to dribble the ball four times without moving his or her feet, using one hand, and then stop by catching the ball. Repeat a second trial. | • Contacts ball with one hand at about belt level.<br>• Pushes ball with fingertips (not a slap).<br>• Ball contacts surface in front of or to the outside of foot on the preferred side.<br>• Maintains control of ball for four consecutive bounces without having to move the feet to retrieve it. |
| Catching | A 4-inch plastic ball, 15 feet of clear space, and tape. | Mark off two lines 15 feet apart. The child stands on one line and the tosser on the other. Toss the ball underhand directly to the child with a slight arc aiming for his or her chest. Tell the child to catch the ball with both hands. Only count those tosses that are between the child's shoulders and belt. Repeat a second trial. | • Preparation phase where hands are in front of the body and elbows are flexed.<br>• Arms extend while reaching for the ball as it arrives.<br>• Ball is caught by hands only. |
| Kicking | An 8-to 10-inch plastic, playground, or football ball; a beanbag; 30 feet of clear space; and tape. | Mark off one line 30 feet away from a wall and another line 20 feet from the wall. Place the ball on top of the beanbag on the line nearest the wall. Tell the child to stand on the other line. Tell the child to run up and kick the ball hard toward the | • Rapid continuous approach to the ball.<br>• An elongated stride or leap immediately prior to ball contact.<br>• Non-kicking foot place even with or slightly in back of the ball.<br>• Kicks ball with instep of preferred foot (shoelaces) or toe. |

| | | | |
|---|---|---|---|
| | | wall. Repeat a second trial. | |
| Overhand Throw | A tennis ball, a well, tape, and 20 feet of clear space. | Attach a piece of tape on the floor 20 feet from a wall. Have the child stand behind the 20-foot line facing the wall. Tell the child to throw the ball hard at the wall. Repeat a second trial. | • Windup is initiated with downward movement of hand/arm.<br>• Rotates hip and shoulders to a point where the non-throwing side faces the wall.<br>• Weight is transferred by stepping with the foot opposite the throwing hand.<br>• Follow-through beyond ball release diagonally across the body toward the non-preferred side. |
| Underhand Roll | A tennis ball for pupils ages 3 to 6; softball for pupils ages 7 to 10; two cones; tape and 25 feet of clear space. | Place the two cones against a wall so they are 4 feet apart. Attach a piece of tape on the floor 20 feet from the wall. Tell the child to roll the ball hard so that it goes between the cones. Repeat a second trial. | • Preferred hand swings down and back, reaching behind the trunk while chest faces cones.<br>• Strides forward with foot opposite the preferred hand toward the cones.<br>• Bends knees to lower body.<br>• Releases ball close to the floor so ball does not bounce more than 4 inches high. |

**Test Location**

The PRE and AE trainings and measurements of gross motor skills were conducted on the sports field while measurement of physiological parameters took place in the classrooms of the schools involved between the hours of 4:00 – 6:00pm of each contact session.

**Modalities for Aerobics Exercise Training**

The participants involved in five-station weekly activities of three (3) sets with 3, 2 and 1 repetitions respectively in the first week. Week second ,third, fourth, fifth, eighth, ninth, tenth and eleventh had four (4) sets of 4,3,2,and 1 repetition respectively whereas weeks six (6) and Seven (7) with four (4) sets had 4,3,3 and 3 repetitions. The last week had five (5) sets with 5,4,3,2 and 1 repetition in each of the stations. Excluding warm up and cool down, the participants were made to continuously rotating within the stations until activities are completed. They were randomly divided into five groups of twelve each. The detail order of exercise in each station is in appendix 2.

**Modalities for Progressive Resistance Exercise Training**

The training protocol was based on incremental number of repetitions (3 sets of 3 to 12 repetitions each) in line with Faigenbaum and Westcott (2000) submission that 1 set of 11-15 repetitions that end at the point of fatigue is the best stimulus for adaptation for prepubertal PR exercisers. Resistance was increased with each set. Participants were randomly divided into six lines of ten participants in each. Seven exercises were given one after the other and participants repeated after the instructor (researcher). For detail order of the exercises, turn to appendix 3.

**Pilot Study**

To acquaint the researcher and his assistants with the research instruments, methods and procedures and to allow for detection of any unforeseen constraints in the research work, fourteen (seven private and seven public) pupils from Master Model Nursery and Primary School and Community Primary School 11 both in Ijokodo, Ibadan, who were not part of the actual study were engaged for pilot study.

The obtained results of the pilot study conducted showed that there were no significance improvement in gross motor skills performance and physiological parameters responses of the participants. Also, there was no significance differences in the improvement level of the participants in all variables tested after two weeks of aerobic and progressive resistance exercise trainings. These imply that two weeks of exercise trainings are not enough to yield much improvement in gross motor skills and physiological parameters of primary school pupils.

However, pilot study conducted enabled the researcher to conscript as well as increase volunteers that were the participants for the actual study from the proposed 180 to 200. It also assisted the researcher to increase and replace as applicable recruited research assistants from 12 to 15. The numbers of equipment proposed for the actual study were increase by twenty percent. The training periods proposed were shifted from early morning to evening after the normal school hours in the actual study.

**Procedure for Data Analysis**

The descriptive statistics of mean and standard deviation of data collected were analysed. Normative tables and figures were used to illustrate research questions. Inferential statistics of Analysis of Covariance (ANCOVA) was computed to compare the three groups based on the variables showed in hypotheses 1, 2, 3 and 4. The Scheffé post hoc test which Maxwell and Delaney (2004) supported to be preferred when many contrasts are of interest was adopted for specific differences in ANCOVA results. Independent t-test was carried out to compare the training effects on the variables based on gender and types of school as presented in hypotheses 5 and 6, all at the 0.05 level of significance.

# CHAPTER FOUR

## RESULTS, ANALYSES AND DISCUSSIONS OF FINDINGS

This experimental study investigated the effects that occurred in the Gross Motor Skills (GMSs) and Physiological parameters of Primary School Pupils in Ibadan as a result of Aerobic Exercise (AE) and Progressive Resistance Exercise (PRE) Trainings. To achieve this, some statistical analysis and interpretations were made on the collected data. The descriptive statistics of mean and standard deviation were computed. Research question 1 was answered using Ulrich (2000) GMSs norm while research questions 2 and 3 were answered using physiological paediatric norms of Kliegman (2007) for BP, Jewkes, Luba and McCusker (2005) for heart rate, Freedman et al (2009) for %BF and CDC Growth Charts for BMI.

The results and analysis were described under each of the figures and tables while discussions of findings were made at the concluding end of this chapter.

**Results and Analyses**

**Demographic Characteristics of the Participants**

**Table 4.1: Frequency distribution of the Participants by Class**

| **Class** | **Frequency (F)** | **Percentage (%)** |
|---|---|---|
| Primary 3 | 48 | 26.7 |
| Primary 4 | 75 | 41.7 |
| Primary 5 | 57 | 31.6 |
| **Total** | **180** | **100.0** |

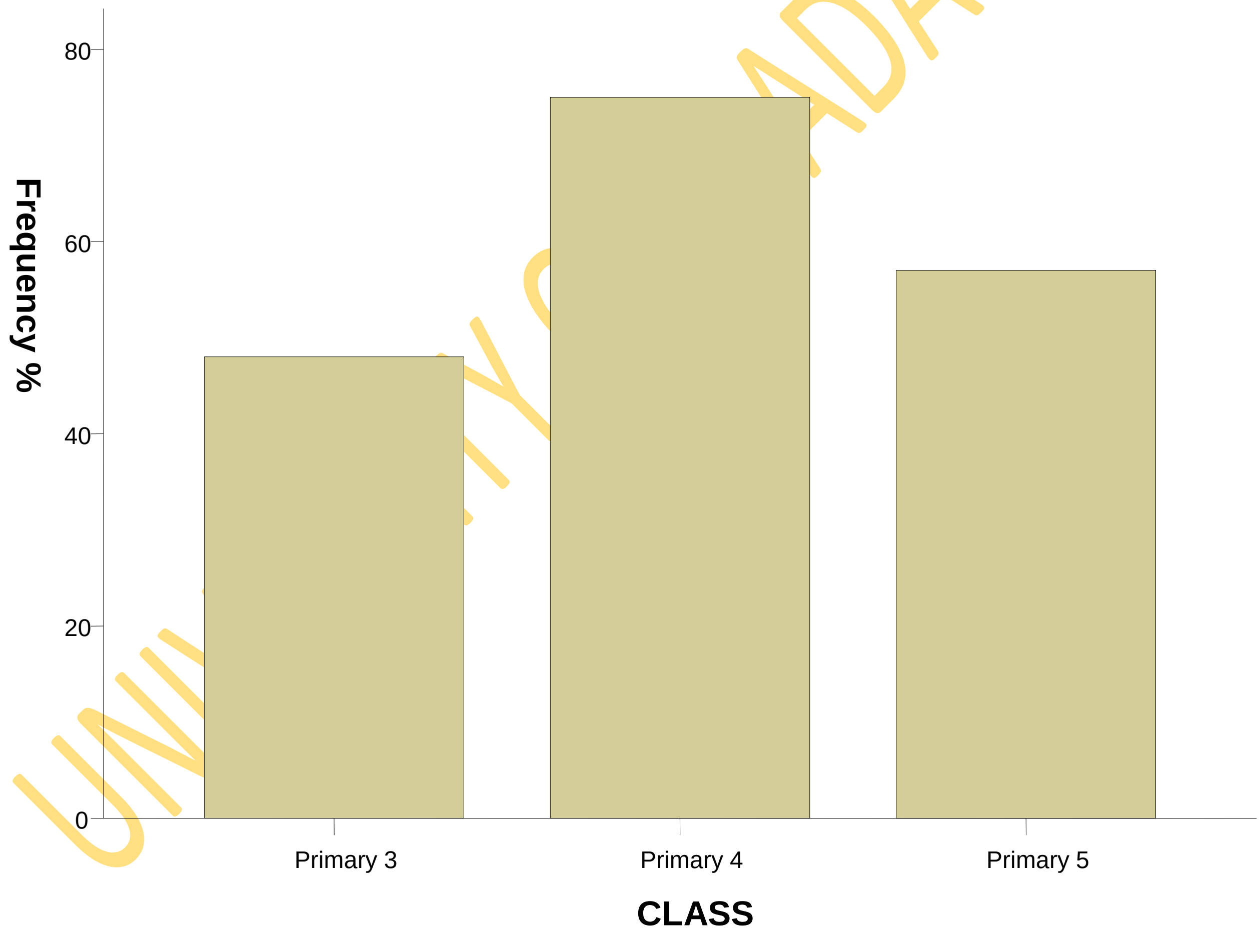



**Fig. 4.1: Bar Chart showing the Class of the Participants**

Figure 4.1 is a bar chart that illustrates the class distribution of the participants where 48(26.7%) were in primary 3, 75 (41.7%) were in primary 4 and 57(31.6%) were in primary 5.

**Table 4. 2: Frequency distribution of the Participants by Age**

| Age (year) | Frequency (F) | Percentage (%) |
|---|---|---|
| 7 | 9 | 5.0 |
| 8 | 27 | 15.0 |
| 9 | 36 | 20.0 |
| 10 | 59 | 32.8 |
| 11 | 20 | 11.1 |
| 12 | 29 | 16.1 |
| **Total** | **180** | **100.0** |

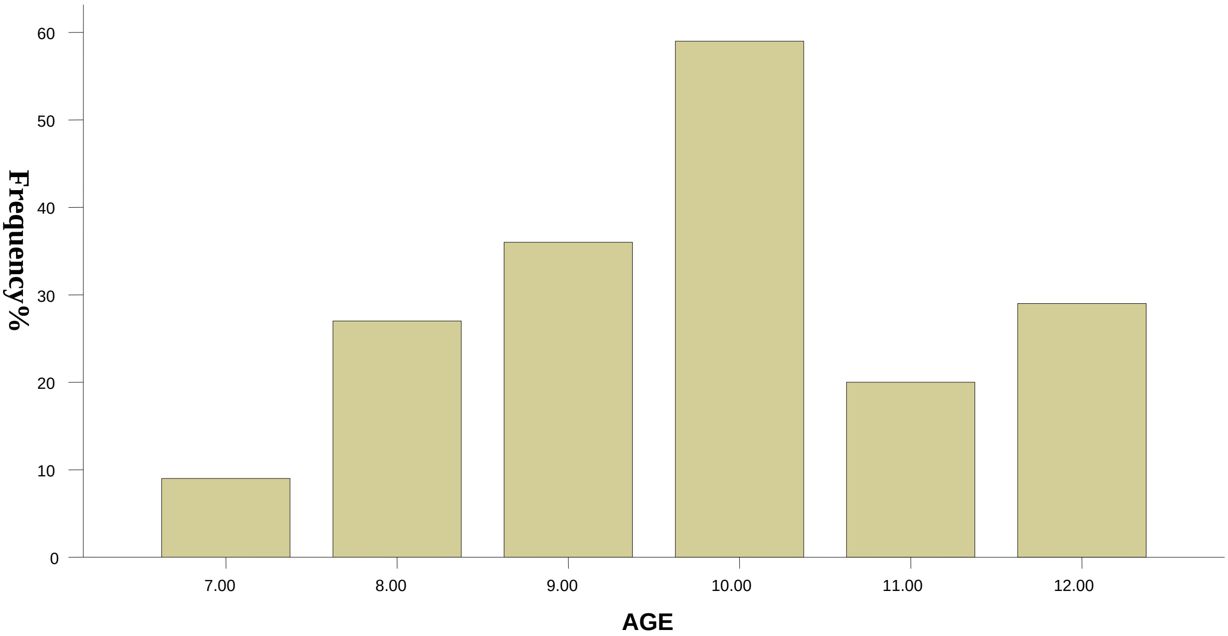
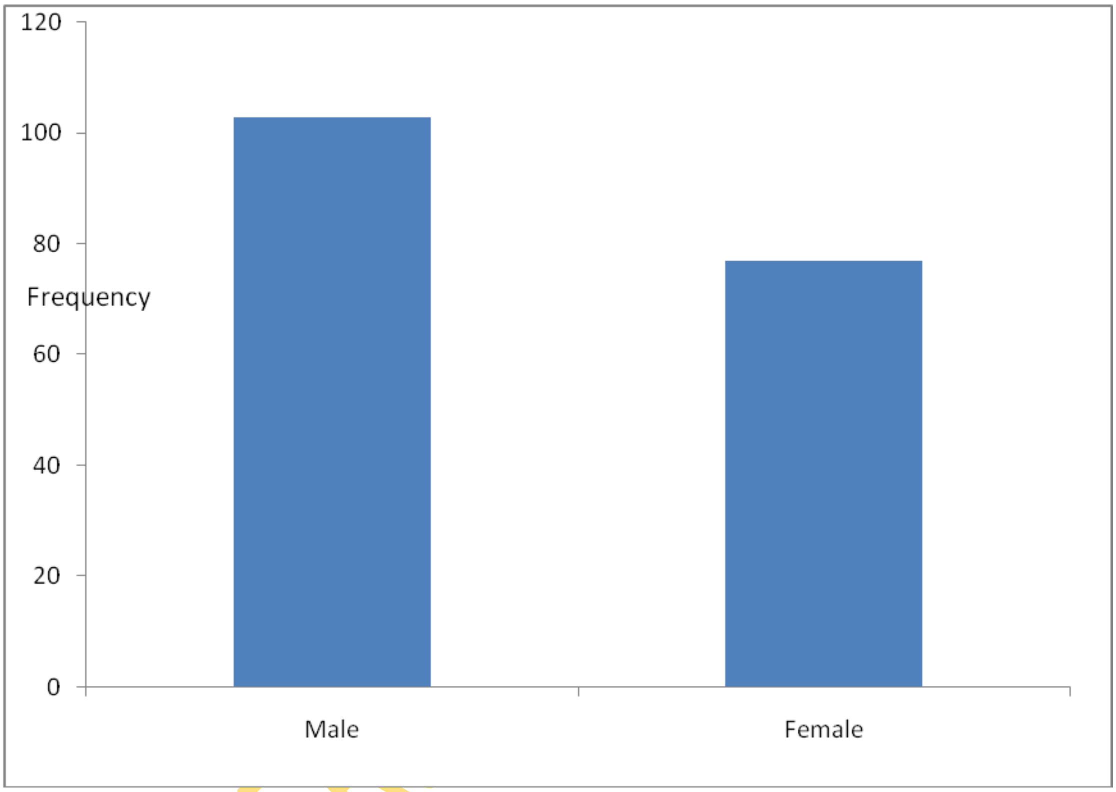



**Fig.4.2: Bar chart showing the Age of the Participants**

From figure 4.2 which is a bar chart showing the participants' age, 9 (5.0%) of the participants were 7 years, 27 (15.0%) were 8 years, 36 (20.0%) were 9 years, 59 (32.8%) were 10 years, 20 (11.1%) were 11 years while 29 (16.1%) were 12 years with average age of 9 years 8 months.

**Table 4. 3: Frequency distribution of the Participants by Gender**

| **Gender** | **Frequency (F)** | **Percentage (%)** |
|---|---|---|
| Male | 103 | 57.2 |
| Female | 77 | 42.8 |
| **Total** | **180** | **100.0** |




**Gender**

**Fig.4. 3: Bar Chart showing the Participants Gender**

The bar chart in figure 4.3 shows that 103 (57.2%) of the participants were male while 77 (42.8%) were female. This shows that most of the participants used in this study were males.

**Table 4.4: Descriptive statistics showing Pretest-Posttest Means and Standard Deviations of the variables in the Aerobic Exercise Group**

| Variables | Pre-test Mean & Std. | Post-test Mean & Std. | Mean Difference |
|---|---|---|---|
| Height (m) | 1.31 ± 0.07 | 1.35±0.08 | 0.04 |
| Weight (kg) | 25.52±5.25 | 27.40±4.90 | 1.88 |
| Running | 2.43±0.96 | 5.75±0.95 | 3.32 |
| Galloping | 1.82±0.85 | 5.27±0.94 | 3.45 |
| Hopping | 2.00±1.07 | 5.10±1.16 | 3.10 |
| Leaping | 1.78±0.86 | 4.37±0.80 | 2.59 |
| Horizontal Jumping | 2.32±1.11 | 5.33±0.99 | 3.01 |
| Sliding | 1.52±0.87 | 4.95±1.17 | 3.43 |
| **Locomotor Skills** | 1.00±0.00 | 4.27±1.10 | 3.27 |
| Striking a Stationary Ball | 2.25±1.05 | 5.58±1.14 | 3.33 |
| Stationary Dribbling | 2.10±1.02 | 5.15±1.04 | 3.05 |
| Catching | 2.23±1.05 | 4.88±1.11 | 2.65 |
| Kicking | 2.15±1.09 | 5.17±1.01 | 3.02 |
| Overhead Throwing | 2.08±1.06 | 5.75±1.11 | 3.67 |
| Underhand Rolling | 2.42±0.85 | 6.80±7.96 | 4.38 |
| **Object Control Skills** | 1.00±0.00 | 4.73±1.76 | 3.73 |
| **Gross Motor Skills (GMSs)** | 46.05±0.39 | 66.90±7.45 | 20.85 |
| Resting SBP (mmHg) | 97.33±8.99 | 98.50±9.88 | 1.17 |
| Resting DBP (mmHg) | 64.17±10.78 | 62.10±8.23 | 2.07 |
| Resting Heart Rate (bpm) | 82.27±9.32 | 77.25±11.56 | 5.02 |
| Percent Body Fat (%) | 7.21±4.23 | 7.17±4.22 | 0.04 |
| Body Mass Index (BMI, $kg/m^2$) | 14.81±3.29 | 14.80±2.20 | 0.01 |

**Keys:** SBP= Systolic Blood Pressure, DBP= Diastolic Blood Pressure

Table 4.4 illustrated the mean and standard deviation of the variables measured at the pre and post training stages in the AE group. The pre-test locomotor skills mean was 1.00±0.00 while post-test mean was 4.27±1.10 with mean difference of 3.27. AE had pre-test object control skills means of 1.00 ± 0.00 as against post-test means of 4.73± 1.76 with mean difference of 3.67. The pretest mean for GMSs in the AE was 46.05±0.39 whereas post-test mean was 66.90±7.45 with mean difference of 20.85. The AE group had SBP pre-test mean of 97.33±8.99 mmHg however post-test mean was 98.50±9.88mmHg with mean difference of 1.17mmHg. Pre-test means of 64.17±10.78mmHg as well as post-test mean of 62.10±8.23mmHg with mean differences of 2.07mmHg was recorded for DBP in AE.

Heart rate in the AE group had a pretest-posttest means of 82.27±9.32 and 77.25±11.56 with mean difference of 5.02bpm. Percent body fat in the AE group had a pre-test and post-test means of 7.21±4.23 and 7.17±4.22 with mean difference of 0.04%. The table also had pre-test and post-test means of 14.81±3.29 and 14.80±2.20kg/m$^2$ for BMI in the AE group with mean difference of 0.01kg/m$^2$.

**Table 4.5: Descriptive statistics showing Pretest-Posttest Means and Standard Deviations of the variables in the Progressive Resistance Exercise Group**

| Variables | Pre-test Mean & Std | Post- test Mean & Std | Mean Difference |
|---|---|---|---|
| Height (m) | 1.35±0.08 | 1.36±0.09 | 0.01 |
| Weight (kg) | 27.4±3.75 | 29.52± 5.82 | 2.04 |
| Running | 1.90±1.21 | 5.97±0.94 | 4.07 |
| Galloping | 1.40±1.61 | 5.60±1.04 | 4.20 |
| Hopping | 1.80±1.15 | 5.58±1.14 | 3.78 |
| Leaping | 1.28±0.78 | 4.78 ±1.09 | 3.50 |
| Horizontal Jumping | 1.72±0.92 | 5.93±1.44 | 4.21 |
| Sliding | 0.75±0.79 | 4.77±0.91 | 4.02 |
| **Locomotor Skills** | 1.05±0.22 | 4.90±1.36 | 3.85 |
| Striking a Stationary Ball | 1.57±0.81 | 6.15±1.04 | 4.58 |
| Stationary Dribbling | 1.50±0.91 | 5.63±1.28 | 4.13 |
| Catching | 1.92±1.08 | 5.22±1.08 | 3.30 |
| Kicking | 1.65±0.86 | 5.60±1.24 | 3.95 |
| Overhead Throwing | 1.75±1.04 | 6.50±1.20 | 4.75 |
| Underhand Rolling | 1.85±0.82 | 6.43±1.20 | 4.58 |
| **Object Control Skills** | 1.02±0.13 | 6.27±2.14 | 5.25 |
| **Gross Motor Skills (GMSs)** | 46.05±0.39 | 73.30±8.39 | 27.25 |
| Resting SBP (mmHg) | 107.00 ±12.12 | 95.17±14.20 | 11.83 |
| Resting DBP (mmHg) | 65.33 ±5.67 | 60.67±7.78 | 4.66 |
| Resting Heart Rate (bpm) | 81.07 ±4.95 | 81.37±11.87 | 0.30 |
| Percent Body Fat (%) | 6.04±3.59 | 7.89±3.85 | 1.85 |
| Body Mass Index (BMI, kg/m$^2$) | 15.09 ±1.66 | 15.66±2.07 | 0.57 |

**Keys:** SBP= Systolic Blood Pressure, DBP= Diastolic Blood Pressure

Table 4.5 showed the mean and standard deviation of the variables measured at the pre and post training stages in the PRE group. The pre-test locomotor skills mean was 1.05±0.22 while post-test mean was 4.90±1.36 with mean difference of 3.85 for PRE. PRE had pre-test object control skills mean of 1.02 ± 0.13 as against post-test mean of 6.27± 2.14 with mean difference of 5.25. The pretest mean for

GMSs in the PRE was 46.05±0.39 whereas post-test mean was 73.30±8.39 with mean difference of 27.25. The PRE group had SBP of 107.00±12.12 however post-test mean was 95.17±14.20mmHg with mean difference of 11.83mmHg. Pre-test means of 65.33±5.67 as well as post-test mean of 60.67±7.87 with mean difference of 4.66mmHg was recorded for DBP in PRE.

Heart rate in PRE group had pretest-posttest mean of 81.07±4.95 and 81.37±11.87 with mean difference of 0.30bpm. Percent body fat in PRE group had a pre-test and post-test means of 6.04±3.59 and 7.89±3.85 with mean difference of 1.85%. The table had pre-test and post-test means of 15.09±1.66 and 15.66±2.07kg/m$^2$ for BMI in the PRE group with mean difference of 0.57kg/m$^2$.

**Table 4. 6: Descriptive statistics showing Pretest-Posttest Means and Standard Deviations of the variables in the Control Group**

| Variables | Pre-test Mean & Std | Post-test Mean & Std | Mean Difference |
|---|---|---|---|
| Height (m) | 1.33 ±0.08 | 1.35±0.08 | 0.02 |
| Weight (kg) | 26.9±4.00 | 26.78±5.29 | 0.19 |
| Running | 1.15±0.97 | 3.35±0.97 | 2.20 |
| Galloping | 0.87±0.85 | 2.98±0.95 | 2.11 |
| Hopping | 1.27±0.84 | 2.63±1.10 | 1.36 |
| Leaping | 0.88±0.78 | 2.70±0.96 | 1.82 |
| Horizontal Jumping | 1.00±0.96 | 2.97±1.01 | 1.97 |
| Sliding | 0.47±0.72 | 2.43±1.05 | 1.96 |
| **Locomotor Skills** | 1.00±0.00 | 1.08±0.28 | 0.08 |
| Striking a Stationary Ball | 1.40±1.08 | 3.17±0.94 | 1.77 |
| Stationary Dribbling | 1.03±0.99 | 3.05±1.05 | 2.02 |
| Catching | 1.27±1.02 | 2.98±0.95 | 1.71 |
| Kicking | 1.27±0.95 | 2.77±0.98 | 1.50 |
| Overhead Throwing | 1.43±1.16 | 3.17±0.94 | 1.74 |
| Underhand Rolling | 1.62±0.90 | 3.13±0.93 | 1.51 |
| **Object Control Skills** | 1.02±0.13 | 1.22±0.61 | 0.20 |
| **Gross Motor Skills (GMSs)** | 46.15±0.66 | 46.90±2.16 | 0.75 |
| Resting SBP (mmHg) | 101.07±12.52 | 103.17±9.65 | 2.10 |
| Resting DBP (mmHg) | 65.12±8.79 | 62.83±5.85 | 2.29 |
| Resting Heart Rate (bpm) | 79.98±10.39 | 86.97±12.37 | 6.99 |
| Percent Body Fat (%) | 7.39±3.77 | 7.95±3.79 | 0.56 |
| Body Mass Index (BMI, kg/m$^2$) | 15.18±1.89 | 14.39±1.74 | 0.79 |

**Keys:** SBP= Systolic Blood Pressure, DBP= Diastolic Blood Pressure

Table 4.6 also illustrated the mean and standard deviation of the variables measured at the pre and post training stages in the control group. The pre-test locomotor skills mean was 1.00±0.00 while post-test mean was 1.08±0.28 with mean difference of 0.08 for control group. Control group had pre-test object control skills mean of 1.02 ± 0.13 as against post-test means of 1.22± 0.61 with mean difference of 0.20. The pretest mean for GMSs in the control group was 46.15±0.66 whereas post-test mean was 46.90±2.16 with mean difference of 0.75. The control group had 101.07±12.52 however post-test mean was 103.17±9.65mmHg with mean difference of 2.10mmHg. Pre-test mean of 65.12±8.79 as well as post-test mean of 62.83±8.85 with mean difference of 2.29 mmHg was recorded for DBP in control group.

Heart rate in control group had pretsest-posttest means of 79.98±10.39 and 86.97±12.37 with mean difference of 6.99bpm. Percent body fat in the control group had pre-test and post-test means of 7.39±3.77 and 7.95±3.79 with mean difference of 0.56%. The table had pre-test and post-test means of 15.18±1.89 and 14.39±1.74kg/m$^2$ for BMI in the control group with mean difference of 0.79kg/m$^2$.

**Answer to Research Questions**

The obtained GMSs and PPs (cardiovascular and body composition) values in this study were compared with scientifically established norms for effective ratings as shown below in tables 4.2 – 4.5 as well as figures 4 and 5 respectively.

**Research Question 1: What is the gross motor skills level of pupils in Ibadan?**

**Table 4. 7: Descriptive Statistics showing the mean of gross motor skills after trainings**

| Variable | AE Mean | PRE Mean | Control Mean | Grand Mean |
|---|---|---|---|---|
| Gross Motor Skills | 66.90 | 73.30 | 46.90 | 62.37 |

**Table 4.8: Normative Values of Gross Motor Skills**

| Subtest Standard Scores | Gross Motor Skills | Descriptive Ratings |
|---|---|---|
| 17-20 | >130 | Very Superior |
| 15-16 | 121-130 | Superior |
| 13-14 | 111-120 | Above Average |
| 8-12 | 90-110 | Average |
| 6-7 | 80-89 | Below |
| 4-5 | 70-79 | Poor |
| 1-3 | <70 | Very Poor |

Source: Ulrich, (2000)

Table 7 revealed that the participants had average mean of 62.37 in GMSs which was less than 70 shown in the ratings table 4.8. This showed that the participants have very poor GMSs. This low score implied that the pupils have weak locomotor and object control skills. Ulrich (2000) opined that a mild deficit in GMSs can cause a child's movements to be clumsy, uncoordinated or inefficient.

**Research Question 2: What is the cardiovascular (Blood pressure and Heart rate) level of pupils in Ibadan?**

**Table 4.9: Descriptive Statistics showing the mean of Blood Pressure after trainings**

| Variables | AE Mean | PRE Mean | Control Mean | Grand Mean |
|---|---|---|---|---|
| Systolic Blood Pressure (mmHg) | 98.50 | 95.17 | 103.17 | 98.94 |
| Diastolic Blood Pressure (mmHg) | 62.10 | 60.67 | 62.83 | 61.87 |

**Table 4.10: Normative Values of Children Blood Pressure**

| Age | Systolic Blood Pressure (mmHg) | Diastolic Blood Pressure (mmHg) |
|---|---|---|
| Premature | 55-75 | 35-45 |
| 0-3 months | 65-85 | 45-55 |
| 3-6 months | 70-90 | 50-65 |
| 6-12 months | 80-100 | 55-65 |
| 1-3 years | 90-105 | 55-70 |
| 3-6 years | 95-110 | 60-75 |
| 6-12 years | 100-120 | 60-75 |
| Over age 12 | 110-135 | 65-85 |

Source: Kliegman, (2007)

The average age of the participants was 9 years 8 months which indicated that their average blood pressure (98.94/61.87mmHg) as shown in table 4.9 was normal within 100-120/60-75mmHg rating of Kliegman (2007) showed in table 4.10. Agrawal, (2010) stated that BP in pupils works in the opposite way as compared to the other physiological parameters in that it tends to increase as pupils age. Blood pressures can be quite low in newborns, and remain on the low side until pupils reach toddlerhood

**Table 4 .11: Descriptive Statistics showing the mean of Heart rate after trainings**

| **Variable** | **AE Mean** | **PRE Mean** | **Control Mean** | **Grand Mean** |
|---|---|---|---|---|
| Heart rate (bpm) | 77.25 | 81.37 | 86.97 | 81.86 |

**Table 4.12: Normative Values of Children Heart rates**

| **Age** | **Heart rate (bpm)** |
|---|---|
| <1 | 110-160 |
| 1-2 | 100-150 |
| 2-5 | 95-140 |
| 5-12 | 80-120 |
| >12 | 60-100 |

Jewkes, Luba and McCusker, (2005)

The HR (81.86bpm within 80-120bpm presented on tables 4.11 and 12) of the participants in this study was at the normal level because their age range (7-12 years) was within age 5-12 years showed in table 4 .12 as reported by Jewkes, Lubas and McCusker (2005).

**Research Question 3: What is the level of body composition of pupils in Ibadan?**

**Table 4.13: Descriptive Statistics showing the mean of Percent Body Fat after trainings**

| Variable | AE Mean | PRE Mean | Control Mean | Grand Mean |
|---|---|---|---|---|
| %BF | 7.17 | 7.89 | 7.95 | 7.67 |

**Fig.4.4: Body Fat Charts for Boys 7-18 Years**

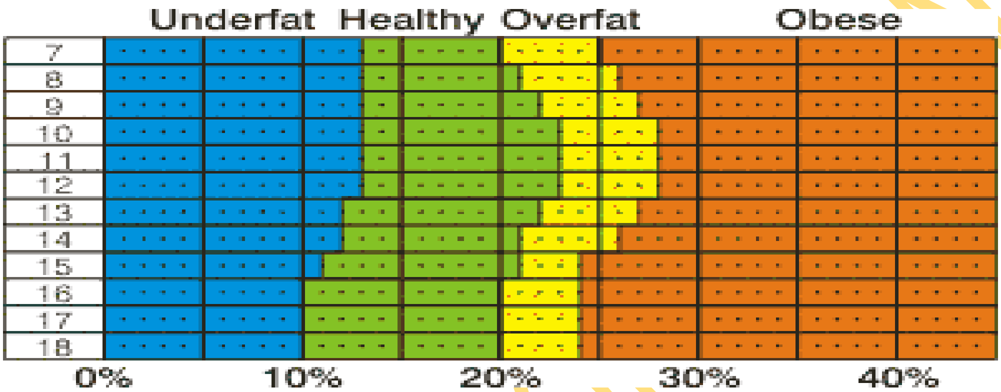
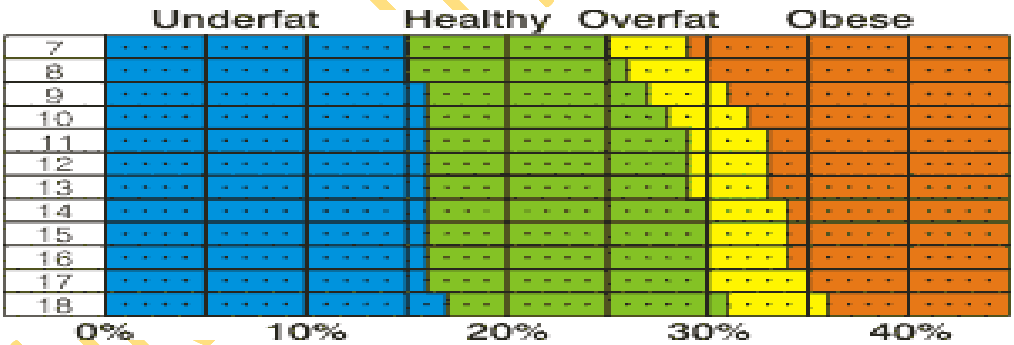



**Fig. 4.5: Body Fat Charts for Girls 7-18 Years**




Source: Freedman, Wang, Thornton, Mei, Sopher, Pierson (Jr), Dietz and Horlick, (2009).

The mean %BF of 7.67% showed on table 4.13 for participants in this study was in the underfat level based on the body fat charts for boys and girls 7-18 years reported by Freedman etal (2009).

**Table 4.14: Descriptive Statistics showing the mean of Body Mass Index after trainings**

| Variable | AE Mean | PRE Mean | Control Mean | Grand Mean |
|---|---|---|---|---|
| BMI | 14.81 | 15.66 | 14.39 | 14.95 |

**Table 4.15: Pupils BMI-For-Age Weight Status Categories and the Corresponding Percentiles**

| Weight Status category | Percentile Range |
|---|---|
| Underweight | Less than the $5^{th}$ percentile |
| Healthy weight | $5^{th}$ percentile to less than the $85^{th}$ percentile |
| Overweight | $85^{th}$ to less than the $95^{th}$ percentile |
| Obese | Equal to or greater than the $95^{th}$ percentile |

Source: CDC Growth Charts.

Based on the centre for disease control and prevention chart for pupils' BMI-for-age- weight categories (see appendix 5) and the corresponding percentiles showed in table 4.15, the BMI (14.96kg/$m^2$ showed on table 4.14) value of the participants in this study was in the underweight category as it was less than the $5^{th}$ percentile level. These primary school pupils were experiencing malnutrition disorder in their development stage.

**Hypotheses testing**

**Hypothesis 1:** There will be no significant difference in locomotor skills (Run, Gallop, Hop, Leap, Horizontal Jump and Slide) of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.16: ANCOVA result showing the effect of aerobic exercise and progressive resistance exercise on locomotor skills**

| Source of Variation | Sum of Squares | df | Mean Squares | F | Sig. of F | Remark |
|---|---|---|---|---|---|---|
| Covariates | 11.208 | 1 | 11.208 | 10.655 | .001 | |
| Main Effects of Treatment Groups | 491.419 | 2 | 245.709 | 233.600 | .000 | Sig. |
| Explained | 502.626 | 3 | 167.542 | 159.285 | .000 | |
| Residual | 185.124 | 176 | 1.052 | | | |
| Total | 687.750 | 179 | 3.842 | | | |

The table 4.16 showed the results of ANCOVA on the effect of Aerobic and progressive resistance exercises trainings on locomotor skills of primary school pupils in Ibadan. The main effects of the test on the participants (experimental groups and control group) were statistically significant at 0.05 significant level [($F_{3,176}$) =233.600, $p<0.05$]. There were significant differences in the effects of Aerobic and progressive resistance exercises on locomotor skills. Hence the hypothesis was rejected. The mean score for the PRE group was 4.90, AE was 4.27, and control group was 1.08 while grand mean score was 3.42.

**Table 4.17: Result on Multiple Classification Analysis of pretest and posttest showing the direction of the significant interaction effects on locomotor skills, Grand mean = 3.42**

| Variable category | N | Unadjusted Deviation | Eta | Adjusted for Independents + Covariates Deviation | Beta |
|---|---|---|---|---|---|
| PRE | 60 | 1.48 | | 1.47 | |
| AE | 60 | 0.85 | | 0.86 | |
| Control | 60 | -2.33 | 0.85 | -2.33 | 0.85 |
| Multiple R Square | | | | | 0.731 |
| Multiple R | | | | | 0.855 |

Table 4.17 showed the MCA results of Aerobic and progressive resistance exercises on locomotor skills of primary school pupils in Ibadan. From the table, experimental group of PRE has an adjusted mean score value of 4.90 (3.42+1.48), experimental group of AE has the adjusted mean score value of 4.27(3.42+0.85) and control group has the adjusted mean score value of 1.08 (3.42-2.33). The result indicated that PRE training was more effective than AE.

**Table 4.18: Result on Scheffe Post hoc Analysis for Locomotor Skills**

| Variable | Treatment Groups | Treatment Groups | Mean Difference | Sig. |
|---|---|---|---|---|
| Locomotor Skills Abilities | PRE | AE | .6333* | .004 |
| | | Control | 3.8167* | .000 |
| | AE | PRE | -.6333* | .004 |
| | | Control | 3.1833* | .000 |
| | Control | PRE | -3.8167* | .000 |
| | | AE | -3.1833* | .000 |

*=The mean significant is at the 0.05 level. The significant difference in locomotor skills abilities as indicated by scheffe is between control and PRE (P<0.05) on one side and control and AE on the other side (P<0.05).

**Hypothesis 2:** There will be no significant difference in object control skills (Striking a stationary Ball, Stationary Dribble, Catch, Kick, Overhand Throw and Underhand Roll) of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.19: ANCOVA result showing the effect of aerobic exercise and progressive resistance exercise on Object Control Skills of the Participants**

| Source of Variation | Sum of Squares | df | Mean Squares | F | Sig. of F | Remark |
|---|---|---|---|---|---|---|
| Covariates | .370 | 1 | .037 | .137 | .000 | |
| Main Effects of Treatment Groups | 805.211 | 2 | 402.605 | 148.712 | .000 | Sig. |
| Explained | 805.581 | 3 | 268.527 | 99.187 | .000 | |
| Residual | 476.480 | 176 | 2.707 | | | |
| Total | 1282.061 | 179 | 7.162 | | | |

Table 4.19 revealed that there was significant difference in the object control skills among the primary school pupils in Ibadan exposed to each of the experimental groups and control group [$(F_{3,176})$ =148.712, $p<0.05$]. With this value of F, the hypothesis was rejected. This indicated that there were significant differences in the effect of the trainings on object control skills of the pupils. This is because the F-test at $p<0.05$ shows a significant difference exist among the three groups. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on object control skills, MCA as presented below was applied.

**Table 4.20: Result on Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean= 4.07**

| Variable category | N | Unadjusted Deviation | Eta | Adjusted for Independents + Covariates Deviation | Beta |
|---|---|---|---|---|---|
| PRE | 60 | 2.19 | | 2.19 | |
| AE | 60 | .66 | | .67 | |
| Control | 60 | -2.86 | .79 | -2.86 | .79 |
| Multiple R Square | | | | | .628 |
| Multiple R | | | | | .793 |

The MCA in table 4.20 revealed a pattern similar to ANCOVA in table 4.19. From the table, experimental group of PRE has an adjusted mean score value of 6.27 (4.07+2.19), experimental group of AE has the adjusted mean score value of 4.73 (4.07+0.67) and control group has the adjusted mean score value of 1.22 (4.07-2.86). The result indicated that PRE training was more effective than AE. Detailed explanations were shown in the next scheffé post hoc table.

**Table 4.21: Result on Scheffe Post hoc Analysis for Object Control Skills**

| Variable | Treatment Groups | Treatment Groups | Mean Difference | Sig. |
|---|---|---|---|---|
| Object Control | PRE | AE<br>Control | 1.5333*<br>5.0500* | .000<br>.000 |
| | AE | PRE<br>Control | -1.5333*<br>3.5167* | .000<br>.000 |
| | Control | PRE<br>AE | -5.0500*<br>-3.5167* | .000<br>.000 |

*=The mean significant was at the 0.05 level. The significant difference in the various object control skills as indicated by scheffe in table 4.21 was among the three groups (P<0.05).

**Hypothesis 3(a):** There will be no significant difference in resting systolic blood pressure of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.22: ANCOVA result showing the effect of aerobic exercise and progressive resistance exercise on Resting Systolic Blood Pressure of the Participants**

| Source of Variation | Sum of Squares | df | Mean Squares | F | Sig. of F | Remark |
|---|---|---|---|---|---|---|
| Covariates | 162.658 | 1 | 162.658 | 1.237 | .267 | |
| Main Effects of Treatment Groups | 1802.820 | 2 | 901.410 | 6.858 | .001 | Sig. |
| Explained | 1965.478 | 3 | 655.159 | 4.984 | .002 | |
| Residual | 23133.967 | 176 | 131.443 | | | |
| Total | 25099.444 | 179 | 140.220 | | | |

Table 4.22 indicated that there was significant difference in the SBP among the primary school pupils in Ibadan exposed to each of the experimental groups and

control group [($F_{3,176}$) =6.858, $p<0.05$]. With this value of F, hypothesis 3 (a) was rejected. This indicates that there were significant differences in the effect of the trainings on SBP of the pupils. This is because the F-test at $p<0.05$ shows a significant difference exist among the three groups. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on SBP, MCA as presented below was applied.

**Table 4.23: Result on Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 98.94**

| Variable category | N | Unadjusted Deviation | Eta | Adjusted for Independents + Covariates Deviation | Beta |
|---|---|---|---|---|---|
| PRE | 60 | -3.78 | | -3.60 | |
| AE | 60 | -.44 | | -.60 | |
| Control | 60 | 4.22 | .28 | 4.20 | .27 |
| Multiple R Square | | | | | .078 |
| Multiple R | | | | | .280 |

The MCA in table 4.23 revealed a pattern similar to ANCOVA in table 4.22. From the table, experimental group of PRE has an adjusted mean score value of 95.17 (98.94-3.60) mmHg, experimental group of AE has the adjusted mean score value of 98.50 (98.94-0.60) mmHg and control group has the adjusted mean score value of 103.17 (98.94+4.20) mmHg. The result indicated that PRE training was more effective than AE. Detailed explanations were shown in the next scheffé post hoc table.

**Table 4.24: Result on Scheffe Post hoc Analysis for Resting Systolic Blood Pressure**

| Variable | Treatment Groups | Treatment Groups | Mean Difference | Sig. |
|---|---|---|---|---|
| Systolic Blood Pressure | PRE | AE | -3.3333 | .282 |
| | | Control | -8.0000* | .001 |
| | AE | PRE | 3.3333 | .282 |
| | | Control | -4.6667 | .085 |
| | Control | PRE | 8.0000* | .001 |
| | | AE | 4.6667 | .085 |

*=The mean significant is at the 0.05 level. The significant difference in SBP as indicated by scheffe in table 4.24 is PRE and control (P<0.05).

**Hypothesis 3(b):** There will be no significant difference in resting diastolic blood pressure of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.25: ANCOVA result showing the effect of aerobic exercise and progressive resistance exercise on Resting Diastolic Blood Pressure of the Participants**

| Source of Variation | Sum of Squares | df | Mean Squares | F | Sig. of F | Remark |
|---|---|---|---|---|---|---|
| Covariates | 24.933 | 1 | 24.933 | .459 | .499 | |
| Main Effects of Treatment Groups | 143.377 | 2 | 71.688 | 1.319 | .270 | N.S. |
| Explained | 168.310 | 3 | 56.103 | 1.032 | .380 | |
| Residual | 9564.490 | 176 | 54.344 | | | |
| Total | 9732.800 | 179 | 54.373 | | | |

Table 4.25 showed that there was no significant difference improvement in the DBP among the primary school pupils in Ibadan exposed to each of the experimental groups and control group $[(F_{3,176}) = 1.319, p > 0.05]$. With this value of F, hypothesis 3 (b) was accepted. This is because the F-test at $p < 0.05$ shows that significant difference does not exist among the three groups. However, in order to determine the magnitude and direction of the contribution of the trainings on DBP, MCA as presented below was applied.

**Table 4.26: Result on Multiple Classification Analysis showing the direction of the significant interaction effects on Resting Diastolic Blood Pressure,**

**Grand mean = 61.87**

| Variable category | N | Unadjusted Deviation | Eta | Adjusted for Independents + Covariates Deviation | Beta |
|---|---|---|---|---|---|
| PRE | 60 | -1.20 | | -1.18 | |
| AE | 60 | .23 | | .20 | |
| Control | 60 | .97 | .12 | .98 | .12 |
| Multiple R Square | | | | | .017 |
| Multiple R | | | | | .132 |

The MCA in table 4.26 revealed a pattern similar to ANCOVA in table 4.25. From the table, experimental group of PRE has an adjusted mean score value of 60.67 (61.87-1.18) mmHg, experimental group of AE has the adjusted mean score value of 62.10 (61.87+0.20) mmHg and control group has the adjusted mean score value of 62.83 (61.87+0.98) mmHg. The result indicated that PRE training was more effective than AE.

**Hypothesis 3(c):** There will be no significant difference in resting heart rate of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.27: ANCOVA result showing the effect of aerobic exercise and progressive resistance exercise on Resting Heart Rate of the Participants**

| Source of Variation | Sum of Squares | df | Mean Squares | F | Sig. of F | Remark |
|---|---|---|---|---|---|---|
| Covariates | 12.274 | 1 | 12.274 | 10.260 | .000 | |
| Main Effects of Treatment Groups | 354.698 | 2 | 177.349 | 148.243 | .000 | Sig. |
| Explained | 366.972 | 3 | 122.324 | 102.249 | .000 | |
| Residual | 210.555 | 176 | 1.196 | | | |
| Total | 577.528 | 179 | 3.226 | | | |

In checking for significant difference, table 4.27 showed that there was significant difference improvement in the heart rate among the primary school pupils in Ibadan exposed to each of the experimental groups and control group [($F_{3,176}$)

=148.243, p<0.05]. With this value of F, hypothesis 3 (c) was rejected. This indicates that there were significant differences in the effect of the trainings on heart rate of the pupils. This is because the F-test at p<0.05 shows that a significant difference exist among the three groups. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on heart rate, MCA as presented below was applied.

**Table 4.28: Result on Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 81.86**

| Variable category | N | Unadjusted Deviation | Eta | Adjusted for Independents + Covariates Deviation | Beta |
|---|---|---|---|---|---|
| PRE | 60 | -.49 | | -.49 | |
| AE | 60 | -4.61 | | -4.81 | |
| Control | 60 | 5.11 | .30 | 5.29 | .31 |
| Multiple R Square | | | | | .103 |
| Multiple R | | | | | .321 |

The MCA in table 4.28 revealed a pattern similar to ANCOVA in table 4.27. From the table, experimental group of PRE has an adjusted mean score value of 81.37 (81.86-0.49) bpm, experimental group of AE has the adjusted mean score value of 77.25 (81.86-4.81) bpm and control group has the adjusted mean score value of 86.97 (81.86+5.29) bpm. The result indicated that PRE training was more effective than AE. Detailed explanations were shown in the next scheffé post hoc table.

**Table 4.29: Result on Scheffe Post hoc Analysis for Resting Heart Rate**

| Variable | Treatment Groups | Treatment Groups | Mean Difference | Sig. |
|---|---|---|---|---|
| Heart Rate | PRE | AE<br>Control | -4.11667<br>-5.60000 | .208<br>.056 |
| | AE | PRE<br>Control | -4.11667<br>-9.71667* | .208<br>.000 |
| | Control | PRE<br>AE | 5.60000<br>9.71667* | .056<br>.000 |

*=The mean significant is at the 0.05 level. The significant difference in the skill of overhead throw as indicated by scheffe in table 4.29 was between control and AE ($P<0.05$).

**Hypothesis 3(d):** There will be no significant difference in percent body fat of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.30: ANCOVA result showing the effect of aerobic exercise and progressive resistance exercise on Percent Body Fat of the Participants**

| Source of Variation | Sum of Squares | df | Mean Squares | F | Sig. of F | Remark |
|---|---|---|---|---|---|---|
| Covariates | 18.487 | 1 | 18.487 | 1.179 | .279 | |
| Main Effects of Treatment Groups | 20.640 | 2 | 10.320 | .658 | .519 | N.S. |
| Explained | 39.127 | 3 | 13.042 | .832 | .478 | |
| Residual | 2758.931 | 176 | 15.676 | | | |
| Total | 2798.058 | 179 | 15.632 | | | |

Table 4.30 showed significant difference did not exist in the %BF among the primary school pupils in Ibadan exposed to each of the experimental groups and control group [($F_{3,176}$) =0.658, $p>0.05$]. With this value of F, hypothesis 3 (d) was accepted. This is because the F-test at $p>0.05$ shows that significant difference does not exist among the three groups. In order to determine the magnitude and direction of the contribution of the trainings on %BF, MCA as presented below was applied.

**Table 4.31: Result on Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 7.67**

| Variable category | N | Unadjusted Deviation | Eta | Adjusted for Independents + Covariates Deviation | Beta |
|---|---|---|---|---|---|
| PRE | 60 | .22 | | .15 | |
| AE | 60 | -.50 | | -.47 | |
| Control | 60 | .28 | .09 | .32 | .09 |
| Multiple R Square | | | | | .014 |
| Multiple R | | | | | .118 |

The MCA in table 4.31 revealed a pattern similar to ANCOVA in table 4.56. From the table, experimental group of PRE has an adjusted mean score value of 7.89 (7.67+0.15)%, experimental group of AE has the adjusted mean score value of 7.17 (7.67-0.47)% and control group has the adjusted mean score value of 7.95 (7.67+0.32)%. The result indicated that PRE training was more effective than AE. Detailed explanations were shown in the next scheffé post hoc table.

**Hypothesis 3 (e):** There will be no significant difference in body mass index of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.32: ANCOVA result showing the effect of aerobic exercise and progressive resistance exercise on Body Mass Index of the Participants**

| Source of Variation | Sum of Squares | df | Mean Squares | F | Sig. of F | Remark |
|---|---|---|---|---|---|---|
| Covariates | 18.128 | 1 | 18.128 | 4.572 | .034 | |
| Main Effects of Treatment Groups | 50.474 | 2 | 25.237 | 6.365 | .002 | Sig. |
| Explained | 68.602 | 3 | 22.867 | 5.767 | .001 | |
| Residual | 697.878 | 176 | 3.965 | | | |
| Total | 766.480 | 179 | 4.282 | | | |

Table 4.32 revealed that statistically significant difference existed in BMI among the primary school pupils in Ibadan exposed to each of the experimental groups and control group [$(F_{3,176})$ =6.365, p<0.05]. With this value of F, hypothesis 3 (e) was accepted. This indicates that there were significant differences in the effect of the trainings on BMI of the pupils. This is because the F-test at p<0.05 shows a

significant difference exist among the three groups. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on BMI, MCA as presented below was applied.

**Table 4.33: Result on Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 14.95**

| Variable category | N | Unadjusted Deviation | Eta | Adjusted for Independents + Covariates Deviation | Beta |
|---|---|---|---|---|---|
| PRE | 60 | .71 | | .70 | |
| AE | 60 | -.15 | | -.12 | |
| Control | 60 | -.56 | .26 | -.58 | .26 |
| Multiple R Square | | | | | .090 |
| Multiple R | | | | | .299 |

From the table 4.33, experimental group of PRE has an adjusted mean score value of 15.66 (14.94+0.70) kg/m$^2$, experimental group of AE has the adjusted mean score value of 14.81(14.94-0.12) kg/m$^2$ and control group has the adjusted mean score value of 14.39 (14.94-0.58) kg/m$^2$. The result indicated that AE made better improvement to BMI than the PRE. Detailed explanations were shown in the next scheffé post hoc table.

**Table 4.34: Result on Scheffe Post hoc Analysis for Body Mass Index**

| Variable | Treatment Groups | Treatment Groups | Mean Difference | Sig. |
|---|---|---|---|---|
| Body Mass Index | PRE | AE | .8525 | .070 |
| | | Control | 1.2688* | .003 |
| | AE | PRE | -.8525 | .070 |
| | | Control | .4163 | .527 |
| | Control | PRE | -1.2688* | .003 |
| | | AE | -.4163 | .527 |

*=The mean significant is at the 0.05 level. The significant difference in the skill of overhead throw as indicated by scheffe in table 4.34 was between control and AE (P<0.05).

**Hypothesis 4:** There will be no significant difference in gross motor skills of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.35: ANCOVA result showing the effect of aerobic exercise and progressive resistance exercise on Gross Motor Skills of the Participants**

| Source of Variation | Sum of Squares | df | Mean Squares | F | Sig. of F | Remark |
|---|---|---|---|---|---|---|
| Covariates | 195.571 | 1 | 195.571 | 4.468 | .000 | |
| Main Effects of Treatment Groups | 22562.831 | 2 | 11281.415 | 257.747 | .000 | Sig. |
| Explained | 22758.402 | 3 | 7586.134 | 173.321 | .000 | |
| Residual | 7703.398 | 176 | 43.769 | | | |
| Total | 30461.800 | 179 | 170.178 | | | |

From table 4.35, it can be seen that Aerobic and progressive resistance exercises trainings will improve the GMSs of primary school pupils in Ibadan. This is because of the significant difference existing between GMSs of pupils exposed to each of the experimental groups and control group [($F_{3,176}$) =257.747, $p<0.05$]. With this value of F, hypothesis 4 was rejected. This indicates that there were significant differences in the effect of the trainings on GMSs of the pupils. This is because the F-test at $p<0.05$ shows a significant difference exist among the three groups. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on GMSs, MCA as presented below was applied.

**Table 4.36: Result on Multiple Classification Analysis showing the direction of the significant interaction effects, Grand mean = 62.37**

| Variable category | N | Unadjusted Deviation | Eta | Adjusted for Independents + Covariates Deviation | Beta |
|---|---|---|---|---|---|
| PRE | 60 | 10.93 | | 10.93 | |
| AE | 60 | 4.53 | | 4.53 | |
| Control | 60 | -15.47 | .86 | -15.47 | .86 |
| Multiple R Square | | | | | .747 |
| Multiple R | | | | | .864 |

The MCA in table 4.36 revealed a pattern similar to ANCOVA in table 4.35. From the table, experimental group of PRE has an adjusted mean score value of

73.30 (62.37+10.93), experimental group of AE has the adjusted mean score value of 66.90 (62.37+4.53) and control group has the adjusted mean score value of 46.90 (62.37-15.47). The result indicated that PRE training was more effective than AE. Detailed explanations were shown in the next scheffé post hoc table.

**Table 4.37: Result on Scheffe Post hoc Analysis for Gross Motor Skills**

| Variable | Treatment Groups | Treatment Groups | Mean Difference | Sig. |
|---|---|---|---|---|
| Gross Motor Skills | PRE | AE | 6.4000* | .001 |
| | | Control | 26.4000* | .000 |
| | AE | PRE | -6.4000* | .001 |
| | | Control | 20.0000* | .000 |
| | Control | PRE | -26.4000* | .000 |
| | | AE | -20.0000* | .000 |

*=The mean significant is at the 0.05 level. The significant difference in the skill of overhead throw as indicated by scheffe in table 4.37 was among the three groups ($P<0.05$).

**Hypothesis 5:** Gender will not significantly influence gross motor skills of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.38: Result of Independent t-test Analysis on the gross motor skills between primary school pupils in Ibadan based on gender following aerobic and progressive resistance trainings**

| Source of Variable | Gender | N | Mean | Standard Deviation | Cal-t. | df | P | Remark |
|---|---|---|---|---|---|---|---|---|
| Pre-GMSs | Male | 103 | 46.09 | 0.51 | .127 | 178 | .899 | NS |
| | Female | 77 | 46.08 | 0.48 | .128 | 168.317 | .899 | |
| Post-GMSs | Male | 103 | 62.49 | 12.78 | .141 | 178 | .888 | |
| | Female | 77 | 62.21 | 13.48 | .140 | 158.934 | .889 | |

The above table 4.38 indicated the t-test comparison of gross motor skills of the participant based on gender. Results show that male has mean score of 46.09 ± 0.51 while female has mean score of 46.08 ± 0.48 in gross motor skills at the pre-training performance. At the post-training performance, male has 62.49±12.78 as female has 62.21±13.48. There are no significant difference ($p>0.05$) in the performance both groups. Therefore, the hypothesis on there will be no significant difference in the gross motor skills of primary school pupils in Ibadan based on gender following aerobic exercise and progressive resistance exercise trainings was accepted.

**Hypothesis 6:** Types of school will not significantly influence gross motor skills of primary school pupils in Ibadan, Nigeria, following a 12-week aerobic exercise and progressive resistance exercise trainings.

**Table 4.39: Result of Independent t-test Analysis on the gross motor skills of primary school pupils in Ibadan based on types of school following aerobic and progressive resistance training**

| Source of Variable | Type of School | N | Mean | Standard Deviation | Cal-t. | df | P | Remark |
|---|---|---|---|---|---|---|---|---|
| Pre-GMQ | Private | 93 | 46.03 | 0.31 | -1.437 | 178 | .152 | NS |
| | Public | 87 | 46.14 | 0.63 | -1.408 | 123.479 | .162 | |
| Post-GMQ | Private | 93 | 63.10 | 13.85 | 0.775 | 178 | .439 | |
| | Public | 87 | 61.57 | 12.16 | 0.779 | 177.313 | .437 | |

The above table 4.39 showed t-test relationship of gross motor skills of primary school pupils in Ibadan based on type of school. Private schools had mean of 46.03 ± 0.31 that was not significantly different (p>0.05) from the public schools that had a mean of 46.14 ± 0.63 at the pre-training performance. At the post–training performance, private schools had a mean score of 63.10 ± 13.85 that was also not significantly different (p>0.05) from the public school with a mean score of 61.57 ± 12.16. The null hypothesis that there will be no significant difference in the gross motor skill of primary schools pupils in Ibadan based on type of school following aerobic exercise and progressive resistance exercise trainings was hence upheld.

**Discussion of findings**

The results of this study revealed that out of the 180 participants used in the study, 48(26.7%) were in primary 3, 75 (41.7%) were in primary 4 and 57(31.6%) were in primary 5. They were between 7 and 12 years with average age of 9 years 8 months which agreed with the submission of Huebler (2005) that, in Nigeria, only 36.6% of all 6-year-olds were attending primary school at the time of his survey and that primary school attendance reaches its peak between 9 and 11 years of age, when around 72% of all pupils are in primary school.

Majority of them, 103 (57.2%), were male compare to 77 (42.8%) that were female which confirmed to the fact that male's enrolment in physical activities is more than female as research suggests that girls as a group are not so active as boys as a group and many girls tend to drop out of physical activity than boys (Taggart and Keegan, 1997). When comparisons are possible because of similar or identical testing protocols, Corbin and Pangrazi (1998) opined that improvement in selected motor tests is evident in both boys and girls until adolescence. Taggart and Keegan (1997) affirmed that at approximately 13 years of age the performance of girls in some tests reaches a plateau, and may even decline thereafter, while boys continue to improve in skills requiring strength, power, and muscular endurance. Exceptions to these generalizations occurred in arm and shoulder girdle muscular endurance, as measured by the flexed-arm hang, where boys had superior performances beginning at age 7.

Boys have been found to perform better in manipulative movement skills (Castelli and Valley, 2007; Junaid and Fellowes, 2006; Okely et al., 2001). Okely et al., (2001) studied a sample of 2,026 boys and girls, aged 13 and 15 years, who completed fundamental movement tasks involving throwing and catching skills, and reported boys having significantly higher scores for both tasks at each age level. Existing evidence indicates that 12- and 14-year-old boys are better in locomotor skills, such as leaping and running, possibly due to the higher strength level of the boys (Nupponen and Telama, 1998). Overall, the findings concerning gender differences in movement skills are interesting because they may be related to the reported higher levels of physical activity of boys (Aarnio et al., 2002; Castelli and Valley, 2007; Riddoch et al., 2004).

The findings of this study, with respect to gross motor skill development, support the reviewed literatures that gross motor skills can be improved by an appropriate training programme (Booth, etal, 1999; Bower and McLellan, 1994; DeMello-Meirelles and Gomes, 2004). Literature indicated that the foundation of learning for young pupils is physical interaction with the world (Hagens, 1994). Just running around the playground is not enough. Planning for the whole child must include planning for the acquisition of a movement training programme. Folio and Fewell (2000) pointed out that the concept of motor development has been widely researched since the 1930s. Theorists in the 1980s proposed that motor skills could be improved through practice, learning, and environmental interaction, which promote the integration of the identified sequential maturational stages of motor development (Gallahue, 1993; Gallahue and Ozmun, 1995).

GMSs of the participants were very poor, and they were underfat based on %BF and underweight as regards BMI. However, significant improvement occurred after trainings. They, however, have normal SBP, DBP and HR. The findings of this study indicated that aerobic exercise and progressive resistance exercise trainings have significant effect on GMSs and PPs of pupils but PRE had better effect. The results agree with the observations of Misra, Alappan, Vikram, Goel, Gupta, Mittal, Bhatt, and Luthra (2008) that exercise training, whether aerobic or resistance, leads to an increase in skeletal muscle, fat-free mass, fat mass, brings about functional changes in the muscle. They further opined that the addition of resistance exercise to aerobic training can help achieve the targets in shorter time than achievable by isolated aerobic exercise alone.

The results of the study showed that difference did not exist in the significant improvement that occurred in GMSs and PPs of the pupils based on gender and type of school after Aerobic and progressive resistance exercises. Significant differences however existed in GMSs which include running, galloping, hopping, leaping, horizontal jumping, sliding, striking a stationary ball, stationary dribbling, catching, kicking, overhead throwing, and underarm rolling as well as PPs of SBP, HR, and BMI.

The improvement in GMSs that was better in the PRE than AE is in line with Campos, Luecke and Wendeln (2002) affirmation that PRE generally works across conditions to improve the ability of muscle to produce force, and effect sizes, depending on the population studied and the type of programme, can vary from modest to rather large. There is evidence that improvements in the ability to generate muscle force can carry over into an improved ability to do everyday tasks. According to the principle of specificity of training, improvements are specific to the manner in which training is completed so that one would not necessarily expect improvements in the ability to generate muscle force in the training setting to translate to an improved ability to perform everyday activities (ACSM, 2007). Taylor, Dodd, and Damiano (2011) asserted the evidence that PRE programmes that lead to improvements in the ability to increase force production also lead to improvements in muscle power and endurance. AE effectiveness among pupils can be encouraged as running 2 miles per day every day for 3 months lowered blood pressure in 101 out of 105 subjects (Kelley and Kelley, 2000). In another study, jogging 60 minutes per day (target HR was 60-70% of age-adjusted maximum), twice weekly for 3 years, produced a satisfactory BP-lowering response (Ketelhut, et al. 2004).

The improvement recorded is on the fact that the development of GMS is not automatic as a child grows and develops, but is largely influenced by environmental factors; and the understanding that FMS are the foundations of a physically active lifestyle (Gallahue and Ozmun, 2002).These skills also appear to be related to the health of young people. For example, prior studies have shown that pupils and adolescents with greater fundamental movement skill proficiency tend to be more physically active (Okely et al.,200; Saakslahti et al., 1999; Ulrich, 1987);have higher levels of aerobic fitness (Okely, 2001) and self-esteem (Ulrich, 1987); and are less likely to be overweight (Okely et al., 2004).Studies have shown that if these skills can be well-delivered through appropriate professional development programmes, teachers will respond positively and find it easy to integrate them into their teaching programme (McKenzie et al., 1998; Okely et al., 2003).

After six weeks motor skills programme carried out by Hui-Ching, Chien-Chih, Chih-Yun and Chih-Wei, (2005) it was noticed that experiment group significantly improved motor skills and cognition of movement concept. But the control group had no significant correlation between fundamental motor skills and cognition of movement concept. Therefore, through education, motor skills will improve the ability of cognition learning, apprehension, and application. And, through meaningful motor skills experience will change the cognition learning behaviour forever. In order to learn motor skills, preschool pupils need an appropriate learning environment, induction and frequently exercise opportunity to develop, expert, fiddly all motor skills; not only with the maturational factor (Hsu and Hsu 2001;Gallahe, 1997).

Fundamental motor skills (FMS) are commonly considered the building blocks to more advanced movement skills and specific sport skills (Gabbard, 2000; Haywood and Getchell, 2001; Payne and Isaacs, 2002; Seefeldt, 1980) and are included in the national content standards in physical education (National Association for Sport and Physical Education, 1995). In his model of the progression of motor skill proficiency, Seefeldt (1980) proposed that pupils must learn a certain level of competency in FMS if they are to break through a hypothetical "proficiency barrier" and successfully engage in sport specific skills later in life. Seefeldt suggested that early childhood was the time to best develop FMS. Motor development textbooks (Gabbard, 2000; Haywood and Getchell, 2001; Payne and Isaacs, 2002) support this view, indicating the importance of early childhood for motor skill development. However, these skills do not naturally "emerge" during early childhood; rather, they result from many factors influencing the child's motor skill development such as Aerobic and progressive resistance exercises (Newell and van-Emmrik, 1989).

Contemporary literature on the benefits of motor skill interventions for young pupils is limited (Connor-Kuntz and Dummer, 1996; Hamilton, et al., 1999;

Valentini, 1997; Zittel and McCubbin, 1996). Haywood and Getchell, (2001) documented the positive influence of instruction on typical young pupils's throwing performance. Hsu and Hsu (2001) reported that typical preschool pupils demonstrated qualitative performance gains in six fundamental motor skills from pretest - posttest as a result of two 5-week instructional units consisting of direct instruction. In contrast, the control group, who engaged in well equipped free play, made no significant gains in motor skill development. A study by Connor-Kuntz and Dummer (1996) found significant pretest-posttest gains in FMS in typical preschool pupils, head start (disadvantaged) preschool pupils, and preschool pupils with disabilities, as a result of an 8-week intervention. Despite significant improvements, pupils in Head Start and Special Education were still below expected standard scores for their age at the post-test.

Hamilton et al., (1999) found that prior to motor intervention; disadvantaged preschool pupils demonstrated developmental delays in object control skills. Following an 8-week parent-assisted intervention, they found significant pretest - posttest gains in object control skills for the experimental group, as compared to a control group who did not demonstrate significant change in motor performance. Finally, Valentini (1997) found that a 12-week, student-centered instructional program resulted in significant gains in the EMS of developmentally delayed kindergarten pupils from pre- to post-intervention. What was interesting about this study was that the control group did not change from pre- to post-intervention, despite the fact both groups had received 30 mm of daily physical education per day throughout the intervention period. In contrast to the above studies, Zittel and McCubbin (1996) used a single-subject design to examine the influence of an 8-week motor skill intervention on the motor skill acquisition of 4 developmentally delayed preschool pupils.

Hirasing etal (2001) used heart rate and log book recordings to compare daily activity patterns between pupils who attended day care and those enrolled in a developmental movement programme. The pupils in the study were largely sedentary with mean heart rates ranging from 109 beats per minute to 115 beats per minute while some pupils did not record a single reading above 130 beats per minute for four consecutive hours. Pupils involved in a directed movement programme had significantly higher activity levels than those in care; however no difference between the groups existed during time spent at home.

This supports other investigations of preschoolers that have found little time is spent engaged in vigorous activity with the greatest portion of time devoted to sedentary or low level activity (Brooks, Fahey and White, 1996; Bar-Or, 2000). Higher levels of physical activity have been associated with outdoor play (Lee, Blair and Jackson, 1999). The positive effect of an outdoor environment on activity levels of pupils may have important implications because of the greater tendency for large muscle motor activity and higher levels of physical activity in comparison to indoor environments (Lee, Blair and Jackson, 1999; Campbell, Waters, O'Meara and Summerbell, 2001).

With sedentary adults, the anaerobic threshold will vary from 120 to 150 bpm. Thus the optimal heart-rate-training stimulus may be relatively higher for sedentary pupils than for sedentary adults. Other evidence supporting the high-intensity stimulus theory is the fact that activity levels in pupils are not related to $V0_2$max (Rowlands etal, 2000). Armstrong and Welsman, (1994) showed that general activity does not provide a training stimulus as pupils have a natural fitness. Physiologically, pupils have inferior cooling mechanisms, due to low blood volume and high skin temperature. They also expend more energy per kilogram of body weight. Pupils have a higher $VE/V0_2$ ratio due to their inferior lung function and they rely more on fat metabolism because of a lack of muscle glycogen and glycolytic enzymes. All these factors reduce physiological efficiency. Combined, these biomechanical and physiological limitations lead to a reduced running economy, though this seems to improve with age from 8 to 20 years (Wilmore and Costill, 1994).

Although they are biomechanically and physiologically inefficient, pupils rely heavily on aerobic metabolism for exercise. Sharp and Reed (1992) described them as aerobic animals. The anaerobic capacity for both boys and girls increases with age, but is not fully developed until around 20 years. The main reason for this is probably the lack of muscle mass. Pupils are thus unable to generate the low blood pH or high blood lactate values that are associated with anaerobic work (Malina, 1991). This means that the natural fatigue mechanisms from intense work that adults possess do not exist with pupils.

Pupils can compensate a little again, as their arterial venous oxygen difference is greater. This suggests that a greater percentage of the cardiac output goes to the working muscles than in adults (Wilmore and Costill, 1994). Because of the fact that lung and heart capacity increase with age, one would expect aerobic capacity to increase accordingly. Therefore, relative to bodyweight, pupils have a Cardio-respiratory system for effective aerobic exercise. This is demonstrated by the fact that pupils can run quite well compared to adults.

# CHAPTER FIVE

## SUMMARY, CONCLUSION AND RECOMMENDATION

This study examined effects of aerobic exercise and progressive resistance exercise trainings on gross motor skills and physiological parameters of primary school pupils in Ibadan, Nigeria. This chapter presents a summary of preceding chapters, it highlights major findings of the study and conclusions were drawn after which recommendations and contributions of the study to the body of knowledge were further stated.

### Summary

The major role aerobic exercises and progressive resistance exercises played in the development of motor skills and prevention of diseases cannot be over emphasized. This study therefore investigated the effects of a 12-week aerobic exercise and progressive resistance exercise training programmes on gross motor skills and some physiological parameters of pupils in Ibadan, Nigeria. One hundred and eighty apparently healthy primary school pupils (AE=60, PRE=60 and control=60) between the ages of 7 and 12 years successfully completed the study. Ninety three of the samples were in public primary school whereas eighty seven were in private primary school.

Prior to and upon completion of the 12 – week Aerobic and progressive resistance exercises trainings, each of the participants was measured for gross motor skills and physiological parameters. The variables analysed in the study included running, galloping, hopping, leaping, horizontal jumping, sliding, striking a stationary ball, stationary dribbling, catching, kicking, overhead throwing, underhand rolling, systolic blood pressure, diastolic blood pressure, heart rate, percent body fat and body mass index.

The average age of the participants was 9 years 8 months. 48(26.7%) of the participants were in primary 3, 75 (41.7%) were in primary 4 and 57(31.6%) were in primary 5. 9 (5.0%) of the participants were 7 years, 27 (15.0%) were 8 years, 36 (20.0%) were 9 years, 59 (32.8%) were 10 years, 20 (11.1%) were 11 years while 29

(16.1%) were 12 years with average age of 9 years 8 months. 103 (57.2%) of the participants were male while 77 (42.8%) were female. The participants had very poor GMSs from the point of view of process assessment carried out in the study. The average blood pressure (98.94/61.87mmHg) was normal. The HR (81.86bpm within 80-120bpm) of the participants in this study was at the normal level. The mean %BF of 7.67% and BMI of 14.96kg/m$^2$ values were in the underfat and underweight categories respectively. Hypotheses revealed that PRE trainings enhanced gross motor skills performance, systolic blood pressure, heart rate and body mass index better than AE.

Significant difference existed among AE, PRE and control groups in all gross motor skills, SBP, HR and BMI. However, there were no significant differences among AE, PRE and control groups in DBP and %BF. There were no significant differences in gross motor skills and physiological parameters of the participants based on gender and type of school.

## Conclusion

Based on the findings of this study, the following conclusions were made.

1. The gross motor skill abilities of primary school pupils in this study were very poor when compared with normative values in terms of process assessment.
2. Pupils in this study were underfat and underweight but had normal systolic and diastolic blood pressure and heart rate.
3. Aerobic exercise and progressive resistance exercise trainings influenced locomotor skills (running, galloping, hopping, leading, horizontal jumping and sliding) of primary school pupils positively.
4. Aerobic exercise and progressive resistance exercise trainings influenced object control skills (striking a stationary ball, stationary dribbling, kicking, catching, overhand throwing and underhand rolling) of the pupils positively.
5. Aerobic exercise and progressive resistance exercise trainings improved gross motor skills (locomotor and object control) of the pupils considerably.

6. There were no differences in the gross motor skills improvement of pupils in this study based on gender and type of school.
7. This study demonstrated that aerobic and progressive resistance exercise trainings are essential to the improvement of the gross motor skills and physiological parameters, a position supported by related literature.

**Recommendations**

Based on the findings of the study, the researcher offers the following recommendations for practice:

1. It is recommended that there should be regular and frequent use of aerobic and progressive resistance exercise trainings at the primary school level to develop GSMs.
2. In order to achieve an effective exercise programmes, a longer period of time should be used. The longer time span would allow the time necessary for the growth and development of an individual in gross motor skills.
3. Training the teachers to teach an organised exercise programmes would expand the opportunity for pupils to participate in these exercise programmes. In order to give a chance for every child to participate in an exercise programme, it is recommended that all primary school teachers have some experience with such programme(s) as part of their professional training. This training could be obtained through an in-service training programme.
4. Greater effort should be made to develop guidelines for teaching process movement skills whereby teachers and primary school heads can positively identify gross motor skills in pupils so that they can develop their potential.
5. Periodic and annual process assessment of specific gross motor skills subset should be carried out instead of the usual product evaluation.
6. Also, study on the effects of either aerobic exercise or progressive resistance exercise training is recommended rather than both simultaneously investigated in order to confirm the findings of the study.

7. An instrument to test gross motor skills of children developed by Nigerian using her pupils is recommended to be carried out as a further this study.

**Contribution of the study to the body of knowledge**

The result of this study revealed the level of gross motor skills and physiological parameters of primary school pupils in Ibadan, Nigeria, which represented a base line data for other studies in the same area.

It confirmed that structured aerobic and progressive resistance exercise trainings could improve gross motor skills including running, galloping, hopping, leaping, horizontal jumping, sliding, striking a stationary ball, stationary dribbling, catching, kicking, overhead throwing and underhand rolling.

The result of this study also established that primary school pupils being within the same age range responded equally to different modes (AE and PRE) of exercise training.

The result of this study established that primary school pupils in the sampled area in Ibadan were underfat and underweight and that there were no significant differences in their DBP and %BF following separate 12-week aerobic and progressive resistance exercise trainings.

The study established that process assessment score of gross motor skills as different from accustomed product assessment could be obtained.

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## APPENDIX 1

### Informed Consent for Exercise Training Programme and Measurement

**Dear Sir/ Madam,**

I, MOSES, M. Omoniyi, Ph.D(Physiology of Exercise) student of the department of Human Kinetics and Health Education, Faculty of Education, University of Ibadan. I realised that my discipline can actually improve the physical activity life and health of primary school pupils through a well administered Exercise Trainings. Hence, I chose to carry out a research on Aerobic and Progressive Resistance Exercise Training Effects on Gross Motor Skill and Physiological Parameters of Pupils in Ibadan, Nigeria, where your school /ward(s) from his or her school has been sampled for the study.

The research training will last for twelve weeks, three (3) days per week after teaching school hours. It is meant to improve the health status and movement abilities of the pupils. The Health Status **(**blood pressure, heart rate, percent body fat and body mass index) and Movement Abilities (locomotor and object control abilities) of the pupils will be assessed before and after the twelve weeks exercise training. All necessary security will be strictly ensured and confidentiality will be at the utmost as the result will be for the research solely.

Sir / Madam your consent to release your ward(s) for this pupils improvement study is now being sought.

I, ………………………………………………………………………, was given detail instructions about exercise training programmes that will last for twelve weeks. I understand that the training will improve my health status and movement abilities. I was made to understand that I would be assessed before and after the twelve weeks exercise training on: Health Status (blood pressure, heart rate, percent body fat and body mass index) and Movement Abilities (locomotor and object control abilities). I realise that it is necessary for me to promptly report symptoms and signs indicating any difficulty to the exercise supervisor (researcher) / assistants where immediate measure deemed advisable by him/assistant should be taken.

I, therefore, as parent, proprietor (proprietress)/head teacher and class teacher consented that my child should participate in the exercise training programmes after the exercise supervisor had answered all questions to my satisfactions.

| | |
|---|---|
| …………………………………….. | …………………………. |
| Name and Signature of the Pupil's Parent | Name and Signature of the Pupil's Proprietor/ Proprietress / Head-Teacher |
| ……………………………………… | ……………………………. |
| Name and Signature of the Pupil's Class Teacher | Name and Signature of Researcher |

## APPENDIX 2

## AEROBIC EXERCISE TRAINING

The training protocol presented below was used in the aerobic exercise training with low intensities less than 50 Max$V0_2$.

| Activity | Set | | Repetition | | | Duration |
|---|---|---|---|---|---|---|
| **Week 1** | | | | | | |
| Running within interval of 10m | 3 | | 3 | 2 | 1 | 6mins |
| Sliding | 3 | | 3 | 2 | 1 | 6mins |
| Overhand throwing and catching | 3 | | 3 | 2 | 1 | 6mins |
| Kicking and stopping | 3 | | 3 | 2 | 1 | 6mins |
| Horizontal jumping | 3 | | 3 | 2 | 1 | 6mins |
| **Week 2 & 3** | | | | | | |
| Striking stationary ball | 4 | 4 | 3 | 2 | 1 | 7mins |
| Hopping | 4 | 4 | 3 | 2 | 1 | 7mins |
| Stationary dribbling | 4 | 4 | 3 | 2 | 1 | 7mins |
| Leaping | 4 | 4 | 3 | 2 | 1 | 7mins |
| Underhand rolling | 4 | 4 | 3 | 2 | 1 | 7mins |
| **Week 4 & 5** | | | | | | |
| Galloping to and fro | 4 | 4 | 3 | 2 | 1 | 7mins |
| Overhand throwing and catching | 4 | 4 | 3 | 2 | 1 | 7mins |
| Hopping | 4 | 4 | 3 | 2 | 1 | 7mins |
| Sliding | 4 | 4 | 3 | 2 | 1 | 7mins |
| Running | 4 | 4 | 3 | 2 | 1 | 7mins |
| **Week 6 & 7** | | | | | | |
| Leaping to and running fro | 4 | 4 | 3 | 3 | 3 | 8mins |
| Striking stationary ball | 4 | 4 | 3 | 3 | 3 | 8mins |
| Galloping | 4 | 4 | 3 | 3 | 3 | 8mins |
| Stationary dribbling | 4 | 4 | 3 | 3 | 3 | 8mins |
| Kicking and stopping | 4 | 4 | 3 | 3 | 3 | 8mins |
| **Week 8 & 9** | | | | | | |
| Horizontal jumping | 4 | 4 | 3 | 2 | 1 | 7mins |
| Underhand rolling | 4 | 4 | 3 | 2 | 1 | 7mins |
| Hopping | 4 | 4 | 3 | 2 | 1 | 7mins |
| Running | 4 | 4 | 3 | 2 | 1 | 7mins |
| Galloping | 4 | 4 | 3 | 2 | 1 | 7mins |
| **Week 10 & 11** | | | | | | |
| Kicking and stopping | 4 | 4 | 3 | 2 | 1 | 7mins |
| Overhand throwing and catching | 4 | 4 | 3 | 2 | 1 | 7mins |
| Sliding | 4 | 4 | 3 | 2 | 1 | 7mins |
| Leaping | 4 | 4 | 3 | 2 | 1 | 7mins |
| Horizontal jumping | 4 | 4 | 3 | 2 | 1 | 7mins |
| **Week 12** | | | | | | |
| Striking stationary ball | 4 | 4 | 3 | 2 | 1 | 7mins |

| | | | | | | |
|---|---|---|---|---|---|---|
| Kicking and stopping | 4 | 4 | 3 | 2 | 1 | 7mins |
| Stationary dribbling | 4 | 4 | 3 | 2 | 1 | 7mins |
| Horizontal | 4 | 4 | 3 | 2 | 1 | 7mins |
| Underhand rolling | 4 | 4 | 3 | 2 | 1 | 7mins |

## APPENDIX 3

### THE PROGRESSIVE RESISTANCE EXERCISE TRAINING

The training protocol presented below was used for progressive resistance exercise training with intensities greater than 70 $MaxV0_2$.

**Week 1-2**

| Activity | Set 1 | Set 2 | Set 3 |
|---|---|---|---|
| Bear Crawl | 3 | 4 | 5 |
| Coffee Grinder | 3 | 4 | 5 |
| Spread-Eagle Walk | 2 | 3 | 4 |
| Shoulder Curl | 2 | 3 | 4 |
| Half Curl | 2 | 3 | 4 |
| Half-V-Sits | 3 | 4 | 5 |
| V-Sits | 2 | 3 | 4 |

**Week 3-4**

| Activity | Set 1 | Set 2 | Set 3 |
|---|---|---|---|
| Alternate Leg Lift | 3 | 4 | 5 |
| Back Arch | 3 | 4 | 5 |
| Heel Drops | 3 | 4 | 5 |
| Rocking Horse | 3 | 4 | 5 |
| Rabbit Hop | 3 | 4 | 5 |
| Blast Off | 3 | 4 | 5 |
| Heel Lifts | 3 | 4 | 5 |

**Week 5-6**

| Activity | Set 1 | Set 2 | Set 3 |
|---|---|---|---|
| Flex leg back stretch | 4 | 5 | 6 |
| Shoulder Shrug | 4 | 5 | 6 |
| Squat | 4 | 5 | 6 |
| Sit up | 4 | 5 | 6 |
| Leg extension | 4 | 5 | 6 |
| Abdominal Strengthening | 4 | 5 | 6 |
| Pull up | 4 | 5 | 6 |

**Week 7-8**

| Activity | Set 1 | Set 2 | Set 3 |
|---|---|---|---|
| Double Knee Pull | 5 | 6 | 7 |
| Arm Curl | 5 | 6 | 7 |
| Modified knee Push | 5 | 6 | 7 |
| Modified sit up | 5 | 6 | 7 |
| Side lying leg lift | 5 | 6 | 7 |

| | | | |
|---|---|---|---|
| Chest stretch | 5 | 6 | 7 |
| Side Stretch | 5 | 6 | 7 |
| **Week 9-10** | | | |
| Activity | Set 1 | Set 2 | Set 3 |
| Windshield Wiper | 8 | 9 | 10 |
| Kneel Lift | 8 | 9 | 10 |
| Ankle Pull | 8 | 9 | 10 |
| Bicycle | 10 | 11 | 12 |
| Dumbbell knee extension | 10 | 11 | 12 |
| Greet Yourself | 10 | 11 | 12 |
| Single Leg Squat | 8 | 9 | 10 |
| **Week 11-12** | | | |
| Activity | Set 1 | Set 2 | Set 3 |
| Super Circles | 4 | 8 | 8 |
| Star Burst | 4 | 8 | 8 |
| Giraffe | 4 | 8 | 8 |
| Chicken Walk | 4 | 8 | 8 |
| Straddle Stretch | 4 | 8 | 8 |
| Fencer's Lunge | 4 | 8 | 8 |
| Grid Flexibility | 4 | 8 | 8 |

## APPENDIX 4

## DATA COLLECTION FORM

**Name ……………………………………………………**
**Name of School……………………………………………………………**
**Class……………**
**Age………………………    Gender……………………    Height…………m**
**Weight…………kg**

**PHYSIOLOGICAL PARAMETERS**

**Blood Pressure……………/………mmHg    Heart Rate…………………bpm**

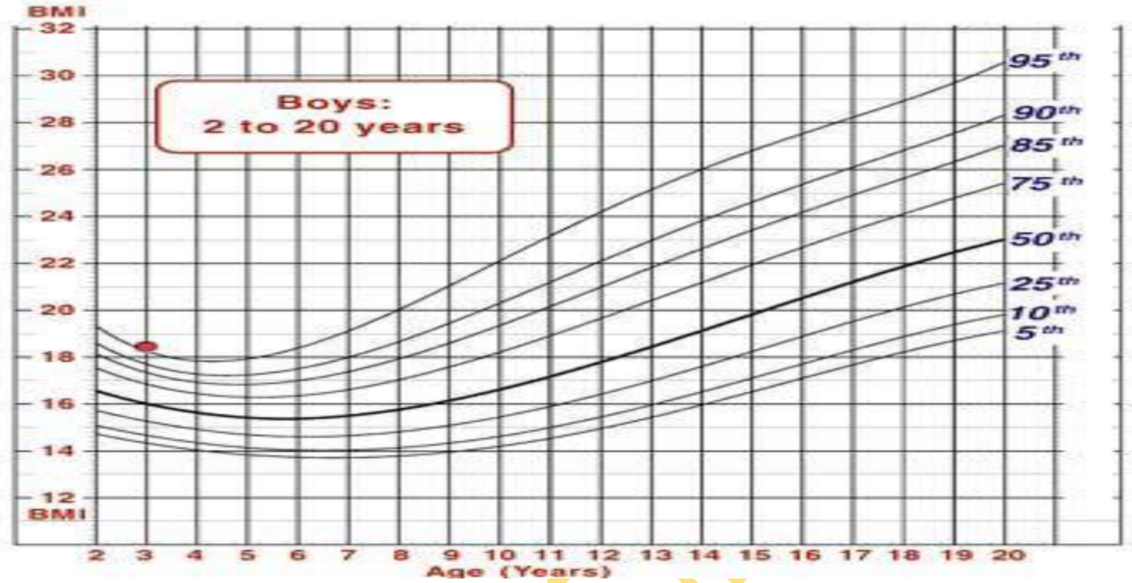
**Percent body fat: chest…….mm, triceps………mm, subscapular………mm, axilla………mm, suprailiac………mm, abdomen………mm and thigh……..mm**

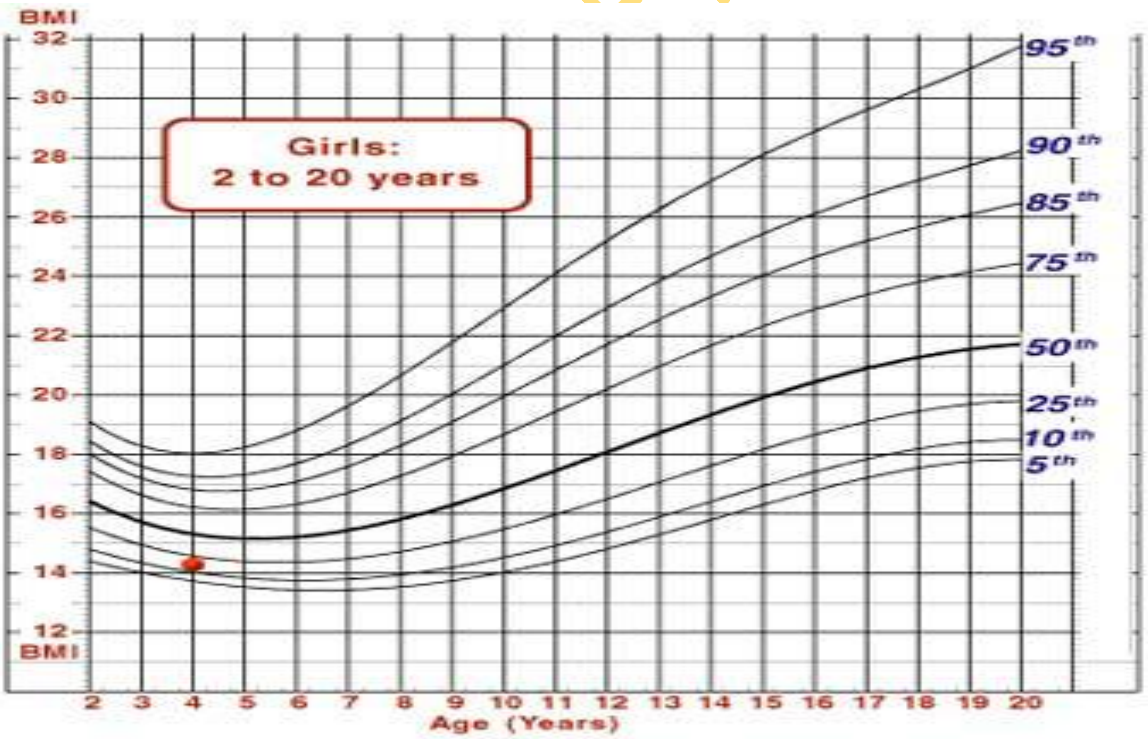
**Body Mass Index………………...Kg/m$^2$**

**GROSS MOTOR ABILITIES**

| LOCOMOTOR SKILLS | 1st Trial | 2nd Trial | Total |
|---|---|---|---|
| Running | | | |
| Galloping | | | |
| Hopping | | | |
| Leaping | | | |
| Horizontal Jump | | | |
| Sliding | | | |
| **OBJECT CONTROL** | | | |
| Striking a stationary Ball | | | |
| Stationary Dribble | | | |
| Catching | | | |
| Kicking | | | |
| Overhand Throw | | | |
| Underhand Roll | | | |

**APPENDIX 5**
**THE CDC BMI-FOR-AGE GROWTH CHARTS**




Source: CDC Growth Chart

**APPENDIX 6**

TABLE B.1

Converting Subtest Raw Scores to Percentiles and Standard Scores
Locomotor Subtest
Female and Male

| %iles | Age 3-0 through 3-5 | 3-6 through 3-11 | 4-0 through 4-5 | 4-6 through 4-11 | 5-0 through 5-5 | 5-6 through 5-11 | 6-0 through 6-5 | 6-6 through 6-11 | 7-0 through 7-5 | 7-6 through 7-11 | 8-0 through 8-11 | 9-0 through 10-11 | Std. Scores |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <1 | • | • | • | • | 1–6 | 1–9 | 1–12 | 1–14 | 1–16 | 1–19 | 1–20 | 1–23 | 1 |
| <1 | • | • | • | 1–6 | 7–9 | 10–12 | 13–15 | 15–17 | 17–19 | 20–22 | 21–23 | 24–26 | 2 |
| 1 | • | • | 1–6 | 7–9 | 10–12 | 13–15 | 16–18 | 18–20 | 20–22 | 23–25 | 24–27 | 27–29 | 3 |
| 2 | • | 1–6 | 7–9 | 10–12 | 13–15 | 16–18 | 19–21 | 21–23 | 23–25 | 26–28 | 28–30 | 30–32 | 4 |
| 5 | 1–6 | 7–9 | 10–12 | 13–15 | 16–18 | 19–21 | 22–24 | 24–26 | 26–28 | 29–31 | 31–33 | 33–35 | 5 |
| 9 | 7–9 | 10–12 | 13–15 | 16–18 | 19–21 | 22–24 | 25–28 | 27–29 | 29–31 | 32–34 | 34–36 | 36–37 | 6 |
| 16 | 10–12 | 13–15 | 16–18 | 19–21 | 22–24 | 25–28 | 29–31 | 30–32 | 32–34 | 35–37 | 37–38 | 38–39 | 7 |
| 25 | 13–15 | 16–18 | 19–21 | 22–24 | 25–28 | 29–31 | 32–34 | 33–35 | 35–37 | 38–39 | 39–40 | 40–41 | 8 |
| 37 | 16–18 | 19–21 | 22–24 | 25–28 | 29–31 | 32–34 | 35–37 | 36–39 | 38–40 | 40 | 41–42 | 42–43 | 9 |
| 50 | 19–21 | 22–24 | 25–28 | 29–31 | 32–34 | 35–37 | 38–39 | 40–41 | 41–42 | 41–42 | 43 | 44 | 10 |
| 63 | 22–24 | 25–28 | 29–31 | 32–34 | 35–37 | 38–39 | 40–41 | 42 | 43 | 43 | 44 | 45 | 11 |
| 75 | 25–28 | 29–31 | 32–34 | 35–37 | 38–39 | 40–41 | 42 | 43 | 44 | 44 | 45 | 46 | 12 |
| 84 | 29–31 | 32–34 | 35–37 | 38–39 | 40–41 | 42 | 43 | 44 | 45 | 45–47 | 46–48 | 47–48 | 13 |
| 91 | 32–34 | 35–37 | 38–39 | 40–41 | 42 | 43 | 44 | 45 | 46–47 | 48 | • | • | 14 |
| 95 | 35–37 | 38–39 | 40–41 | 42 | 43 | 44 | 45 | 46–47 | 48 | • | • | • | 15 |
| 98 | 38–39 | 40–41 | 42 | 43 | 44 | 45 | 46–47 | 48 | • | • | • | • | 16 |
| 99 | 40–41 | 42 | 43 | 44 | 45 | 46–47 | 48 | • | • | • | • | • | 17 |
| >99 | 42 | 43 | 44 | 45 | 46–47 | 48 | • | • | • | • | • | • | 18 |
| >99 | 43 | 44 | 45 | 46–47 | 48 | • | • | • | • | • | • | • | 19 |
| >99 | 44–48 | 45–48 | 46–48 | 48 | • | • | • | • | • | • | • | • | 20 |

Source: Ulrich, 2000

## APPENDIX 7

Converting Subtest Raw Scores to Percentiles and Standard Scores
Object Control Subtest
Female

| %iles | Age: 3-0 through 3-5 | 3-6 through 3-11 | 4-0 through 4-5 | 4-6 through 4-11 | 5-0 through 5-5 | 5-6 through 5-11 | 6-0 through 6-5 | 6-6 through 6-11 | 7-0 through 7-5 | 7-6 through 7-11 | 8-0 through 8-11 | 9-0 through 9-11 | 10-0 through 10-11 | Std. Scores |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <1 | • | • | • | • | • | 1–5 | 1–8 | 1–9 | 1–12 | 1–15 | 1–18 | 1–19 | 1–19 | 1 |
| <1 | • | • | • | • | 1–5 | 6–8 | 9–11 | 10–12 | 13–15 | 16–18 | 19–21 | 20–22 | 20–22 | 2 |
| 1 | • | • | • | 1–5 | 6–8 | 9–11 | 12–14 | 13–15 | 16–18 | 19–21 | 22–24 | 23–25 | 23–25 | 3 |
| 2 | • | • | 1–5 | 6–8 | 9–11 | 12–14 | 15–17 | 16–18 | 19–21 | 22–24 | 25–26 | 26–28 | 26–28 | 4 |
| 5 | • | 1–5 | 6–8 | 9–11 | 12–14 | 15–17 | 18–20 | 19–21 | 22–24 | 25–26 | 27–29 | 29 | 29–31 | 5 |
| 9 | 1–5 | 6–8 | 9–11 | 12–14 | 15–17 | 18–20 | 21–23 | 22–24 | 25–26 | 27–29 | 30 | 30–32 | 32–34 | 6 |
| 16 | 6–8 | 9–11 | 12–14 | 15–17 | 18–20 | 21–23 | 24–25 | 25–26 | 27–29 | 30 | 31–33 | 33–34 | 35–37 | 7 |
| 25 | 9–11 | 12–14 | 15–17 | 18–20 | 21–23 | 24–25 | 26–27 | 27–29 | 30 | 31–33 | 34–36 | 35–37 | 38–40 | 8 |
| 37 | 12–14 | 15–17 | 18–20 | 21–23 | 24–25 | 26–27 | 28–29 | 30 | 31–33 | 34–36 | 37–38 | 38–40 | 41 | 9 |
| 50 | 15–17 | 18–20 | 21–23 | 24–25 | 26–27 | 28–30 | 30–32 | 31–33 | 34–36 | 37–39 | 39–40 | 41 | 42 | 10 |
| 63 | 18–20 | 21–23 | 24–25 | 26–27 | 28–30 | 31–32 | 33–34 | 34–36 | 37–39 | 40–41 | 41 | 42 | 43 | 11 |
| 75 | 21–23 | 24–25 | 26–27 | 28–30 | 31–32 | 33–34 | 35–37 | 37–39 | 40–41 | 42–43 | 42–43 | 43–44 | 44 | 12 |
| 84 | 24–25 | 26–27 | 28–30 | 31–32 | 33–34 | 35–37 | 38–40 | 40–41 | 42–43 | 44 | 44 | 45 | 45 | 13 |
| 91 | 26–27 | 28–30 | 31–32 | 33–34 | 35–37 | 38–40 | 41–42 | 42–43 | 44–45 | 45–46 | 45–46 | 46 | 46 | 14 |
| 95 | 28–30 | 31–32 | 33–34 | 35–37 | 38–40 | 41–42 | 43–44 | 44–45 | 46 | 47 | 47–48 | 47–48 | 47–48 | 15 |
| 98 | 31–32 | 33–35 | 35–37 | 38–40 | 41–42 | 43–44 | 45 | 46 | 47 | 48 | • | • | • | 16 |
| 99 | 33–35 | 36–38 | 38–40 | 41–42 | 43–44 | 45 | 46 | 47 | 48 | • | • | • | • | 17 |
| >99 | 36–37 | 39–40 | 41–42 | 43–44 | 45 | 46 | 47–48 | 48 | • | • | • | • | • | 18 |
| >99 | 38–40 | 41–42 | 43–44 | 45 | 46 | 47–48 | • | • | • | • | • | • | • | 19 |
| >99 | 41–48 | 43–48 | 45–48 | 46–48 | 47–48 | • | • | • | • | • | • | • | • | 20 |

Source: Ulrich, 2000

# APPENDIX 8

Converting Subtest Raw Scores to Percentiles and Standard Scores
Object Control Subtest
Male

| %iles | Age: 3-0 through 3-5 | 3-6 through 3-11 | 4-0 through 4-5 | 4-6 through 4-11 | 5-0 through 5-5 | 5-6 through 5-11 | 6-0 through 6-5 | 6-6 through 6-11 | 7-0 through 7-5 | 7-6 through 7-11 | 8-0 through 8-11 | 9-0 through 10-11 | Std. Scores |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <1 | • | • | • | • | 1–6 | 1–8 | 1–11 | 1–14 | 1–17 | 1–19 | 1–22 | 1–26 | 1 |
| <1 | • | • | • | 1–6 | 7–8 | 9–11 | 12–14 | 15–17 | 18–19 | 20–22 | 23–26 | 27–29 | 2 |
| 1 | • | • | 1–6 | 7–8 | 9–11 | 12–14 | 15–17 | 18–19 | 20–22 | 23–26 | 27–29 | 30–32 | 3 |
| 2 | • | 1–6 | 7–8 | 9–11 | 12–14 | 15–17 | 18–19 | 20–22 | 23–26 | 27–29 | 30–32 | 33–34 | 4 |
| 5 | 1–6 | 7–8 | 9–11 | 12–14 | 15–17 | 18–19 | 20–22 | 23–26 | 27–29 | 30–32 | 33–34 | 35–37 | 5 |
| 9 | 7–8 | 9–11 | 12–14 | 15–17 | 18–19 | 20–22 | 23–26 | 27–29 | 30–32 | 33–34 | 35–37 | 38–39 | 6 |
| 16 | 9–11 | 12–14 | 15–17 | 18–19 | 20–22 | 23–26 | 27–29 | 30–32 | 33–35 | 35–37 | 38–40 | 40–41 | 7 |
| 25 | 12–14 | 15–17 | 18–19 | 20–22 | 23–26 | 27–29 | 30–32 | 33–35 | 36–38 | 38–40 | 41 | 42 | 8 |
| 37 | 15–18 | 18–19 | 20–22 | 23–26 | 27–29 | 30–32 | 33–35 | 36–38 | 39–40 | 41 | 42 | 43 | 9 |
| 50 | 19–20 | 20–23 | 23–26 | 27–29 | 30–32 | 33–35 | 36–38 | 39–41 | 41–42 | 42–43 | 43–44 | 44–45 | 10 |
| 63 | 21–23 | 24–26 | 27–29 | 30–32 | 33–35 | 36–38 | 39–41 | 42–43 | 43–44 | 44–45 | 45–46 | 46 | 11 |
| 75 | 24–26 | 27–29 | 30–32 | 33–35 | 36–38 | 39–41 | 42–43 | 44–45 | 45–46 | 46 | 47 | 47 | 12 |
| 84 | 27–29 | 30–32 | 33–35 | 36–38 | 39–41 | 42–43 | 44–45 | 46 | 47 | 47 | 48 | 48 | 13 |
| 91 | 30–32 | 33–35 | 36–38 | 39–41 | 42–43 | 44–45 | 46 | 47 | 48 | 48 | • | • | 14 |
| 95 | 33–35 | 36–38 | 39–41 | 42–43 | 44–45 | 46 | 47 | 48 | • | • | • | • | 15 |
| 98 | 36–38 | 39–41 | 42–43 | 44–45 | 46 | 47 | 48 | • | • | • | • | • | 16 |
| 99 | 39–41 | 42–43 | 44–45 | 46 | 47 | 48 | • | • | • | • | • | • | 17 |
| >99 | 42–43 | 44–45 | 46 | 47 | 48 | • | • | • | • | • | • | • | 18 |
| >99 | 44–45 | 46 | 47 | 48 | • | • | • | • | • | • | • | • | 19 |
| >99 | 46–48 | 47–48 | 48 | • | • | • | • | • | • | • | • | • | 20 |

Source: Ulrich, 2000

**APPENDIX 9**

TABLE C.1

**Converting Sums of Subtest Standard Scores to Percentiles and Quotients**

| Percentile Rank | Sum of Subtest Standard Scores | Quotient |
|---|---|---|
| >99 | 40 | 160 |
| >99 | 39 | 157 |
| >99 | 38 | 154 |
| >99 | 37 | 151 |
| >99 | 36 | 148 |
| >99 | 35 | 145 |
| >99 | 34 | 142 |
| >99 | 33 | 139 |
| >99 | 32 | 136 |
| 99 | 31 | 133 |
| 98 | 30 | 130 |
| 97 | 29 | 127 |
| 95 | 28 | 124 |
| 92 | 27 | 121 |
| 89 | 26 | 118 |
| 84 | 25 | 115 |
| 79 | 24 | 112 |
| 73 | 23 | 109 |
| 65 | 22 | 106 |
| 58 | 21 | 103 |
| 50 | 20 | 100 |
| 42 | 19 | 97 |
| 35 | 18 | 94 |
| 27 | 17 | 91 |
| 21 | 16 | 88 |
| 16 | 15 | 85 |
| 12 | 14 | 82 |
| 8 | 13 | 79 |
| 5 | 12 | 76 |
| 3 | 11 | 73 |
| 2 | 10 | 70 |
| 1 | 9 | 67 |
| <1 | 8 | 64 |
| <1 | 7 | 61 |
| <1 | 6 | 58 |
| <1 | 5 | 55 |
| <1 | 4 | 52 |
| <1 | 3 | 49 |
| <1 | 2 | 46 |

Source: Ulrich, 2000