CHAPTER ONE

INTRODUCTION

Background to the Study

Hearing impairment is one of the most frequent sensory deficits in humans, affecting more than 250 million people in the world (Afolabi, Alabi, Segun-Busari and Aremu, 2012).The sense of hearing is one of the special gifts of God to mankind. It is sometimes referred to as a 'distant sense', because a good hearing system enables an individual to dictate or perceive the presence of sound of different kinds from far and around one's environment. In other words, the hearing system can effectively be used as a continua source of information about things and happenings within our immediate physical environment. It also provides warning signals that are important to physical safety. Hence, hearing is very important in the life of man. The main system nature has provided for this important function is the auditory system. The auditory system includes the totality of all the organs that work in a complimentary manner to bring about hearing in man. It includes the ear, the auditory nerves and the auditory cortex (Okuoyibo, Oyewumi and Adediran, 2007).

The World Health Organization (WHO) (2001) defines hearing impairment as difficulty in hearing whether permanent or fluctuating that adversely affects child's performance. The term hearing impairment covers the entire range of auditory disorders, encompassing not only the deaf but also people with a very mild loss who may understand speech without difficulty (Mba, 1995). Hearing impairment is a handicapping condition that affects the organ of hearing of an individual. Onwuchekwa (1992) is of the opinion that definition of hearing impairment depends on the point of view and angles one sees hearing impairment. For instance clinical definition may be directed towards aetiology of impairment or degree of hearing. While in school setting the definition may reflect functionability of the organ of hearing as in a condition where learner ask for repetition of statement always. Many instances have proved wrong those who are of the opinion that adolescents with hearing impairment cannot be engaged in physical exercise. To this end, Silverman (1998) opined that there are many situations in which we do not need our hearing. In addition, Silverman (1998) stressed that recreation should find a central place in the life of those suffering from hearing loss.

Faith (1991) emphasized that persons with hearing impairment should have every opportunity to develop physically and socially to their highest degree possible in physical education through the media of sports and exercise. It was further expressed that little or no restriction should be imposed on their physical education programme. In the same vein, Lockwood (2010) opined that structured physical activity programme would improve the physical fitness, wellness status and motor proficiency of persons with hearing impairment.

The involvement of adolescent in sports has received support from many researchers over the years. In the light of this, Onwuchekwa (2005) asserted that persons with hearing impairment can engage in different types of athletic competitions, such as football, volleyball, basketball and the likes. She stressed further that the adolescents with hearing impairment are willing to participate successfully in sports but, they need more encouragement from all and sundry to participate in sport at local, national and international levels.

The period of life known as “adolescence” is a unique one. It is unique in the sense that it is a period of rapid changes. The adolescence period generally is a period of transition. These fundamental transitions according to Falaye (2001) are evident in the biological, cognitive and psychosocial changes that occur in adolescence. The biological transition occurring in adolescence is generally referred to as puberty. Puberty encompasses all the physical changes that occur in adolescents as they biological transit from childhood to adulthood. Puberty leads to full physical and sexual maturity. Fayombo (2004) and Fieldman, (2000) asserted that adolescence is a period in which the growing child experiences considerable acceleration in growth. It is also a stage in human development in which children experience transformation in their physique, emotions, cognitive and social interactions.

According to Ariba (2000) and Canadian Fitness and Lifestyle Research Institute (CFLRI), (2000) the peripheral age parameter defining the stage of adolescence is age 11 to 18 years. The adolescents make up about 20% (1.8 Billion) of world population (Famen, 2003). The adolescence period is characterized by fast developmental changes that is, physiological structures that have implications for sports performance. Physical educators are in the best position to provide the adolescents with the opportunity to participate in activities that will lead to the satisfaction of their positive needs. As applied to physical education, adolescents can satisfy the need for belonging, for example, by being given the opportunity to play in a team (Bucher, 1979). Adolescents' participation in sports is necessary for these individuals to receive sports values and other benefits of good sportsmanship, leadership, followership, self discipline, and social acquaintance (Carr, 2002).

Kagan and Sega (1988) opined that adolescence brings dramatic changes in physical appearance. It is time when self –image is very much dependent on body image. Adolescents who see themselves as deviating from "ideal" physique can quickly loose their self-esteem. Being overweight or too fat can be particularly devastating to adolescents. This concern is regarded as one of the factors that lead some adolescents to embark on abnormal and ultimately life threatening steps to remain thin (Slim fit), particularly girls. Positive changes in the circulatory and respiratory system give the adolescent increased strength and ability to tolerate more rigorous exercises.

When planning a training programme it is important to understand the different types of exercise. There are two types of exercise: aerobic and anaerobic exercises. These are based on two forms of chemical reactions that produce energy for the exercise. One form is oxygen dependent, the other is not. The aerobic form which is oxygen dependent includes activities of low to moderate intensity such as dancing. Anaerobic is the other type which is not oxygen dependent. It includes activities of high intensity but of low duration. Weight lifting is an example of anaerobic exercise. Aerobic endurance is important for any continuous exercise that lasts for more than a minute (Hale and Zartman, 2001). When insufficient oxygen is delivered to the muscle, their ability to perform work diminishes greatly and the anaerobic process account for the majority of the energy produced in the body. The ability to take in and deliver oxygen to the working musculature is an important factor in determining how much work can be performed. The more oxygen the body is able to take in and use the more work a person should be able to perform before fatigue sets in. This aerobic process can be improved through aerobic training (Prentice, 1997).

Aerobic training modes include either continuous modes of training (running, walking, jogging, swimming or cycling) or discontinuous (Fatlek training, interval training and circuit weight training) (Balbach, 2002 and Heyward, 2002). Aerobic training well administered will always enhance the acquisition and improvement of cardiovascular endurance most especially when it includes at least three 20-30 minutes weekly session of sufficient strenuousness while maintaining the aerobic fitness zone (Chad, (2002) and American College of Sports Medicine, (1990). Akinbo and Giwa, (2002); Bizley, (1999) and Nwankwo, (1996) have also shown that trained individuals have lower resting heart rate. Regular aerobic exercise makes the heart to become stronger and more efficient and these results in the reduction of the resting heart rate (Chado, 1991).

Feigenbaum (2000) opined that resistance exercise has proven to be a safe and effective method of conditioning for individuals with various needs, goals and abilities. Resistance exercise is a specialized method of conditioning that involves the progressive use of resistance to increase one's ability to exert force. Heyward (2002) reported that resistance training can lead to reduction in the resting blood pressure of people with hypertension or borderline hypertension. According to Fleck and Kraemer (1997) moderate to high-intensity resistance training performed 2 to 3 days per week for 3 to 6 months improves muscular strength and endurance in men and women of all ages by 25% to 400% depending on the training stimulus and initial level of strength. The main goal of resistance training programme is to overload the muscles of the arms, shoulders, back, abdomen and legs. Overloading a muscle group involves a combination of resistance, repetitions, sets and frequency. Both aerobic endurance exercise and resistance training can promote substantial benefit in physical fitness and health related factors (Pollock and Vincent, 1996). Resistance training offers greater development of muscular strength, endurance and mass. It also increase metabolic rate (to complement aerobic training for weight control), and helps to prevent falls in the elderly (Pratley, Nicklas, Rubin, Miller, Smith, Hurley, & Goldberg, 1994).

Blood pressure (BP) is the force or pressure that the blood exerts on the walls of all the vessels within the cardiovascular system (Venes, 2009). The highest pressure (systolic BP) reflects the pressure in the arteries during systole of the heart when myocardial contraction forces a large volume of blood into the arteries. Following systole, the arteries, recoil and the pressure drops during diastolic, or the filling phase of the heart-diastolic. Blood pressure is the lowest pressure in the artery during the cardiac cycle. Resting systolic blood pressure varies between 110 and 140mmHg, and diastolic blood pressure between 60 and 80mmHg. The difference between the systolic and diastolic blood pressures is known as the pulse pressure (Heyward, 2002). Stone, Fleck, Triplett and Kramer (1991) asserted that during a resistance exercise bout, systolic increases, which suggest that caution should be observed in persons with cardiovascular disease. Brownley, West, Hinderliter and Light (1996) observed that moderate aerobic exercise reduced blood pressure of individuals with high blood pressure.

Heart rate is an important physiological index of cardio respiratory fitness which can be monitored at rest or during exercise. Heart rate is the number of heart beats per minute (Heyward, 2002). Nwankwo (1996) reported that exercise training lowers the resting heart rate. Normal resting heart rate may range from as low as 28 to 100 beats per minutes. The average resting heart rate for adolescents is around 70 and 72 beats per minute. According to American Academy of Orthopedic (AAO) (2002), one should do aerobic exercise intensely enough to reach the target heart rate to strengthen it, which is 60 to 80% heart rate maximum.

The maximal volume of oxygen one can consume during exhausting exercise (VO_2 max) is considered the best index of aerobic fitness. (Baumgartner and Jackson, 1999). Pollock and Wilmore (1994) defined maximum oxygen consumption as the largest amount of oxygen that one can utilize under the most strenuous exercise. It is considered as the best indicator of cardiovascular fitness, aerobic fitness, or exercise capacity. Fitness can be measured by the volume of oxygen one can consume while exercising at one's maximum capacity. Those who are fit have higher VO_2 max value and can exercise more intensely than those who are not as well conditioned. If exercise intensity increases after one have reached ones VO_2 max, the body use predominantly anaerobic (without oxygen) pathway rapidly. One can continue exercising at that level for a few minutes at most (Baumgartner and Jackson, 1999). VO_2 max value in endurance athletes from weight-bearing sports are usually well in excess of 75ml/kg/ min for males and > 70m1/kg/min for females. The VO_2 max of most elite male distance runner is greater than 70ml/kg/min. A high VO_2 max gives a runner the potential to be an elite middle and long distance runner. It is one of the key physiological factors determining the average speed sustained during a race (Maughan, 1999)

Many sporting activities depend on the muscles ability to repeatedly develop and sustain near maximal or maximal forces. This capacity to sustain repeatedly muscles actions, such as when performing sit-ups or push- ups, or to sustain fixed or static muscle actions for an extended period of time, such as when attempting to pin an opponent in wrestling, is termed muscular endurance (Wilmore & Costil, 1994). Muscular strength and muscular endurance are developed by the progressive overload principle that is, by increasing more than normal the resistance to movement or frequency and duration of activity (Fleck & Kraemer, 1997).

According to Chad (2001) muscle strength is the maximal force, which can be put forth in one maximum contraction of a few seconds in duration. In other words, it is the ability of a muscle to perform one powerful contraction to overcome a simple large resistance (Wilmore and Costil, 1994). Igbanugo (2000) defines strength as the ability of the body or its segments to apply force. Although literature reflects a wide range of improvement in muscle strength for sedentary young and middle-aged men and women for up to 6 months of training of about 25-30% (Fleck&Kraemer, 1997).

Speed is an important factor in almost all court and field games and it can make the difference in whether a performer is able to gain advantage over his opponent or not. Hockey (1993) defines speed as the quickness with which one is able to move his body from one point to another. Heyward (2002) defines speed as the velocity of body, body parts or an object, that is, it is the rate of motion. It is concerned with the time required to move or swim a given distance. Hockey (1993) defines flexibility as a functional capacity of the joints to move through a full range of motion. An individual should aim at possessing free range of physical activities. Flexibility as an important component of performance often serves to prevent serious muscles injury (Amusa and Abass, 1995).Wilmore and Costil (1994) defines agility as the ability to shift the direction of movement rapidly without loss of balance or sense of position. It is the maneuverability of the body and its parts with accuracy. Agility is the combination of several athletic traits including strength, reaction time, and speed of movement, power and coordination.

Ibadan metropolis is situated in the southwest of Nigeria. It is an urban area and it is the capital of Oyo State. It has many secondary schools and tertiary institutions spread all over the area. There are 324 secondary schools and 1,576 primary schools. There are 10 special secondary schools in Ibadan metropolis. 5 of these special schools are integrated while 5 operate as separate unit. 7 of these special schools are owned by the government and the remaining 3 by private individuals or organization. These special schools do not have organized sporting programme for the deaf students whereas there is special sports at the National and Olympic competitions. These schools supposed to be the venue for talent identification in sports. It is in the light of these that the researcher is set to find out the effects of two modes of exercise training programme on selected physiological and motor variables of in-school adolescents with hearing impairment in Ibadan metropolis.

Statement of the Problem

Adolescents with hearing impairment are neglected and discriminated upon in the school and society which invariably affect their level of psychosocial well-being. As a result of this they feel inferior to their counterparts with normal hearing when sporting activities are organized. Consequently, they find it difficult to develop good motor skills that could enhance their physical fitness.

Furthermore, the adolescence period no doubt is characterized by changes and crises biologically, emotionally and socially which has implication for sports performance. Since they are denied the opportunity to participate freely in sporting activities, this will not enable them to have satisfaction of their positive needs, sports values and other benefits of sportsmanship. Hearing together with sight, is of paramount importance at work and in acquisition of skills. Physiologically, hearing in motor learning has its base in vestibular fibres that acts as organ of balance in the ear synapse in the medulla oblongata with neurons which then pass to the cerebellum. There is an intricate relationship between the cerebellum and cerebrum in the coordination and refinement of motor activity to produce skilled movement patterns. However, among the benefits of physical fitness and exercise is to rejuvenate and make body organs reach functional capacity.

Given the importance placed on physical fitness levels and the connection with its benefit in reducing risk factors associated with various diseases, many studies have not been done on levels of fitness of children with hearing impairment. Also, little attempts have been made to study the effects of modes of training on fitness level of in-school adolescents with hearing impairment. This study therefore, examined the effects of two modes of exercise training programmes on selected physiological and motor variables of in-school adolescents with some hearing impairment.

Objectives of the study

The main objective of the study was to examine the effects of two modes of exercise training programme on selected physiological and motor variables of in-school adolescents with hearing impairment in Ibadan metropolis. The specific objectives of this study include:

1. To examine the effects of aerobic and progressive resistance exercise trainings on physiological and motor variables of in-school adolescents with hearing impairment.
2. To find out the effect of degree of impairment on physiological and motor variables of in-school adolescents with hearing impairment.
3. To examine gender effect on physiological and motor variables of in-school adolescents with hearing impairment.
4. To find out the effect of age on physiological and motor variables of in-school adolescents with hearing impairment.

Research Questions

The following research questions were answered in the study.

1. What will be the effect of two modes of training on the physiological characteristics of in-school adolescents with hearing impairment?
2. What will be the effect of training on motor performance characteristics of in-school adolescents with hearing impairment?
3. Which of the training modes will be more suitable and beneficial to the in-school adolescent students with hearing impairment?

Hypotheses

The following hypotheses were tested in this study.

1. There will be no significant difference in the pretest-posttest physiological variables (resting systolic blood pressure, resting diastolic blood pressure, resting heart rate and maximum oxygen uptake) between experimental and control groups following a12-week aerobic and progressive resistance exercise trainings.

2. There will be no significant difference in the pretest-posttest motor variables (muscular endurance, muscular strength, flexibility, speed and agility) between experimental and control groups following a 12-week aerobic and progressive resistance exercise trainings.
3. There will be no significant difference in the pretest-posttest physiological and motor variables of in-school adolescent students with hearing impairment, based on degree of impairment following a 12-week aerobic and progressive resistance exercise trainings.
4. There will be no significant difference in the physiological and motor variables of in-school adolescent students with hearing impairment, based on gender following a 12-week aerobic and progressive resistance exercise trainings.
5. There will be no significant difference in the physiological and motor variables of in-school adolescent students with hearing impairment, based on age following a 12-week aerobic and progressive resistance exercise trainings.

Delimitations of the Study

This study was delimited to the following:

1. 12-weeks of aerobic exercise and progressive resistance exercise trainings
2. Adolescent male and female in-school students with hearing impairment in Ibadan metropolis.
3. One hundred and twenty (120) volunteers, 60 males and 60 females
4. Randomized pretest-posttest control group design.
5. Two experimental groups and one control group.
6. Two public secondary schools for students with hearing impairment in Ibadan (Methodist Junior and Senior Grammar School Bodija Ibadan and Ijokodo Junior and Senior High School Polytechnic road, Ibadan).
7. Physiological variables of resting systolic blood pressure, resting diastolic blood pressure, resting heart rate and maximum oxygen uptake.
8. Motor variables of muscular endurance, muscular strength, flexibility, speed and agility.
9. The following instruments:

a. Sphygmomanometer for blood pressure

b. Stethoscope for heart rate.

c. 400m track for one-mile-run/walk to estimate VO_2 Max

d. Flex box for flexibility.
e. 50 meters measuring tape to measure Illinos agility run test course and 50 yards sprint test.
f. Stop watch calibrated from 0-30 minutes for timing.
g. Handgrip dynamometer for muscular strength.
h. Whistle
i. Weighing scale.
j. Height meter.
k. Audiometer to measure degree of impairment.
10. The descriptive statistics of mean and standard deviation.
11. The inferential statistics of Analysis of Covariance (ANCOVA) and t test were used to analyze the data for this study. Level of significance was set at 0.05.

Limitations of the Study

The first limitation to this study was that of non-compliance of participants with frequency of attendance to the exercise training programme.

The second limitation to this study was that Christian Mission School for the Deaf located at Jericho which could have been included in this study does not have sufficient space where the initial measurement and the exercise training programme could take place.

Thirdly, the researcher could not control all threats to external validity in this study.

Significance of the Study

Motor and physiological efficiencies are the qualities desired in adolescents who are by nature suppose to be energetic and full of life. The study has revealed which of the two modes of exercise training programme best improved specific physiological and motor performance variables of adolescent student with hearing impairment. The outcome of this research revealed that the two modes of exercises produced different effect on physiological and motor performance characteristics based on the exercise training groups, age and gender .Therefore the results of the study are specifically relevant in the following ways.

Physical educators and exercise physiologists are now better informed in the selection of exercise training mode when dealing with adolescent students with hearing impairment. This is because the findings of this study has revealed the best training mode that could be used to assess or improve certain physiological and motor variables of this special people.

The study has generated base line data on the current physiological and motor variables of adolescent students with hearing impairment. This should help the concerned authorities in planning and developing exercise programmes that would promote the level of physical fitness for this group of students with special needs.

Related to the above, it is believed that this study was beneficial to the well being of the participants in this study. The study has served useful purpose to those who participated in the programme on the benefits of regular physical exercises.

The study has further provided data that could be used for comparison with related data abroad in similar studies, thereby encouraging promotion of cross-cultural efforts in research affecting the students with special needs.

Definition of Terms

Adolescent Students: Students between 11 and 18 years of age.

Hearing Impairment: This refers to complete or partial loss of the ability to hear from one or both ears.

One Repetition maximum (IRM) The maximum amount of resistance an individual is able to lift in a single effort.

Resistance Training: Specialized procedure of conditioning that involves the progressive use of resistance.

Aerobic Exercise: Any activity that delivers a steady supply of oxygen to the working muscles over a period of time.

Muscular strength: The ability of a muscle or muscle group to exert maximum force against a resistance.

Muscular Endurance: The ability of a muscle or muscle group to exert sub-maximal force repeatedly for a long period of time.

Flexibility: The functional ability of a joint to move through a full range of motion.

Agility: This is the ability to change the direction of movements of the body while still in motion

Speed: This is the ability to move quickly from one point to another.

Blood Pressure: The force exerted by blood against the walls of blood vessels.

Systolic Blood Pressure: The highest pressure in the arteries during the cardiac cycle.

Diastolic Blood pressure: The lowest pressure in the arteries during the cardiac cycle.

Maximum Oxygen Consumption: Maximum level of oxygen the body is capable of processing and using.

Heart Rate: The number of heart beats per minute.

Sedentary Person: A person who is not participating in organized regular physical activities.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The review of related literature covered in this study was discussed under the following sub headings:

1. Adolescence and physical activity.
2. Concepts of hearing impairment
    - (a) Types of hearing loss
    - (b) Causes of hearing impairment
    - (c) Degree of hearing loss
    - (d) Hearing impairment and sporting activities
3. Physiological variables and exercise training
    - (a) Resting Heart Rate and Exercise Training
    - (b) Blood Pressure Responses during Training
    - (c) Systolic blood pressure and Exercise Training
    - (d) Diastolic blood pressure and Exercise Training
    - (e) Maximum oxygen consumption and Exercise Training
4. Motor variables and Training performance
    - (a) Muscular endurance and Training performance
    - (b) Muscular strength and Training performance
    - (c) Speed and Training performance
    - (d) Flexibility and Training performance
    - (e) Agility and Training performance
5. Factors guiding exercise training.
    - a) Frequency of exercise
    - b) Intensity of exercise
    - c) Duration of exercise
    - d) Mode of exercise

Adolescence and Physical Activity

Adolescence is a period of rapid and emotional change, characterized by stresses and tensions as the child strives to establish an individual identity on the journey from dependence to independence and adulthood (Moronkola and Aremu, 2004). It originated from a Latin word "adolescence" which represents a period of growth beginning with puberty and ending at the beginning of adulthood. Girls usually start puberty between ages 10 and 12, while many boys begin between 12 and 14, (Awake, 2004).

According to Crompton, Lamb and Vedlitz, (1979) the adolescent phase of development is a widely recognized and convenient stage in the human life cycle. It brings dramatic changes in physical appearance. The girls begin to look like women, and the boys like men. All these changes are set in motion by the increased activity of the pituitary gland, which stimulates the sex glands to produce large quantities of the hormones estrogen in the female and androgen in the male, (Awake, 2004; Steinberg, 1996 and Kagan and Sega, 1988). The onset of these activities may occur one or two years earlier in girls than in boys, (Kagan and Sega, 1988).

Adolescence participation in sports is necessary for these individuals to receive sports values, and other benefits of good sportsmanship, leadership, followership and self discipline (Carr, 2002). In recent years, the public health benefit of reducing sedentary lifestyle and promoting physical activity became increasingly apparent. Increasing one's levels of physical activity has been shown to have multiple health benefits (Peltzer, Phaswana and Promtussananon, 2002).

Concepts of Hearing Impairment

Hearing impairment is a generic term that is used to describe all forms of hearing loss, like deafness and hard-of-hearing. Barker (2003) defines hearing impairment as impairment in hearing whether permanent or fluctuating that adversely affects child's educational performance. The World Health Organization (WHO) (2001) opined that hearing impairment is a broad term used to describe the loss of hearing in one or both ears. According to WHO (2005), hearing impairment refers to complete or partial loss of the ability to hear from one or both ears. It was also observed by WHO (2005) that there are two types of hearing impairment defined according to where the problem occurs (conductive hearing impairment), which is a problem in the outer or middle ear. This type of hearing loss is often medically or surgically treatable. While the other one is sensorineural hearing loss. It is usually due to a problem with the inner ear, and occasionally with the hearing nerve going from there to the brain. This type of hearing problem is usually permanent and requires rehabilitation, such as with a hearing aid. The common causes of sensorineural impairment are excessive noise and aging (WHO, 2005).

World Health Organisation (2005) reported that hearing sensitivity is indicated by the quietest sound that an animal can detect, called the hearing thresholds. In the case of humans and some animals, this threshold can be accurately measured by a behavioural audiogram. A record is made of the quiet that consistently prompts a response from the listener. The test is carried out for sounds of different frequencies. There are also electro physiological tests that can be performed without requiring a behavioural response.

Normal hearing thresholds within any given species are not the same for all frequencies. If different frequencies of sound are played at the same amplitude, some will be perceived as loud, and others quiet or even completely inaudible. Generally, if the gain or amplitude is increased, a sound is more likely or be perceived. Ordinarily, when animals use sound to communicate, hearing in that type of animal is most sensitive for the frequencies produced by calls, or in the case of human speech. All levels of the auditory system contribute to this sensitivity towards certain frequencies; from the outer ear's physical characteristics to the nerves and tracts that convey the nerve impulses of the auditory portion of the brain.

A hearing loss exists when the animal has diminished sensitivity to the sounds normally heard by its species. In humans, the term hearing impairment is usually reserved for people who have relative insensitivity to sound in the speech frequencies. The severity of a hearing loss is categorized according to the volume that must be made above the usual level before the listener can detect it. In profound deafness, even the loudest sounds that can be produced by an audiometer (an instrument used to measure hearing) may not be detected (WHO, 2005).

Hutzler and Sherrill (2007) found out that 278 million people worldwide have moderate to profound hearing loss in both ears. They further stressed that 80% of deaf and people with hearing impairment live on low and middle –income countries. The number of people worldwide with all levels of hearing impairment is rising due to a growing global population and longer life expectancies.

Types of Hearing Loss

According to Karchmer and Mitchell (2003), the four major types of hearing loss are:

1. Conductive hearing loss
2. Sensorineural hearing loss
3. Mixed hearing loss
4. Central auditory processing dysfunction.

Conductive hearing losses can be the result when sound does not get through the outer and middle ear structures efficiently. Any blockage of the ear canal, such as a buildup of excessive ear wax (cerumen) or the failure of the canal to develop at birth, can interfere with sound transition. Conductive hearing loss is often caused by a buildup of fluids in the middle ear due to infections (Otitis media). This buildup of fluid impedes the work of the ossicular chain in transmitting sound to the inner ear. Infections and diseases may also cause the eardrum or the ossicles to work inefficiently. Quite often, conductive loss can be overcome by surgery, medical treatment, or amplification of incoming sounds so they can get past the middle ear and stimulate the inner ear structures. Many conductive losses are transitory, lasting no longer than several days. Repeated untreated infection can lead to permanent damage of the hearing mechanism. (Karchmer and Mitchell, 2003).

According to Karchmer and Mitchell (2003), Sensorineural hearing losses occur when sound that gets to the inner ear is not transmitted to the brain or is transmitted in a distorted manner. Damage to the Cochlea and the auditory nerve will bring about sensorineural hearing loss. The most common causes of this damage are viral diseases, Rh incompatibility, medications that have the side effect of harming the hearing mechanism (Ototoxic Medicines) while correcting other conditions in the body, normal aging, and repeated exposure to loud noise. Sensorineural hearing loss is usually permanent; it is treated with amplification but is not usually treatable medically or surgically.

A mixed hearing loss occurs when a person has a combination of both a conductive hearing loss and a sensorineural hearing loss. Central auditory processing problems do not result from the inability of the mechanism to deliver the auditory signal to the brain, but rather from the inability of the brain to process or interpret the signals that are delivered. This symbolic processing disorder may show itself in the inability of a person to perceive sounds, discriminate among sounds or even comprehend language that is received. People with auditory processing problems are the result of lesions or growths within the nervous system or direct damage to those parts of the brain and nervous system that are dedicated to the processing of auditory signal.

Causes of Hearing Impairment

Alade (2005) found out that the causes of hearing impairment can be classified into three sections namely:

- Causes occurring before birth
- Causes occurring during birth and
- Causes occurring after birth

She also opined that the causes of hearing impairment can be classified into outer, middle and inner ear.

Impairment of the Outer Ear

Alade (2005) opined that impairment of the outer ear, either pathological or resulting from accident or infections, can lead to conductive hearing loss. According to her the following are the common impairments of the outer ear:

- Atresia: Condition in which the external auditory canal does not form in some children.
- Presence of foreign objects in the external ear.
- External ottitis: This refers to a situation whereby the external auditory canal is infected.
- Pathological growth like tumor in the ear.
- Accumulation of cerumen or ear wax which can block the external auditory canal.
- The eardrum can become perforated as a result of clearing or scratching that canal, a blow to the head or excessive pressure in the middle ear.

Impairment of Middle Ear

Alade (2005) found out that the impairment in the middle ear are generally more serious than those of the external or outer ear. According to her, Otitis Media, an infection of the middle ear space and non –supportive Otitis Media and disruption of the functioning of the Eustachian tube, are the common causes of middle ear impairment.

Impairment of the Inner Ear.

Alade (2005) identified the fact that the most causes of inner ear impairments are meningitis, a disease of the inner membrane covering the brain, maternal rubella and hereditary factors. In addition, she found out that the following are other causes of inner ear impairments:

- Premature birth

- Viral infections, such as mumps and measles.
- Prenatal infections of mother, such as congenital syphilis
- Rh factor – that is, blood incompatibility between the mother and child.
- Unforeseen and unwanted side –effect of some antibiotics
- Blows to the head and
- Excessive noise levels.

Degree of Hearing Loss

The degree or severity of a hearing loss will often directly correlate with the characteristics behaviours that student with the hearing impairment displays. According to Karchman & Mitchell (2003), the following five terms are frequently employed in describing the severity of a hearing loss:

1. Slight - 20 to 40dB
2. Mild - 40 to 60dB
3. Moderate - 60 to 75dB
4. Severe - 75 to 90dB
5. Profound - 90dB and above.

These descriptive labels are determined by the student's ability to hear sound at different frequencies and at different intensities. Sound is measured by its intensity and frequency. Intensity and frequency are physical measures that are most easily understood as loudness and pitch. The loudness of a perceived sound is measured in decibels, abbreviated as dB. At 0 dB, a person with normal hearing can detect the faintest sound. Whispered speech would be about 10 dB and conversational speech about 50 dB. A sound louder than 125 dB will cause pain and can destroy the hair cells of the cochlea.

Karchmar and Mitchell (2003) opined that this information can be translated into five severity categories:

1. A person with normal hearing will hear sounds between 0 and 20 dB with little difficulty and have no difficulty hearing in any conversational setting.
2. A person with slight hearing loss will hear sounds at an intensity of 20 to 40 dB or louder and may have difficulty with faint speech. School difficulties are not usually present and can be remedied with careful seating near the teacher.

3. A person with mild hearing loss cannot hear sounds produced at less than 40 to 60 dB but can usually understand face-to-face conversation. The student may miss as much as 50 percent of classroom conversations, especially in noisy environments. The student may have a limited vocabulary and oral speech problems. Special services are usually indicated. This group can do well in sporting activities because of their ability to understand face-to-face conversation. They would be able to perform to instructions guiding performance of specific sport skills.
4. A person with moderate hearing loss cannot hear sounds less intense than 60 to 75 dB, which excludes all but loud conversation. Impaired speech and language are usual, and the students will most often required special class placement or a resource teacher. The implication of this for physical activities is that the individual will not be able to perform well due to inability to hear instruction that will guide his performance.
5. A person with severe hearing loss cannot hear sounds below 75 to 90 dB as exemplified by loud voices less than one foot from his or her ear. These students may identify environmental noises but cannot hear most consonant sounds. Speech and language is usually impaired or nonexistent of the loss occurred prior to one year of age. Special education placement and special classroom placement are likely. The implication of this for physical activities is that the performance of the person will be affected because of his inability to follow rules and regulations.
6. A person with profound hearing loss cannot hear sounds quieter than 90 dB, which means that he or she cannot hear conversational speech. This student may sense vibrations more than hear sounds and rely on vision rather than hearing for learning. This student is unlikely to develop oral speech or language and will usually rely on sign language and be placed in a special class or school for the deaf. The implication of this for physical activities is that the individual can only perform sporting activities with minimal instruction, that is, with less rules and regulations.

Hearing Impairment and Sporting Activities

Deaf and hard-of-hearing children do not, as a rule, need a different set of activities from typical children. However, in many instances, because of the limitations imposed by the hearing disorder, physical and motor development may be retarded. Therefore, it is wise to be aware of possible physical underdevelopment and poor motor coordination among deaf and hard-of-hearing persons'. The objectives in a physical education programme for hard-of-hearing children are the same as those for normal children. However, loss of hearing, which impairs the ability to communicate effectively with others, is a great social handicap. Therefore, an objective that should be given priority is the provision of opportunity for social interaction through games with other students. Also, deaf children tend to have poor body mechanics and poor patterns of locomotion (Crowe; Auxter & Pyfer, 1994).

Regular physical activity and physical fitness are especially important in maintaining the health and well being of people of all ages. Research clearly indicates that virtually all individuals, including those with disabilities, can gain health benefits from regular physical activity. The health promotion and disease prevention needs of people with disabilities who have secondary health conditions may be complicated by specific medical aspects of disabilities. People with disabilities may be at greater risk of future problems e.g. individuals with spinal cord injuries are more likely to have to address pressure sores. For deaf individuals with no or minimal secondary health conditions, there are great potentials for effective participation in physical activity programmes.

According to the National Institutes of Health (1993), approximately 1 of every 1000 children is born with profound hearing loss. Many more are born with less severe degree of loss, while others may develop hearing loss over time. Reduced hearing acuity during infancy and early childhood infers with the development of speech and language skills. Communication difficulties may also adversely affect social, emotional, cognitive and academic development. Since physical activity and fitness are tied to these developmental constructs, hearing loss may influence physical activity patterns and levels of physical fitness.

In a study by Longmuir and Bar-or (2000), assessing the physical activity level of youths with disabilities, individuals with hearing loss had the highest level of physical activity participation compared to individuals with cerebral palsy, spinal bifida, muscular dystrophy, and other chronic medical conditions such as Arthritis and Kidney disease. Most of the participants in the study were recruited from schools for deaf youths that provide in-school and extracurricular physical activity programmes. Of the 104 individuals with hearing loss who completed the survey on physical activity levels, 87 individuals perceived themselves as active and 28 sedentary.

Research studies dating from the early part of the 20th century have compared the motor performance of deaf children and youth with their hearing counterparts. Goodman and Hopper (1992), in a comprehensive historical review of the psychomotor behaviour of children and youth with hearing loss, found deaf children and youth in some cases had similar profiles to their hearing counterparts, with the possible exception of balance. Vance 1968 quoted by Dolores (1978) suggested that day-school hearing boys and , to a lesser extent, hearing girls had superior motor abilities to day-school deaf boys and deaf girls, respectively. Measures included grip strength, burpee squat thrust, ball throw at a target, speed and 50-yard dash.

According to Crowe, Auxter and Pyfer (1994), children who are deaf may be prone to lower fitness because they tend to be sedentary. Low fitness not only has implications for poor functional health but also may limit or constrain any number of daily activities including participation in sports and recreation. Research on physical fitness (including strength) of children who are deaf remains inconclusive. Individuals with moderate to severe hearing loss were more likely than individuals without hearing loss to have impaired activities of daily living.

The deaf community has a significant history of involvement in sport. The oldest U.S disability sport organization, the American Athletic Association for the deaf, now recognized by the name, USA deaf sports federation, was founded in1945. Most of the research on physical activity programmes for deaf individuals has focused on physical education in schools and sports programmes for children and youth. However, the physical activity needs of the adult population have received little attention beyond competitive sport. Information on lifestyle and leisure activities, informal and unstructured physical activity and play, and active living is virtually non-existent. To achieve the physical activity health objectives of the nation, there is a need to enhance physical activity levels of deaf individuals, beyond school-based physical education and competitive sport programmes, promoting a variety of lifestyle physical activity opportunities, including embracing the concept of “Active Loving” a way of life that integrates physical activity into delay routines, should become a health objective priority (Dolores, 1978).

Public laws 101-336, Americans with Disabilities Act (1990) have provided support for individuals with disabilities to participate in physical activity and sport programmes. The public accommodations title has resulted in greater access for individuals with hearing loss. Although PL 101-336 promotes integration into mainstream activities, the deaf community has a distinct sport culture. Deaf sport refers to sports as a specific cultural event for athletes who are deaf

(Stewart and Ellis, 1999) and it has emerged as a cultural celebration and as essential element of the deaf community. The USA deaf sports federation (USADF) provides competitive sport opportunities for individuals with hearing loss through state, regional, and national tournaments. The deaf lympics, formerly known as the World Games for the deaf provide summer and winter competitions for deaf athletes from various countries. Generally, deaf sport has distanced itself from other disability sport groups.

The historical research studies indicated many equivalencies in physical fitness categories, but also found that deaf (Df) and hearing impaired (HI) children not perform as well as hearing (H) children overall. Campbell (1983) reported that H subjects were superior to HI and Df subjects in cardiorespiratory endurance , running speed and leg strength. However, Pender and Petterson (1982) concluded that Df subjects were superior in cardiorespiratory endurance and running speed. Only about a third of Df boys and girls were able to achieve Plateau and maximum oxygen uptake in the Shephard et al (1987), and their physical work capacity was below that of their peers. Vance (1968) showed both male and female Df groups to be statistically inferior in grip strength compared to H group.

Ellis, Butterfield, and Lehnhard (2000) compared the grip strength of children, ages 6 to 19 years, from a residential school for the deaf to a matched sample of hearing children from public schools and found no significant differences. Campbell (1983) found that H subjects outperformed HI and Df subjects in overall sit-up performance.

Ellis, Lieberman, Fittipauldi-wert, and Dummer (2005) found that deaf children (ages 6 to 11) have at least minimally acceptable levels of fitness. Dair, Ellis and Lieberman (2006) found that the prevalence of overweight deaf children aged 6-11 was above the national percentage of boys were overweight than girls. Very few studies attempted to compare the psychomotor performance of children and youth with varying levels of hearing loss. Butterfield (1987) found those subjects with the greatest hearing loss performed kicking at a more mature level and that hearing level was not related to jumping, catching and throwing performance. In the Campbell (1983) study, HI subjects balanced longer and outperformed Df subjects in sit-ups, standing broad jump, 30 foot shuttle run, 30-yard run, and 9-minute run. Winnick and Short (1986) indicated no significant difference between the physical fitness levels of the HI and Df subjects. Overall, there is no compelling evidence of substantial motor performance differences across levels of hearing loss.

However, the deaf individual's experiences greater difficulties in performing motor functions or motor movement, locomotion coordination and speed. The deaf individual is also noted for poor posture, and balance, weakness in muscular control, strength and agility. Also, there is higher incidence of lateral preference (handedness) in the deaf population than in the hearing population (Suarau, 1992).

The USA Deaf sports Association sponsors a wide array of affiliated sports. The following have national association status: basketball, cycling, golf, ice hockey, martial arts, shouting, ski and snow board, soccer, handball and track and field. The following are managed by individual communities: badminton, baseball, bowling, orienteering, swimming, table tennis, volleyball and water polo.

Integration and involvement in community sport and recreation activities present challenges. These activities are most often staffed witch coaches and teachers who are untrained in physical education and lack specific communication skills. Special training is needed for communication with deaf individuals. All physical educators should learn at least some basic signs language and how to communicate with manual and total communication methods. Signing is also a skill that can be used between people when one wishes not to vocalize. Hearing children with knowledge of sign language can help with mainstreaming and social integration. Assingning a peer buddy to a student with a hearing loss has proven to be an effective teaching strategy (Ellis,Lieberman, Fittipauldi-Wert & Dummer 2005).

It is especially important that physical educators and youth coaches be familiar with the specific need support and encouragement to learn motor skills. Our modern day view of providing physical education programmes to help individuals develop healthy and active lifestyles in adult life is a critical issue for the deaf community. The goal of a school physical programme for deaf student should be the promotion of an active and healthy lifestyle that would include but not be limited to sport participation. Children need the tools to achieve this goal, including effective motor skills and adequate physical fitness; special instruction should also emphasize communication skills in the physical activity setting. Schools should actively promote sports for deaf children due to the prominent place of sport for Deaf community (Stewart and Ellis 2005) schools should not view physical education as simple time away from classroom studies but as an essential part of the entire curriculum (Stewart and Ellis, 1999).

A challenge is promoting health and wellness for individuals with hearing loss may rest with the deaf community. Deaf sports are a tradition and part of the culture of the deaf community. How to provide physical activity opportunities beyond sport for its members and how to effectively access resources and information generally available to hearing individuals are two significant issues. There is limited research to date that focuses on deaf adults and physical activity programmes.

PHYSIOLOGICAL VARIABLES AND EXERCISE TRAINING

Heart Rate and Exercise Training

Heart rate is the number of heart beats per minute. It is an important physiological index of cardio respiratory fitness which can be monitored at rest or during exercise. At rest the heart typically beats between 60 and 80 times per minute. However, in highly conditioned athletes, the physiological adaptations of endurance training can result in a resting heart rate as low as 28 beats per minute (Heyward, 2002 and Kenney, Wilmore and Costill, 2012). The decrease is thought to be a result of an increase in the stroke volume of the heart in combination with an increase in the parasympathetic influence of the nervous system. Conversely, a high resting heart rate could be a sign of poor cardiorespiratory function, overtraining, increases in stress, and a host of other factors that may be counterproductive to clients (Hanson, 2009). Heart rate is used to monitor the intensity of exercise training. This is because there is a linear relationship between heart rate and workload, (Bizley, 1999). There is a linear increase in heart rate with increase in workload or VO_2 in trained and untrained individual (ACSM, 1990).

Findings of several studies (Bizley, 1999; McGlynn, 1999 and Nwankwo, 1996), have shown that exercise training lowers the resting heart rate. Hockey (1993) reported that for an average person at rest who does not exercise regularly, the heart will beat about 70 to 75 times per minute. According to Cobin and Lindsey (1997) men and women less than 20 years old, a heart rate of 180 to 190 beats per minute during work interval should indicate that work is sufficiently intense for both athletes and non-athletes. The average resting heart rate for adolescents is around 70 and 72 beats per minute, (Bizley, 1999 and McGlynn, 1999).

During exercise, heart rate is a good indicator of relative exercise intensity and is used widely to monitor cardiorespiratory function in both health and disease (Hanson. 2009). The heart muscle is one of the few tissues capable of generating its own impulse, and it does this at the sinoatrial (SA) node, which is located on the right ventricle (Sharkey and Gaskill, 2007). The

SA node is considered the pacemaker of the heart. It is innervated by sympathetic and parasympathetic nerve fibers that emanate from the medulla oblongata and the cardiorespiratory control centers within the central nervous system. Both sets of nerve fibers innervate the SA node; the atrioventricular (AV) node provides a tonic influence that can be either enhanced or depressed. The sympathetic nerve fibers increase heart rate, whereas parasympathetic nerve fibers slow it down. At rest, parasympathetic influence usually dominates control of the heart rate by reducing the heart's natural, or inherent rate of about 100 beats per minute (bpm), to somewhere between 60 and 80 bpm (Kenney, Wilmore and Costill 2012). At the initiation of exercise, the removal of parasympathetic influence initially allows the heart rate to increase to about 100 bpm, followed by an increase in sympathetic activity that further accelerates heart rate based on circulatory demands (Kenney, Wilmore and Costill 2012). The average resting heart rate for adolescents is around 70 and 72 beats per minute, (Bizley, 1999 and McGlynn, 1999). The heart rate maximum percentage indicates exercise intensity. However, a reasonable estimate of the maximum heart rate (HR-Max) is done using the Karvonen formula where age is subtracted from 220, which is constant, (Chado, 1991). Simply, the formula is: HR Max = 220-age.

To strengthen the heart one should do aerobic exercise intensely enough to reach the target heart rate, which is 60 to 80% HR Max (AAO, 2002). Guyton and Hall (1996) described two major methods of determining heart rates. These are as follows.

Auscultation: The counting techniques used for monitoring heart rate are very similar for auscultation and palpation. However, with auscultation the pulse waves that are felt are replaced by the sounds of the myocardium, large arteries, or both. Placement of the ball of a stethoscope over the third intercostals space to left of the sternum brings sounds to one's ears from the heart. The number of such sounds heard and counted over a period of one minute or its fractions are multiplied to make up the number of beats per minute, gives the heart rate in beats per minutes.

Procedure

- The diaphragm of the stethoscope should be placed directly onto the subject with the entire diaphragm of the stethoscope flush with the surface of the skin. The diaphragm should be placed over the apical (apex) region of the heart or over the base of the heart between the second and third ribs just below the proximal end of the clavicle (Adams and Beams, 2008). Slight pressure on the diaphragm may improve the quality of the heart sounds

- Once the stethoscope is in place, similar procedure to those of palpation can be used to count or time the beats of the heart. Both the palpation and the auscultatory methods are easier to conduct during exercise than at rest. Although the beats are occurring at a much faster pace during exercise, the strength of the pulse waves and of the contraction of the heart make the pulse easier to feel and hear.

Palpation: Palpation is the process of determining heart rate by feeling the distension of the arteries as a bolus of blood passes through the vessel. Numerous large arteries run close to the surface of the skin making them ideal for palpation. Deeper arteries and those surrounded by excessive adipose tissue can make palpating the pulse difficult. Also, exercises such as walking and running during measurement can confound the ability to count a pulse because the rhythmic body movements make distinguishing pulse waves difficult. Furthermore, it is important not to occlude (pinch) the artery with the pressure of the fingers. This is especially important when taking a pulse using the carotid artery; occluding the artery can hamper blood flow to the brain leading to syncope (dizziness) and possibly injury. The technique is to locate a relatively large artery, place the fingertips over it, and count the number of beats that occur in a given period of time (Hanson, 2009). In using this technique for determining heart rate, the pulse is palpated at one of the following sites:

- Brachial artery: On the inside of the upper arm behind the biceps brachi and below the axilla
- Carotid artery: In the neck just lateral to the larynx.
- Radial artery: On the antero – lateral aspect of the wrist directly in line with the base of the thumb.
- Temporal artery: Along the hairline of the head at temple.

The following procedures are to be followed when determining hearts rate by palpation:

- Use the tip of the middle and index finger.

  Do not use your thumb because it has a pulse of its own and may produce an inaccurate count. Place the finger over a point (site where the pulse is found).
- When palpating at the carotid site, do not apply heavy pressure on the area. Baroceptors in the carotid arteries detect this pressure and cause a reflex slowing of the heart rate.

- The procedure begins by counting the first pulsation as zero and then counting the number of completed beats for the predetermined period of time. Start the stopwatch simultaneously with the pulse beat.
- Because heart rate is usually expressed in beats per minute (bpm), the amount of time a pulse is monitored is conveniently divisible into 60 seconds. For example, a pulse taken for 10 seconds can be multiplied by 6 to estimate bpm. Time increments of 15 seconds × 4 and 30 seconds × 2 are commonly used (Adams and Beams, 2008).

Blood Pressure Responses during Training

According to Heyward, (2002), blood pressure is a measure of the force or pressure exerted by the blood on the arteries. The highest pressure (systolic blood pressure) reflects the pressure in the arteries during systole of the heart when myocardial contraction forces a large volume of blood into the arteries. Following systole, the arteries recoil and the pressure drops during diastolic pressure. Diastolic blood pressure is the lowest pressure in the arteries during the cardiac cycle. The resting systolic blood pressure varies between 100 and 140mmHg, and diastolic blood pressure between 60 and 80mHg. Usually a person is not classified as hypertensive unless the blood pressure remains elevated (>140/90mmHg) on two occasions. The difference between the systolic and diastolic blood pressures is known as the pulse pressure.

Pollock and Wilmore (1994) found out that systolic blood pressure rises linearly with increase levels of exercise, and diastolic blood pressure should decrease slightly or may remain rather constant. Exercise had been proved to lower blood pressure and that exercise is now been recommended as a useful measure to lower blood pressure in many guidelines in the management of hypertension (Arakawa, 1999). Brownley, West, Hinderliter and Light (1996) observed that moderate aerobic exercise reduced blood pressure of individuals with elevated blood pressure. McGlynn, (1999) explained that people under thirty years of age probably see no significant of any reduction in blood pressure resulting from exercise training. As the result of acute bouts of aerobic exercise, systolic blood pressure will typically increase to meet the metabolic demands of the tissues. Diastolic blood pressure will most likely stay the same, leading to an expansion of both Mean Arterial Pressure (MAP) and Pulse Pressure (PP). A release of the sympathetic neurotransmitters epinephrine (EPI) and norepinephrine (N-EPI), causes an increase in both heart rate (HR) and Stroke Volume (SV) contributing to an expansion in arterial blood volume and ultimately Arterial Blood Pressure (ABP). At the same time, this sympathetic response causes a temporary vaso-constriction of the peripheral vessels allowing relatively less blood to exit the arterial circulation in comparison to the amount flowing in from the increase in Cardiac Output (Q). Together, these variables temporarily expand arterial blood volume, increase ABP, and promote a greater distribution of the blood to active muscles (Kenney, Wilmore and Costill 2012).

Prolonged, vigorous activity resulting in excessive sweating leads to a decrease in plasma volume resulting in dehydration, an increase in hemo-concentration, and a decrease in blood pressure. Under these conditions, antidiuretic hormone (ADH) is produced and then secreted by the hypothalamus. Also known as vasopressin, ADH acts on the kidneys to help retain water in an effort to dilute the hemoconcentration (Kenney, Wilmore and Costill, 2012). During acute bouts of intense anaerobic activity (e.g., weight training), Systolic blood pressure is likely to increase substantially along with a concomitant increase in diastolic blood pressure. Pressures as high as 480/350 mmHg have been recorded during maximal lifts (MacDougall, Tuxen, Sale, Moroz and Sutton, 1985). For this reason, weight training has historically been contraindicated for many people with cardiovascular disease. However, the American Heart Association has recently acknowledged the safety and potential value of strength training as a mode of therapeutic exercise if contemporary recommendations are followed (Thompson, Franklin, Balady, Blair, Corrado, Estes, Mark III, and Fulton, 2007).

Measurement of Blood Pressure

Blood pressure is measured in millimeters of mercury (mmHg.) and is written as systolic /diastolic. A sphygmomanometer is used to measure blood pressure. McGlynm (1999) provided the following steps for measuring blood pressure.

1. Have the individual sit comfortably on a chair with the left arm at heart level and supported on a table.
2. Place the air –tight blood pressure cuff on the arm just above the elbow and securely wrap it around it.
3. Place the stethoscope over the artery in the center of the elbow crease and hold it firmly.
4. Hold the bulb in your hand so that you can open and close the screw valve with one hand.
5. Close the valve and pump air into the cuff by pressing the bulb. As the cuff becomes tighter, it compresses a large artery in the arm-the brachial artery. This temporarily cuts

blood flow to the forearm. Inflate the pressure to approximately 160 to 180mmHg, as read on the pressure gauge.

6. Slowly open the screw valve, letting air escape and watch the fall on the pressure gauge.
7. Listen for the pressure of a beat or thumping sound (Korotkoff sound) and mark the pressure at which the sound was first heard. This will be the systolic pressure.
8. Continue to decrease the cuff pressure while listening for the beat sound. When the beat sound disappears, mark the pressure level and record the number as diastolic pressure.
9. Record as shown below:

Blood pressure (BP) = Systolic BP = mmHg

Diastolic BP=mmHg

Maximum Oxygen Consumption (VO_2 max) and Exercise Training

Maximal oxygen consumption (VO_2 max) is a measure of the maximum rate of oxygen consumption in the mitochondria during oxidative phosphorylation. Thus, it is the maximal capability of the oxidative energy system to produce adenosine triphosphate (ATP) during exercise. Moreover, it is a function of the capacity of the heart, lungs, and blood to transport oxygen to the working muscle and of the ability of the muscles to use oxidative phosphorylation to create ATP aerobically. The term maximal aerobic power can be synonymous with VO_2 max, indicating the maximal rate at which oxygen can be taken up, transported, and used during physical activity (Haff and Dumke, 2012). It is also defined as the largest amount of oxygen that one can utilize under the most strenuous exercise. It is considered as the best indicator of cardiovascular fitness, aerobic fitness, or exercise capacity (Baumgartner and Jackson, 1999 & Heyward, 2002).

According to Haff and Dumke (2012) the VO_2 max test is generally considered the best noninvasive measure of cardiorespiratoy fitness. It is highly correlated to maximal cardiac output and therefore provides an excellent index of the heart’s capacity to pump blood. It is not, however, considered to be a good predictor of performance in endurance events. According to McGlynn (1999) training may be a 20 percent determining factor, where as the remaining 80 percent is thought to be genetically determined. This is in agreement with Fox and Mathew, (1981). Aerobic fitness or VO_2 max is age dependent, steadily increasing during childhood and reaching a peak at about age 25, after which it slowly declines (Bosquet, Leger and Legros, 2002). The VO_2 max of women is about 80% of the men. Maximum oxygen consumption can be measured using laboratory or field tests. Direct measurement of VO_2 max is not feasible (Otinwa, 1998). This method involves the measurement of expired gases during exercise test, (Baumgartner and Jackson, 1999). The second laboratory test is to estimate $V0_2$ max from maximum power output. This test involves monitoring the heart rate and blood pressure during maximum effort, (Baumgartner and Jackson, 1999). Haff and Dumke (2012) opine that a subject VO_2 max can be influenced by several factors:

1. Heredity-25% to 50% genetic components
2. Sex- male values15% to 20% higher than female values for same population
3. Age- peak at15 to 18 years, gradual decline of about 8% per decade from 30 years on (can be counteracted by regular exercise)
4. Training status- possible 6% to 25% improvement in values with training (higher values for aerobically trained individuals)
5. Mode of exercise- outcome affected by choice of exercise

According to Amusa, Igbanugo and Toriola, (1998), the estimation of VO_2 max from heart rate is justified because the relationship between the heart rate and oxygen uptake is linear over a wide range. The laboratory methods use treadmills, bicycle ergo meter and step devices. They are not practical for testing a very large group, hence, the need for field tests.

The field tests include the distance run –walk tests. They are usually scored in two ways; it is either the time it takes to cover a specified distance of run-walk tests, as in 1 and 1.5 mile run/walk tests, or the distance covered in a fixed time as in 9 and 12 minutes run-walk tests, (Baumgartner and Jackson, 1991; Nam, 2003; Safrit and Wood, 1995 and Verducci, 1980). The 1-mile (1600m) run/walk for time or the 9-minute run/walk for distance is recommended for secondary school boys and girls (Kirkendall, Gruber and Johnson, 1987). The obtained scores may be employed in a regression equation to estimate VO_2 max.

For example, Cureton, Stoniger, Bannon, Black and McCormack (1995) formulated a generalized equation for estimating VO_2 max from 1-mile-run walk test. The equation is VO_2 max (ml/kg/min) = 108.94 - (8.41XT) + ($0.34XT^2$) + (0.21 x Age x G) – (0.84XBM1).

Where, T = time in minutes for 1-mile –run/walk test. BMI =Body Mass Index (W/H^2) and G = Gender –coded; female =0; male = 1

This equation has multiple correlation of 0.72, (Baumgartner and Jackson, 1999).

MOTOR VARIABLES AND EXERCISE TRAINING

Muscular Endurance and Training Performance

According to McGlynn (1999) muscular endurance is probably the most important components of physical fitness. It reflects the state of some of the physiological systems that are vital to the general health of an individual. He also asserted that it is the most important factor in human performance and it is a major factor in most sports and training adaptability. Lorhman (1992) defines muscular endurance as the ability or the capacity of a muscle group to perform repeated contractions against a load or sustain contraction. According to Nam (2003) muscle endurance is the ability of muscle or group of muscles to perform repeated contractions over an extended period of time. Nam (2003) also defines it as the ability of a muscle or groups of muscles to work against a moderate resistance for long periods of time.

According to Chad (2001) muscular endurance is more often associated with individual muscle groups and is specific to performance. This opinion is corroborated by the findings of Chad (2001) who compared throwers and jumpers. The throwers were found to be stronger in the arm muscles but had lowest leg muscle endurance. The male middle and long distance runners did not have stronger leg muscle than did the average men, but they had more impressive muscular endurance. These results reflect the difference in training in these groups of subjects.

The endurance of a muscle is dependent upon the following:

i. The quality of the muscles

ii. The extensiveness of their capillary beds and

iii. The nerve mechanism supplying them.

Muscular endurance is an essential component of physical fitness and its importance is highly indicated in such athletic events that use many repetitions e.g. walking, jogging, and running, skiing, and cycling. Even in weight training; the principle of lifting a load certain numbers of time through full range of motion implies isotonic muscular endurance. From the point of view of sport science, it has been shown by ACSM (2000) that people need endurance to perform well in prolonged activities. Ajidua (1990) opined that a good football team that has trained adequately for endurance stands a better chance of winning prolonged football matches.

Chado (1991) described muscular endurance as either anaerobic or aerobic. Anaerobic endurance depends on the intensity and duration of the sustained or repeated contractions, and on the metabolic pathway used. While some athletic events like distance running rely mainly on aerobic local muscular endurance, some other athletic events of short duration lasting under two minutes, may rely predominantly on anaerobic local muscle endurance. Many sports, particularly the ball games rely on both anaerobic and aerobic endurance in varying proportions to cope with the sustained level of play throughout the game. Anaerobic endurance is the ability to persist at a repeated high intensity task, for a short duration. Invariably, high intensity repeated task may rarely last beyond one minute. The rationale for categorizing this type of endurance as anaerobic should be obvious as the energy demand for this type of repeated exertion is predominantly from the anaerobic energy systems (Otinwa, 1998). Owolabi (1985) opined that anaerobic endurance may hence be called short term endurance.

Aerobic endurance on the other hand may be described as the ability to persist at a repeated task, usually of moderate to fairly heavy intensity for a long duration. This type of endurance is required in distance run lasting from two to many hours and even days. It may be referred to as long-term endurance (Owolabi; 1985).

Muscular Strength and Training Performance

Muscular strength is often equated with muscular force (Siff 2000; Stone, Stone, and Sands 2007) and can be defined as the ability of a muscle or group of muscles to produce a force against an external resistance. Canadian Fitness and Lifestyle Research Institute, CFLRI (2000) described muscular strength as the force or tension a muscle or a muscle group exert against resistance in one maximal effort. Miller (2012) defines muscular strength as the ability of a muscle or group of muscles to voluntarily produce a force or torque against an external resistance under specific conditions defined by muscle action, movement velocity, and posture. Maximal muscular strength is then the ability to voluntarily produce a maximal force or torque under specific conditions defined by muscle action, movement velocity, and posture. According to Chad (2001) muscle strength is the maximal force, which can be put forth in one maximum contraction of a few seconds in duration. Strength has also been defined as the ability of a muscle to exert force. In other words it is ability of a muscle to perform one powerful contraction to overcome a simple large resistance (Wilmore, 1994). Igbanugo (2000), defines strength as the ability of the body or its segments to apply force. Relating muscular strength to the ability of a muscle or group of muscles to produce a force highlights the importance of muscular strength in sports and clinical settings. Defining muscular strength in terms of the force capabilities of the muscles is also informative because the mechanical and physiological factors that influence force production in skeletal muscle have been determined. As a result, these factors can be considered when establishing the utility of muscular strength tests. CFLRI (2000) identified two types of muscle strength namely static or isometric strength and dynamic or isotonic strength. Static strength is that strength which is applied against a fixed non-moving resistance. Dynamic strength on the other hand involves actual movement of the involved muscles, joints and the resistance through a range of motion which is more regularly utilized on physical performance. Contractile forces of the muscles causing movement (argonists), the ability to coordinate the agonistic muscles with the antagonists, the neutralizers and the stabilizers and the mechanical ratio of the lever (bone) arrangement involved in the movement have therefore been identified as three important factors necessary for the development of muscle strength. Strength is basic to performance in athletic activities. Increase in strength results in improved performance in most sports skills, including swimming, soccer, basketball and track and field athletics (Chad 2001).

Strength training has been widely reported to increase strength endurance of the muscle (Watson, 1993). A proper understanding of how a muscle reacts to the stress imposed on it by strength training will enable the coach or athlete plan the training programme in a scientific way to achieve the objectives of the programme. Hypertrophy in human muscles due to strength training is usually evidenced by the excessive muscles seen in person who perform in sport activities, which imply engagement in heavy resistance training e.g. body builder, weightlifter, javelin and discus throwers, short putters etc. However, it is still under dispute to what extent the large muscles of these persons are due to training on one hand and to hereditary factors on the other (Prentice 1994).

Kaidal and Chado (1991) opined that even though nearly all movements are performed against some resistance, athletes perform movements against much greater resistance than usual. For example in the shot put, discus throw, pole vault, various gymnastic movements, jumping, running, swimming and leaping, the body segments must exert maximal-force. If all these remain equal, greater strength often results in better performance than normal. In some athletic events, strength is the primary contributor and is therefore fundamental to excellence in this event. In addition to its importance in athletic performance, muscular strength also plays an important role in protecting athletes from injury. Strong muscle enables an athlete to move quickly and avoid accident and they also increase joint stability. In addition to overall strength of the muscles whose tendons cross over the joint, one also must be concerned about the relative strength of the opposing muscle groups (antagonists). There is substantial evidence to support the idea, a knee joint is more prone to injury when there is an unbalance of strength in either group (Kaidal and Chado 1991), for muscle strength to increase rapidly, muscles must be contracted against heavy resistance and must be increased as the muscle become stronger. In other words, the muscles are overloaded, meaning they are loaded beyond their normal requirements and progressive resistance is applied meaning that as the muscle become stronger they are worked against correspondingly greater resistance.

It has however been demonstrated that endurance exercise does not ordinarily increase skeletal muscle strength and size as does high resistance exercise such as weight training (Pollock and Wilmore 1994). Muscular strength is considered to be a very important health related component of physical fitness because a minimum level of strength is require by every individual which becomes detrimental to health anytime a lower level is maintained. Muscular strength is certainly necessary for satisfactory performance in athletic events and in everyday human activities. A developed muscular strength is also required to help prevent low back pain and excessive spinal curvature that lead to discomfort (Amusa and Abass 1995). Also they went further to say that since strength is relative to specific areas of the body and to ability in skill performance, people will always strive to improve on their strength not only for the sake of achieving pleasing appearance but also for the purpose of avoiding unnecessary pathological or health problems.

Muscular strength could be evaluated in many ways. For example strength could be measured statically or dynamically using the back and leg dynamometer, hand grip dynamometer, and cable tensiometer (Amusa and Abass, 1995). According to Kaidal and Chado (1991) dynamic strength could also be measured using maximum lifts with weight training equipment and also using movement against one’s body weight such as pull ups, sit ups and flexed arm hang. It was however noted that these tests does not measure pure strength but a combination of strength and endurance. According to them, any test calling for repetitions of movements (such as a maximum number of pull ups) combines strength with endurance. Wilmore and Costil (1994) reported a mean range performance of 8.36 to 29.75 and also 7.74 to 27.66 for right and left hand grip strength of college students.

Factors Affecting Muscular Force Production

The factors that affect force production in skeletal muscle include contraction type, muscle fiber type, contractile history, and neural influences.

Contractile Type

A muscle can develop force under either static conditions (muscle length remains constant) or dynamic conditions (muscle length changes). When the force is developed and muscle length remains constant, the muscle is said to be performing an isometric contraction. Under dynamic conditions, the muscle can contract eccentrically (i.e., force is developed as the muscle lengthens) or concentrically (i.e., force is developed as the muscle shortens). Recently, muscle physiologists have asserted that the terms eccentric and concentric are inappropriate and misleading (Faulkner, 2003). A special case of a dynamic muscle contraction is an isokinetic contraction. Here, force is developed with the muscle acting either eccentrically or concentrically, but the velocity of the contraction apparently remains constant.

It should be noted that although the type of contraction performed by a muscle may be obvious in vitro, the distinction is not always clear in vivo. For example, previous research by Reeves and Narici (2003) have shown that muscle behaviour does not necessarily correspond to joint movement because of the presence of extensible tendons operating in series with the muscle. Specifically, when a joint is accelerated into extension and the muscle crossing the joint are assumed to be operating eccentrically, as isometric contraction may be performed while the tendon is stretched. Such issues may affect the external validity of a test of muscular strength.

It has been established that the force developed by a muscle while operating isometrically depends upon muscle length (Rassier, Maclntosh, and Herzog, 1999). This force-length relationship is essentially due to changes in overlap of the myofilaments (shallow ascending limb, plateau, and descending limb) and the thick filaments abutting the Z-disks (steep ascending limb). The practical significance of this relationship is that the expression of muscular strength will vary with muscle length, which in turn will vary with the joint angle selected during the specific test of strength. Although the force-length relationship can be used to describe the force developed under isometric conditions, this relationship cannot be used to describe the behaviour of muscle contracting dynamically. Rather, the force-velocity relationship describes the force developed by a muscle when contracting eccentrically or concentrically. The precipitous drop in force development as the shortening velocity increases can be explained in terms of chemical reaction rates associated with actomyosin cycling as described by the cross- bridge theory of muscle contraction (Lieber, 2002). The rise in force associated with eccentric muscle contractions cannot readily be explained by the original cross-bridge theory; some authors propose sarcomere inhomogeneities as an explanation (Harry, Ward, Heglung, Morgan and McMahon 1990; Morgan, 1990).

Researchers have demonstrated that the force developed during a concentric contraction can be enhanced when it is preceded by an eccentric contraction (Finni, Ikegawa, and komi, 2001). This sequencing of concentric and eccentric muscle contractions is termed the stretch-shortening cycle (SSC) and has been shown to enhance concentric force development through mechanisms including elastic energy contributions, reflex activation, and architectural changes (Komi, 2003). Because the SSC is a naturally occurring sequence of muscle contractions used in sporting and daily activities, its inclusion in a test of muscular strength will influence the validity of the test.

Muscle Architecture

The architecture characteristics that can affect the expression of muscular strength are the cross-sectional area of the muscle and the pennation angle.

Cross-Sectional Area.

The cross-sectional area (CSA) of a muscle is related to the number of sarcomeres in parallel. Because this number affects the muscle’s ability to develop force, greater CSA is associated with greater force production (McComas, 1996). Thus, hypertrophy of a muscle is a way to increase force capabilities. Despite the importance of CSA to the force capabilities of muscles, fibers operate at an angle to the line of action of the muscle (e.g, rectus femoris). In such situations, the physiological cross- sectional area should be calculated (Leiber, 2002), whereby the angle between the orientation of the fascicles and the line of action of the muscular force, the pennation angle, is considered.

Pennation Angle

The pennation angle, defined as the angle between the orientation of the fascicles and the line of action of muscular force, can have a significant effect on muscular force – a greater pennation angle indicate greater force capabilities (Ichinose Kanchisa, Ito, Kawakami and Fukunaga, 1998). with more fibers packed into a given volume of muscles. Researchers have reported significant positive correlation between muscle thickness and pennation angles (Ichinose et al. 1998; Kawakami, Abe, and Fukunaga, 1993), suggesting that increases in pennation angle may contribute to muscle hypertrophy. Because the pennation angle of a muscle can change depending on the joint angle (Kawakami, Ichinose, Kubo, Ito, Imai and Fukunaga, 2000), the force capability of a muscle will likely be affected by the joint angle selected in a given strength test.

Muscle Fiber Type.

Skeletal muscle is composed of fibers that differ in terms of their contractile properties. The type of myosin heavy chain (MHC) isoform (of which types I, IIa, and IIx are found in human skeletal muscle) is used to classify muscle fiber types (Baldwin and Haddad, 2001).Research with muscle fibers in vitro has revealed that MHC type IIx fibers have greater specific tension than MHC type one fibers (Stienen, Kiers, Bottinelli and Reggiani, 1996). Researchers have found positive correlations between MHC type II percentage and muscular strength (Aagaard and Anderson, 1998).Conversely, type1fibre have a greater oxidative capacity and therefore have greater endurance capabilities (Bottinelli and Reggiani, 2000)

Contractile History

Prior muscular contractions can have a significant effect on the ability of a muscle to develop force through fatigue and post activation potentiation mechanisms.

Fatigue

Fatigue can be defined as a reversible decline in muscle performance associated with muscle activities and is marked by a progressive reduction in the force developed by a muscle (Allen, Lamb, and Westerblad, 2008). The reduction in force may not be as pronounced during submaximal contractions as it is during maximal contractions, during which fatigue manifests as an inability to maintain the activity at the required intensity (Allen, Lamb, and Westerblad, 2008). Muscle fibers expressing a high proportion of MHC type 1 are better able to resist fatigue during repeated contractions (Bottinelli and Reggiani, 2000). Although the mechanisms behind fatigue are complex and specific to task (Maclntosh, Gardiner, and McComas, 2006) it is clear that the completion of prior muscular contractions can have a significant effect on the expression of muscular strength.

It is important to note that the fatigue is not just an acute phenomenon that occurs immediately following muscular contractions, dissipating rapidly to restore muscle function; the depression in force following muscular contractions could last days, especially when the movements involve the SSC (Nicol, Avela and Komi 2006; Stewart, Duhamel, Rich, Tupling and Green, 2008). Therefore, both the short-and long-term effects of prior muscular contractions on muscular force should be considered when measuring muscular strength.

Post activation Potentiation

Research has shown that performing maximal or near-maximal muscular contractions can produce short-term increases in the maximal force produced by the stimulated muscles in a phenomenon known as post activation potentiation (PAP) (Hodgson, Docherty, and Robbins, 2005). The mechanical specificity between the exercise used to induce PAP and the performance exercise appears to confer a substantial influence on the efficacy of the PAP effect (Hodgson, Docherty and Robbins, 2005). Although mechanisms responsible for the PAP effect are not completely clear (Robbins, 2005). PAP represents a method to potentially increase the expression of muscular strength in the short-term.

Neural Influences on Muscular Strength.

Up to this point, consideration has only been given to the mechanical variables associated with isolated skeletal muscle or groups of muscles and how force production is affected. However during muscular efforts by the intact motor system, the central nervous system has a profound effect on the expression of muscular strength. Increasing the number of motor units recruited during a voluntary contraction can increase the magnitude of muscular force, while increasing the rate at which the motor neurons discharge action potentials (rate coding) will have a similar effect (Duchateau, Semmlar, and Enoka, 2006).The force at which the voluntary recruitment of motor unit is complete differs among muscles (Moritz, Barry, Pascoe and Enoka, 2005; Oya, Rick, and Creswell 2009).

An understanding of neural influences on the expression of strength has led to the developments of methods to augment muscular strength, For example superimposition of an electrical stimulus during a maximal voluntary muscular contraction has been shown to increase the magnitude of the force developed (Paillard, Noe, Passelergue and Dupui, 2005). This has led some authors to distinguish between voluntary muscular strength and absolute (Superimposed stimulation) muscular strength (Zatsiorsky, 1995). Although such superimposition methods have been used to test the strength of isolated muscles or the activity of muscles acting across a single joint, their utility with complex, multijoints movements such as those experienced in sport and daily activities have been questioned on both practical and safety grounds (Stone, Stone, and Sands, 2007).

As previously stated, the expression of muscular strength in a given test is likely to result from the interaction of the force developed by groups of muscles. A simplified representation of a joint served by an antagonistic pair of muscles shows that the force associated with the contraction of the agonist is influenced by the activity of the antagonist. Therefore, the net force developed during a given movement depends on the degree of coactivation between the antagonistic pair of muscles acting across a joint. Researchers have shown that athletes exhibit less coactivation during muscular strength tests than sedentary people do (Amiridis, Martin, Morlon, Martin, Cometti, Pousson and VanHoecke, 1996), which may partly explain the greater strength values recorded for well- trained subjects. The activation of motor units during a task has been shown to be affected by the orientation of the body segments and the direction of force applied during a given movement (Brown, Kautz, and Dairaghi, 1996). This implies that the expression of muscular strength is influenced by posture.

Joint Torque.

The motion of body segments is the result of torques acting at joints as opposed to muscular forces alone. In a strictly mechanical sense, a torque involves pure rotation and so the correct mechanical terminology refers to the moment of a force, or simply the moment, acting at a joint (Chapman, 2008). A torque is the rotational effect of force acting on a body that is constrained to rotate about a fixed axis. It is important to recognize that joint motion in vivo rarely results from the torque produced by a single muscle. Rather, a number of muscles operate simultaneously, each of which has unique mechanical characteristics (e.g. fiber type, architecture, moment arms). Therefore, the expression of strength in a given test will result from the interaction of mechanical properties associated with groups of activated muscles.

Specificity of Muscular Strength

It should be apparent that the expression of muscular strength is specific to the test employed based on the mechanical and physiological factors affecting muscular strength. Therefore, fitness professionals should consider the movement characteristics of any strength test used; the movement should be similar to the performance of interest with respect to the following mechanical factors (Siff 2000; Stone, Stone, and Sands, 2007):

Movement Pattern

1. Complexity of movement: This involves such factors as single versus multijoint movements.
2. Postural factors: The posture adopted in a given movement dictates the activation of the muscles responsible for force production.
3. Range of motion and regions of accentuated force production: During typical movements, the range of motion at a joint will change as will the associated muscular forces and torques. Such information can be gathered from a biomechanical analysis of the movement.
4. Muscle actions: This concerns the performance of concentric, eccentric, or isometric muscle contractions. As mentioned previously, such information is not always intuitive and may not be identifiable from observing the joint motion associated with the movement.

Force Magnitude (Peak and Mean Force)

Force magnitude refers to joint torques as well as ground reaction forces (GRF) during the movement. This information is garnered from biomechanical analyses.

Rate of Force Development (Peak and Mean Force)

Rate of force development refers to the rate at which a joint torque or the GRF is developed.

Acceleration and Velocity Parameters

Usually, in sporting and everyday movements, both velocity and acceleration characteristics change throughout the movement. Velocity is defined as the rate at which the position of a body per unit of time, whereas acceleration refers to the rate at which the velocity changes per unit of time. Given Newton's second law of motion ($a= F/m$), the greatest accelerations are observed when the net forces acting on the body are largest. However, the greatest velocities will not coincide with the largest accelerations and, therefore, the largest net forces (unless the person is moving in a dense fluid such as water).

Ballistic Versus Nonballistic Movements

Ballistic movements are those in which motion results from an initial impulse from a muscular contraction, followed by the relaxation of the muscle. The motion of the body continues as a result of the momentum that it possesses from the initial impulse (this is the impulse-momentum relationship). This is in contrast to nonballistic movements, in which muscular contraction is constant throughout the movement. These categories of movements involve different mechanisms of nervous control (Miller, 2012). The type of equipment used for muscular strength tests has significant implications. For example, some tests of muscular strength can be performed using either machine weights, in which the movement is constrained to follow a fixed path, or free weights, in which the movement is relatively unconstrained. However, a test performed with machine weights will not necessarily produce the same outcome as the same test performed with free weights. Cotterman, Darby and Skelly (2005) reported that the values recorded for measures of maximal muscular strength were different during both the squat and bench press movements when the exercises were performed in a smith machine compared to when they were performed with free weights. Testing muscular strength with different types of equipment introduces significant systematic bias into the data and therefore severely compromises the reliability of the measures as well as the external validity.

Warm-Up Considerations

A warm-up is often performed prior to exercise to optimize performance and reduce the risk of injury (Bishop, 2003). The force capabilities of a muscle can be affected by the completion of previous contractions, resulting in either a decrease in force (fatigue) or an increase in force (PAP). Indeed, both fatigue and PAP are proposed to exist at opposite ends of a continuum of skeletal muscle contraction (Rassier, 2000). Therefore, exercises performed as part of an active warm-up could significantly alter the expression of muscular strength during the test. An increase in the temperature of the working muscles has been reported following both passive (e.g. external heating) and active (e.g. engaging in specific exercises) warm-up activities (Bishop 2003).

Static stretches are often included in the warm-up routines of athletes. Researchers have reported a reduction in force during maximal voluntary contractions following an acute bout of static stretches (Behm, Button, and Butt 2001; Kokkonen, Nelson, and Cornwell, 1998), leading some to propose that static stretches be excluded from warm-up routines prior to strength and power performances (Young and Behm, 2002). However, Rubini, Costa and Gomes (2007) recently noted methodological issues with many of the static stretching studies, concluding that an interference with muscular strength is usually observed following a stretching protocol in which many exercises are held for relatively long durations, which runs counter to common practice. Therefore, including static stretches in a warm-up routine prior to muscular strength testing may be permissible, as long as the total stretch duration is not excessive (four sets of exercises for each muscle group with 10-30 seconds stretch duration is recommended) and that the exercises are performed consistently during subsequent testing sessions.

Clearly, the warm-up performed prior to a strength test can have a significant influence on the expression of muscular strength, and so the examiner should give the warm-up due consideration. However, the most important factor associated with the warm-up would appear to be the consistency of the exercises incorporated; any alteration in the exercises performed will compromise the validity and reliability of the test (Miller, 2012). Jeffreys (2008) outlined the following warm-up protocols:

General warm-up: Five to 10 minutes of low- intensity activity aimed at increasing heart rate, blood flow, deep muscle temperature, and respiration rate.

Specific warm-up: Eight to 12 minutes of performing dynamic stretches incorporating movements that work through the range of motion required in the subsequent performance. This period is followed by gradually increasing the intensity of the movement-specific dynamic exercises.

Timing and Order of Tests

Researchers have reported that the expression of strength under both isometric and isokinetic conditions is affected by the time of day the tests are taken, with greater strength values being recorded in the early evening (Guette, Gondin, and Martin, 2005; Nicolas, Gauthier, Bessot, Moussay and Davenne, 2005). Although the mechanisms behind this diurnal effect are unclear, the implication is that examiners need to consider the time of day when administering strength tests and to ensure consistency when administering the test during future sessions.

A test of muscular strength may be one of a number of tests performed on a person. In this case, the fitness professional needs to consider where to place the muscular strength test in the battery. This consideration is important given the effect that contractile history can have on the expression of muscular strength. Harman (2008) proposed the following order for tests in a battery based on energy system requirements and the skill or coordination demands of the tests:

Non-fatiguing tests (anthropometric measurements)

Agility tests

Maximum power and strength tests

Sprint tests

Muscular endurance tests

Fatiguing anaerobic tests

Aerobic capacity tests

Following this order should maximize the reliability of each test.

Speed and Training Performance

Speed is an important factor in almost all court and field games and it can make the difference in whether a performer is able to gain advantage over his opponent or not. Speed can be defined as the velocity of body, body parts or an object, that is, it is the rate of motion. It is concerned with the time required to move or swim a given distance (Heyward, 2002). Hockey (1993) defined speed as the quickness with which one is able to move his body from one point to another. According to Wilmore and Costil (1994) speed is the rate of motion or the velocity of the body or any of its parts. Hands and Larkin (1997) opined that speed tells how fast an object is moving, the distance an object will travel in a given time, but it tells nothing about the direction of movement. Speed is basically a result of applying force to mass.

In the case of human movements, the body or segments of it, represents the mass, and the muscle contraction represents the force. Speed is an important factor in almost all court and field games and which can make the difference in whether a performer is able to gain an advantage over his opponent or not (Kaidal and Chado, 1991). The speed of body movement is of paramount importance in soccer excellence. Players are required most of the time to sprint to receive or connect passes or to overtake an opponent who is through of course, during counter attack in soccer, speed is required to change the pace of the game and to catch opponents off their guard. Thus, it follows that every soccer players should be capable of generating high speed at will and when needed (Igbanugo, 1987). Basketball too needs to chase bail and opponents around and to burst out towards the basket during fast breaks and during defensive phases. Fast connection and acceleration can enable a player to compete better against an opponent in all phases of play.

Similar example of the importance of acceleration speed manifests in such games as handball, tennis and badminton. Safrit and Wood (1995) stated that speed differs from endurance in that, it requires the expenditure of an enormous amount of energy in a short time and is specific to the area developed. This requires performance of extremely short duration such as a swim sprint, a 100 meters dash or a rope climb. Daniel (1998) was of the opinion that strength and speed are closely related and is difficult to separate in sprinting. However, improvement of a sprinter's absolute strength does automatically result in an increase in running speed. A training programme to develop speed must concentrate on the area being developed. It can be that of general body or that of isolated limbs or body segments. Speed is dependent on strengths reaction time and flexibility. A lot of studies in physical education and other fields have been conducted to investigate the various facets of speed as a performance factor in sports. Kaidal and Chado (1991) identified two different forms of speed.

1. **Speed of Movement of Body Parts**

Speed of movement is highly specific to areas of the body. An individual with fast arm movements may have slow leg movements. We may for instance speak of a fast runner, but cannot justify in assuming that the same individual can bowl a cricket ball. This obviously calls for specificity in selection and training, if fast arm movement is required, training must involve activities that are designed to increase speed of the arms. Such drills must be repeated until the required skills are learned (Igbanugo, 1987).

2. **Running Speed**

Running speed can be discussed in term of two factors: reaction time and rate of acceleration. Reaction time is the interval between a stimulus and initiation of a movement. It depends upon the length of the neural loop between the receptor organ and the responding muscles, together with delays incurred in the central processing of information. If under-aroused it may respond sluggishly, if over-aroused, the impulse corresponding to the starter's signal will be delayed by the processing of irrelevant materials. Prentice (1997) reported that reaction time in specific movement will improve as a result of extensive practice. Rate of acceleration will depends upon the relationship between the inertia of the body or body parts and the explosive force developed by the driving muscles. Inertia is proportional to mass. This explains why it is difficult for a heavily built person to accelerate to maximum speed (Igbanugo, 1987). Age has been recognized as a factor that can largely influence speed of performance. Demiche, Pollock and Graves (1997) opined that age is one of the factors to be considered for speed attainment. At about 20 years, an individual is said to attain his peak in speed.

Foss and Keteyian (1998) stated that speed is measured from the initiation of stimulus such as the starter's gun until the athlete crosses the finish line. Generally, speed has been measured by short distance/dashes and tests of speed are not only relatively easy to perform but also tend to motivate most people favourably (Heyward 2002). He said further that proper distance must be chosen for the tests in order to minimize the influences of other physical fitness factors such as muscle power or explosive strength and endurance.

However, distances over 100 meters are usually not recommend. Age, sex and characteristics of the subjects should be the major consideration in selecting tests of speed. Tests of speed include the 50-yard dash and 100 yard dash (Heyward 2002).

Flexibility and Training Performance

Flexibility has been recognized as one of the components of physical fitness needed for normal body functioning regardless of whether the individual is an athlete or not. Hockey (1993) defined flexibility as a functional capacity of the joints to move through a full range of motion. Jensen and Fisher (1984) opined that flexibility which is expressed by the range of motion in a given joint is influenced by three factors.

1. The bone and ligament structure of the joint
2. The amount of buck surrounding the joint and
3. The extensibility of muscles whose tendons cross the joint.

The third factor is said to be a great importance to those seeking to increase flexibility. Flexibility is not a general factor in performance. Every individual is flexible in one part of the body or the other but, the difference lies in the magnitude. An individual should aim at possessing free range of motion at the joint because in most sports and physical activities, flexibility as an important component of performance often serves to prevent serious muscular injury (Amusa and Abass 1995). There are two types of flexibility, dynamic and static. Static flexibility is defined as the range of motion that occurs in a joint when the muscles are relaxed. In certain types of sports like gymnastics, extreme static flexibility is very important. Dynamic flexibility is the range of motion that occurs in a joint as a result of contractions of the muscles, which controls the joint. This type of flexibility is of greater concern in performance. It is essentially the inverse of viscosity and is an important determinant of other factors of athletic performance like speed (Watson 1993). Flexibility can be increased by using either ballistic (bobbing) as slow-tension (static stretching) exercise. The slow-tension exercise is preferred because these is less danger of exceeding the limits of extensibility of the tissues, which can cause injury and soreness; the method does not activate the stretch reflex and it provides the opportunity to relax the antagonistic muscles consciously and allow them to stretch (Watson 1993; Kaidal and Chado 1991).

Amusa and Abass (1995) opined that there is no set standard as to the amount of flexibility a person should possess because we all engage in different activities, which requires different degree of flexibility. Whereas activities like jogging and ball games may require normal or average flexibility, activities like gymnastics, diving, hurdling, modern dance and ballet require great flexibility in order to demonstrate good form. There are many ways by which the range of motion at the different joint of the body could be evaluated. Commonly used tests include (i) sit and reach test (ii) trunk extension (iii) shoulder lift test and (iv) standing and reach test (Amusa and Abass 1995). Wilmore and Costil (1994) in a sit up test administered on college women reported a range of performance between 7cm and 28cm.

Agility and Training Performance

Agility is an important physical fitness component in many sports. Agile individuals can change body position in space efficiently and easily (Watson, 1993). Agility is often represented by the term “maneuver ability” “mobility” and “shiftness” which is the ability to shift the direction of movement rapidly without loss of balance or sense of position (Wilmore and Costil, 1994). It is defined by Jackson and Ross, (1997) as the ability to change direction of the body and its parts rapidly. According to Watson, (1993), agility is generally considered as one’s ability to change direction with minimum loss of speed. It is the maneuverability of the body and its parts with accuracy. In the opinion of Nam (2003), agility is an elusive construct which integrates larger movement of the body being controlled by coordinative abilities. Agility is the combination of several athletic traits including strength, reaction time, and speed of movement, power and coordination. Agility is demonstrated in such movements as dodging, zigzag running, stopping and starting and changing body positions quickly. Strength contributes to agility because adequate strength is required to control the weight of the body against the force of inertia and to maneuver the body and its parts rapidly.

Prentice (1997) observed that the shuttle run which is a commonly used test of agility was highly loaded in the explosive strength or power factor. Since coordination implies the ability to combine separate movements, it is also expect to influence agility. Agility thus may be seen as the ability for fast coordinated movements (Owolabi, 1985). Owolabi (1985) however submitted that agility may be inversely related to body weight. There are speculations that agility may be genetic but researchers (Chado, 1991 and Chad, 2002) have demonstrated that it can be improved with practice and training. Since reaction time, movement time, strength and coordination of the large muscles are important aspects, practice and training in activities that will improve these factors will also improve agility.

Agility is both general and specific. Every sport requires agility though it varies in degree. Practically, all court games such as basketball, handball, volleyball, badminton, field games, soccer, and hockey, security agency such as Police Force, Army, Navy and Air force require agility to a large degree. However, in the majority of activities, performance will improve with increased agility (Kaidal and Chado 1991). Of all the several athletic traits that make up agility, coordination is by far the important components of agility. Therefore great emphasis should be placed on developing coordination in the movement patterns essentials to the given performance.

Factors Guiding Exercise Training

Physiological profiles can be developed by many exercise programmes, especially aerobic or cardio respiratory exercise programmes, (AAO, 2002; Balbach, 2000; Chad 2002 and Heyward, 2002). Regular physical activity and exercise are critical elements of health promotion. It is a behaviour that should be learned from childhood because much adulthood physical inactivity has its root in childhood. During adolescence, physical activities decline dramatically, (Baumgartner & Jackson, 1999). In designing a development exercise programme, certain factors must be considered. Chad, (2001) mentioned that every cardio vascular exercise should start with a good warm-up and end with a cool down. A good warm-up should be done for at least 5 to 10 minutes at low intensity. It is usually done by doing the same activity as the aerobic workout but at an intensity of 50 -60% of maximum heart rate (max HR). After 5-10 minutes warm up at a relatively low intensity, the primary muscles used in the warm-up should be stretched before proceeding to the aerobic exercise, (AAO, 2002, Balbach, 2000; Getchell, 1983 and Mc Glynn, 1999). The cool down follows the exercise bout. It is not good to stop suddenly at the end of exercise training. This is because the body is still sending extra blood to the muscles. Stopping suddenly can lead to muscle cramping and dizziness. This is why there should be a cool down at the end of the aerobic section, (Balbach, 2002). This tapering off period can be made up of activities as slow jogging, walking and stretching the major muscle groups, (Getchell, 1983).

For maximum effectiveness and safety in the use of exercise in developing physiological profiles, specific instruction on the following factors should be considered. These factors are intensity, duration, frequency and mode of exercise, (American College of Sports Medicine, (ACSM) 1990; 1999 and 2000).

Frequency of Exercise

This is the first component of aerobic exercise, (Chad, 2001) which refers to the number of exercise sessions per week (Watson, 1993). To develop both cardiovascular fitness and to decrease body fat (physiological profiles) or to maintain body fat at optimal levels, aerobic exercise should be performed at least three days a week, (Chad, 2001). Several studies (Shephard, 1991; Verducci, F. M., 1980) cited by Watson, (1993) have found that training for only one day per week produced no improvement in aerobic fitness. The American College of Sports and Medicine, (ACSM, 1990; 1999 and 2000), recommended that training should be done three to five days a week. It is important to allow twenty-four to forty-eight hours for rest and recovery between exercise bouts, (Mc Glynn, 1999).

Pollock and Wilmore, (1994) reported the result of a study on aerobic capacity involving two groups of men trained for either 3 or 5 days per week for eight weeks. The findings showed that the 5 days per week group showed more improvement than the 3 days group. In an attempt to equalize training effects, the 3 -day's group continued to train for another 5 weeks.

The distribution of training session in the week (placement) can be Monday, Tuesday and Wednesday or Monday, Wednesday and Friday. Study has shown that gains were as great when training took place on consecutive days as when it occurred on Monday, Wednesday and Friday, (Watson, 1993).

Intensity of Exercise

This is the level of physiological stress on the body during exercise, (McGlynn, 1999). It refers to how vigorous an exercise must be in order to contribute toward the development of aerobic fitness, (Hockey, 1993). It is an important consideration in exercise training. It is usually quantified in terms of the percentage of VO_2 max or HR Max, (Chado, 1991 and Watson, 1993). The VO_2 max is the most recommended because it is related to the amount of energy utilization, but it is very difficult to measure and equipment needed are expensive, (Chado, 1991). The %HR max is much easier to measure in a practical training situation, (Watson, 1993). Chado (1991) found that the percentage of heart rate reserve (HRR), used during exercise was highly related to the percentage of VO_2 max (HRR=max HR-RHR). The recommended intensity for aerobic fitness is 60 to 80% max HR, (AAO, 2002; ACSM 2000; Balbach, 2002 and Chad, 2001). An increase in heart rate equal to 75 percent of the heart rate reserve is safe and reasonable intensity for participants, (Getchell, 1983). The formula below is followed to calculate this training heart rate (THR).

THR (75% max HR) = (Max HR-RHR X 0.75) + RHR. For most young adults, this intensity means a training heart rate in the range of 150 to 170b/min; (Getchell, 1983).

Duration of Exercise

This is a factor that can make or mar an exercise training programme. It refers to the length of each training session, (Chad, 2001 and Watson, 1993). According to Pollock and Wilmore, (1994), improvement in aerobic capacity is directly related to duration of exercise. They reported improvement in aerobic fitness after 6 to 10 sessions, each lasting only 5 to 10 minutes. Earlier studies, (Watson, 1993), found that greater gains occurred during 20 to 30 minutes periods of work than from 10 minute period. The American College of Sports Medicine recommended a minimum of 10 minutes per session, (ACSM, 1990). Other authorities have recommended a period of 20 to 60 minuets per sessions, (AAO, 2002; Balbach, 2002; Chad, 2001 Mc Glynn, 1999). Hockey (1993) recommended that less than 20 years old should have a warm-up (5-10min); aerobic session (20 – 30 min) and cool down (5-10 min).

Mode of Exercise

This refers to the type of activity that is used to achieve the desire outcome. The types of exercise that belong to the aerobic exercise include vigorous, continuous and rhythmic activities that use the large muscle groups (Getchell, 1983 and Balbach, 2002). These activities include aerobic dance, walking, biking, jogging, running, swimming, roping, canoeing, stair climbing, rowing and other activities of long duration, yet low in intensity (AAO, 2002; Balbach, 2000; Getchell, 1983; Heyward, 2002 and Hockey, 1993). Football, soccer, volley ball, golf, weight lifting, bowing, gymnastics and tennis are anaerobic activities (Balbach, 2002) or poor aerobic activities (Hockey, 1993).

CHAPTER THREE

METHODOLOGY

The research methodology used in this study was discussed under the following headings:

1. Research design
2. Population
3. Sample and Sampling Technique
4. Research Instruments
5. Validity of the instrument
6. Reliability of the instruments
7. Research schedule
8. Procedure for data collection
9. Procedure for Training programme
10. Pilot Study
11. Procedure for Data Analysis

Research Design

The randomized pretest-posttest control group research design was used for this study. The study was an experimental study in which participants were randomly assigned to experimental and control groups. The first group was exposed to aerobic exercise training while the second received progressive resistance exercise training programme. The two experimental groups and control group were given pretest and posttest evaluation. The control group received lecture on the importance of physical exercises. The random assignment to the treatment and control groups was to satisfy the condition of homogeneity of groups at entry. This is regarded as an important step in any experimental study, if actually the observed differences at the end of the treatment are to be attributed to the treatment. The combination of random assignment and the presence of a pretest and control group serve to control all the threats to internal validity (Bryman, 2001; Thomas & Nelson, 2001).

	PRE	X	POST (Experimental)
R	PRE	X	POST (Experimental)
	PRE	X	POST (Control)

Population

The population for this study consisted of all in-school adolescent male and female secondary school students with hearing impairment in Ibadan metropolis.

Table 3.1: Tabular Presentation of the Population

Class	Methodist Grammar School Bodija, Ibadan		Ijokodo High School Poly Road, Ibadan.		Total
	Male	Female	Male	Female	
JS 1	09	06	07	09	31
JS 2	10	12	10	07	39
JS 3	11	10	08	07	36
SS 1	09	07	07	08	31
SS 2	07	06	08	07	28
Total	46	41	40	38	165

Sample and Sampling Technique

The sample for this study was one hundred and twenty (120) sedentary adolescent secondary school students with hearing impairment who volunteered themselves for this study. The volunteers came from two public secondary schools for hearing impairment within Ibadan. Purposive sampling technique was used to select all the participants because of their peculiar characteristics. Volunteers whose degree of hearing loss falls between 60 to 90dB and above were used for this study. The participants were screened with audiometer to determine their degree of hearing loss.

There were sixty volunteers (30 males and 30 females) from each of the two secondary schools. The one hundred and twenty participants were randomly assigned to experimental and control groups with the use of table of random numbers. The first 10 volunteers in each sex from each school were put in the control group while the second and the third 20 volunteers were assigned to each of the experimental groups. Therefore, each of the three groups were made up of 40 participants (20 boys and 20 girls) to give the sample size of 120 participants

Table two below shows how the participants were assigned.

Table 3.2: Illustration of Participants Assignment Based on School and Gender

SCHOOL	GENDER	EXPERIMENTAL GROUPS		Control Group	TOTAL
		X1 Aerobic	X2 Anaerobic		
Methodist Grammar School, Bodija, Ibadan	MALE	20	-	10	30
	FEMALE	20	-	10	30
Ijokodo High School, Poly Road, Ibadan	MALE	-	20	10	30
	FEMALE	-	20	10	30
TOTAL	120	40	40	40	120

Note: X1= Aerobic Group

X2= Anaerobic Group

Research Instrument

The following instruments were used for data collection.

1. **Sphygmomanometer:** The sphygmomanometer manufactured by the Med. Laboratory, England was used in conjunction with the stethoscope to measure systolic and diastolic blood pressures.
2. **Stethoscope:** The liftman's stethoscope made in the United States of America (U.S.A.) was used to measure heart rate and blood pressure profiles of the participants.
3. **Weighing Scale:** Hana portable weight measuring scale (RA9012) made in England was used to measure the weight of the participants in kilogram (kg)
4. **Stop Watch:** The track star jewels digital stop watch made in Switzerland was used in timing the participants' heart rate and related exercise measurement.
5. **Height scale:** This was used to measure subjects' height.
6. **Four hundred meter (400m) Track:** This was used for 1 mile run/walk test.
7. **Hand Grip Dynamometer:** Takie Physical Fitness Test Grip-D, Grip Strength Dynamometer T.K.K. 5401 Grip-D, Takie Scientific Instruments Co. LTD, Japan. It is calibrated from 0-100kg**.**

8. **Whistle:** The champion whistle made in China was used to start run/walk events.
9. **Measuring tape:** A 50 meters length measuring tape was used for 50-yards sprint test and Illinois agility run course.
10. **Flex Box:** A calibrated flexometer box was used for measuring trunk flexibility of participants.
11. **Audiometer:** The Amplivos screening audiometer model 116 made by Sonic Innovations software Japan was used to measure the degree of hearing loss.

Validity of the Instruments

Validity is the ability of a tool to measure what it is designed to measure (Brymen, 2001 and Thomas and Nelson, 2001). The greater the degree of validity of any instrument, the higher the confidence of the researcher about his or her result. The instruments for this study are validated and standardized instruments. However, the researcher and his supervisor cross checked the calibration of each instrument to ensure that they are in proper working condition before usage.

Reliability of the Instrument

Reliability refers to the degree of consistency between two sets of scores (or observations) obtained with the same instrument or equivalent forms of the instrument. Watson, (1993) recorded a reliability coefficient of 0.96 for the weighing scale. Safrit and Wood (1995) recorded a reliability coefficient 0.99 for the height meter scale. The test-retest reliability co-efficient for agility is .93 for male and .80 for female (Johnson and Nelson, 1979). Baumagartner and Jackson (1999) also recorded Pearson Product Moment Correlation Co-efficient ranging from .89 to.97 for sphygmomanometer.

Research Schedule

The following research schedule were followed in this study

Test Location

The playing grounds of Methodist Grammar School, Bodija and Ijokodo High School Polytechnic road, Ibadan served as the test location for this study. The participants for the study were selected from these two schools.

Procedure for Data Collection

All the tests were carried out by the researcher with the help of 6 trained research assist ants. They helped to record, observe and time the participants. Two sign language teachers were among the research assistants. Data were collected in the following order.

1. **Age:** The age of the participants was recorded in years to the nearest birthday.
2. **Height:** The heights of the participants were measured using a calibrated wall. The participants were asked to take off their shoes and stand erect on the flat base of the height meter, feet put together with heels, buttock and rear of the head in contact with the height meter while looking straight ahead. The height was measured to the nearest 0.5cm.
3. **Weight:** The participants weight was measured with Hana bathroom scale (model no BR 9011). Each participants was weighed while in light sports dress and without foot wears nor caps. Measurements were made to the nearest 0.5kg.
4. **Heart rate:** The resting heart rate value was obtained using stethoscope and a stopwatch. The stethoscope ear piece was placed in the ears so that the angle of the ear piece tube will point forward. The diaphragm of the stethoscope was placed on the left side of the participant's chest, over the apex of the heart. The number of beats in fifteen seconds were counted and multiplied by four to get the heart rate (per minute)
5. **Blood pressure:** The blood pressure profiles were measured with the use of stethoscope and sphygmomanometer. The participants sat comfortably on a stool and support the arm on a table such that it lies mid-chest level. The cuff of the sphygmomanometer was wrapped firmly around the arm at 2cm above the cubital fossa. The radial pulse was palpated up to 180mmHg above the arterial pressure at which the radial pulse is expected to disappear.

   The blood pressure was determined by ausculating the brachial artery at the lateral cubital aspect of the cubital space with a stethoscope. The cuff pressure was gradually deflated at the rate of 2mmHg per second. The pressure at which the first "Korotkof-sound" was heard was recorded as the systolic blood pressure, while diastolic blood pressure was the pressure where the last sound was heard. The blood pressure was recorded in mmHg. (Millimeter of mercury) systolic over diastolic pressure.

6. Maximum Oxygen uptake: 1-mile-run/walk test was used

1. Participants were instructed to run 1 mile, (4 laps or 1,600m) on the 400m track as fast as possible.
2. They start on the signal "Ready, Go" Walking was permitted but not be encouraged to get the best from them. Five participants run at a time to put in some elements of competition.
3. The stop watch was started at the start of the race and the time spent by each athlete to complete the race was read from the stopwatch and recorded immediately. The time spent was used to estimate the value VO_2 max.
4. Currenton's 1-mile-run/walk generalized equation to estimate max VO_2 was used for this study. VO_2 max (ml.kg.min) =108.9-(8.41 xT) + (0.34 x T^2) + (0.21 x Age x G) – (0.84 x BM1). **Where:** T=1mile run/walk time in minutes, G=Gender coded, female =0; male =1, BMI =Body Mass Index (W/H^2), Kg/m. The multiple correlations of the generalized equation was 0.71 (Baumgartner and Jackson, 1999).

7. General Muscle Endurance

The Burpee (Squat thrust) test: This was used to measure general body endurance. From a standing position, the participant bends at the knee, places his hands on the floor in front of his feet and then thrust his legs backward. Again, he returns to the squat position and straighten to a standing position. This represents one complete repetition. The number of repetitions made in one minute was recorded for each participant. According to Safrit and Wood (1995), a reliability of 0.92 was reported for this measuring instrument.

8. Arm Muscle Strength

The Takie Physical Fitness Test Grip-D, Grip Strength Dynamometer T.K.K. 5401 calibrated from 0-100kg. was used to estimate static strength of the arm muscles. The dynamometer was placed away from participant's hand with dial facing away from the palm. The participant stands erects, looking straight forward with the arm at the side slightly abducted away from the body. The dynamometer was squeezed once, sharply and as hard as possible without moving the arm. Three trials were given and the score was recorded at the end of each trial to the nearest 0.5kg. The best of the three trials was used.

9. Flexibility Test

This test involves sitting on the floor with legs stretched out straight ahead. Shoes removed, and the soles of the feet were placed flat against the box. Both knees were locked and pressed flat to the floor. The tester may assist by holding them down. With the palms facing downwards, and the hands placed on stop of each other or side by side, the subject reaches forward along the measuring line as far as possible. The researcher ensured that the hands remain at the same level, not one reaching further forward than the other. After some practice reaches, the subject reaches out and holds that position for at least one or two seconds while the distance was recorded. There must be no jerky movements. The score was recorded to the nearest centimeter (http://www.topendsports.com)

10. 50 yards Sprint Test for Speed

The participants assumed a standing start position. One leg was placed forward very close to the starting line while the other leg is placed behind. At the command 'GO' the 50 yards sprint test commenced and the participants run as fast as possible on their lanes to the finishing line. The time spent to complete the race was recorded to the nearest tenth of a second (Davis et al, (2000).

11. Agility Test

The participant lies face down on the floor at the starting point. On the researcher's command the participant jumped to his/her feet and negotiates the course around the cones to the finish. The assistant records the total time taken from the command to the participant completing the course. Time taken to complete the whole task or course were recorded in minutes and seconds (http://www.brianmac.co.uk/illinois.htm)

Procedures for Training Programme

The following procedures were followed

1. The training programme comprised of aerobic exercise training programme for experimental group one and progressive resistance exercise training programme for experimental group two.
2. The training programme lasted for 12 weeks. There were three sessions per week for each experimental group.

3. The placement (days for training) were Mondays, Wednesdays and Fridays for the experimental group one, while Tuesdays, Thursdays and Fridays for experimental group two.
4. The time of training for the two schools took place in the morning (between 10.30 am and 12.30 pm) on the designated days for each school. The participants for the training programme were screened with audiometer to measure their level of hearing impairment a week before the commencement of the programme.
5. Every training session was made up of three segments. They are general body warm-up, conditioning bout and cool down.
6. All training and measurement took place in the sports ground of the two schools that were used for this study.
7. The researcher with the help of six trained research assistants administered the treatment and measurements.
8. Each exercise was demonstrated by the researcher before allowing the participants to perform the exercises.
9. The order of training programme is shown in appendix III and IV.

Pilot Study

A pilot study was carried out before the main study. Ten (10) male and ten (10) female adolescent secondary school students with hearing impairment from IMG Grammar School Sharp Corner, Oke-Bola, Ibadan. Ibadan, were used for the pilot study. This enabled the researcher to be well acquainted with the research instruments, methods, procedures and establish the feasibility of the study. It also informed the researcher on the need to sustain the interest and commitment of the participants to the programme.

Data Analysis

The data collected were analyzed using the descriptive statistics of mean and standard deviation. The inferential statistics of Analysis of Covariance (ANCOVA), was used to test the effect of the treatments on hypotheses 1-3. The Scheffe post hoc analysis was computed where F statistics was significant. Independent t-test was used for hypotheses 4 and 5. Levels of significance were set at 0.05.

CHAPTER FOUR

RESULTS ANALYSIS AND DISCUSSIONS OF FINDINGS

The main thrust of this experimental study investigated the effects of two modes of exercise training programmes on selected physiological and motor variables of in-school adolescents with hearing impairment in Ibadan metropolis. In order to achieve this, the data collected were subjected to statistical analysis and interpretations. The descriptive statistics of mean and standard deviation were computed. Inferential statistics of Analysis of Covariance (ANCOVA) was computed to compare the groups based on the variables listed in hypotheses 1, 2 and 3. The Scheffe post hoc analysis was computed where F statistics was significant. Independent t-test was carried out to compare the training effects on the variables based on gender and age in hypotheses 4 and 5.

Demographic Characteristics of the Participants

Fig. 1: Bar chart showing the distribution of participants by age

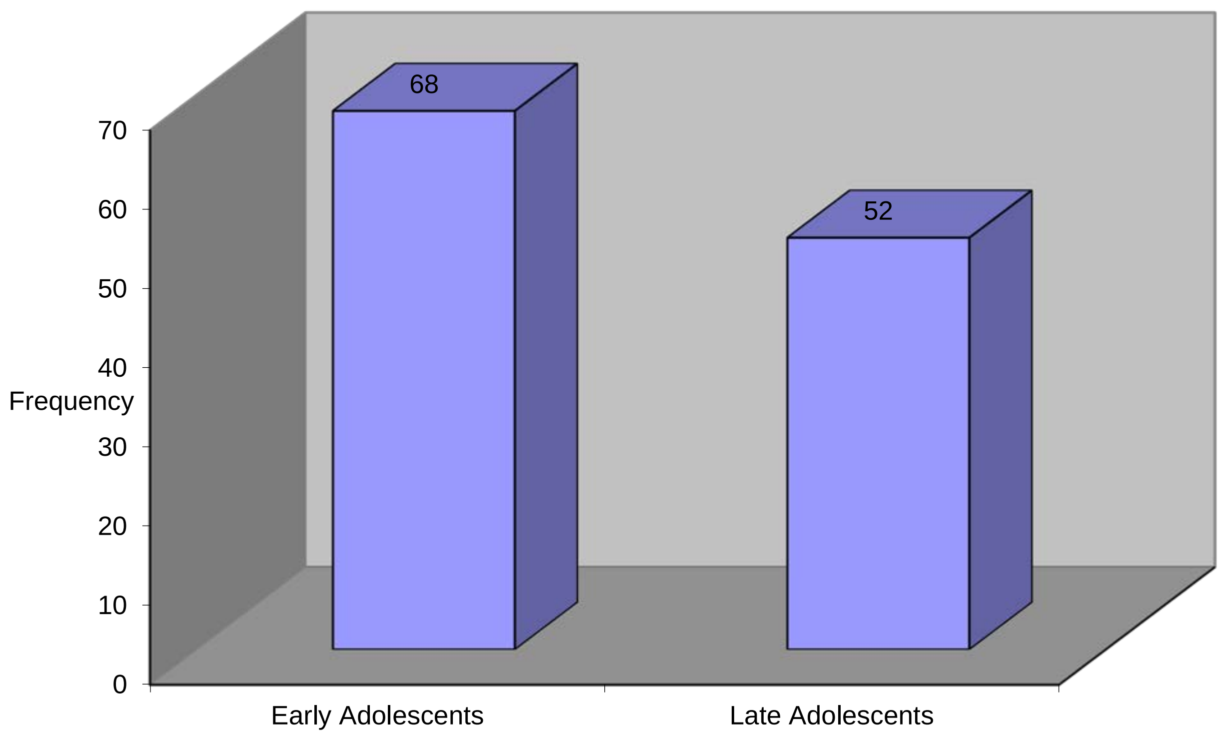
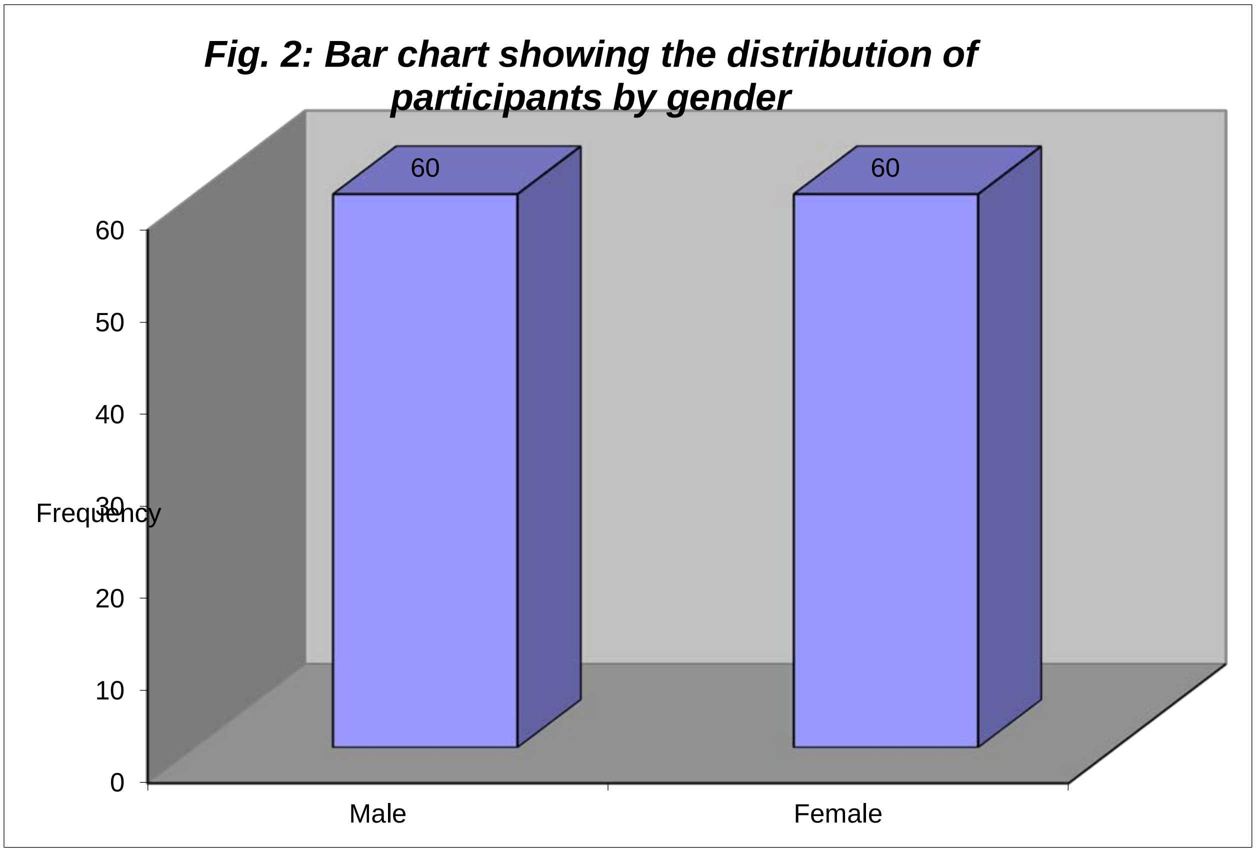


Table 4.1 above indicates the age distribution of the participants. 68 (56.7%) of the participants were early adolescents while 52 (43.3%) were late adolescents.



The bar chart in figure 2 shows that the male and female participants were equal i.e. male participants were 60 and female participants also were 60.

Table 4.1: Pretest- Posttest Means and Standard Deviations for Aerobic Exercise Group

Variables	Pretest		Posttest		Mean Difference
	Mean	Standard Deviation	Mean	Standard Deviation	
Age (yrs)	15.02	1.67	15.02	1.67	0.00
Heights (m|)	1.52	6.18	1.53	6.01	0.01
Weight (kg)	50.07	6.14	48.13	6.13	1.94
DHI	76.60	11.19	76.60	11.29	0.00
Muscular Endurance (rpm)	26.70	4.58	28.30	3.83	1.60
Muscular strength (kg)	28.08	7.50	30.17	7.46	2.09
Flexibility (cm)	8.55	4.92	9.95	4.68	1.40
Speed (sec)	6.49	0.93	6.43	0.92	0.06
Agility (sec)	16.35	1.66	15.39	1.19	0.96
SBP (mmHg)	103.75	8.45	108.75	8.22	3.00
DBP (mmHg)	71.13	6.15	71.37	5.42	0.24
Heart Rate (bpm)	80.70	8.14	75.88	4.79	4.82
$V0_2$ max (M1/kg)mm	46.13	6.78	47.32	6.53	1.19

Keys: DHI = Degree of hearing Impairment, SBP = Systolic Blood pressure, DBP = Diastolic Blood Pressure

Table 4.1 illustrates the means and standard deviations of the variables that were measured at the pre and post training stages in the AE group. This group had a pretest muscular endurance mean 0f 26.70 ± 4.58 and a posttest mean of 28.30 ±3.83. This shows a mean difference of 1.60. The pretest mean for muscular strength in this group was 28.08 ± 7.50 and posttest mean of 30.17 ± 7.46 with mean difference of 2.09. The group had a pretest flexibility mean of 8.55 ± 4.92 and a posttest mean of 9.95 ± 4.68 with a mean difference of 1.40. The AE group had speed pretest mean of 6.49 ± 0.93 and posttest mean of 6.43 ± 0.92 with mean difference of 0.06.

A pretest mean of 16.35± 1.66 and posttest mean of 15.39 ±1.19 with a mean difference of 0.96 were recorded for agility. The AE group had SBP pretest mean of 103.75 ± 8.45 and posttest mean of 108.75 ± 8.22 mmHg with mean difference of 3.00mmHg. A pretest mean of 71.13mmHg ± 6.15 and posttest mean of 71.37 mmHg ± 5.42 with mean difference of 0.24 mmHg were recorded for DBP. Heart rate in AE group had pretest posttest means of 80.70 ± 8.14

and 75.88 ± 4.79 with mean difference of 4.82 bpm. The AE group finally had a pretest-posttest means of 46.13 ± 6.78 and 47.32 ± 6.53 for Vo_2 Max with mean difference of 1.19 M1/kg/min.

Table 4.2: Pretest-Posttest Means and Standard Deviations for Progressive Resistance Exercise Group

Variables	Pretest		Posttest		Mean Difference
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	
Age (yrs)	15.43	1.74	15.43	1.75	0.00
Heights (m|)	1.52	6.59	1.53	6.42	0.01
Weight (kg)	50.14	6.83	48.76	7.08	1.38
DHI	77.45	11.34	77.45	11.34	0.00
Muscular Endurance	22.50	2.99	24.85	3.08	2.35
Muscular strength (kg)	25.89	5.11	28.15	5.20	2.26
Flexibility (cm)	9.63	2.92	10.38	2.83	0.75
Speed (sec)	6.26	0.77	6.13	0.68	0.13
Agility (sec)	17.07	1.37	16.94	1.28	0.13
SBP (mmHg)	110.13	7.38	111.88	7.65	1.75
DBP (mmHg)	71.25	5.16	71.88	5.02	0.63
Heart Rate	78.05	6.39	75.85	4.67	2.20
VO_2 max (M1/kg/min	46.96	6.60	48.02	6.30	1.06

Keys: Systolic Blood Pressure, DBP = Diastolic Blood Pressure, DHI = Degree of Hearing Impairment.

Table 4.2 above shows the mean and standard deviations of the variables measured at the pre and post training stages in the PRE group. This group had a pretest muscular endurance mean of 22.50 ± 2.99 and a posttest mean of 24.85 ± 3.08 with a mean difference of 2.35. The group had a pretest muscular endurance strength mean of 25.89 ± 5.11 and a posttest mean of 28.15 ± 5.20 with a mean difference of 2.26. The pretest mean for flexibility in this group was 9.63 ± 2.92 and posttest mean of 10.38 ± 2.83 with mean difference of 0.75. The pretest mean for speed was 6.26 ± 0.77 and posttest mean was 6.13 ± 0.68 with mean difference of 0.13. A pretest mean of 17.07 ± 1.37 and posttest mean of 16.94 ± 1.8 with mean difference of 0.13.

The PRE group had SBP pretest mean of 110.13 ± 7.38 and posttest mean of 111.88 ± 7.65 mmHg with mean difference of 1.75mmHg. A pretest mean of 71.25 ± 5.16 and posttest mean of 71.88 ± 502 with mean difference of 0.63 mmHg were recorded for DBP in PRE group. The pretest mean for Heart rates was 78.05 ± 6.39 and posttest mean was 75.85 ± 4.67 with mean difference of 2.20. The table finally shows a pretest and posttest means of 46.96 ± 6.60 and 48.02 ± 6.30 for VO_2 max with mean difference of 1.06m1/kg/min.

Table 4.3: Pretest-Posttest Means and Standard Deviations for Control Group

Variables	**Pretest**		**Posttest**		**Mean Difference**
	Mean	**Standard deviation**	**Mean**	**Standard deviation**	
Age (yrs)	15.2	1.56	15.2	1.56	0.00
Heights (m|)	1.49	6.15	1.50	6.08	0.01
Weight (kg)	49.10	6.87	49.09	6.87	0.01
DHI	76.05	10.48	76.05	10.48	0.00
Muscular Endurance (rpm)	26.93	3.81	26.83	3.88	0.1
Muscular strength (kg)	28.42	6.02	29.05	5.56	0.63
Flexibility (cm)	7.43	3.49	7.85	3.08	0.4
Speed (sec)	6.25	0.39	6.24	0.41	0.01
Agility (sec)	15.99	1.14	15.97	1.14	0.02
SBP (mmHg)	107.38	7.68	107.75	7.33	0.37
DBP (mmHg)	73.00	4.36	73.25	4.61	0.25
Heart Rate (bpm)	79.25	6.10	79.30	6.14	0.05
VO_2 max (M1/kg)mm	47.57	5.19	47.77	5.17	0.2

Keys: DHI = Degree of Hearing Impairment, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure.

Table 4.3 shows the means and standard deviations of the variables measured at the pre and post training stages in the control group. This group had a pretest muscular endurance mean of 26.93 ± 3.81 and a posttest mean of 26.83 with a mean difference of 0.1. The group had a pretest mean of 29.05 ± 5.56 with a mean difference of 0.63. The pretest mean for flexibility was 7.43 ± 3.49 and posttest mean was 7.85 ± 3.08 with mean difference of 0.4. Speed had pretest and posttest means of 6.25 ± 0.39 and 6.24 ± 0.4 with mean difference of 0.01. The group also had a pretest agility mean of 15.99 ± 1.14 and posttest mean of 15.97 ± 1.14 with mean difference of 0.02. The control group had SBP pretest mean of 107.38 ± 7.68 and posttest mean of 107.75 ± 7.33 mmHg with mean difference of 0.25mmhg was recorded for DBP. Heart rate in control group had pretest mean of 79.25 ± 6.10 and Posttest mean of 79.30 ± 6.14 with mean difference of 0.05.Vo_2 max in control group had pretest –posttest means of 47.57 ± 5.19 and 47.77 ± 5.17 with mean difference of 0.2

Research Question Analysis

Level of selected physiological and motor performance characteristics of the participants

Table 4.4: Norms for Blood Pressures

Age	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Premature	55-75	35-45
0-3 months	65-85	45-55
3-6months	70-90	50-65
6-12months	80-1009	55-65
1-3 years	90-105	55-65
3-6years	95-110	60-75
6-12years	100-120	60-75
Over age 12	110-135	65-85

Source: Kliegman (2007)

The mean age of the participants was 15 years which revealed that their average blood pressure (BP) of 107.08/ 71.79 was considered normal within 110-135/65-85 rating of Kliegman (2007). According to Agrawal (2010), blood pressure tends to increase as children age. It is quite low in newborns, and remains on the low side until children reach toddlerhood.

Table 4. 5: Norm for Heart Rate

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

Source: Jewkes, Luba and Mccusker (2005)

The heart rate of 77.01 bpm of the participants in this study falls within normal heart rate level of 60-100bpm. This is because their mean age (15.22) was within age 12 years and above shown in table 5.

Table 4.6: VO_2 max values for females as measured in Ml/kg/min

Age	Poor	Fair	Good	Excellent	Superior
13-19	25.0-30.9	31.0-34.9	35.0-38.9	39.0-41.9	<41.9
20-29	23.6-28.9	29.0-32.9	33.0-36.9	37.0-41.0	> 41.0
30-39	22.8-26.9	27.0-31.4	31.5-35.6	35.7-40.0	>40.0
40-49	21.0-24.4	24.5-28.9	29.0-32.8	32.9-36.9	>40.0
50-59	20.2-22.7	22.8-26.9	27.0-31.4	31.5-35.7	>35.7
60+	20.2-244	20.2-244	24.5-30.2	30.33-31.4	>31.4

Source Gettman, 1993

The female participants in this study had a mean score of 41.05 which was considered superior when compared with VO_2 max norms for females.

Table 4.7: VO_2 max values for males as measured in (Ml/kg/min)

Age	Poor	Fair	Good	Excellent	Superior
11-19	≤ 42	44-46	48-51	52-57	58+
20-29	≤ 41	42-45	46-50	51-55	56+
30-39	≤ 40	41-43	44-47	48-53	54+
40-49	≤ 37	38-41	42-45	46-52	53+
50-59	≤ 34	35-37	38-42	43-49	50+
60- 69	≤ 30	31-34	35-38	39-45	46+
70-79	≤ 27	28-30	31-35	36-41	42+

Source: Gettman, 1993

The male participants in this study had a mean score of 52.35 which falls under excellent when compared with the VO_2 max norms for males.

Table 4.8 Normative data for the grip strength test

(Norms for 14-19 years old.)

Gender	Excellent	Above average	Average	Below Average	Poor
Male	>56	51-56	45-50	39-44	<39
Female	>36	31-36	25-30	19-24	<19

Source: Davis et al; 2000

The mean score of 32.41 obtained by the male participants in this study falls under poor which shows that they have very low level of grip strength when compared with the norms. The female participants on the other hand have a mean score of 25.83 which falls under average when compared with the norms.

Table 4.9: Normative Data for Muscular Endurance (Burpee Test)

Males Values in ml/kg/min

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<35.0	35.0-38.3	38.4-45.1	45.2-50.9	51.0-55.9	>55.9
20-29	<33.0	33.0-36.4	36.5-42.4	42.5-46.4	46.5-52.4	>52.4
30-39	<31.5	31.5-35.4	35.5-40.9	41.0-44.9	45.0-49.4	>49.4
40-49	<30.2	30.2-33.5	33.6-38.9	39.0-43.7	43.8-48.0	>48.0
50-59	<26.1	26.1-30.9	31.0-35.7	35.8-40.9	41.0-45.3	>45.3
60+	<20.5	20.5-26.0	26.1-32.2	32.3-36.4	36.5-44.2	>44.2

Source: Cross fiteastsac.com

The mean score value of 38.77 was obtained by the participants in this study which falls under fair when compared with the norms.

Female Values in ml/kg/min

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<25.0	25.0-30.9	31.0-34.9	35.0-38.9	39.0-41.9	>41.9
20-29	<23.6	23.6-28.9	29.0-32.9	33.0-36.9	37.0-41.0	>41.0
30-39	<22.8	22.8-26.9	27.0-31.4	31.5-35.6	35.7-40.0	>40.0
40-49	<21.0	21.0-24.4	24.5-28.9	29.0-32.8	32.9-36.9	>36.9
50-59	<20.2	20.2-22.7	22.8-26.9	27.0-31.4	31.5-35.7	>35.7
60+	<17.5	17.5-20.1	20.2-24.4	24.5-30.2	30.3-31.4	>31.4

Source: Cross fiteastsac.com

The female participants in this study had a mean score value of 34.55 which falls under fair when compared with the norms.

Table 4.10: Normative data for the sit and reach test for flexibility

Gender	Excellent	Above average	Average	Below average	Poor
Male	>17cm	6 to 16cm	0 to 5cm	-8 to -1cm	< - 20cm
Female	>21cm	11 to 20cm	1 to 10cm	-7 to 0 cm	< - 15cm

Source: Davis et al; 2000

The male participants used in this study had mean of 8.60cm which falls within above average level when compared with the norm. The female participants also had flexibility mean of 11.18cm which falls within above average level when compared with the norm.

Table 4.11: Normative data for the Illinois Agility Run Test

Gender	Excellent	Above average	Average	Below average	Poor
Male	<15.2 sec	15.2-16.1sec	16.2-18.sec	18.2-19.3sec	>19.3sec
Female	< 17.0sec	17.0-17.9sec	18.0-21sec	21.8-23.0sec	>23.0sec

Source: Davis et al; 2000

Male agility mean value in the study was 15.40 seconds which was above average when compared with the norm. The female participants had agility mean value of 16.80 which was excellent when compared with the norm.

Table 4.12: Normative rating for speed Time to run 50-yards sprint test (in seconds)

Rating	Men	Women
Very good	<4.80sec	<5.30sec
Good	4.80-5.09sec	5.30-5.59sec
Average	5.10-5.29sec	5.60-5.89sec
Fair	5.30-5.60sec	5.90-6.20 sec
Poor	>5.60sec	>6.20sec

Source: Davis et al; 2000

The speed mean value for the male participants in the study was 5.92 seconds and this was considered poor when compared with the norm. The female participants had 6.62 seconds which was also considered poor when compared with the norm.

Hypothesis Testing

Hypothesis 1: There will be no significant difference in the pretest-posttest physiological variables (resting systolic blood pressure, resting diastolic blood pressure, resting heart rate and maximum oxygen uptake) between experimental and control groups following a 12 –week aerobic and progressive resistance exercise training programme.

Hypothesis 1(a): There will be no significant difference in the pretest-posttest resting systolic blood pressure between experimental and control groups following a 12-week aerobic and progressive resistance exercise training programme

Table 4.13: ANCOVA on effect of aerobic and progressive resistance exercises on Resting Systolic Blood Pressure of the participants

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	5991.786	3	1997.262	165.723	,000	
Covariates	5621.369	1	5621.369	466.435	.000	
Treatment group(Main effect)	341.655	2	170.828	14.174	.000	Sig.
Error(Residual)	1398.006	116	12.052			
Corrected total	7389.792	119				

In table 4.13 above the ANCOVA results indicated a significant difference in the pre-post resting systolic blood pressure based on the treatment groups ($F_{(3,116)} = 14.174$, $P< 0.05$). With this F value, hypothesis 1 (a) was therefore rejected. This indicated that there is significant effect of aerobic exercise and progressive resistance exercise on the systolic blood pressure of adolescent students with hearing impairment. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on SBP, Multiple Classification Analysis (MCA) as presented below was applied.

Table 4.14: Multiple Classification Analysis showing the direction of the significant interaction effects. Grand mean=109.46

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
AE	40	-1.71		-1.97	
PRE	40	-.71		2.23	
Control	40	2.42	.22	-.27	.22
Multiple R Square					.811
Multiple R					.900

MCA in table 4.14 reveals a pattern similar to ANCOVA in table 4.10. From the table, experimental group of AE has an adjusted mean score value of 107.75(109.46-1.97), experimental group of PRE has the adjusted mean score value of 108.75(109.46+2.23) and control group has the adjusted mean score value of 111.88(109.46-0.27). The result indicated that AE was the most effective, followed by PRE and the control group was the least effective. Detailed explanations were shown in the next scheffe post hoc table.

Table 4.15: Scheffe Post hoc Analysis for Resting Systolic Blood Pressure

Variable	**Treatment Groups**	**Treatment Groups**	**Mean Difference**	**Sig.**
RSBP	AE	PRE Control	-3.1250 -3.3350*	.201 .033
	PRE	AE Control	-3.1250 -3.3390*	.201 .046
	Control	AE PRE	-3.3350* -3.3390*	.033 .046

*=The mean difference was significant at the 0.05 level. The significant difference in the resting systolic blood pressure as indicated by Scheffe was between control and AE ($P<0.05$) on one side and control and PRE on the other side ($P<0.05$)

Hypothesis 1(b): There will be no significant difference in the pretest posttest resting diastolic blood pressure between experimental and control groups following a 12-week aerobic and progressive resistance exercise training programme.

Table 4.16: ANCOVA on effect of aerobic and progressive resistance exercises on Diastolic Blood Pressure of the participants

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	12669.426	3	889.809	281.063	,000	
Covariates	2594.009	1	2594.009	819.368	.000	
Treatment group(Main effect)	3.017	2	1.508	.476	.622	N.S.
Error(Residual)	367.241	116	3.166			
Corrected total	3036.667	119				

Table 4.16 shows there was no significant difference in the pre-post Diastolic blood pressure based on the treatment group and the control groups ($F(_{3,116}$=.476, P>0.05. With the value of F, hypothesis 1 (b) is therefore accepted. This reveals that there is no significant effect of aerobic and progressive resistance exercises on Diastolic blood pressure of adolescent students with hearing impairment. However, in order to determine the magnitude and direction of the contribution of the trainings on DBP, MCA as presented below was applied.

Table 4.17: Multiple Classification Analysis showing the direction of the significant interaction effects. Grand mean=72.17

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
AE	40	-.79		-.20	
PRE	40	-.29		.19	
Control	40	1.08	.16	.00	.03
Multiple R Square					.879
Multiple R					.938

MCA in table 4.17 reveals a pattern similar to ANCOVA in table 4.13. From the table, experimental group of AE has an adjusted mean score value of 71.38(72.17-.20), experimental group of PRE has the adjusted mean score value of 71.88(72.17+.19) and control group has the adjusted mean score value of 73.25(72.17+.00). The result indicated that AE was the most effective, followed by PRE and the control group was the least effective.

Hypothesis 1 (c): There will be no significant difference in the pretest –posttest heart rate between experimental and control groups following a 12-week aerobic and progressive resistance exercise training programme.

Table 4.18: ANCOVA on effect of aerobic and progressive resistance exercises on Heart Rate of the participants

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	2268.859	3	756.286	70.405	,000	
Covariates	1971.809	1	1971.809	183.562	.000	
Treatment group(Main effect)	356.483	2	178.242	16.593	,000	Sig.
Error(Residual)	1246.066	116	10.742			
Corrected total	3514.925	119				

Table 4.18 shows that there was a significant difference in the pre-post Heart rate based on the treatment groups (F($_{3,116}$= 16.593, P <0.05) The null hypothesis is therefore rejected. This indicated that aerobic exercise and progressive resistance exercise trainings have significant effect on the heart rate of adolescent students with hearing impairment. 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 4.19: Multiple Classification Analysis showing the direction of the significant interaction effects. Grand mean=76.97

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
AE	40	-1.10		-1.91	
PRE	40	-1.13		-.37	
Control	40	2.23	.29	2.27	.32
Multiple R Square					.645
Multiple R					.803

MCA in table 4.19 reveals a pattern similar to ANCOVA in table 4.13. From the table, experimental group of AE has an adjusted mean score value of 75.88(76.97-1.91), experimental group of PRE has the adjusted mean score value of 75.85(76.97-.37) and control group has the adjusted mean score value of 79.20(76.97+2.27). The result indicated that PRE was the most effective, followed by AE and the control group was the least effective. Detailed explanations were shown in the next scheffe post hoc table.

Table 4.20: Scheffe Post hoc Analysis for Heart Rate

Variable	**Treatment Groups**	**Treatment Groups**	**Mean Difference**	**Sig.**
Heart Rate	AE	PRE Control	2.500 -3.3250*	1.000 .020
	PRE	AE Control	-2.5000 -3.3500*	1.000 .019
	Control	AE PRE	3.3250* 3.3500*	.020 .019

*=The mean difference was significant at the 0.05 level. The significant difference in the heart rate as indicated by Scheffe was between control and AE (P<0.05) on one side and control and PRE on the other side (P<0.05)

Hypothesis 1 (d): There will be no significant difference in the pretest-posttest VO_2 max between experimental and control groups following a 12-week aerobic and progressive resistance exercise training programme.

Table 4.21: ANCOVA on effect of aerobic and progressive resistance exercises on $V0_2$ max of the participants

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	4189.117	3	1396.372	2120.512	,000	
Covariates	4179.173	1	4179.173	6346.437	.000	
Treatment group(Main effect)	20.819	2	10.410	15.808	,000	Sig.
Error(Residual)	76.387	116	.659			
Corrected total	4265.503	119				

Table 4.21shows that there was a significant difference in the pretest posttest VO_2 max based on the treatment groups ($F_{(3,116}$=15.808, P <0.05) With this value of F, the null hypothesis is therefore rejected. This shows that aerobic exercise and progressive resistance exercise have significant effect on the VO_2 max of adolescent students with hearing impairment. In oder to determine the magnitude and direction of the differences as well as the contribution of the trainings on VO_2 max, MCA as presented below was applied.

Table 4.22: Multiple Classification Analysis showing the direction of the significant interaction effects. Grand mean=47.70

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
AE	40	-.38		.35	
PRE	40	.31		.24	
Control	40	.07	.05	-.59	.07
Multiple R Square					.982
Multiple R					.991

MCA in table 4.22 reveals a pattern similar to ANCOVA in table 4.18. From the table, experimental group of PRE has an adjusted mean score value of 47.32(47.70-.35), experimental group of AE has the adjusted mean score value of 48.02(47.70-.24) and control group has the adjusted mean score value of 47.27(47.70-.59). The result indicated that AE was the most effective, followed by PRE and the control group was the least effective. Detailed explanations were shown in the next scheffe post hoc table.

Table 4.23: Scheffe Post hoc Analysis for VO_2 max

Variable	Treatment Groups	Treatment Groups	Mean Difference	Sig.
VO_2 max	AE	PRE Control	-.6955 -.4483	.876 .946
	PRE	AE Control	.6955 .2472	.876 .983
	Control	AE PRE	.4483 -.2472	.946 .983

*=The mean difference was significant at the 0.05 level. The scheffe did not indicate significant difference in VO_2 max among the three groups (P<0.05).

Hypothesis 2: There will be no significant difference in the pretest-posttest motor variables (muscular endurance, muscular strength, flexibility, speed and agility) between experimental and control groups following a 12-week aerobic and progressive resistance exercise training programme.

Hypothesis 2 (a): There will be no significant difference in the pretest-posttest muscular endurance between experimental and control groups following a 12 week aerobic and progressive resistance exercise training programme.

Table 4.24: ANCOVA on effect of aerobic and progressive resistance exercises on Muscular Endurance of the participants

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	1567.418	3	522.473	300.668	,000	
Covariates	1327.701	1	1327.701	764.055	.000	
Treatment group(Main effect)	78.540	2	39.270	22.599	,000	Sig.
Error(Residual)	201.574	116	1.738			
Corrected total	1768.992	119				

Table 4.24 shows that there was a significant difference in the pretest-posttest muscular endurance based on the treatment groups ($F_{(3,116)}$= 22.599, $P < 0.05$ level of significance. The null hypothesis is therefore rejected. This reveals that aerobic exercise and progressive resistance exercise have significant effect on muscular endurance of adolescent students with hearing impairment. In order to determine the magnitude and direction of the differences as well as the contribution of the trainings on muscular endurance, MCA as presented below was applied.

Table 4.25: Multiple Classification Analysis showing the direction of the significant interaction effects. Grand mean=26.66

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
AE	40	1.64		.48	
PRE	40	-1.81		.71	
Control	40	.17	.37	-1.19	.22
Multiple R Square					.886
Multiple R					.941

MCA in table 4.25 reveals a pattern similar to ANCOVA in table 4.21. From the table, experimental group of AE has an adjusted mean score value of 28.30(26.66+.48), experimental group of PRE has the adjusted mean score value of 26.83(26.66+.71) and control group has the adjusted mean score value of 24.85(26.66-1.19). The result indicated that AE was the most effective, followed by PRE and the control group was the least effective. Detailed explanations were shown in the next scheffe post hoc table.

Table 4.26: Scheffe Post hoc Analysis for Muscular Endurance

Variable	Treatment Groups	Treatment Groups	Mean Difference	Sig.
Muscular Endurance	AE	PRE Control	3.4500* 1.4750	.000 .194
	PRE	AE Control	-3.4500* -1.9750*	.000 .054
	Control	AE PRE	-1.4750 1.9750*	.194 .054

*=The mean difference was at 0.05 levels. The significant difference in muscular endurance as indicated by Scheffe in table 4.23 was between PRE and AE (P<0.05) and PRE and control (P<0.05)

Hypothesis 2 (b): There will be no significant difference in the pretest –posttest muscular strength between experimental and control groups following a 12-week aerobic and progressive resistance exercise training programme

Table 4.27: ANCOVA on effect of aerobic and the progressive resistance exercises on Muscular Strength of the participants

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	4184.937	3	1394.978	495.915	,000	
Covariates	4102.826	1	4102.826	1458.554	.000	
Treatment group(Main effect)	55.533	2	27.767	9.871	,000	Sig.
Error(Residual)	326.301	116	2.813			
Corrected total	4511.238	119				

Table 4.27 reveals that there was significant difference in the pretest-posttest muscular strength based on the treatment groups ($F_{(3, 116)}$ = 9.871, P< 0.05 level of significance. With the value of F, hypothesis 2 (b) is therefore rejected. This shows that there is significant effect of aerobic exercise and progressive resistance exercise on muscular strength of adolescent students with hearing impairment. In order to determine the magnitude and the direction of the differences as well as the contribution of the trainings on muscular strength, MCA as presented below was applied.

Table 4.28: Multiple Classification Analysis showing the direction of the significant interaction effects. Grand mean=29.12

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
AE	40	1.05		.47	
PRE	40	-.98		.50	
Control	40	-.07	.13	-.97	.11
Multiple R Square					.928
Multiple R					.963

MCA in table 4.28 reveals a pattern similar to ANCOVA in table 4.24. From the table, experimental group of AE has an adjusted mean score value of 29.05(29.12+.47), experimental group of PRE has the adjusted mean score value of 30.17(29.12+.50) and control group has the adjusted mean score value of 28.15(29.12-.97). The result indicated that PRE was the most effective, followed by AE and the control group was the least effective. Detailed explanations were shown in the next scheffe post hoc table.

Table 4.29: Scheffe Post hoc Analysis for Muscular Strength

Variable	Treatment Groups	Treatment Groups	Mean Difference	Sig.
Muscular Strength	AE	PRE Control	2.0225 1.1175	.343 .720
	PRE	AE Control	-2.0225 -.9050	.343 .806
	Control	AE PRE	-1.1175 .9050	.720 .806

*=The mean difference was at 0.05 levels. The Scheffe did not indicate significant difference in muscular strength among the three groups (P<0.05).

Hypothesis 2 (c): There will be no significant difference in the pretest- posttest flexibility between experimental and control groups following a 12-weeek aerobic exercise and progressive resistance exercise training programme

Table 4.30: ANCOVA on effect of aerobic and progressive resistance exercises on Flexibility of the participants

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	1510.315	3	503.438	338.982	.000	
Covariates	1364.098	1	1364.098	918.493	.000	
Treatment group(Main effect)	24.214	2	12.107	8.152	,000	Sig.
Error(Residual)	172.277	116	1.485			
Corrected total	1682.592	119				

Table 4.30 reveals that there was significant difference in the pretest-posttest flexibility based on the treatment groups ($F_{(3,116)}$ = 8.152, $p<0.05$. alpha level. The null hypothesis is therefore rejected. This shows that there is significant effect of aerobic exercise and progressive resistance exercise on flexibility of adolescent students with hearing impairment. This is because the F-test at $p<0.05$ shows that 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 training on flexibility, MCA as presented below was applied.

Table 4.31: Multiple Classification Analysis showing the direction of the significant interaction effects. Grand mean=9.39

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
AE	40	.56		.54	
PRE	40	.98		.02	
Control	40	-1.54	.29	-.56	.12
Multiple R Square					.898
Multiple R					.947

MCA in table 4.31 reveals a pattern similar to ANCOVA in table 4.27. From the table, experimental group of AE has an adjusted mean score value of 9.95(9.39+.54), experimental group of PRE has the adjusted mean score value of 10.38(9.39+.02) and control group has the adjusted mean score value of 7.85(9.39-.56). The result indicated that PRE was the most effective, followed by AE and the control group was the least effective. Detailed explanations were shown in the next scheffe post hoc table.

Table 4.32: Scheffe Post hoc Analysis for Flexibility

Variable	Treatment Groups	Treatment Groups	Mean Difference	Sig.
Flexibility	AE	PRE	-.4250	.872
		Control	2.1000*	.038
	PRE	AE	.4250	.872
		Control	2.5250*	.009
	Control	AE	-2.1000*	.038
		PRE	-2.5250*	.009

*=The mean significant is at 0.05 level. The significant difference in flexibility as indicated by Scheffe in table 4.29 occurs between control and AE as well as between control and PRE ($P<0.05$).

Hypothesis 2 (d): There will be no significant difference in the pretest-posttest speed between experimental and control groups following a 12-week aerobic and progressive resistance exercise training programme.

Table 4.33: ANCOVA on effect of aerobic and progressive resistance exercises on Speed of the participants

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	51.824	3	17.275	253.877	.000	
Covariates	49.886	1	49.886	733.150	.000	
Treatment group(Main effect)	.334	2	.167	2.451	.091	NS
Error(Residual)	7.893	116	6.804			
Corrected total	59.717	119				

Table 4.33shows there was no significant difference in the pretest-posttest speed based on the treatment groups ($F_{(3,116)}$=2.451, P<0.05 level of significance. The null hypothesis is therefore accepted. This indicates that there were no significant differences among the three groups.

Table 4.34: Multiple Classification Analysis showing the direction of the significant interaction effects. Grand mean=6.27

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
AE	40	.17		.02	
PRE	40	-.14		-.07	
Control	40	-.03	.18	.05	.07
Multiple R Square					.868
Multiple R					.932

MCA in table 4.34 reveals a pattern similar to ANCOVA in table 4.30. From the table, experimental group of AE has an adjusted mean score value of 6.24(6.27+.02), experimental group of PRE has the adjusted mean score value of 6.13(6.27-.07) and control group has the adjusted mean score value of 6.43(6.27+.05). The result indicated that PRE was the most effective, followed by AE and the control group was the least effective. Detailed explanations were shown in the next scheffe post hoc table.

Table 4.35: Scheffe Post hoc Analysis for Speed

Variable	Treatment Groups	Treatment Groups	Mean Difference	Sig.
Speed	AE	PRE Control	.3080 .1930	.151 .473
	PRE	AE Control	-.3080 -.1150	.151 .766
	Control	AE PRE	-.1930 .1150	.473 .766

*=The mean significant is at 0.05 level. The scheffe did not indicate significant difference in speed among the three groups (P<0.05).

Hypothesis 2 (e): There will be no significant difference in the pretest-posttest agility between experimental and control groups following a 12-week aerobic and progressive resistance exercise training programme

Table 4.36: ANCOVA on effect of aerobic and progressive resistance exercises on Agility of the participants

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	158.823	3	52.941	102.723	.000	
Covariates	109.812	1	109.812	213.072	.000	
Treatment group(Main effect)	24.451	2	12.225	23.721	.000	Sig.
Error(Residual)	59.783	116	.515			
Corrected total	218.607	119				

Table 4.36 shows there was significant difference in the pretest-posttest agility based on the treatment groups ($F_{(3,116)}$ =23.721, P<0.05 level of significance. With the obtained value of F, the null hypothesis is therefore rejected. This shows that aerobic and progressive exercises have significant effect on agility of students with hearing impairment. In order to determine the magnitude and the direction of the differences as well as the contribution of the trainings on agility, MCA as presented below was applied.

Table 4.37: Multiple Classification Analysis showing the direction of the significant interaction effects. Grand mean=6.27

Variable category	N	Unadjusted Deviation	Eta	Adjusted for Independents + Covariates Deviation	Beta
AE	40	-.71		-.63	
PRE	40	.84		.43	
Control	40	-.13	.47	.20	.34
Multiple R Square					.727
Multiple R					.852

MCA in table 4.37 reveals a pattern similar to ANCOVA in table 4.33. From the table, experimental group of AE has an adjusted mean score value of 15.39(16.10-.63), experimental group of PRE has the adjusted mean score value of 15.94(16.10+.43) and control group has the adjusted mean score value of 16.94(16.10+.20). The result indicated that AE was the most effective, followed by PRE and the control group was the least effective. Detailed explanations were shown in the next scheffe post hoc table.

Table 4.38: Scheffe Post hoc Analysis for Agility

Variable	Treatment Groups	Treatment Groups	Mean Difference	Sig.
Agility	AE	PRE	-1.5488*	.000
		Control	-.5770	.105
	PRE	AE	1.5488*	.000
		Control	.9718*	.002
	Control	AE	.5770	.105
		PRE	-.9718*	.002

*=The mean significant is at 0.05 level. The significant difference in agility as indicated by Scheffe in table 4.22 was between PRE and AE (P<0.05) on one side and PRE and control on the other side (P<.0.05).

Hypothesis 3: There will be no significant difference in the pretest-posttest physiological and motor variables of adolescent students with hearing impairment, based on degree of impairment following a 12- week aerobic and progressive resistance exercise trainings.

Hypothesis 3 (a) There will be no significant difference in the pretest-posttest resting systolic blood pressure of adolescent students with hearing impairment, based on degree of impairment following a 12- week aerobic and progressive resistance exercise trainings.

Table 4.39: ANCOVA on effect of aerobic and progressive resistance exercises on resting systolic blood pressure based on degree of impairment.

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	5684.39	3	1894.80	128.88	.000	
Covariates	5592.47	1	5592.47	380.39	.000	
Treatment group(Main effect)	34.26	2	17.13	1.17	.316	NS
Error(Residual)	1705.40	116	14.70			
Corrected total	7389.79	119				

Table 4.39 shows the results of ANCOVA on the effect of aerobic exercise and progressive resistance exercise on resting systolic blood pressure based on degree of impairment of adolescent students with hearing impairment. The main effects of the training on the participants were not statistically significant at 0.05 level of significance ($F_{(3,116}=1.17$, $p<0.05$). This shows that there was no significant effect of aerobic and progressive resistance exercises on resting systolic blood pressure of the participants based on degree of impairment. The null hypothesis is therefore accepted.

Hypothesis 3 (b) There will be no significant difference in the pretest-posttest resting diastolic blood pressure of adolescent students with hearing impairment, based on degree of impairment following a 12- week aerobic and progressive resistance exercise trainings.

Table 4.40: ANCOVA on effect of aerobic and progressive resistance exercises on resting diastolic blood pressure based on degree of impairment.

Source of Variation	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	2675.69	3	891.90	286.61	.000	
Covariates	2657.82	1	2657.82	854.09	.000	
Treatment group(Main effect)	9.28	2	4.64	1.49	.229	NS
Error(Residual)	360.98	116	3.11			
Corrected total	3036.67	119				

Table 4.40 shows there was no significant difference in the resting diastolic blood pressure of adolescent students with hearing impairment based on degree of impairment exposed to aerobic and progressive resistance exercise trainings, ($F(_{3,116}=1.49$, $p<0.05$). With this value of F, hypothesis 3b was therefore accepted. This is because F tests at $p< 0.05$ shows that there is no significant difference among the three groups.

Hypothesis 3 (c): There will be no significant difference in the pretest-posttest heart rate of adolescent students with hearing impairment based on degree of impairment following a 12-week aerobic and progressive resistance trainings.

Table 4.41: ANCOVA on effect of aerobic and progressive resistance exercises on heart rate based on degree of impairment

Source	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	1940.85	3	646.95	47.68	.000	
Covariates	1934.80	1	1934.80	142.58	.000	
Treatment group(Main effect)	28.47	2	14.24	1.05	.354	NS
Error(Residual)	1574.08	116	13.57			
Corrected total	3514.93	119				

In the table above, it was shown that there was no significant difference in the heart rate of adolescent students with hearing impairment based on degree of impairment exposed to aerobic exercise and progressive resistance exercise trainings ($F(_{3.116} = 1.05$ $P< 0.05$). The null hypothesis is therefore accepted. This indicates that there is no significant effect of aerobic exercise and progressive resistance exercise on heart rate of the participants based on hearing impairment.

Hypothesis 3 (d): There will be no significant difference in the pretest-posttest VO_2 max of adolescent students with hearing impairment based on degree of impairment following a 12-week aerobic and progressive resistance exercise trainings.

Table 4.42: ANCOVA on effect of aerobic and progressive resistance exercises on VO_2 max based on degree of impairment

Source	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	4168.88	3	1389.63	1668.21	.000	
Covariates	4166.76	1	4166.76	5002.08	.000	
Treatment group(Main effect)	.577	2	.289	.347	.708	NS
Error(Residual)	96.63	116	.833			
Corrected total	4265.50	119				

The table above shows that there was no significant difference in the VO_2 Max of adolescent students with hearing impairment based on degree of impairment exposed to aerobic and progressive resistance exercise trainings ($F(_{3,116}=.347$, $P <.0.05$) Hence the null hypothesis is therefore accepted. The result shows that there is no significant effect of aerobic and progressive resistance exercises on VO_2 max based on degree of impairment of adolescent students with hearing impairment.

Hypothesis 3 (e): There will be no significant difference in the pretest-posttest muscular endurance of adolescent students with hearing impairment based on degree of impairment following a 12-week aerobic and progressive resistance exercise trainings.

Table 4.43: ANCOVA on effect of aerobic and progressive resistance exercises on Muscular Endurance based on degree of impairment

Source	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	1493.27	3	497.76	209.42	.000	
Covariates	1476.75	1	1476.75	621.30	.000	
Treatment group(Main effect)	4.40	2	2.20	.925	.400	NS
Error(Residual)	275.72	116	2.38			
Corrected total	1768.99	119				

The table above shows that there was no significant difference in the muscular endurance of adolescent students with hearing impairment based on degree of impairment exposed to aerobic and progressive resistance exercise trainings ($F(_{3,116}$=.925, $P <.0.05$) Hence the null hypothesis is therefore accepted. The result shows that there was no significant effect of aerobic and progressive resistance exercises on muscular endurance based on degree of impairment of adolescent students with hearing impairment.

Hypothesis 3 (f): There will be no significant difference in the pretest-posttest muscular strength of adolescent students with hearing impairment based on degree of impairment following a 12-week aerobic and progressive resistance exercise trainings.

Table 4.44: ANCOVA on effect of aerobic and progressive resistance exercises on Muscular Strength based on degree of impairment

Source	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	4140.89	3	1380.30	432.34	.000	
Covariates	4032.50	1	4032.50	1263.05	.000	
Treatment group(Main effect)	11.49	2	5.74	1.80	.170	NS
Error(Residual)	370.35	116	3.19			
Corrected total	4511.24	119				

The table above shows that there was no significant difference in the muscular strength of adolescent students with hearing impairment based on degree of impairment exposed to aerobic and progressive resistance exercise trainings ($F(_{3,116}=1.80$, $P <.0.05$). Hence the null hypothesis is therefore accepted. The result shows that there was no significant effect of aerobic and progressive resistance exercises on muscular strength based on degree of impairment of adolescent students with hearing impairment.

Hypothesis 3 (g): There will be no significant difference in the pretest-posttest flexibility of adolescent students with hearing impairment based on degree of impairment following a 12-week aerobic and progressive resistance exercise trainings.

Table 4.45: ANCOVA on effect of aerobic and progressive resistance exercises on Flexibility based on degree of impairment

Source	Sum of Square	Df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	1487.63	3	495.88	295.03	.000	
Covariates	1482.27	1	1482.27	881.91	.000	
Treatment group(Main effect)	1.53	2	.762	.454	.636	NS
Error(Residual)	194.97	116	1.68			
Corrected total	1682.592	119				

The table above shows that there was no significant difference in the flexibility of adolescent students with hearing impairment based on degree of impairment exposed to aerobic and progressive resistance exercise trainings ($F(_{3,116}=.454$, $P <.0.05$) Hence the null hypothesis is therefore accepted. The result shows that there was no significant effect of aerobic and progressive resistance exercises on flexibility based on degree of impairment of adolescent students with hearing impairment.

Hypothesis 3 (h): There will be no significant difference in the pretest-posttest speed of adolescent students with hearing impairment based on degree of impairment following a 12-week aerobic and progressive resistance exercise trainings.

Table 4.46: ANCOVA on effect of aerobic and progressive resistance exercises on Speed based on degree of impairment

Source	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	51.57	3	17.19	244.60	.000	
Covariates	50.98	1	50.98	725.43	.000	
Treatment group(Main effect)	7.51	2	3.75	.534	.588	NS
Error(Residual)	8.15	116	7.03			
Corrected total	59.72	119				

The table above shows that there was no significant difference in the speed of adolescent students with hearing impairment based on degree of impairment exposed to aerobic and progressive resistance exercise trainings ($F(_{3,116}=.534$, $P <.0.05$) Hence the null hypothesis is therefore accepted. The result shows that there was no significant effect of aerobic and progressive resistance exercises on speed based on degree of impairment of adolescent students with hearing impairment.

Hypothesis 3 (i): There will be no significant difference in the pretest-posttest agility of adolescent students with hearing impairment based on degree of impairment following a 12-week aerobic and progressive resistance exercise trainings.

Table 4.47: ANCOVA on effect of aerobic and progressive resistance exercises on Agility based on degree of impairment

Source	Sum of Square	df	Mean Square	F	Sig.	Remark
Corrected model(Explained)	137.31	3	45.77	65.31	.000	
Covariates	136.79	1	136.79	195.18	.000	
Treatment group(Main effect)	2.94	2	1.47	2.10	.128	NS
Error(Residual)	81.30	116	.701			
Corrected total	218.61	119				

The table above shows that there was no significant difference in the agility of adolescent students with hearing impairment based on degree of impairment exposed to aerobic and progressive resistance exercise trainings ($F(_{3,116}=2.10$, $P <.0.05$). Hence the null hypothesis is therefore accepted. The result shows that there was no significant effect of aerobic and progressive resistance exercises on agility based on degree of impairment of adolescent students with hearing impairment.

Hypothesis 4: There will be no significant difference in physiological and motor variables of adolescent students with hearing impairment, based on gender following a 12 – week aerobic and progressive resistance exercise trainings.

Hypothesis (4a): There will be no significant difference in resting systolic blood pressure of adolescent students with hearing impairment based on gender following aerobic and progressive resistance exercise trainings

Table 4.48: t-test showing difference in Resting Systolic Blood Pressure based on gender following aerobic and progressive resistance exercise trainings.

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Resting Systolic Blood Pressure	Male Female	60 60	109.7500 109.1667	7.7254 8.0867	.404	118	.687	NS

The above table indicates t-test comparison of resting systolic blood pressure of the participant based on gender. The result shows that male has mean score of 109.7500±7.7254 while female has mean score of 109.1667±8.0867. The t observed indicating the difference between gender is .404; P, 0.05. Since P value is greater than 0.05, the null hypothesis (4a) is therefore accepted.

Hypothesis (4b): There will be no significant difference in resting diastolic blood pressure of adolescent students with hearing impairment based on gender following aerobic and progressive resistance exercise trainings

Table 4.49: t-test showing difference in Resting Diastolic Blood Pressure based on gender following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Resting Diastolic Blood Pressure	Male Female	60 60	71.8333 72.5000	5.1228 5.0000	-.721	118	.472	NS

Table 4.49 above indicates t-test comparison of resting diastolic blood pressure of the participants based on gender. The table reveals that male has mean score of 71.8333±5.1228 while female has mean score of 72.5000±5.0000. The t observed indicating difference between gender is -.721; P < 0.05. Since the P value is greater than 0.05, the null hypothesis 4(b) is therefore accepted.

Hypothesis (4c): There will be no significant difference in resting heart rate of adolescent students with hearing impairment based on gender following aerobic and progressive resistance exercise trainings

Table 4.50: t-test showing difference in Resting Heart Rate based on gender following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Resting Heart Rate	Male Female	60 60	77.3333 76.6167	5.9108 4.9372	.721	118	.472	NS

The table above indicates t-test comparison of resting heart rate of the participants based on gender. The table shows that male has the mean score of 77.3333±5.9108 while the female has the mean score of 76.6167±4.9372. The t observed indicating difference between gender is .721; P < 0.05. Since the P value is greater than 0.05, the null hypothesis 4(c) is therefore accepted.

Hypothesis (4d): There will be no significant difference in VO_2 max of adolescent students with hearing impairment based on gender following aerobic and progressive resistance exercise trainings

Table 4.51: t-test showing difference in VO_2 max based on gender following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-VO_2 max	Male Female	60 60	52.3522 43.0508	3.4080 4.0855	13.542	118	.000	Sig.

Table 4.51 above indicates t-test comparison of VO_2 max of the participants based on gender. The table shows that male has the mean score of 52.3522±3.4080 while the female has the mean score of 43.0508±4.0855. The t observed indicating difference between gender is 13.542; P < 0.05. Since the P value is less than 0.05, the null hypothesis 4(d) is therefore rejected. This result therefore implies that there is a significant difference in gender on VO_2 max of adolescent students with hearing impairment.

Hypothesis (4e): There will be no significant difference in muscular endurance of adolescent students with hearing impairment based on gender following aerobic and progressive resistance exercise trainings

Table 4.52: t-test showing difference in Muscular Endurance based on gender following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Muscular Endurance	Male Female	60 60	28.7667 24.5500	3.5000 2.9483	7.137	118	.000	Sig.

The table above indicates t-test comparison of muscular endurance of the participants based on gender. The table shows that male has the mean score of 28.7667±3.5000 while the female has the mean score of 24.5500±2.9483. The t observed indicating difference between gender is 7.137;

P < 0.05. Since the P value is less than 0.05, the null hypothesis 4(e) is therefore rejected. This result therefore shows that there is a significant difference in muscular endurance based on gender of adolescent students with hearing impairment.

Hypothesis (4f): There will be no significant difference in muscular strength of adolescent students with hearing impairment based on gender following aerobic and progressive resistance exercise trainings.

Table 4.53: t-test showing difference in Muscular Strength based on gender following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Muscular Strength	Male Female	60 60	32.4133 25.8283	5.8595 4.4810	6.915	118	.000	Sig.

Table 4.53 above indicates t-test comparison of muscular strength of the participants based on gender. The table reveals that male has the mean score of 32.4133±5.8595 while the female has the mean score of 25.8283±4.4810. The t observed indicating difference between gender is 6.915; P < 0.05. Since the P value is less than 0.05, the null hypothesis 4(f) is therefore rejected. This result clearly shows that there is a significant difference in muscular endurance based on gender of adolescent students with hearing impairment.

Hypothesis (4g): There will be no significant difference in flexibility of adolescent students with hearing impairment based on gender following aerobic and progressive resistance exercise training.

Table 4.54: t-test showing difference in Flexibility based on gender following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Flexibility	Male Female	60 60	8.6000 10.1833	3.7696 3.6102	-2.350	118	.020	Sig.

Table 4.54 above indicates t-test comparison of flexibility of the participants based on gender. The table reveals that male has the mean score of 8.6000±3.7696 while the female has the mean

score of 10.1833±3.6102. The t observed indicating difference between gender is – 2.350; P < 0.05. Since the P value is less than 0.05, the null hypothesis 4(g) is therefore rejected. This result clearly shows that there is a significant difference in flexibility based on gender of adolescent students with hearing impairment.

Hypothesis (4h): There will be no significant difference in speed of adolescent students with hearing impairment based on gender following aerobic and progressive resistance exercise training.

Table 4.55: t-test showing difference in Speed based on gender following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post- Speed	Male Female	60 60	5.9170 6.6155	.3912 .7817	-6.190	118	.000	Sig.

The table above indicates t-test comparison of speed of the participants based on gender. The table shows that male has the mean score of 5.9170±.3912 while the female has the mean score of 6.6155±.7817. The observed t indicating difference between genders is -6.190; P < 0.05. Since the P value is less than 0.05, the null hypothesis 4(h) is therefore rejected. This result therefore shows that there is a significant difference in speed based on gender of adolescent students with hearing impairment.

Hypothesis (4i): There will be no significant difference in agility of adolescent students with hearing impairment based on gender following aerobic and progressive resistance exercise training.

Table 4.56: t-test showing difference in Agility based on gender following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post- Agility	Male Female	60 60	15.4063 16.7998	1.0320 1.2856	-6.547	118	.000	Sig.

Table 4.56 above indicates t-test comparison of agility of the participants based on gender.

The table reveals that male has the mean score of 15.4063±1.0320 while the female has the mean score of 16.7998±1.2856. The observed t indicating difference between genders is -6.547; P < 0.05. Since the P value is less than 0.05, the null hypothesis 4(i) is therefore rejected. This result therefore shows that there is a significant difference in agility based on gender of adolescent students with hearing impairment.

Hypothesis 5: There will be no significant difference in physiological and motor variables of adolescent students with hearing impairment, based on age following a 12 – week aerobic and progressive resistance exercise trainings.

Hypothesis 5(a): There will be no significant difference in resting systolic blood pressure of adolescent students with hearing impairment based on age following aerobic and progressive resistance exercise trainings

Table 4.57: t-test showing difference in Resting Systolic Blood Pressure based on age following aerobic and progressive resistance exercise trainings.

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Resting Systolic Blood Pressure	Early Adolescents	68	108.6029	7.7192	-1.365	118	.175	NS
	Late Adolescents	52	110.5769	8.0229				

Table 4.57 indicates t-test comparison of resting systolic blood pressure of the participant based on age. The result shows that early adolescents have mean score of 108.6029±7.7192 while late adolescents have mean score of 110.5769±8.0229. The t observed indicating the difference between age is -1.365; P, 0.05. Since P value is greater than 0.05, the null hypothesis 5(a) is therefore accepted.

Hypothesis 5(b): There will be no significant difference in resting diastolic blood pressure of adolescent students with hearing impairment based on age following aerobic and progressive resistance exercise trainings

Table 4.58: t-test showing difference in Resting Diastolic Blood Pressure based on age following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Resting Diastolic Blood Pressure	Early Adolescents	68	71.4706	4.4099	-1.741	118	.084	NS
	Late Adolescents	52	73.0769	5.7012				

Table 4.58 above indicates t-test comparison of resting diastolic blood pressure of the participants based on age. The table reveals that early adolescents have mean score of 71.4706±4.4099 while late adolescents have mean score of 73.0769±5.7012. The t observed indicating difference between age is .084; P < 0.05. Since the P value is greater than 0.05, the null hypothesis 5(b) is therefore accepted.

Hypothesis 5(c): There will be no significant difference in resting heart rate of adolescent students with hearing impairment based on age following aerobic and progressive resistance exercise trainings

Table 4.59: t-test showing difference in Resting Heart Rate based on age following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Resting Heart Rate	Early Adolescents	68	76.6912	4.8753	.-.653 .	118	.515	NS
	Late Adolescents	52	77.3462	6.1194				

The table above indicates t-test comparison of resting heart rate of the participants based on age. The table shows that early adolescents have the mean score of 76.6912±4.8753 while late adolescents have the mean score of 77.3462±6.1194. The t observed indicating difference between age is -.653; P < 0.05. Since the P value is greater than 0.05, the null hypothesis 5(c) is therefore accepted.

Hypothesis 5(d): There will be no significant difference in VO_2 max of adolescent students with hearing impairment based on age following aerobic and progressive resistance exercise trainings

Table 4.60: t-test showing difference in VO_2 max based on age following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-VO_2 max	Early Adolescents	68	47.1916	5.7942	-1.067	118	.288	NS
	Late Adolescents	52	48.3683	6.2235				

Table 4.60above indicates t-test comparison of VO_2 max of the participants based on age. The table shows that early adolescents have the mean score of 47.1916±5.7942 while late adolescents have the mean score of 48.3683±6.2235. The t observed indicating difference between age is -1.067; P < 0.05. Since the P value is greater than 0.05, the null hypothesis 5(d) is therefore accepted.

Hypothesis 5(e): There will be no significant difference in muscular endurance of adolescent students with hearing impairment based on age following aerobic and progressive resistance exercise trainings

Table 4.61: t-test showing difference in Muscular Endurance based on age following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Muscular Endurance	Early Adolescents	68	26.7353	3.5476	.249	118	.804	NS
	Late Adolescents	52	26.5577	4.2584				

Table 4.61 above indicates t-test comparison of muscular endurance of the participants based on age. The table shows that early adolescents have the mean score of 26.7353±3.5476 while the late adolescents have the mean score of 26.5577±4.2584. The t observed indicating difference between age is .249; P < 0.05. Since the P value is greater than 0.05, the null hypothesis 5(e)

is therefore accepted.

Hypothesis 5(f): There will be no significant difference in muscular strength of adolescent students with hearing impairment based on age following aerobic and progressive resistance exercise trainings

Table 4.62: t-test showing difference in Muscular Strength based on age following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Muscular Strength	Early Adolescents	68	27.9868	5.2111	-2.351	118	.020	Sig.
	Late Adolescents	52	30.6038	6.9874				

Table 4.62 above indicates t-test comparison of muscular strength of the participants based on age. The table shows that early adolescents have the mean score of 27.9868±35.2111 while the late adolescents have the mean score of 30.6038±6.9874. The t observed indicating difference between age is -2.351; $P < 0.05$. Since the P value is less than 0.05, the null hypothesis 5(f) is therefore rejected.

Hypothesis 5(g): There will be no significant difference in flexibility of adolescent students with hearing impairment based on age following aerobic and progressive resistance exercise trainings

Table 4.63: t-test showing difference in Flexibility based on age following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Flexibility	Early Adolescents	68	9.2206	3.6276	-.568	118	.571	NS
	Late Adolescents	52	9.6154	3.9514				

Table 4.63 above indicates t-test comparison of flexibility of the participants based on age. The table shows that early adolescents have the mean score of 9.2206±3.6276 while the

late adolescents have the mean score of 9.6154±3.9514. The t observed indicating difference between age is -.568; P < 0.05. Since the P value is greater than 0.05, the null hypothesis 5(g) is therefore accepted.

Hypothesis 5(h): There will be no significant difference in speed of adolescent students with hearing impairment based on age following aerobic and progressive resistance exercise trainings

Table 4.64: t-test showing difference in Speed based on age following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Speed	Early Adolescents	68	6.2134	.6180	-.934	118	.352	NS
	Late Adolescents	52	6.3354	.8127				

Table 4.64 indicates t-test comparison of speed of the participants based on age. The table reveals that early adolescents have the mean score of 6.2134±.6180 while the late adolescents have the mean score of 6.3354±3.8127. The t observed indicating difference between age is .352; P < 0.05. Since the P value is greater than 0.05, the null hypothesis 5(h) is therefore accepted.

Hypothesis 5(i): There will be no significant difference in agility of adolescent students with hearing impairment based on age following aerobic and progressive resistance exercise trainings

Table 4.65: t-test showing difference in Agility based on age following aerobic and progressive resistance exercise trainings

Source of variable	Gender	N	Mean	Standard Deviation	Cal-t	Df	P	Remark
Post-Agility	Early Adolescents	68	16.0134	1.2918	-.828	118	.409	NS
	Late Adolescents	52	16.2204	1.4385				

Table 4.65 above indicates t-test comparison of speed of the participants based on age.

The table reveals that early adolescents have the mean score of 16.0134±1.2918 while the late adolescents have the mean score of 16.2204±1.4385. The t observed indicating difference between age is -.828; $P < 0.05$. Since the P value is greater than 0.05, the null hypothesis 5 (i) is therefore accepted.

Discussion

The findings of this study reveal that there is a significant change in the resting systolic blood pressure of the participants exposed to the Aerobic Exercise (AE) and Progressive Resistance Exercise (PRE) trainings. This confirmed the report of Wilmore, Costill, and Kenney, 2008 that as a result of aerobic exercise bout systolic blood pressure (SBP) will typically increase to meet the metabolic demands of the tissues. This finding also support the report of Agrawal (2010) that blood pressure tends to increase as children age. The reason might be that the participants in this study are still growing and have not yet reach adulthood. The result showed no significant change in the diastolic blood pressure and this is in line with the findings of Pollock and Wilmore, 1994; Kenney, Wilmore and Costill, 2008) that diastolic blood pressure (DBP) will most likely stay the same, leading to the expansion of mean arterial pressure (MAP) and pulse pressure (PP). The participants' blood pressure 107.08/71.79 was considered normal within 110-135/65-85 rating of Kliegman (2007). This agrees with Aniodo's (2003) report that individuals may not usually have high DBP if their fitness level is average and their SBP is normal. The degree to which both SBP and DBP will be elevated seems to be linked to the relative intensity of the exercise (MacDougall et al. 1985).

Both AE and PRE show significant reduction in the resting heart rate of the participants. The resting heart rate of 77.01 bpm in this study was considered normal because it falls within normal heart rate level of 60-100 bpm for their age level. Generally, heart rate reduction following exercise training has been associated with exercise intensity (Rassier, 2000). Kravitz (1996) demonstrated a decrease in resting heart rate by 5 to 25 beats per minute after participating in aerobic endurance training, while Stone et al observed a reduction of up to 11% from baseline in heart rates of participants who engaged in supervised progressive resistance training. This study agrees with several studies (Arakawa, 1999; Bizley, 1999, McGLynn, 1999 and WHO, 2001) that exercise training lowers the resting heart rate.

Based on the findings of the study, AE and PRE have significant effect on VO_2 max of the participants which may be attributed to the intensity of training and which support the findings of Chad (2001) that training consistently for two to three times in a week or participation in severe interval training can increase VO_2 max as much as 40%. Studies also confirm that a linear increase occurs in VO_2 max over ten weeks of training and that a leveling off of the VO_2 max values after only a few weeks of training exist (Bizley, 1991; Getchell, 1993 and McGlynn, 1999). The tremendous increase observed in VO_2 max of the males (52.35m1/kg/min) further support the findings of Adams, 1998) that VO_2 max increase by an average of about 15% as a result of an endurance training, the largest increase are associated with de-conditioned or populations having very low pre-training VO_2 max values. This study therefore confirmed the finding above because the participants in this study were sedentary individuals.

AE and PRE significantly improve muscular endurance of the participants. It was evident in the study that AE increases muscular endurance more than progressive resistance exercises. This support the findings of Pollock and Wilmore (1994) that aerobic exercise increase skeletal muscle endurance and size as does high resistance exercise such as weight training. There is also significant difference in muscular strength of the participants in this study. Muscular strength is considered to be a very important health related component of physical fitness because a minimum level of strength is required by every individual which becomes detrimental to health anytime a lower level is maintained. Kaidal and Chado (1991) opined that even though nearly all movements are performed against some resistance, athletes perform movements against much greater resistance than normal. For example in the shot put, discus throw, pole vault, various gymnastic movements, jumping, running, swimming and leaping, the body segments must exert maximal force. The expression of muscular strength in a given test is likely to result from the interaction of the force developed by groups of muscles. A simplified representation of a joint served by an antagonist pair of muscles shows that the force associated with the contraction of the agonist is influenced by the activity of the antagonist. Therefore, the net force developed during a given movement depends on the degree of coactivation between the antagonist pair of muscles acting across a joint. This study therefore agrees with (Amiridis et al. 1996), that athletes exhibit less coactivation during muscular strength tests than sedentary people do, which may partly explain the greater strength values recorded for well-trained subjects.

The study reveals that AE and PRE also have significant effect on flexibility. Both exercise modes could be used to improve flexibility. This result agrees with Watson, (1993) that dynamic flexibility occurs in a joint as a result of contractions of muscles, which controls the joint. This type of flexibility is of greater concern in performance. It is essentially the inverse of viscosity and is an important determinant of other factors of athletic performance like speed.
It was revealed in the study that the AE group had a flexibility mean score of 9.95 while the PRE group had a mean score of 10.38. The two groups mean value falls under average score when compared with the norms. The result of this study also reveals that both AE and PRE have no significant effect on speed of adolescent students with hearing impairment. This did not support the findings of Chado, 1991 and Chad, 2002) that agility and speed can be improved with practice and training. The 12-week duration of training in this study did not bring about significant improvement in speed of the participants. Speed mean value of 6.24 and 6.13 were recorded for AE and PRE respectively. This value when compared with the norms shows that the participants have low speed level. The result of the study shows that there was no significant difference in the degree of hearing impairment and all the motor and physiological variables tested. This might be due to the fact that hearing impairment has nothing to do with physiological and motor performance.

Based on gender, the results show that there were significant differences in muscular endurance, muscular strength, flexibility speed and VO_2 max. The male participants in this study shows greater improvement in muscular endurance than the females. The male participants had a mean score of 28.77 while the female mean score was 24.55. The difference might result because male had better muscular endurance that is dependent on the quality of the muscles, the extensiveness of their capillary beds and the nerve mechanism supplying them. This result agrees with the findings of Fleck and Kraemer (1997) that males show more significant improvement in muscle endurance than females. In muscular strength the males had a mean score of 32.41 while the females had a mean value of 25.83. This result also supports the findings of Pollock and Wilmore (1994) that greater improvement in strength training was observed in male subjects than female subjects. Significant difference was observed in the speed between male and female participants. The male participants had a mean score of 5.92 while that of the female was 6.62. It was observed that females show significant improvement in flexibility. The females had flexibility mean score of 10.18 while the males had mean score of 8.60. This shows that female participants used in this study were more flexible than males. The reason might be that male had greater extensibility of the periarticular structures (e.g. muscles, tendon, fascia) which limit the amount of motion in a degree of freedom (DOF). A joint has range of motion (ROM) in each plane of movement in which that joint can rotate, known as a DOF. In the absence of joint pathology, ROM is often considered a measure of the extensibility of those periarticular structures. Extensibility of the particular structures is joint specific. It is generally accepted that flexibility is not a general characteristic of a person (Berryman, Reese and Bandy, 2002), but rather, is joint specific. Therefore, no one test can determine how “flexible” a person is.

The result shows that there was significant difference in the VO_2 max between male and female participants. The male participants had higher mean score value of 52.4 while that of the female was 41.05. This finding is in line with Maughan (1999), who found thatVO_2 max value in endurance athletes from weight bearing sports are usually well in excess of 75ml/Kg/min for males and > 70ml/Kg/min for females. In another study carried out by Maughan (1999), the VO_2 max of most elite male distance runner is greater than 70ml/kg/min and an elite female distance runner is greater than 65ml/kg/min. The higher a runner’s VO_2 max, the higher their peak running speed and the better their endurance performance potential. A high VO_2 max gives a runner the potential to be an elite middle and long distance runner, it is one of the key physiological factors that determine the average speed sustained during a race.

Based on age the result reveals significant difference only in muscular strength of the participants. This is because muscular strength increases with age until 25 years. The improvement in muscular strength occurs as a result of the training programme. This supports the findings of Amusa, Igbanugo and Toriola (1998) that an individual could develop his muscular endurance through the use of appropriate exercises.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

SUMMARY

The study examined the effects of two modes of exercise training programme on selected physiological and motor variables of adolescent students with hearing impairment in Ibadan metropolis. The physiological and motor variables studied for both male and female were resting systolic blood pressure, resting diastolic blood pressure heart rate, maximum oxygen uptake, muscular endurance, muscular strength, flexibility, speed and agility.

The two exercise modes used in this study were Aerobic Exercises (AE) and Progressive Resistance Exercises (PRE). The subjects for this study were one hundred and twenty in-school adolescents with hearing impairment (AE-40, PRE-40 and Control-40) between the ages of 12 and 18 years successfully completed the study.

To carry out this study research questions and five hypotheses were stated covering all the selected physiological and motor performance variables. The subjects were volunteers and were randomly assigned to two exercise groups, AE and PRE and a control group.

Prior to the main study a pilot study was conducted with twenty in-school adolescents with hearing impairment (10 males and 10 females) from I.M.G. Grammar School Sharp Corner, Oke-Bola, Ibadan. The experience acquired from the pilot study provided firsthand experience in field testing especially in testing the research instruments and to get familiar with the realities of the usage of the instrument in field situation.

The design used in this study was the randomized pretest-posttest control group design. One experimental group was subjected to an eight-station of aerobic exercise (AE) training, the other experimental group participated in another eight-station of progressive resistance exercise (PRE) training, while the third group which is the non-exercising group served as the control for the two experimental groups. The training lasted for 12-weeks with a frequency of three times per week. All the subjects were tested before and after treatment.

The data from the pretest and posttest were analyzed using Analysis of Covariance (ANCOVA) to compare the intergroup means and to determine if the treatment and control groups are significantly different. The Scheffe post hoc analysis was computed where F statistics was significant. Independent t-test was carried out to compare the training effects on the variables based on gender and age. Hypotheses were either accepted or rejected at 0.05 level of significance.

The result of the study shows that both aerobic and progressive resistance exercise trainings had significant effect on resting systolic blood pressure, heart rate, VO_2 max, muscular endurance, muscular strength, flexibility, and agility. The result also reveals that progressive resistance training had greater significant effect on heart rate, VO_2 max, muscular strength, flexibility and speed while aerobic exercise had more effect on systolic blood pressure, diastolic blood pressure, muscular endurance and agility. However, there were no significant difference in the degree of hearing impairment and all the variables tested among the three groups. Based on gender the results reveal that there were significant differences in muscular endurance, muscular strength, flexibility, speed, agility and VO_2 max. Based on age the results show that there was significant difference in muscular strength only.

Conclusion

Based on the result of this study the following conclusions were made:

1. Both aerobic and progressive resistance exercises had significant effect on resting systolic blood pressure, heart rate, VO_2 max, muscular endurance, muscular strength, flexibility and agility of the participants.
2. Aerobic exercise training had greater significant effect on resting systolic blood pressure, diastolic blood pressure, muscular endurance and agility while progressive resistance exercise training had more significant effect on heart rate, VO_2 max, muscular strength, flexibility and speed of the participants.
3. There were no significant effects of the two modes of exercise training and degree of hearing impairment on selected physiological and motor variables.
4. Aerobic exercise and progressive resistance exercise training programmes have similar effect in maintaining the level of diastolic blood pressure

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Aerobic and progressive resistance exercises should be encouraged by physical educators and exercise physiologists in designing exercise fitness programme for in-school adolescents with hearing impairment.
2. Institutions for hearing impairment should be encouraged to design simple exercises for in-school adolescents with hearing impairment so as to encourage them participate during their leisure time.
3. Physical education teachers should encourage students with hearing impairment to take part in practical physical education classes so as to improve their level of physical fitness.
4. It is recommended that similar study should be carried out using subjects of similar age and sedentary life style in other schools for students with hearing impairment.
5. The relationship between aerobic and progressive resistance exercises should provoke more studies in Nigerian population.
6. The government should provide sports equipment and facilities in all schools for students with hearing impairment. This would enable them participate freely in physical education classes and during their leisure time.
7. The ministry of education should also make the teaching of practical physical education compulsory in all schools for students with hearing impairment.

Contribution to knowledge

The result of this study serves as a base line data for physiological and motor performance variables of adolescent students with hearing impairment in Ibadan metropolis.

This study has established that aerobic and progressive resistance exercise trainings could improve physiological and motor performance variables of in-school adolescents with hearing impairment.

The result of the study also established the fact that aerobic exercise training was more superior to progressive resistance exercise in improving resting systolic blood pressure, diastolic blood pressure, muscular endurance and agility while progressive resistance exercise was superior to aerobic exercise in improving muscular strength, flexibility, speed, heart rate and VO_2 max of the participants.

The result of the study also established the fact that the two modes of exercise training and degree of hearing impairment had no significant effect on selected physiological and motor variables.

REFERENCES

Aagaard, P. & Andersen, J.I. 1998. Correlation between contractile strength and myosin heavy Chain isoform composition in human skeletal muscle. *Medicine and Science in Sports and Exercise* 30: 1217-1222.

Adams, G. M. & Beams, W. 2008. *Exercise Physiology Laboratory Manual,* 5th ed. Boston:McGraw Hill.

Adams, G. M. 1998. Exercise Physiology Laboratory Manual. 3rd ed. Boston: McGraw-Hill.

Afolabi, O. A., Alabi, B. S., Segun-Busari, S. & Aremu, S. K. (2012). *Conductive Hearing Loss Due to Trauma, Hearing Loss,* Dr. Sadaf Nas (Ed.) In Tech, Available from : http://www.intechopen.com/books/hearing-loss/-conductive-hearing-loss-due-to-trauma. Retrieved 16/02 2014.

Agrawal, S. 2010. Normal vital signs in children: Heart Rate, Respiration, Temperature and Blood pressure Complex child E. Magazine Available online (a) www.Complex child.com. Retrieved 17/01/2011

Ajidua, A. O. 1990. Lack of adequate endurance training: the bane of Nigerian soccer. Journal of Nigerian Association of Sports Science and Medicine.

Akinbo, S.R.A. & Giwa, O.O. 2002. Cardi respiratory responses to exercise rehabilitation in hemiplegic patients with cardiovascular accident. *Journal of the Nigerian Medical Rehabilitation Therapist 7:1.*

Alade, E.B. 2005. Hearing Impairment. In J.N. Onwuchekwa,. (Ed.). A *Comprehensive Textbook of special Education. Ibadan:* Agbo Areo Publishing Ltd.

Allen, D.G., Lamb, G.D. & Westerblad, H. 2008. Skeletal muscle fatigue: Cellular mechanisms. *Physiology Reviews* 88: 287-332.

American Academy of Orthopedic, (AAO). 2002. Your Orthopedic Connection; http://orthoinfo.aaos=wellness.Retrieved 20/04/2010

American College of Sports Medicine, (ACSM), 1990. The recommended quantity and quality of exercise for developing and maintaining cardiorespirtory and muscular fitness in health adults. *Medicine and Science in Sports and Exercise.* 22.265-274.

_______ (ACSM), 1999. Guidelines for exercise testing and prescription. Available on line www.acm.org. Retrieved 10/02/2006

_______ (ACSM). 2000. Guidelines for exercise testing and prescriptions. Available on line www.acsm.org. Retrieved 12/01/2006

Amiridis, I.G., Martin, A., Morlon, B., Martin, L., Cometti, G., Pousson, M. & Van Hoecke, J. 1996. Co-activation and tension-regulating phenomenon during isokinetic knee extension in sedentary and highly skilled humans. *European Journal of Applied Physiology* 73: 149-156.

Amusa, L.O. & Abass, A. O. 1995. *Physiology for physical conditioning, Ibadan.* External studies unit, University of Ibadan.

_____ Igbanugo, V.C. & Toriola, A.L. 1998. *Experiments and laboratory experiences in exercise physiology, (2*nd ed). Nigeria: LAP Publication Limited.

Aniodo, D.O. 2003. Comparative effects of two modes of aerobic training on the cardiorespiratory endurance indices of Police Trainees at Iperu, Ogun State, Nigeria.

Arakawa, A. 1999. Exercises: A measure to lower blood pressure and reduce other risks. *Clinical and Experimental Hypertension:* 21 (5).297.

Ariba, A.J. 2000. Female life and sexuality education: An overview. *Nigerian School Health Journal:* 12.1-10.

Balbach, L. 2002. Interval step aerobics/muscle-conditioning class. Httpii/k2.kirtland.cc.mi.us/-2002. What is aerobic exercise and why should you do it? http:lik2.kirtland.cc.mi.us/-balbach//aerobic.

Baldwin, K.M. & Haddad, F. 2001. Effects of different activity and inactivity paradigms on myosin heavy chain gene expression in striated muscle. *Journal of Applied Physiology* 90: 345-357.

Barker, L. J. 2003. Computer-assisted vocabulary acquisition: The CSLU vocabulary tutor in oral-deaf education. Journal of deaf Studies and Deaf Education, 8, 187-198.

Baumagartner, J.A. & Jackson, A.S., (1991). *Measurement for evaluation in physical education. (3rd ed). Dubuque, Lowe: WMC Brown Group.*

Baumgartner, J.A. & Jackson, A.S. 1999. *Measurement for evaluation in physical education and exercise science* (6th ed). Boston; WCB McGraw-Hill.

Behm, D.G., Button, D.C. & Butt, J.C. 2001. Factors affecting force loss with prolonged stretching. *Canadian Journal of Applied Physiology* 26: 262-272.

Berryman, Reese, N. & Bandy,W.D. 2002. Joint Range of Motion and Muscle Length Testing. Philadephia: W.B. Saunders.

Bishop, D. 2003. Warm-up I. Potential mechanism and the effects of passive warm-up on exercise performance. *Sports Medicine* 33: 439-454.

Bizley, K. 1999. *Examining physical education. (4th ed).* Oxford: Heinemann Education Publishers.

Bottinelli,R. & Reggiani, C. 2000. Human skeletal muscle fibers: Molecular and functional diversity. *Progress jn Biophysics and Molecular Biology* 73: 195-262.

Bosquet, I., Leger, I. &Legros, P. 2002. Methods to determine aerobic endurance. *Sports Medicine* 32: 675-700.

Brown, D.A., Kautz,S.A. & Dairaghi, C.A. 1996. Muscle activity patterns altered during pedaling at different boy orientations. *Journal of Biomechanics* 29: 1349-1356.

Brownley, K.A., West, S.G. Hinderliter, A.L. & Light, K.C. 1996. Acute aerobic exercise in borderline hypertensive men and women. *American Journal of Hypertensive:* 9(3): 200-206.

Brymen, A. 2001. *Social research method.* Oxford: Oxford University Press.

Bucher, C.A. 1979. *Foundation of physical and health education* (7th ed.) St. Louis, Toronto, London: The C.V. Mosby Company.

Butterfield, S. A. 1987. The influence of age, sex, hearing loss, etiology, and balance ability on the fundamental motor skills of deaf children. In M.E. Berridge and G.R. Ward (Eds.). *International perspectives on adapted physical activity* champaign, IL: Human Kinectics. pp. 43-51.

Campbell, M.E. 1983. *Motor fitness characteristics of hearing impaired and normal hearing children.* Unpublished Master's thesis, Northeastern University.

Canadian Fitness and Lifestyle Research Institute, (CFLRI), 2000. Physical activity monitor http//www.eflri.ca/cflri/pa/surveys/2000 survey. htmc.

Carr, S. 2002. The influence of significant others on the goal orientations of youngster. *Journal of sports behaviour* 6-8

Chad, T. 2002. Cardiovascular exercise-principles and guidelines Brain Barton Jumpsite.www. Empiregym.net.

Chado, M. A. 1991. *Physilogical basis of physical fitness and conditioning. Zaria: ABU Press Ltd.*

Chapman, A. 2008. *Biomechanical Analysis of Fundamental Human Movements*. Champaign, IL: Human Kinetics.

Crompton, J. L., Lamb, C.W. & Vedlitz, A. 1979. Age and sex difference among adolescent participants in outdoor recreation activities. *Research Quarterly*: 50 (4).589-598.

Corbin, C. B. & Lindsey, R. 1997. *Concept of physical fitness.* (9th ed). Dubuque. IA: NM.C. Brown.

Cotterman, M. L., Darby, L. A. & Skelly, W. A. 2005. Comparison of muscle force production using the Smith machine and free weights for bench press and squat exercises. *Journal of Strength and Conditioning Research* 19: 169-176.

Crowe, W. C., Auxter, D. & Pyfer, J. 1994. *Principles and Methods of Adapted Physical Education and Recreation.* (4th ed.) London: The C.V. Mosby Company.

Cureton, K. J., Stoniger, M. A., Bannon, J. P., Black, D. M. & McCormack, W. P. 1995. A generalized equation for prediction of Vo2 peak from 1-mile run/walk performance. *Medicine and Science in Sports and Exercise* 27: 445-451.

Dair, J., Ellis, M. K. & Lieberman, L. J. 2006. Prevalence of overweight among deaf children. *American Annals of the deaf,* 151 (3), 318-326

Daniel, E.L. 1998. A multi-intervention weight management programme for low-income rural women. *Journal of American Dietetic Association.* 89:1311.

Demichele, P.D., Pollock, M.L & Graves, J.E. 1997. Effect of training frequency on the development of isometric torso rotation strength. *Arch Psy. Med. Rehabilitation* 28 (1):64-67.

Dolores, G. 1978. Motor development profiles of preschool deaf and hard-of-hearing children. *Perceptual and Motor Skills*. Vol. 46 pp. 291-2244 dol: 10.2466/pms.1978.46.

Dunchateau, J., Semmler, J.G. & Enoka, R.M. 2006. Training adaptations in the behaviour of human motor units. *Journal of applied Physiology* 101: 1766-1775.

Ellis, K., Butterfield, S. A., & Lehnhard, R. 2000. Grip-strength performances by 6-to-19 year old children with and without hearing impairments. *Perceptual and motor skills,* 90, 279-282.

Ellis, K., Lieberman, L., Fittipauldi-Wert, J. & Dummer, G. (2005). Health-Related fitness of deaf children. How do they measure up? *Palaestra,* 21(3) 36-43.

Faigenbaum, A., 2000. Age and sex related differences and their implications for resistance exercise. *National Strength and Conditioning Association.* (2): 169-186.

Faith, H. F. 1991. *Special Physical Education, Adapted, Corrective Developmental*. Saunders Colleges' Publisher, Washington D. C. 71-85

Famen,F. 2003. Introducing sex education to adolescents. www.voanews.com/englishtoafrica/education.Retrieved 14/07/2008

Falaye, A.O. 2001. *Human life span development: A basic text in developmental psychology*. Ibadan: Stirling-Horden Publishers (Nig) Ltd.

Faulkner, J.A. 2003. Terminology for contraction of muscles during shortening, while isometric, and during lengthening. *Journal of Applied Physiology* 95: 455-459.

Fayombo, G.A. 2004. *Human development across life span.* Ibadan: Alafas Nigeria Company.

Fieldman, R.S. 2000. *Essentials of understanding psychology.* Boston: McGraw-Hill.

Finni, T., Ikegawa, S. & Komi, P.V. 2001. Concentric force enhancement during human movement. *Acta Physiologica Scandinavica* 173: 369-377.

Fleck, S. J. & Kraemer, K.J. 1997. *Designing Resistance Training Programme.* 2nd ed. Champaign, 111: Human Kinetics.

Foss, M. & Keteyian, S. 1998. *Fox's physiological basis for exercise and sport.* Dubuque:McGraw-Hill.

Fox, E. L. & Mathew, D.K. 1981. *Physiological basis of physical education and athletics.* (3rd ed.). Philadelphia: Saunders Publishing Co.

Getchell, D. 1993. *Physical fitness: A way of life.* (3rd ed). New York; John Willey and Sons Inc.

Gettman, L. R. 1993. The effects of circuit weight training on strength, cardiorespiratory function and body composition of adult men. *Med. Sci. Sports* 10: 171 – 176.

Goodman, J., & Hopper, C. 1992. Hearing impaired children and youth: A review of psychomotor behaviour. *Adapted Physical Activity Quarterly*, 9, 214-236.

Guette, M., Gondin, J. & Martin A. 2005. Time-of-day effect on the torque and neuromuscular properties of the dominant and non-dominant quadriceps femoris. *Chronobiology International* 22: 541-558.

Guyton, A.C. & Hall, J.E. 1996. *Textbook of Medical Physiology*. W.B. Saunders Company.

Haff, G.G. & Dumke, C. 2012. *Laboratory manual for exercise physiology.* USA: Human Kinetics Champaign, IL

Hands, B. & Larkin, D. 1997. Gender bias in measurement of movement. *The ACPHER Health lifestyles Journal* 44(1), 12-16

Hanson, S. P. 2009. Rationale for Sports and Physical Education Programmes for the Handicapped. *Scottish Journal of Physical Education* 18, 9-13

Harman, E. 2008. Administration, Scoring and Interpretation of Selected Tests. In: Baechle T. R. and Earle, R. W., eds., *Essentials of Strength Training and Conditioning.* 3rd ed. National Strength and Conditioning Association. Champaign, IL: Human Kinetics.

Harry, J.D., Ward, A.W., Heglung, N.C., Morgan,D.L. & McMahon, T.A. 1990. Cross-bridge cycling theories cannot explain high-speed lengthening behavior in frog muscle. *Biophysics Journal*

Heyward, V. H. 2002. *Advanced fitness assessment and exercise prescription.* (4th ed.). United State of America; Human Kinetics.

Hockey, R.V. 1993. *Physical fitness: Pathway to healthful living.* (7th ed.). St. Louis: Mosby-Year Book Inc.

Hodgson, M., Docherty, D. & Robbins, D. 2005. Post-activation potentiation: Underlying physiology and implications for motor performance. *Sports Medicine* 35: 585-595.

http://www.brianmac.co.uk/illinois/agility.htm. Retrieved 23/08/2009

http://www.crossfiteastsac.com/burpee/norm Retrieved 23/08/2009

http://www.topendsports/sitandreach.com Retrieved 23/08/2009

Hutzler, Y & Sherrill, C. 2007. Defining Adapted Physical Activity: International Perspectives. *Adapted Physical Activity Quaterly* 24(1): 1-20

Ichinose, Y., Kanchisa, H., Ito, M., Kawakami, Y. & Fukunaga, T. 2000. Relationship between muscle fiber pennation and forced generation capabilities in Olympic athletes. *International Journal of Sports Medicine* 19: 541-546.

Igbanugo, V.C. 1987. Physiological determinants of athletic performance. *Nigeria Association for Sports Science and Medicine* (NASSM).

Igbanugo, V.C. 2000. *Physiology of Human Activity.* Center for external studies University of Ibadan.

Jackson, A.S. & Ross, R.M. 1997. *Understanding exercise for health and fitness* (3rd ed). Dubuque: Kendall/Hurt Publishing Co.

Jeffreys, I. 2008. Warm-up and stretching. In *Essentials of Strength Training and Conditioning*, edited by T.R. Bacchle and R.W. Earle, 295-324. Champaign, IL: Human Kinetics.

Jenson, C.R & Fisher, A.C. 1984. *Scientific basis of athletic conditioning.* Philadelphia: Lea and Fabiger.

Jewkes, F., Lubas, P. & McCusker, K. 2005. Advanced Paediatric Life Support: The Practical Approach, (5th ed.). Advanced Life Support Group, Blackwell Publishing Group. ISBN 0-7279-1847-8

Johnson, B.L. & Nelson, J.K. 1979. *Practical measurements for evaluation in physical education* (3rd ed). Minneapolis: Burgess Publishing Co.

Kagan, J. & Sega, J. 1988. *Psychology: An introduction.* (6th ed). San Dicgo: Harcourt Brace Jovanovic Publishers.

Kaidal, A & Chado, M.A. 1991. Athlete groups and cardiorespiratory performance in different distance run tests. In L.O. Amusa (ed.) *Sports Science and Medicine.* 1:238-242.

Karchmer, M.A. & Mitchell, R.E. 2003. *Demographic and achievement characteristics of deaf and hard of hearing students.* In M. Marschark & P.E. Spence, (Eds.). Oxford Handbook of deaf studies, Language and education (p.21-37). New York: Oxford University Press.

Kawakami, Y., Abe, T. & Fukunaga, T. 1993. Muscle-fiber pennation angles are greater in hypertrophied than in normal muscle. *Journal of Applied Physiology* 74: 2740-2744.

Kawakami, Y., Ichinose,Y., Kubo, K., Ito, M., Imai, M. & Fukunaga, T. 2000. Architecture of contracting human muscles and its functional significance. *Journal of Applied Biomehanics* 16: 88-98.

Kenney, W. L., Wilmore, J. H. & Costill, D. L. 2012. *Physiology of Sport and Exercise.* 5th ed. Champaign, IL: Human Kinetics.

Kirkendally, D.R., Gruber, J.J. & Johnson, R.E. 1987. *Measurement and evaluation for physical education,* (2nd ed.) United State of America: Human Kinetics Publishers INC.

Kliegman, R.M. 2007. *Nelson Textbook of Pediatrics.* (18th ed). Philadelphia: Saunders Elsevier, 389.

Kokkonen, J., Nelson, A.G. & Cornwell, A. 1998. Acute muscle stretching inhibits maximal strength performance. Research Quarterly for Exercise and Sports 69: 411-415.

Komi, P.V. 2003. Stretch-shortening cycle. *In strength and power in sport,* edited by P.V. Komi. Oxford, U.K: Blackwell Science Ltd.

Leiber, I. 2002. Skeletal *Muscle Structure, Function, and Plasticity. The Physiological Basis of Rehabilitation.* Baltimore: Lippincott Williams and Wilkins.

Lockwood, R. 2010. Physical Education and Disabilty. Australian Council for Health, Physical Education and Recreation, Parkside S. A. Australia 37-42.

Longmuir, P. E., & Bar-or, O. 2000. Factors influencing the physical activity levels of youth with physical and sensory disabilities. *Adapted Physical Activity Quarterly*, 17, 40-53.

MacDougall, J.D., Tuxen, D., Sale, D.G., Moroz, J.R. & Sutton, 1985. Arterial blood pressure response to heavy resistance exercise. *Journal of Applied Physiology.* (Bethesda, MD: 1985) 58 (3) (03): 785-790.

Maclntosh, B.R., Gardiner, P.F. & McComas, A.J. 2006. *Skeletal Muscle: Form and Function.* Champaign, II: Human Kinetics.

Maughan, R.J. 1999. *Basic and Applied Sciences for Sports Medicine* (1st ed). Oxford: Butterworth Heinemann.

Mba, P.O. 1995. *Fundamental of Special Education and Vocational Rehabilitation.* Ibadan: Codat Publications.

McComas, A.I. 1996. *Skeletal Muscle: Form and Function.* Champaign, IL: Human Kinetics.

McGlynn, G. 1999. *Dynamic of fitness: A practical approach,* (5th ed). Boston: WCB McGraw.

Miller, T. 2012. *NSCA'S Guide to Tests and Assessments*. United States: Human Kinetics.

Morgan, D. 1990. New insight into the behavior of muscle during active lengthening. *Biophysics Journal* 57: 209-221.

Moritz, C.T., Barry, B.K., Pascoe, M.A. & Enoka, R.M. 2005. Discharge rate variability influences the variation in force fluctuations across the working range of a hand muscle. *Journal of Neurophysiology* 94: 2449-2459.

Moronkola, O.A. & Aremu, A.O. 2004. *Contemporary issues and researches on adolescents.* In I. A. Nwazuoke, Y. Bamgbose &O. A. Moronkola (Eds.). Royal People (Nigeria) Ltd. Ibadan.

Nam, D.H. 2003. Cardiovascular-respiratory endurance test equating. *Journal of the International Council for Health, Physical Education, Recreation, Sport and Dance* (ICHPER-SD). 39 (1):55-59.

Nicol, C., Avela, J. & Komi, P.V. 2006. The stretch-shortening cyle. A model to study naturally occurring neuromuscular fatigue. *Sports Medicine* 36: 977-999.

Nicolas, A., Gauthier, A., Bessot, N., Moussay, S. & Davenne, D. 2005. Time-of-day effects on myoelectric and mechanical properties of muscle during maximal and prolonged isokinetic exercises. *Chronobiology International* 22: 997-1011.

Nwankwo, E.I., 1996. *Applied Anatomy and Physiology.* Ibadan:Sibon Books Ltd.

Onwuchekwa, J. N. 1992. *The education of the hearing impaired*. Ibadan: Department of Adult Education, University of Ibadan.

Onwuchekwa, J. N. 2005. A *Comprehensive Text of Special Education. Ibadan:* Agbo Aero Publishers.

Okuoyibo, J. M., Oyewumi, A. M. & Adediran, D. A. 2007. *An Introduction to the Education of Children with Special Needs*. Ibadan: Emola-Jay Communications (INC).

Otinwa, G.O., 1998. Changes in hematological health and performance related variables of rehabilitated male drug addicts following structured exercise programme. Ph.D. Thesis. Human Kinetics and Heath Education Department, University of Ibadan.

Owolabi, E.O., 1985. An investigation of selected physical physiological and motor performance requirement of volleyball players. Unpublished Ph.D. thesis. University of Birmingham, United Kingdom.

Oya, T., Rick, S. & Cresswell, A.G. 2009. Recruitment and rate coding organization for soleus motor units acrossentire range of voluntary isometric plantar flexions. *Journal of Physiology* 587: 4737-4748.

Paillard, T., Noc, P., Passelergue, P. & Dupui, P. 2005. Electrical stimulation superimposed onto voluntary muscular contraction. *Sports Medicine* 35: 951-966.

Peltzer, K., Phaswana, M. & Promtussananon, S. 2002. Physical activity among rural black South African children. *African Journal for Physical, Health Education Recreation and Dance*, (AJPHERD): 8 (2).

Pender, R. H., & Patterson, P.E 1982. A comparison of selected motor fitness items between congenitally deaf and hearing children. *The Journal for special Educators,* 18(4), 71-75.

Pollock, M.L. & Wilmore J.H. 1994. *Exercise in health and disease.* (3rd ed). Philadelphia: W.B. Saunders.

Pollock, M.L. & Vincent, K.R. 1996. Resistance Training For Health. *The President's Council on Physical Fitness and Sports Research Digest.* Services 2, No 8..

Prentice, W.E. 1997. *Fitness and wellness for life.* (4th ed). Boston: WCB McGraw-Hill.

Pratley, R, Nicklas, B, Rubin, M; Miller, J, Smith,. A; Smith, M, Hurley, B, & Goldberg, A. 1994. Strength training increases resting metabolic rate and norepinephrine levels in healthy 50-65 years old men. *J. Appl. Physiol.* 76:133-137

Rassier, D.E. 2000. The effects of length on fatigue and twitch potentiation in human skeletal muscle. *Clinical Physiology* 20:474-482

Rassier, D.E., Maclntosh, B.R. & Herzog, W. 1999. Length dependence of active force production in skeletal muscle. *Journal of Applied Physiology* 86: 1445-1457.

Reeves, N.D. & Narici, M.V. 2003. Behaviour of human muscle fascicles during shortening and lengthening contractions in vivo. *Journal of Applied Physiology* 95: 1090-1096.

Robbins, D. 2005. Postactivation potentiation and its practical applicability: A brief review. *Journal of Strength and Conditioning Research* 19: 584-592.

Rubini, E.C., Costa, A.I.I. & Gomes, S.C. 2007. The effects of stretching on strength performance. *Sports Medicine* 37: 213-224

Safrit, M.J. & Wood, T.M., 1995. *Introduction to measurement in physical education and exercise science.* (3rd ed.) St. Louis: Mosby Company.

Shephard, R., Ward, R., & Lee, M 1987. Physical ability of deaf and blind children. In M.E. Berridge & G. R. Ward (Eds.). *International perspectives on adapted physical activity* . Champaign, IL: Human kinectics pp. 355-362.

Shephard, R. 1991. How much physical activity is needed for good health. *International Journal of Sports Medicine*, 20: 23-27

Sharkey, B. J. & Gaskill, S. 2007. *Fitness and Health.* 6th ed. Champaign, IL: Human Kinetics.

Siff, M.C. 2000. *Supertraining.* Denver: Supertraining Institute.

Silverman. E., 1998. *Effectively educating students with hearing impairment.* White Plains, Ny: Longman.

Steinberg, L., 1996. *Adolescence.* (4th ed.) New York: McGraw-Hill.

Stewart, D. A, & Ellis, M. K., 1999. Physical education for deaf students. *American Annals of the Deaf*, 144, 315-319.

Stewart, D. A. & Ellis, M.K. 2005. Sports and the deaf child. *American Annals of the Deaf.* 150(1) 59-66.

Stewart, R.D., Duhamel, T.A., Rich, S., Tupling, A.R. & Green, H.J. 2008. Effects of consecutive days of exercise and recovery on muscle mechanical function. *Medicine and Science in Sports Exercise* 40: 316-325.

Stienen, G.J.M., Kiers, J.I., Bottinelli, R. & Reggiani, C. 1996. Myofibrillar ATPase activity in skinned human skeletal muscle fibres: Fibre type and temperature dependence. *Journal of Physiology* 493: 299-307.

Stone, M.H., Fleck, S.J., Triplett, N.T. & Kramer, W.J. 1991. Health and performance related potential of resistance training. *Sports Medicine.* 11:210-231.

Stone, M.H., Stone, M. & Sands, W.A. 2007. *Principles and Practice of Resistance Training.* Champaign, II: Human Kinetics.

Suarau, M. A. 1992. *Motor performances skills of the hearing-impaired, followed A 12-Weeks training programme*. Unpublished Ph.D Thesis University of Ibadan, Ibadan. Nigeria.

Thomas, J.R. & Nelson, J.K. 2001. *Research methods in physical activity.* (4th ed.) United States of America: Human Kinetics.

Thompson, P.D., Franklin, B.A., Balady, G.J., Blair, S.N., Corrado, D., Estes, N., Mark III, N.A. & Fulton, J.F. 2007. Exercise and acute cardiovascular events placing the risks into perspective: A scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism and the Council on Clinical Cardiology Circulation 115 (117) (05/01): 2358-2368.

Vance, B. 1968. *Motor characteristics of deaf children*. (Doctoral dissertation, Colardo State College). Dissertation Abstracts International, 68-74,746.

Venes, D. 2009. *Taber's Cyclopedic Medical Dictionary,* 21st ed. Philadephia: F.A. Davis.

Verducci, F.M. 1980. *Measurement concepts in physical education.* St. Louis: The C.V. Mosby Company.

Watson, A.W.S. 1993. *Physical fitness and athletic performance.* England: Longman Group Limited.

Wilmore, J. H. & Costill, D. L. 1994. *Physiology of sports and exercise.* New Zealand. Human Kinetics.

Winnick, J. P. & Short, F. X. 1986. Physical fitness of adolescents with auditory impairments. *Adapted Physical Activity Quarterly*, 4, 87-95.

World Health Organization (WHO), 2001. International, Classification of Functioning, Disability and Health Geneva, Switzerland: Available online @ http://www.who.in/icf/icftemplate.cfm. Retrieved 27/04/2008.

World Health Organization (WHO), 2005. *Hearing Impairment in Children: New understanding, New hope.* The World Health Report. Geneva: World Health Organization.

Young, W.B., & Behm, D.G. 2002. Should static stretching be used during a warm-up for strength and power activities? *Strength and Conditioning Journal* 24: 33-37

Zatsiorsky, V.M. 1995. *Science and Practice of Strength Training.* Champaign, IL: Human Kinetics.

APPENDIX I

INFORMED CONSENT FORM

Dear students,

I am a doctoral candidate intending to carry out a study on effects of two modes of exercise training programme on selected physiological and motor variables of adolescent students with hearing impairments in Ibadan Metropolis.

This study will require you to participate in a training programme three times per week for twelve weeks. You will be tested before and after the programme to find out the effects of these exercises training programme on selected physiological and motor variables.

I want you to respond to the part below.

Thanks for your anticipated co-operation.

Yours Faithfully,

Abayomi Olawumi

I understand that the purpose of this study is to participate in a 12- week aerobic exercise training programme/resistance exercise training programme. I confirm that my participation is entirely voluntary. I am not forced in any way to cooperate. I have been informed of the procedures involves and my duties as a participant. I wish to give my co-operation.

……………….	……………………	………………
Code	**Date of birth**	**Sex (Gender)**

…………………
Signature/date

APPENDIX II

DATA COLLECTION FORM

Name :……………………………………………………………………………………..

Name of School:…………………………………………………………………………..

Class: ………………………………………………………………………………………

Degree of hearing loss: ……………………………………………………………………….

Age: ……………………………………………………………………years

Gender …………………………………………………………………

Height …………………………………………………………………cm

PHYSIOLOGICAL VARIABLES

Blood Pressure ………………………………………………………mmHg.

Heart Rate ……………………………………………………………bpm

Vo2 max ……………………………………………………………..(Ml/kg/min)

MOTOR VARIABLES

Muscular Endurance ………………………………………………..rpm

Muscular Strength …………………………………………………..kg

Flexibility ……………………………………………………………cm

Speed ………………………………………………………………….Sec

Agility ………………………………………………………………….Sec

APPENDIX III

AEROBIC EXERCISE TRAINING PROGRAMME

Exercise modality and stations

Station one	-	Running on the spot
Station two	-	Push-ups
Station three	-	Step Ups
Station four	-	Hip stretch/rotation
Station five	-	Cycling in the air
Station six	-	Alternate toe touch
Station seven	-	Rope skipping
Station eight	-	Jog-walk

SCHEDULE FOR THE 12 –WEEK TRAINING

Week 1

Frequency of training	:	3 sessions per week
Warm up	:	2 minutes
Performance per aerobic station	:	40 seconds
Number of cycles	:	2
Rest time between stations	:	15 seconds
Cool down	:	2-3 minutes
Maximum total time per session	:	21 minutes

Week 2

Frequency of training	:	3 sessions per week
Warm up	:	2 minutes
Performance per aerobic station	:	45 seconds
Number of cycles	:	2
Rest time between stations	:	15 seconds
Cool down	:	2-3 minutes
Maximum total time per session	:	29 minutes

Week 3 and 4

Frequency of training	:	3 sessions per week
Warm up	:	2 -3minutes
Time allowed per aerobic station	:	50 seconds
Number of cycles	:	2
Rest time between stations	:	15 seconds
Cool down	:	2-3 minutes
Maximum total time per session	:	31 minutes

Week 5 and 6

Frequency of training	:	3 sessions per week
Warm up	:	2 minutes
Time allowed per aerobic station	:	45 seconds
Rest time between stations	:	15 seconds
Number of cycles	:	3
Cool down	:	2-3 minutes
Maximum total time per session	:	31 minutes

Week 7 and 8

Frequency of training	:	3 sessions per week
Warm up	:	2 minutes
Time allowed per aerobic station	:	50 seconds
Rest time between stations	:	15 seconds
Number of cycles	:	3
Cool down	:	2-3 minutes
Maximum total time per session	:	40 minutes

Week 9 and 10

Frequency of training	:	3 sessions per week
Warm up	:	2 minutes
Time allowed per aerobic station	:	40 seconds
Rest time between stations	:	15 seconds
Number of cycles	:	4
Cool down	:	2-3 minutes
Maximum total time per session	:	41 minutes

Week 11 and 12

Frequency of training	:	3 sessions per week
Time allowed per aerobic station	:	45 seconds
Warm up	:	2 minutes
Rest time between stations	:	15 seconds
Number of cycles	:	4
Cool down	:	2-3 minutes
Maximum total time per session	:	45 minutes

Adapted from Hockey (1993)

APPENDIX IV

PROGRESSIVE RESISTANCE TRAINING PROGRAMME

This training prgoramme adopted the progressive resistance principle of Heyward (1991) where there will be periodic increase in the workload to continue over loading the muscle throughout the training programme

Stations and Exercise Modalities

Station one	-	Hip Raiser
Station two	-	Push-ups
Station three	-	Sprinting
Station four	-	Bench Steps
Station five	-	Pull-ups
Station six	-	Sit-ups
Station seven	-	Burpee
Station eight	-	Skipping

Exercise Prescription

Frequency – 3 times a week

Performance Time per station - 45 seconds

Recovery Period - 15 seconds

Station/Circuit = 8 exercise station, clockwise order.

Circuit/session = 3

Time/circuit: 8 minutes

Time/session: 24 minutes

Duration: 12 weeks

Work Intensity will be adjusted fortnightly as below:

	WEEKS						
Exercise	**1-2**	**3-4**	**5-6**	**7-8**	**9-10**	**11-12**	
Hip Raiser	10	12	16	25	35	45	
Push-ups	8	12	20	26	35	40	
Sprinting	20	30	40	50	60	70	
Bench steps	16	20	26	31	36	42	
Pull- ups	8	12	16	25	30	25	
Sit- ups	10	12	16	25	30	25	
Burpee	8	10	20	30	35	42	
Skipping	40	50	60	70	80	90	
INTENSITY	65%	70%	75%	80%	85%	90%	HR Max
	I.RM	I.RM	I.RM	I.RM	I.RM	I.RM	

APPENDIX V

Normative Data for Blood Pressure

Age	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Premature	55-75	35-45
0-3 months	65-85	45-55
3-6months	70-90	50-65
6-12months	80-1009	55-65
1-3 years	90-105	55-65
3-6years	95-110	60-75
6-12years	100-120	60-75
Over age 12	110-135	65-85

Source: Kliegman (2007)

APPENDIX VI

Normative Data for Heart Rate

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

Source: Jewkes, Luba and Mccusker (2005)

APPENDIX VII

Normative Data VO_2 max values for females as measured in Ml/kg/min

Age	Poor	Fair	Good	Excellent	Superior
13-19	25.0-30.9	31.0-34.9	35.0-38.9	39.0-41.9	<41.9
20-29	23.6-28.9	29.0-32.9	33.0-36.9	37.0-41.0	> 41.0
30-39	22.8-26.9	27.0-31.4	31.5-35.6	35.7-40.0	>40.0
110.49	21.0-24.4	24.5-28.9	29.0-32.8	32.9-36.9	>40.0
50-59	20.2-22.7	22.8-26.9	27.0-31.4	31.5-35.7	>35.7
60+	20.2-244	20.2-244	24.5-30.2	30.33-31.4	>31.4

Source: Gettman, (1993)

APPENDIX VIII

Normative DataVO$_2$ max values for males as measured in (Ml/kg/min)

Age	Poor	Fair	Good	Excellent	Superior
11-19	≤ 42	44-46	48-51	52-57	58+
20-29	≤ 41	42-45	46-50	51-55	56+
30-39	≤ 40	41-43	44-47	48-53	54+
40-49	≤ 37	38-41	42-45	46-52	53+
50-59	≤ 34	35-37	38-42	43-49	50+
60- 69	≤ 30	31-34	35-38	39-45	46+
70-79	≤ 27	28-30	31-35	36-41	42+

Source: Gettman, (1993)

APPENDIX IX

Normative Data for the Grip Strength Test (14-19 Years Old)

Gender	Excellent	Above average	Average	Below Average	Poor
Male	>56	51-56	45-50	39-44	<39
Female	>36	31-36	25-30	19-24	<19

Source: Davis et al, (2000)

APPENDIX X

Normative Data for Muscular Endurance (Burpee Test)

Males Values in ml/kg/min

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<35.0	35.0-38.3	38.4-45.1	45.2-50.9	51.0-55.9	>55.9
20-29	<33.0	33.0-36.4	36.5-42.4	42.5-46.4	46.5-52.4	>52.4
30-39	<31.5	31.5-35.4	35.5-40.9	41.0-44.9	45.0-49.4	>49.4
40-49	<30.2	30.2-33.5	33.6-38.9	39.0-43.7	43.8-48.0	>48.0
50-59	<26.1	26.1-30.9	31.0-35.7	35.8-40.9	41.0-45.3	>45.3
60+	<20.5	20.5-26.0	26.1-32.2	32.3-36.4	36.5-44.2	>44.2

Source: Crossfiteastsac/burpee/norm.com

APPENDIX XI

Normative Data for Muscular Endurance (Burpee Test)

Female Values in ml/kg/min

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<25.0	25.0-30.9	31.0-34.9	35.0-38.9	39.0-41.9	>41.9
20-29	<23.6	23.6-28.9	29.0-32.9	33.0-36.9	37.0-41.0	>41.0
30-39	<22.8	22.8-26.9	27.0-31.4	31.5-35.6	35.7-40.0	>40.0
40-49	<21.0	21.0-24.4	24.5-28.9	29.0-32.8	32.9-36.9	>36.9
50-59	<20.2	20.2-22.7	22.8-26.9	27.0-31.4	31.5-35.7	>35.7
60+	<17.5	17.5-20.1	20.2-24.4	24.5-30.2	30.3-31.4	>31.4

Source: Crossfiteastsac/burpee/norm.com

APPENDIX XII

Normative data for the Sit and Reach test for Flexibility

Gender	Excellent	Above average	Average	Below average	Poor
Male	>17	6 to 16	0 to 5	-8 to -1	< - 20
Female	> 21	11 to 20	1 to 10	-7 to 0	< - 15

Source: Davis et al, (2000)

APPENDIX XIII

Normative data for the Illinois Agility Run Test

Gender	Excellent	Above average	Average	Below average	Poor
Male	<15.2 secs	15.2-16.1secs	16.2-18.sec	18.2-19.3secs	>19.3sec
Female	< 17.0secs	17.0-17.9secs	18.0-21secs	21.8-23.0sec	>23.0sec

Source: Davis et al, (2000)

APPENDIX XIV

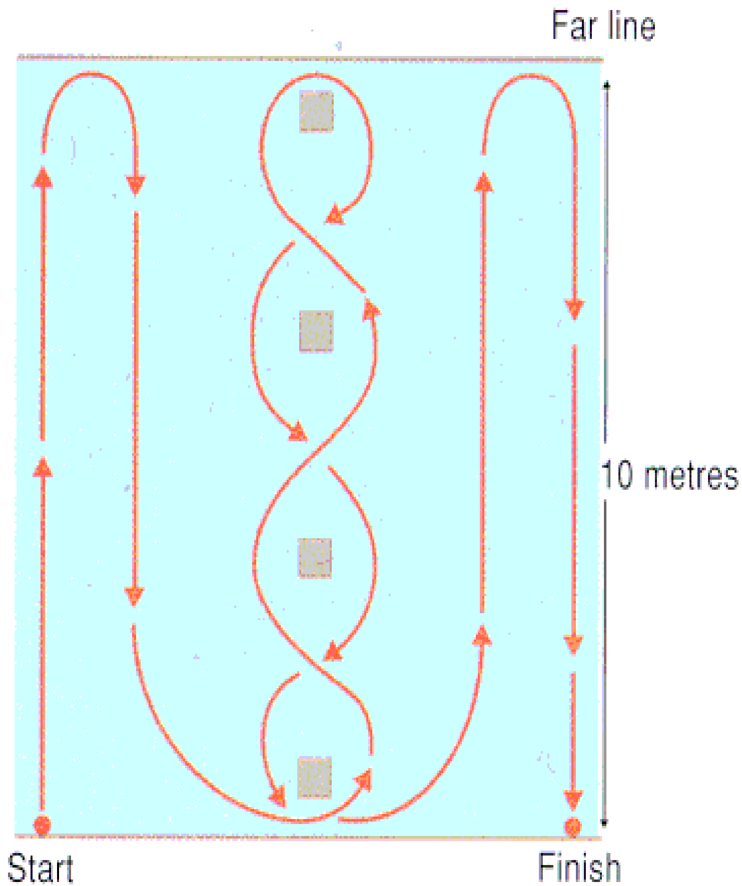
Normative rating for speed Time to run 50-yards sprint test (in seconds)

Rating	Men	Women
Very good	<4.80	<5.30
Good	4.80-5.09	5.30-5.59
Average	5.10-5.29	5.60-5.89
Fair	5.30-5.60	5.90-6.20
Poor	>5.60	>6.20

Source: Davis et al, (2000)

APPENDIX XV

ILLINOIS AGILITY RUN COURSE



Source: http://www.brianmac.co.uk/illinois.htm