

# **THE EFFECTS OF EXERCISE ON THE AGED**

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## **DEDICATION**



**Dedicated to my Mother and Father for always believing in me**

## **ACKNOWLEDGEMENTS**

I would like to record my appreciation to the following people, who assisted in various ways with this study:

### **A special tribute to the Almighty God,**

Thank you to my Mum, Dad, Cathy and Malcolm,

Thank you to my supervisor, Professor Y. Coopoo and my co-supervisor, Mrs. P.D. Ramiah, for their guidance, patience and constructive criticism,

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## **ABSTRACT**

This study aimed to document the effects of regular exercise and physical activity on the aged. Subjects (n=58) over the age of sixty-five participated in the study. All subjects were patrons from various retirement centers of the DAFTA organization (Durban Association for the Aged).

The subjects completed a PAR-Q and informed consent form, which allowed the eligible to participate in the study. A pre and post-test battery was administered to measure the following parameters; body mass, height, girth measurement, agility and dynamic balance, muscle strength and endurance, flexibility, co-ordination, dynamic grip strength and aerobic capacity.

During the experimental period the subjects engaged in a structured intervention exercise programme of 30 weeks. The intervention programme composed of games, walking, stretching, flexibility and resistance training exercises aimed at improving the following fitness components; agility and dynamic balance, strength, flexibility, co-ordination and aerobic capacity.

Inferential and differential statistical methods were employed in order to analyze the data.

The study indicated that regular exercise and physical activity positively impacted the senior citizens' functional capacity and improved their quality of life ( $p < 0.05$ ). The intervention programme served its purpose well. There are, however, many changes to be made to suit specific institutions and individuals. To ensure similar positive effects, follow-up exercise programmes would be necessary.

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## **CHAPTER ONE**

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# **CHAPTER ONE**

## **1 Introduction**

There is substantial evidence indicating that a need exists for studies to be conducted in order to document the effects of exercise and physical activity on the aged. A strong body of research (Robinson, 1938; Benestad, 1965; Krotee & Blair, 1991; Coopoo, 1995; McArdle, Katch & Katch, 1996; O' Hanion, 2000 and ACSM, 2001) supports the premise that the human species experiences a gradual deterioration in health and in quality of life, as a result of ageing. The advancement of technology and modernisation has driven mankind away from an active physical lifestyle, to a more sedentary lifestyle. The combination of the ageing process and sedentarianism has become the human race's most lethal enemy.

Researchers (De Vries, 1970; Adams & De Vries, 1973; Frontera, Meredith & O' Reilley, 1988; Goldman, 1998; Klebanoff, Miller & Fernhall, 1988 and Andrews, 2001) over the decades have pioneered various exercise-training methods and techniques to either delay or retard the ageing and inactivity levels of the human race. There is a gradual change in attitudes and perceptions amongst researchers regarding the older adult's trainability, as well as the benefits they will derive from different exercise components. Initially researchers believed that older adults could receive aerobic benefits from exercise and physical activity only (De Vries, 1970; Adams & De Vries, 1973 and Souminen, Heikkinen & Parkatti, 1977). Studies by Fiatarone, Marks & Ryan, 1990; Parson, Foster & Harman (1992); Munnings (1993) and Ades, Ballor & Ashikaga (1996) have documented the benefits that older adults received from a structured weight resistance training and aerobic programme. Recent studies (Chodzko-Zajko, 2000; Andrews, 2001 and D'Arrigo, 2001) illustrate that aerobic and weight training combined, would definitely improve the older adults' quality of life.

From the foregoing introduction, it is clear that physical activity would be beneficial to older adults. Hence, the purpose of this study is precisely to show that trend in older persons.

In this chapter, the purpose of this study and the hypothesis will be discussed. Further the rationale and objectives of the study will be clearly highlighted. The researcher will also clarify the definitions, abbreviations, and assumptions associated with research conducted in this field of study. The limitations and delimitations experienced by the study will be described.

### **1.1 Aim of the study**

To investigate the effects of a 30-week structured and supervised exercise programme on the aged population. The programme was carried out on subjects living in institutions, or retirement centres in the surrounding communities of Durban. The benefits of this exercise programme would serve to motivate not only this special population, but also others to a greater awareness of physical activity, thereby improving their quality of life and health status.

### **1.2 Objectives of the study**

The objectives of this study may be categorised as follows:

- To determine the effects of an exercise programme on various functional and physiological variables in the aged.
- To compare the gender difference, in the population under scrutiny.
- To compare gender difference, with respect to fitness development.

### **1.3 Purpose of the study**

- To document the effects of exercise and physical activity in the aged.
- To stimulate interest in exercise in this older adult population.

- To subjectively increase the psychological well being and self-esteem of the senior citizens after exercising.
- To establish differences in gender fitness levels among this group of people.

## **1.4 Rationale for the study**

- From a scientific perspective, there was an essential need for such a study to be conducted, in order, to document the effects of exercise and physical activity on the aged in South Africa. This study was developed to verify the authenticity of the myths and assumptions of ageing, in relation to exercise and physical activity.
- Another fundamental rationale behind a study of this nature was to create an interest among the senior citizens in improving their quality of life. This was achieved by assisting the senior citizens to transcend from their monotonous sedentary lifestyles to a more vibrant active one. It was also hoped that the study would create interest amongst the community to adopt a more caring attitude towards the welfare of senior citizens.
- Further the study would increase their knowledge base with respect to exercise and physical activity. Many of the subjects were from an economically disadvantaged population and the introduction of an intervention exercise programme was a novel idea. The intervention exercise programme provided enjoyment, fun and improved quality of life. All subjects would not have had the experience of exercise, had this intervention exercise programme not been developed. Exercising at specific times during a week helped subjects to transcend from their sedentary lives to active lives. Further, the implementation of such a study was cost effective.
- In our communities, most physical activity programmes are planned for the younger people who are elite athletes, high achievers, or school pupils. The rationale behind this philosophy is, if pupils and students are taught lifetime sport activities at an early age, it is presumed likely they will continue these activities

into adulthood. However this does not appear to be the case. Adults must be encouraged to exercise.

- The exercise intervention programme will promote psychological well being in subjects, thus creating greater self-esteem and motivation amongst this population.

## **1.5 Hypothesis**

Regular participation in exercise and physical activity will have beneficial effects on the aged, which will impact positively on balance, muscular strength, co-ordination, flexibility, aerobic capacity, quality of life, and functional activities.

## **1.6 Assumptions**

It is assumed that the subjects did their very best at all times during the testing programme. It is further assumed that this exercise programme would have a carry over value for further recreational pursuits for the elderly in the future.

## **1.7 Delimitations**

The sample groups were taken from communities surrounding the Durban area. The patrons of the Durban Association for the Aged (DAFTA) served as the population under study. The retirement centres that were involved in the study were; Happy Hours Senior Citizens, Woodhurst Senior Citizens, Tenicity Senior Citizens, Bayview Senior Citizens and Shallcross senior Citizens.

The sample groups were limited to people over the age of 60 years. No restrictions were imposed on the subjects in terms of gender and race. The only delimitation imposed on the study was that the subjects had to have been sedentary for at least six months before the study commenced. This delimitation was found to be a natural occurrence amongst the participants from the various old age retirement centres. These retirement centres did not provide any regular structured exercise or physical activity programme for their patrons.

## **1.8 Limitations**

The following limitations were imposed on the study;

- The small subject number was a limitation of this study, however most patrons responded positively.
- The health status of subjects at the time may have limited the number of volunteers for the study. The health status of subjects was determined through a Physical Activity Readiness Questionnaire (PAR-Q) (see Appendix A).
- A further limitation was the question of subjects' "exercise adherence" for the entire duration of the study. Some subjects began the exercise programme, but failed to complete the entire programme and the subsequent post-test exercise battery. The lack of subjects' adherence to the study was mainly due to the variations of their health patterns.

## **1.9 Definitions and abbreviations**

In this section terms used in this study will be defined in order to lend clarity to the various concepts discussed.



## **Aerobic threshold**

is the minimum intensity of training below which there is no observable training effect. The aerobic threshold is usually expressed as a percentage of a person's maximal oxygen consumption (Kent, 1994).

## **Anaerobic threshold**

is the level of activity at which the aerobic system can no longer supply most of the demands for adenosine triphosphate (ATP) (Kent, 1994).

## **Aged**

are persons of sixty and beyond. For the purpose of this study, the words **elderly**, **senior citizens** and **older adults** refer to the aged and are used interchangeably.

## **Co-ordination**

is the ability to integrate the nervous, sensory and skeletal muscular systems in order to control the independent body parts involved in a complex movement pattern and to integrate these parts in a single, smooth, successful effort in achieving some goal (Kent, 1994).

## **Flexibility**

is the range of movement around a joint (Kent, 1994).

## **Gait**

is the style of walking or running (Kent, 1994).

## **Maximal oxygen consumption**

is the greatest rate of oxygen consumption attained during exercise at sea level, expressed generally in litres per minute and represents the maximal rate of aerobic metabolism (Kent, 1994).

## **Muscular endurance**

is the ability of the limbs to support the body weight repeatedly over a specified time period (Kent, 1994).

## **Muscular strength**

is the force or tension that a muscle or muscle group can exert on resistance in one maximal effort (Kent, 1994).

In this section the various abbreviations used in this study will be defined in order to lend more clarity to the concepts discussed.

## **AAPHERD**

refers to American Alliance for Health, Physical Education and Recreation.

## **DAFTA**

refers to Durban Association for the Aged.

## **ETR**

refers to oestrogen therapy replacement.

## **HRmax**

refers to maximal heart rate.

## **PWC**

refers to physical work capacity.

## **VO<sub>2</sub>max**

refers to maximal oxygen consumption.

### **1.10 Summary**

The first chapter has served to clarify the need for this study and has defined the rationale of the study. The scope of the research has been clearly delimited and selected relevant terms have been defined.

## **CHAPTER TWO**

### **REVIEW OF LITERATURE**

#### **2.1 Introduction**

#### **2.2 The physiological stages of ageing**

#### **2.3 The effects of ageing on the various physiological systems of the body**

##### **2.3.1 Cardiovascular system**

##### **2.3.2 Respiratory system**

##### **2.3.3 Musculoskeletal system**

##### **2.3.4 Metabolic changes**

##### **2.3.5 Psychological changes**

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## **2.6 Psychological effects of exercise on the aged**

## **2.7 Benefits of exercise for the aged**

## **CHAPTER TWO**

### **2 REVIEW OF LITERATURE**

#### **2.1 Introduction**

The combination of the rapid uncontrolled birth-rate and the conquest of new acute diseases and the ever-expanding geriatric population are practical problems confronting many nations. As one approaches the half-century mark of life, the limitations of one's body become obviously apparent. Books are suddenly being produced in extremely small print, friends start to mumble in a ridiculously unintelligible fashion and even the weekly bag of groceries becomes a tremendous burden to carry. At this stage of life, one begins to appreciate the significance of research that promises to slow down, halt or even reverse the inexorable loss of bodily functions.

Advancing age is associated with a progressive decline in agility or dynamic balance, muscular strength and muscular endurance, co-ordination, flexibility, dynamic strength and maximal oxygen carrying capacity (Robinson, 1938; De Vries, 1970; Adams & De Vries, 1974 and Seals, Hagberg, Hurley & Ehansi, 1984). Other studies have been conducted which evaluate the benefits that sedentary older citizens would derive from regular physical activity and exercise (Souminen, *et al.*, 1977; Fiatarone, *et al.*, 1990; Kohrt, Mally, Coggan, Spina, Ogawa, Ehansi, Bourey, Martin & Holloszy, 1991; Parson, *et al.*, 1992; Poulin, Paterson & Govindsamy, 1992; Wells, Boorman & Riggs, 1992; Ades, *et al.*, 1996; Protera, 1997; King, Oka & Pruin, 1997 and Chandler, Duncan, Kochersberger & Studenski, 1998).

There exists a large number of myths regarding exercise and ageing. A selected few are as documented by Munnings (1993)

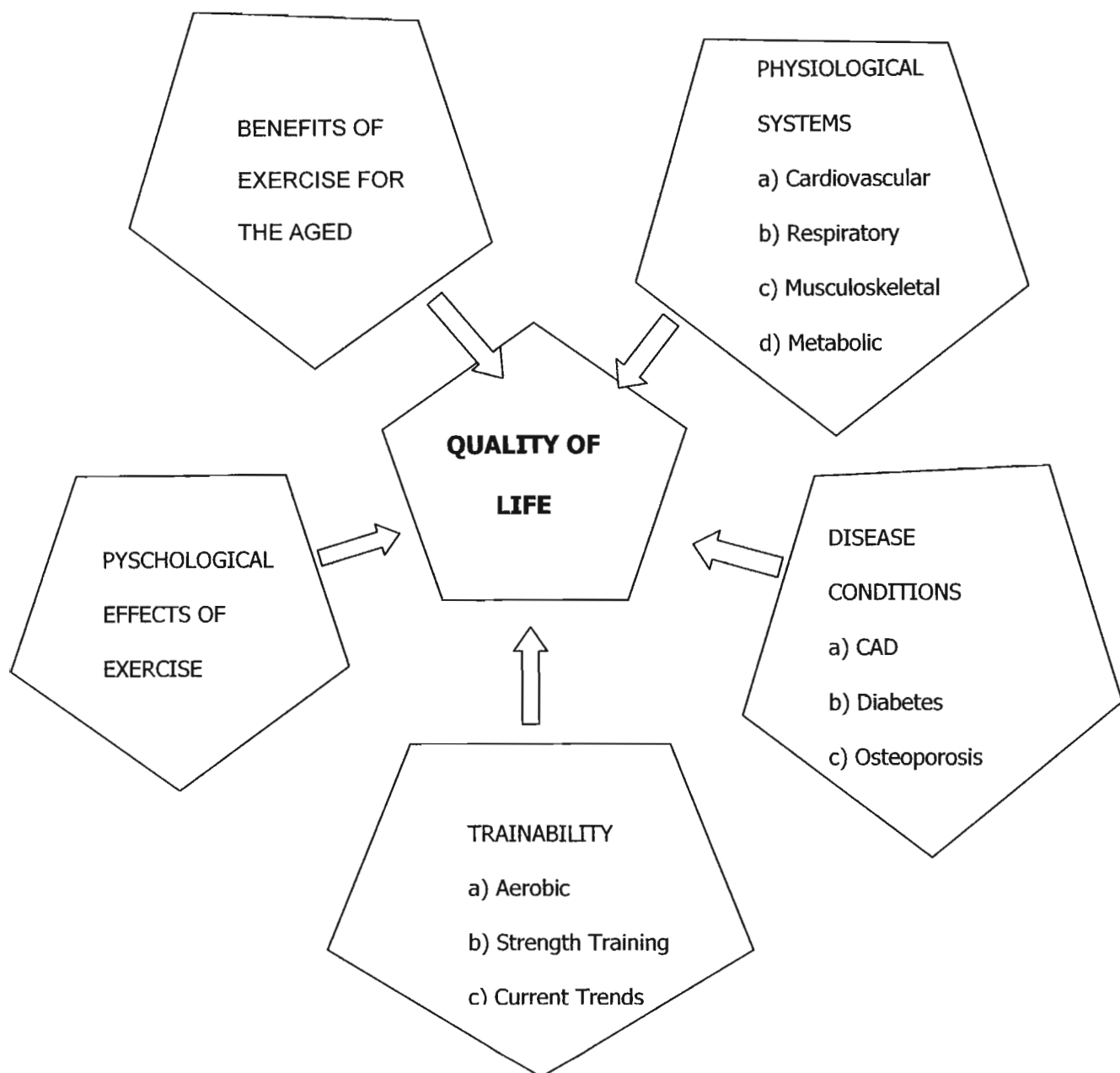
- men and women over sixty years cannot improve their  $VO_2\text{max}$ , by participating in endurance training;

- the aged cannot increase their strength;
- loss of strength is inevitable with ageing; and
- resistance training is dangerous for the aged

Selected research studies presented in this chapter are aimed at dispelling these myths. The above myths directly question the trainability of the older adult. The scientific evidence attempting to dispel these myths, will be arranged in the following sequence:

- the effects of ageing on the various systems in the human body;
- the psychological effects of exercise on the aged;
- the effects that exercise has on various disease conditions that have infected the human body and
- the benefits of exercise for the aged.

The following diagram illustrates the various sections under which the various scientific research pertaining to the effects of exercise on the aged will be discussed. The effects of regular exercise on the aged are well illustrated in the pentagons. Most of the literature presented will demonstrate the positive effects that exercise has on the quality of life of the aged (refer to figure 2.1).



**Figure 2.1: Demonstration of how exercise influences quality of life**



## **2.2 The physiological stages of ageing**

As a result of the availability of current knowledge and research, researchers (Barry, Rich & Carlson, 1993) are now capable of identifying three stages of adulthood; middle age, later maturity and old age. It is during this period of advanced adulthood, that the ageing process begins in earnest. Ageing has been identified as a gradual process of change, which manipulates all aspects of a person's life (physiological, sociological, and intellectual). There exists a considerable difference amongst the aged, in terms of rate and degree of the ageing-process. It is generally not possible to establish a definite chronological age, in the average life span, at which people can be classified as "old". However, it is assumed that old age sets in during the 7<sup>th</sup> decade of life. Generally older elderly adults (older than 75 years of age) are considered as being frail (Barry, *et al.*, 1993).

These people are more dependent and more likely to have diseases and disabilities (including arthritis, dementia, depression and cardiovascular diseases) as compared to the younger, elderly adults, those in the age range of 65 to 75 years (Barry, *et al.*, 1993).

## **2.3 The effects of ageing on the various physiological systems of the body**

This section deals with the physiological changes the systems' of the body undergo due to advancement of age. The ageing of our physiological systems progresses at varied rates and different degrees of dysfunction. The following systems, have been selected to be discussed due to their relevance of this study. They are:

- Cardiovascular system
- Respiratory system
- Musculoskeletal system
- Metabolic changes
- Psychological changes

### **2.3.1 Cardiovascular system**

The effect of ageing has a critical impact on our cardiovascular system, which in turn affects our daily functioning and physical health. Resting heart rate shows little or no change with the advancing of age, however, maximal exercise heart rate shows a decline (Barry, *et al.*, 1993). This decline is partially related to a decline in sensitivity to catecholamines, with ageing. The myocardium undergoes various functional and structural changes. This decrease in maximal heart rate has implications for exercise prescription in the elderly. There is a reduction in the resting cardiac output, which occurs due to a fall in the resting stroke volume, causing myocardial hypertrophy. The elasticity of major blood vessels declines with ageing. This is called atherosclerosis. The increase in blood pressure both at rest and exercise often peaks at the ages of 65 to 75 years, with no or little changes beyond this age (Coopoo, 1995). This increase in blood pressure has implications for exercise prescription in the older person.

Maximal oxygen uptake ( $\text{VO}_2\text{max}$ ) steadily declines with ageing (Robinson, 1938 and Barry, *et al.*, 1993). The rate of  $\text{VO}_2\text{max}$  declines approximately 10% per decade for sedentary people and 5% for endurance-trained people. The decline in  $\text{VO}_2\text{max}$  can be attributed to ageing *per sé* which is primarily due to myocardium changes, which is related to a lack of regular vigorous cardiac output stimulation. This is also related to reduced physical activity rate at this age. Flegg & Lakatta (1988) investigated other factors attributable to age associated loss of muscle. In a highly sophisticated research study involving muscle biopsies, it was found that 50% of age related decline in  $\text{VO}_2\text{max}$  amongst the elderly was explicable by selective muscle loss that accompanies ageing, due to physical inactivity. A major threat to the cardiovascular health of the elderly is coronary artery disease (CAD). This disease with its underlying process of atherosclerosis is the most prevalent chronic disorder found amongst the elderly. The elderly can obtain cardiovascular endurance benefits from regular endurance training. Maximal oxygen consumption can increase in sedentary elderly individuals with regular endurance activity (Barry *et al.*, 1993). Lower heart rates, blood

pressure and blood lactate levels at sub-maximal exercises can be attained with regular exercise and physical activity.

### **2.3.2 Respiratory system**

Physiological changes do occur in the respiratory system as a result of ageing. The residual volume increases 30 to 50%, and the vital capacity decreases 40 to 50% by the age of 70 years (Coopoo, 1995). As a person ages, he or she shows a greater dependency on increased respiratory frequency rather than increased tidal volume during exercise and physical activity. This dependency increases the total effort in breathing. Respiration function does not hinder exercise performance unless function is significantly impaired, as with chronic obstructive pulmonary disease such as emphysema, chronic bronchitis and asthma. Ventilatory changes as a result of ageing do not interfere with a person's ability to improve  $\text{VO}_2\text{max}$ . In normal health, senior citizens' respiratory decline does not negatively impact on aerobic exercise performance.

### **2.3.3 Musculoskeletal system**

There is a 20% decrease in muscular strength, which occurs between the ages of 20 to 65 years. This decrease in muscular strength is not only attributed to advanced age, but also to disuse. The major effect of age on the skeletal system is progressive bone mass loss (Coopoo, 1995 and McArdle, *et al.*, 1996). The bone loss is more prominent amongst women. Women over the age of 35 years lose approximately 1% bone mass per year (Katz & Sherman, 1998). Men begin to sustain bone mass loss to the age 55 years and usually lose ten to 15% by the age of 70. Bone mass loss can be further exacerbated amongst the elderly by an inadequate dietary calcium intake, diabetes mellitus, lack of oestrogen supplementation, lack of progestin in post-menopausal women, renal impairment and immobility (McArdle, *et al.*, 1996). Bone mass loss with resultant loss of muscular bone strength pre-dispose many older adults to fractures, particularly of the hip, vertebrae and forearm. These injuries are significant causes of morbidity and mortality amongst the older adults. The elderly have significant limitations in flexibility. The major cause of this is disuse

of joints, not usually used daily (Bell, 1979; Sharkey, 1990 and ACSM, 2001). Fifty percent of the decline in the physiological functioning that is weak muscles, joint stiffness and low energy levels, is attributed to disuse (O' Hanion, 2000).

Regular strength training amongst older adults can increase muscular strength, as well as bone density (Nagles & Frances, 1973). Clarke & Harrison (1975) agree that a well-balanced programme will increase the elderly person's muscular strength and muscular endurance, flexibility and aerobic capacity.

#### **2.3.4 Metabolic changes**

A person's metabolic rate gradually declines with increasing age, as does  $VO_2\text{max}$ . Sedentary men have shown decreases in  $VO_2\text{max}$  of 10% per decade, compared to their regularly active male counterparts, exhibiting only 5% or lower decline per decade (Sutton, Houston & Grates, 1986). Reduced metabolic rate results in a reduce rate of energy expenditure in the body. This results in an increase in body mass. Regular exercise and physical activity can increase  $VO_2\text{max}$ , increase lean body mass and decrease body fat percentage.

#### **2.3.5 Psychological changes**

In society, retirement often heralds the end of the productive period of one's life. Situations like this have manipulated most of society to relegate the older adults to a sedentary lifestyle (Ruuskanen & Ruoppila, 1995). Regular exercise and physical activity can be an effective tool in maintaining functional ability and promoting an enhanced sense of well being amongst our senior citizens (Andrews, 2001). High levels of regular exercise and physical activity have been related to high quality life indices, and mental health benefits, such as decreased depression, anxiety, and increased confidence and self efficiency (Greg, Krishna, Fox & Cauley, 1996).

### **2.3.6 Motor functioning**

The physiological motor functions of the aged are lower than younger groups. Research indicates a gradual reduction in the dynamic fitness qualities of muscular strength, flexibility, endurance and neuromuscular co-ordination associated with an increase in age after maturity (Nagles & Frances, 1973; Clarke & Harrison, 1975; McArdle, *et al.*, 1996 and ACSM, 2001). Investigators have reported a marked decrease in the hand-grip strength between the period of 60 years and beyond (Norris & Shock, 1960). Flexibility grows steadily poorer with age, as determined by goniometric devices used to measure joint motion (Bell, 1979). Diminished cardio-respiratory functioning occurs as well (Norris & Shock, 1960 and Nagles & Frances, 1973).

## **2.4 Exercise and intervention: its effects on disease pathology**

Currently a greater proportion of people can expect to attain old age. This is due to the fact that the majority of epidemic and endemic infectious diseases and nutritional deficiencies have largely been brought under control. The sector of our population, whose ages range from sixty years and beyond are rapidly expanding their longevity as a result of disease control during middle and old age (D'Arrigo, 2001). The primary focus of preventive medicine is now to maintain health and functional capacity of the elderly (Barry, *et al.*, 1993). Over the decades, there have been many major advances in the medical and surgical treatment of chronic degenerative diseases associated with ageing. Unfortunately, there have not been similar breakthroughs in the area of health maintenance. Exercise and diet are still the most powerful measures available for prevention and reversal of a number of degenerative diseases that plague the aged. These include atherosclerotic coronary artery disease, osteoporosis, non-insulin dependent diabetes mellitus, and hypertension. In this section the effects of exercise on the above disease conditions will be described.

**2.4.1 Coronary Artery Disease (CAD)**

Coronary artery disease refers to a host of disease conditions affecting the heart. These conditions include thrombosis, infarction, pectoris angina, ischemia, and atherosclerosis. There are various risk factors of CAD, which can be classified as either primary or secondary factors (ACSM, 2001). These factors are indicated in

**Table 2.1. Coronary Artery Disease risk factors**

Primary alterable risk factors	Primary unalterable risk factors	Secondary alterable risk factors
Smoking	Age	Obesity
Hypertension	Gender	Unhealthy diet
High cholesterol levels	Genetics	Excessive alcohol intake
Physical Inactivity		Diabetes
		Hormonal imbalances
		Stress Levels

Regular exercise has a beneficial effect on reducing a number coronary risk factors. These include:

- improvement of plasma lipid-lipoprotein profile, with increased HDL cholesterol and decreased total cholesterol/HDL cholesterol ratio (Powell, Thompson, Casperson & Kendrick, 1982).
- lowering of elevated plasma glucose and insulin levels.
- reduction in hypertension (Seals, et al., 1984).
- body mass loss with a decreased body fat content (McArdle, et al., 1996; ACSM, 2001 and D'Arrigo, 2001).

### 2.4.2 Osteoporosis

Osteoporosis is a metabolic bone disorder characterized by a loss of bone mass, which eventually causes a change in the architecture of the bones. Analysis of research by McArdle, *et al.* (1996); Marcus (2000) and Karlsson, Linden, Karlsson, Johnell, Brant & Seeman (2000) indicates that physical activity promotes an increase in bone mineral density and reduces bone loss among young, pre-menopausal and post-menopausal women, thus making exercise and physical activity a strategic key for preventing and treating osteoporosis. Exercise should be continued during old age, to provide bone mineral density and prevent fractures (Karlsson, *et al.*, 2000 and Wade, 2000).

Mechanical and hormonal processes appear to be involved in the rehabilitation of osteoporosis (mechanism by which bone responds to exercise). This is known as the "*error strain distribution hypothesis*" (Katz & Sherman, 1998). This theory suggests that bone cells sense the mechanical strain induced by weight bearing or resistance exercise. These cells then communicate load imbalances with each other on a local level. In vitro, mechanical strain causes a cellular influx of calcium ions, followed by the production of prostaglandin and nitric oxide, increased enzyme activity and the release of growth hormones. These changes trigger bone re-modelling. Hartard, Haber & Illeva (1996) examined the effects of a 24 week strength training intervention programme on 31 post menopausal women. Subjects had a minimum of 30% bone mass lost. Data revealed that the experimental group's bone mineral density did not change, but the control group's did decrease. This evidence does suggest that regular progressive strength training does prevent bone loss. Criticisms of the study were that the study required very sophisticated laboratory testing, which therefore required large financial support and human resources.

An activity such as walking appears to benefit not just weight bearing bones, but also the skeletal system as a whole. Brooke-Wavell, Jones & Hardman (1997) examined the effects of brisk walking for 20 to 30 minutes per day on 84 sedentary females. Subjects' age ranged from 60 to 70 years. The experimental group walked briskly for 12 months. This resulted in

their spinal and calcaneal bone mineral density remaining constant. However, the control group's spinal and calcaneal bone mineral density decreased.

Krall & Dawson-Hughes (1994) found that post menopausal women, who walked for distances greater than 12, 5 km per week, had greater bone mineral density, as compared to women who walked less than 1, 6 km per week. The above two studies highlight an excellent inexpensive form of training for the elderly.

One of the effects of exercise for the aged is the reduction in falls, which has a serious impact on the aged. Falls are the leading cause of injury amongst the aged. Nelson, Fiatarone & Morganti (1994) state that exercise reduces the risk of fractures by preventing falls. They suggest that exercise increase muscle mass and strength. These muscular adaptations then lead to improvements in balance, gait and reaction time. These exercise-related outcomes reduce the propensity for falls.

### **2.4.3 Non-insulin dependent diabetes**

It is a chronic metabolic disorder. The main problem is the inability of cells to use glucose due to the lack of insulin. This lack of insulin also prevents the storage of glucose in the cells of the muscle, resulting in excess amounts of glucose in the blood (Chodzko-Zajko, 2000). This causes fatigue and tiredness because the glucose is not getting to the cells where it is required for energy production.

Glucose tolerance progressively declines with ageing, largely due to a decrease in sensitivity to the insulin action (Giacca, Shi, Maruss, Zinman & Uranic, 1994 and D'Arrigo, 2001). The cardiovascular and neurological complications of diabetes are major causes of disability and mortality amongst the elderly. Non-insulin dependent diabetes mellitus is largely due to a combination of resistance to insulin action and an inadequate compensatory insulin secretory response. Insulin dependant diabetes mellitus is caused by an absolute deficiency of insulin secretion.



Exercising lowers plasma insulin concentrations both during fasting and following glucose ingestion in healthy people. Despite the blunted insulin response to the glucose challenge, glucose tolerance remains normal, or is improved in people who exercise regularly (Kaneko, 1988). Two separate physiological adaptations occur. One results in a diminished insulin response to the same glucose concentration, whilst the other involves an increase in insulin sensitivity, which results in a rapid rate of glucose disposal to result in normal or improved glucose tolerance despite low insulin levels.

Seals, *et al.* (1984) conducted a study, which determined effects of age, physical activity and body fatness on glucose tolerance and insulin sensitivity. Results indicated that regular exercise could prevent the deterioration of glucose intolerance and insulin sensitivity, despite advancing age.

## **2.5 Trainability of older adults**

For many years' people believed that the older adult benefited very little from exercise. As research accumulated on this topic, scientific statements regarding the trainability of the elderly were made conclusively. This brief review of literature will assist in dispelling many of the myths and assumptions of the non-trainability of the elderly. The literature on this section has been divided into three categories. Table 2.2 illustrates these categories.

**Table 2.2: Studies related to the trainability of older adults**

TRAINABILITY		
AEROBIC TRAINABILITY	STRENGTH TRAINABILITY	CURRENT TRENDS
De Vries, 1970 Adams & De Vries, 1973 Souminen, <u>et al.</u> , 1977 Seals, <u>et al.</u> , 1984 Kohrt, <u>et al.</u> , 1991 Poulin, <u>et al.</u> , 1992 Klenbanoff, <u>et al.</u> , 1998	Fiatarone, <u>et al.</u> , 1990 Parsons, <u>et al.</u> , 1992 Krall & Dawson-Hughes, 1994 Nelson, <u>et al.</u> , 1994 Ades, <u>et al.</u> , 1996 Hartard, <u>et al.</u> , 1996 Brooke-Wavell, <u>et al.</u> , 1997 Katz & Sherman, 1998 Chandler, <u>et al.</u> , 1998 Williams, 1999	Giacca, <u>et al.</u> , 1994 King, <u>et al.</u> , 1997 Protera, 1997 Goldman, 1998 Ross, 1998 Chodzko, 2000 Andrews, 2001 D'Arrigo, 2001

A discussion will follow indicating the studies results in each of the three categories, viz. aerobic trainability, strength trainability and current trends.

### **2.5.1 Older adults aerobic trainability**

Earlier available data indicated that men and women over 60 could not increase their maximal oxygen consumption ( $VO_2\text{max}$ ) as a result of endurance training (Hagberg, Graves, Umacher, Woods, Leggett, Cononie, Gruber & Pollock, 1989). This suggested that older adults lose their ability to elicit their physiological adaptations in response to endurance exercise training. Studies by Kohrt, et al. (1991); Wells, et al. (1992); Poulin, et al. (1992) and Klebanoff, et al. (1998) used more intense exercise programmes, which demonstrated that older adults can also improve their maximal aerobic capacity to the same degree to which younger people can.

The following literature will provide scientific evidence, which will abolish this myth. Hagberg, et al. (1989) examined the cardiovascular and muscular strength responses of older men and women to exercise training (n=47). Data revealed that endurance training increased VO<sub>2</sub>max by 22%. Resistance training increased strength by 22%, whilst physical inactivity did not increase VO<sub>2</sub>max nor strength. This study demonstrates that older adults need to have an all-round exercise programme (both resistance and endurance training) to obtain general improved physical fitness.

Cardiorespiratory fitness or aerobic power has been the object of much research (De Vreis, 1970; Adams & De Vreis, 1973 and Souminen, et al., 1977) since the early 1970's. Literature in exercise physiology states that aerobic power declines with age, having achieved a peak value in the person's early twenties (Hagberg, et al., 1989 and McArdle, et al., 1996). Cross-sectional studies on moderately active and sedentary women indicate a decline in VO<sub>2</sub>max compared to their sedentary counterparts of the same gender, but no difference in the rate of decline with age has been noted.

Wells, et al. (1992) suggests that the age of menopausal changes may play a role in the decline in VO<sub>2</sub>max among women. Wells, et al. (1992) conducted a study, which investigated the cardio-respiratory fitness, on 49 trained master female athletes. The researchers came to the following conclusions:

- these highly trained female athletes had higher cardio-respiratory fitness than previously reported for women of comparable age;
- menopausal age did not affect the cardio-respiratory fitness when training was taken into consideration; and
- regular physical training seems to prevent age-related changes in maximal heart rate (HR<sub>max</sub>) in women, but not age-related changes in maximal oxygen uptake.

The literature presented concludes that older adults are aerobically trainable, thereby disputing the non-aerobic trainability myth of older adults (Hagberg, et al., 1989).

### **2.5.2 Older adults' strength trainability**

Old age is associated with numerous changes in body composition. A prominent body composition change, which is well documented, is the decrease in lean body mass. Decreased lean body mass occurs primarily as a result of losses in skeletal muscle mass. This age related loss in muscle mass has been termed sarcopenia. Sarcopenia accounts for age-associated decreases in basal metabolic rate, muscle strength and activity levels, which in turn are the cause for the decreased energy requirements of the elderly. Age related reduction in muscle mass is a direct cause of age related decrease in muscle strength.

In the study of Fiatarone, *et al.* (1990) 10 frail nursing home residents participated in an eight week high intensity resistance training intervention programme. Subjects strength increased by 120%, girth measurements by 9% and speed of gait by 48%. The findings of this study dispels the non-strength trainability of the aged (Munnings, 1993).

In conclusion, the message is that it is never too late to start a resistance training programme, and all may participate safely with correct technique and supervision.

### **2.5.3 Current trends on the progress of older adults' trainability**

The year 1999 was designated the International Year of Older Persons, by the United Nations, and attention was focused on the many challenges facing society as a result of ageing during the 20<sup>th</sup> Century. There is compelling evidence that regular physical activity is associated with significant physiological, psychological and social benefits for the older adults (King, *et al.*, 1997; Protera, 1997; Goldman, 1998 and Ross, 1998). The ability to increase a person's life span through exercise has been globally accepted. Many studies have been conducted to determine the effects of exercising on the older adults' physiological capacity (aerobic, muscular strength and endurance capacities) as well as to determine psychological benefits gained.

Current studies are focusing on a more holistic approach, that is engaging the older adult in a well-balanced exercise programme (King, *et al.*, 1997; Protera, 1997; Chodzko-Zajko, 2000 and Andrews, 2001). The exercise programmes consist of aerobic exercises, muscular strengthening, flexibility and balance activities, functional as well as neuromuscular exercises. ACSM (2001) suggests that prescribing a well balanced exercise programme is most effective in helping an older adult to achieve maximum benefit from his or her exercise programme.

A report by Spina (2000) suggests that exercise may be the closest thing to a fountain of youth. Regular exercise combats the effects of ageing, by lowering blood pressure and cholesterol, improving blood circulation, reducing the risk of cardiac arrests, cardiac diseases and strokes. Regular exercise also strengthens bones, tones muscles, controls weight, relieves stress, and boosts an ageing person's self-confidence.

## **2.6 Psychological effects of exercise on the aged**

The physical and psychological benefits of older adults' participation in exercise and physical activity have been well documented. Ostrow & Dzenaltowski (1986) evaluated society perceptions regarding the physical pursuit of people of various ages. The most significant finding of this study was that subjects felt that the appropriateness of participation in physical activity was, to a large extent based on their perceptions of age appropriateness. Another interesting finding was that older adults' perception of participating in physical activity was based on age-role versus sex-role appropriateness. The results of this investigation provide ample evidence to suggest that age is a far more influential aspect than gender in dictating older adults' perceptions of the appropriateness of participation in physical activity across the life cycle.

Physical activity has significant psychological benefits to the aged. Short term benefits of exercise are – better relaxation and improved mood state (Nieman, Warren, Dotson, Butterworth & Henson, 1993 and Landers & Petruzzeko, 1994) and long term benefits of

exercise are – enhanced life-satisfaction, better cognitive functioning and increased self-confidence (Berger & Hect, 1990; Glen & Puglisi, 1992; O'Connor, Aenchbacher & Dishman, 1993 ; McAuley & Rudolph, 1995 and WHO, 2000). Thus exercise is important for both physical and mental development of humans.

## **2.7 Summary of the benefits of exercise for the aged**

A brief summary of the benefits of exercise for the aged will be listed:

- Reduced risk of CAD (ACSM, 2001).
- Improved plasma lipoprotein profile, with increased HDL cholesterol and reduced total cholesterol (Powell, et al., 1982).
- Lowering of elevated glucose and insulin levels (Seals, et al., 1984).
- Reduction of hypertension (Seals, et al., 1984 and Barry, et al., 1993).
- Body mass loss with reduced fat mass (McArdle, et al., 1996).
- Increased bone mineral density and reduced bone loss (Katz & Sherman, 1998; Marcus, 2000 and Karlsson, et al., 2000).
- Increased VO<sub>2</sub>max (De Vreis, 1970; Adams & De Vreis, 1973; Wells, et al., 1992 and Klebanoff, et al., 1998).
- Increased muscle strength and endurance (Krall & Dawson-Hughes, 1994; Brooke-Wavell, et al., 1997 and Williams, 1999).
- Increased flexibility (Munns, 1981; Barry, et al., 1993; Foss & Keteyian, 1998 and Siegenthaler, 1999).
- Increased co-ordination (Barry, et al., 1993 & D'Arrigo, 2001).
- Increased agility and dynamic balance (Greendale, Barrett-Connor & Edelstein, 1995 and Nelson, et al., 1994).

In summary of this section regular exercise and physical activity will improve the functional capacity and quality of life of the elderly.

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

- 3.1 Sample selection**
- 3.2 Data collection**
- 3.3 Administration of test battery**
- 3.4 Report of activity schedule**
- 3.5 Administration of exercise programme**
- 3.6 Dropout rate**
- 3.7 Description of intervention exercise programme**
- 3.8 Description of games and activities played**
- 3.9 Description of test protocols**
  - 3.9.1 Demographic data**
    - 3.9.1.1 Body mass**
    - 3.9.1.2 Height**

**3.9.1.3 Girth measurement (chest circumference)**

**3.9.2 Agility and dynamic balance**

**3.9.3 Muscular strength and endurance test**

**3.9.4 Soda-pop co-ordination test**

**3.9.5 Flexibility test**

**3.9.6 Dynamic hand grip strength test**

**3.9.7 Rockport one-mile walk test**

**3.10 Analysis of data**



## **CHAPTER THREE**

### **3 RESEARCH METHODOLOGY**

In this chapter the method by which subjects were selected and the subsequent data collection will be discussed. Further, the administration of the test battery, exercise intervention programme, dropout rate, test protocols, and the statistical treatment of the data will be discussed.

#### **3.1 Sample selection**

The researcher invited all the old age retirement centres governed by Durban Association for the Aged (see Appendices B and D) to participate in this study. The invitation was issued to the governing body, Durban Association for the Aged, who then tendered it to all the respective old age retirement centres, within the Durban Metropolitan area. Only five out of the 12 old age retirement centres responded to the invitation. As a result of this, only these old age retirement centres participated in the study. The following were the old age retirement centres that participated in the study: Happy Hours Senior Citizens; Woodhurst Senior Citizens; Tenicity Senior Citizens; Bayview Senior Citizens; and Shallcross Senior Citizens.

All these centres were in and around the Chatsworth area in Durban. The geographical locations of these centres made personal supervision of the intervention exercise programmes easier. Only those subjects from these centres who volunteered for the study were included.

Each subject completed a "Physical Activity Readiness Questionnaire" (PAR-Q) and an informed consent form which helped determine the eligibility of the individual subject to participate in the study (see Appendix A). A briefing session on the test protocols' and the intervention exercise programme occurred. The subjects then volunteered to be included in

this study. The exercise programme started with 100 volunteers. The dropout percentage was 42 % (n=42) with only 58 % (n=58) completing the programme.

The size of the sample group was delimited by the following parameters:

- age of the subjects;
- willingness to participate in this study;
- facilities to train, e.g. outdoor area, halls and equipment;
- the financial cost of the study.

An important delimitation of this study was that subjects had to be sixty years and beyond. No restriction was imposed on the sample group in terms of race or gender. The higher percentage of female participation was a mere coincidence and in no way signifies prejudice or bias on behalf of the researcher. The study focused on the effects of exercise and physical activity on the aged.

### **3.2 Data collection**

Data was collected from subjects participating in both the pre- and post-test batteries. In the experimental phase the subjects (n=58) participated in a 30-week exercise intervention programme. The pre- and post-test batteries were exactly the same. The test batteries were aimed at determining the effects of a 30-week exercise intervention programme on the elderly. Table 3.1 illustrates the various tests, which comprised the actual test battery. These tests were used to determine physical fitness status of the subjects.

**Table 3.1. Test components and objectives of the test battery**

<b>COMPONENTS</b>	<b>SUB-COMPONENTS OF EACH COMPONENT</b>	<b>OBJECTIVES</b>
1. Demographic measurements	<p>Body mass</p> <p>Height</p> <p>Chest circumference</p>	<p>to determine body mass of subjects</p> <p>to determine height of subjects</p> <p>to determine chest circumference of subjects</p>
2. American Alliance for Health, Physical Education and Recreation (AAHPERD) Functional Fitness Test for Older Adults	<p>Agility and dynamic balance test</p> <p>Muscular strength and Endurance test</p> <p>Soda-pop co-ordination test</p> <p>Flexibility test</p>	<p>to determine agility and dynamic balance</p> <p>to determine muscular strength and endurance</p> <p>to determine level of co-ordination</p> <p>to determine flexibility levels</p>
3. Dynamic hand grip strength test	Dynamic hand grip strength	to determine subjects' overall body strength by implication
4. Rockport one-mile walk test	Rockport one-mile walk test	to determine subjects' endurance capacity

### **3.3 Administration of test battery**

The researcher and six graduate assistants were employed to administer the test battery. The researcher and the graduate assistants were thoroughly trained in the proper execution of the test battery. Caution and patience was practised throughout the entire study. Verbal encouragement was used to motivate the subjects to improve their exercise performance. Due to the length of the test battery, only a few subjects were tested per day in the interest of obtaining accurate measurements.

### **3.4 Report of the activity schedule**

The subjects played various games during the first four weeks (refer to table 3.3). Subjects only played two games per week. The aim of this strategy was to gradually introduce subjects to increase physical activity, and to move them away from their sedentary lifestyle. The researcher practised extreme precautions to prevent injury, as well as to increase enjoyment and satisfaction in participation. The nature and intensity of the games gradually increased, to facilitate the increased physical activity, and to develop an adequate foundation for the exercise routine to follow in subsequent weeks.

During weeks five to eight the intensity of the physical activity increased. The subjects began to complete the warm-up phase of the exercise routine. At this stage subjects played two games and completed the warm-up phase of the exercise routine. There was a definite increase in the work rate and physical activity of subjects. At this stage of the year (week nine of the intervention exercise programme) subjects also started to prepare for their annual athletic meeting which took place on the 05 September 1999.

During the 10th to 13th week, subjects started to complete the exercise routine. In the 10th week the subjects completed the warm-up phase and exercise routine. The 11th and 12th weeks were crucial to the success of the project. At this stage the subjects began to

complete the entire exercise routine. The researcher practised extreme precautions to prevent injury. Much motivation was given to increase participation, as well as to motivate subjects to complete the exercise routine. The researcher concentrated on the proper execution of the physical activity and exercise routine. The form and technique was consistently monitored to correct all errors in execution of exercises, as well as to prevent injury. The subjects completed the entire exercise routine at a low intensity.

During weeks 14 to 17, there was an unexpected turn of events. There was an increase in the vigour, vitality and zest of the subjects. The subjects' energy levels soared. The subjects executed activities with greater urgency. The intensity of exercise was slightly increased. Weeks 17 to 30 saw subjects engaging in games, as well as completion of intervention exercise programme. The activity and work rate of subjects did increase.

By the completion of the 30-week intervention exercise programme, the project had been a success in terms of participation of subjects. From the former weeks of low intensity activity to the latter weeks of higher intensity activity, subjects' energy levels increased. Most subjects expressed increased vitality and zest for life. The researcher was able to observe a change in the way of life of the subjects. The subjects' lifestyle moved from being sedentary to moderately active.

### **3.5 Administration of exercise programme**

The researcher and the graduate assistants monitored the subjects' execution of exercise. The researcher also educated the recreational leaders of the centres on the proper execution of the exercise and common errors with regard exercise technique. Bearing this in mind, the exercise programme was constructed in such a manner as to facilitate the change from a sedentary lifestyle to a more active lifestyle. This change was gradual, but effective. The gradual aspect of the change was negotiated by light intensity exercising, increasing to medium intensity. On a Borg Scale (1-20) initial intensity was eleven, which was later

reduced to seven, as they became fitter. At the end of the 30-week intervention exercise programme, all participants subjectively agreed that their initial perception of the intensity of the programme decreased (from 11 to 7 on the Borg scale). This change in the perception of the intensity of the intervention exercise programme was attributed to the regular participation in the exercise programme.

### **3.6 Dropout rate**

One hundred subjects volunteered to participate in the study. Sixty three percent of the 100 subjects were female. The lack of subjects' adherence to the study was mainly due to the deterioration of their health. In the experimental phase (during the winter season) the dropout rate increased due to the cold and harsh weather. Many of the subjects were plagued with various illnesses. Due to illnesses, many subjects with chronic conditions of hypertension, arthritis, coronary artery disease, lower back pain, diabetes, anaemia and asthma, dropped out. Poor health appeared to be the main reason for the subjects to drop out of the study. Hundred subjects started the study only 58 completed the study.

### **3.7 Description of the intervention exercise programme**

There was no financial burden imposed on the subjects to allow them eligibility to participate in the study. The researcher travelled to each old age retirement centre to supervise the execution of the exercise programme. Subjects were not manipulated into participating in the exercise programme at any time during the experimental phase, as they had voluntarily agreed to participate in the study. Prior to commencement of the exercise programme subjects arrived at a mutual consensus with regard to the various days in the week that they would exercise.

Subjects' exercise programme intensity progressively increased (refer to table 3.2). This was done in order for subjects to learn the proper technique when executing each exercise, as

well as to gradually increase their muscle strength and endurance. As subjects' muscular strength and endurance improved, they executed the exercise programme at a higher intensity.

**Table 3.2 : The components and objectives of the intervention exercise programme**

<b>PHASES OF EXERCISE PROGRAMME</b>	<b>TYPE OF EXERCISE IN EACH PHASE</b>	<b>DURATION</b>
1.Warm-up:	Slow walking	Fifteen to 20 minutes. Subjects initially executed this phase for 15 minutes, however, as their muscular strength and endurance improved, the time period for this phase was extended to 20 minutes.
2.Stretching	<p>(a) <b>Neck</b></p> <p>hyperextension</p> <p>flexion</p> <p>lateral extension</p> <p>(b) <b>Shoulders</b></p> <p>rotation forwards and backwards</p> <p>shoulder stretch</p> <p>(c) <b>Triceps</b></p> <p>triceps stretch</p> <p>(d) <b>Hip</b></p> <p>rotation of hips clockwise and anti-clockwise</p>	Fifteen minutes – all subjects performed slow static stretches.



PHASES OF EXERCISE PROGRAMME	TYPE OF EXERCISE IN EACH PHASE	DURATION
	(e) <b>Quads</b> lunges (three sets often repetitions each leg) (f) <b>Calves</b> calf stretch (g) <b>Ankles</b> pronation and supination	
3.Strengthening exercises	(a) Wall push-a-ways (b) Lateral deltoid raises (three sets of ten repetitions) (c) Alternate dumbbell curls (biceps) (d) Shoulder dumbbell press	Ten minutes.
4.Cool down	Slow walking	Ten minutes.

Prior to subjects commencing the exercise programme, they played a variety of games. These games are listed in Table 3.3. As the subjects’ muscular endurance increased, they combined the exercises and the games.

**Table 3.3 Activity schedule of subjects' exercise and physical activity (from 01 June 1999 (week one) to 17 December 1999 (week thirty))**

<b>ACTIVITY SCHEDULE</b>	
<b>WEEK NO.</b>	<b>LIST OF ACTIVITIES</b>
1	<p>Played the following games:</p> <p>musical pillow</p> <p>bouncing ball relay</p>
2	<p>Played the following games:</p> <p>go-tag</p> <p>hot potatoes</p>
3	<p>Played the following games:</p> <p>bean bag shuttle walk</p> <p>bean bag relay</p>
4	<p>Played the following games:</p> <p>corner spray</p> <p>potato race</p>
5	<p>Played one game:</p> <p>bouncing ball relay</p> <p>Completed the warm-up phase of the exercise routine</p>
6	<p>Played one novelty event:</p> <p>obstacle course</p> <p>Completed the warm-up phase of the exercise routine</p>
7	<p>Played one game:</p> <p>go-tag</p> <p>Practiced various events for the Senior Citizens' Annual Athletic Meeting held on 05 September 1999:</p>

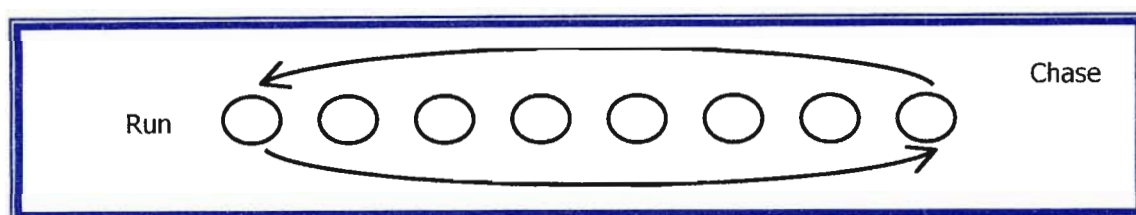
<b>ACTIVITY SCHEDULE</b>	
<b>WEEK NO.</b>	<b>LIST OF ACTIVITIES</b>
	<p>relays</p> <p>sprints (50m and 100m)</p> <p>tug-a-war</p>
8	Practised events for the Senior Citizens' Annual Athletic Meeting
9	Helped with the preparations for the Senior Citizens' Annual Athletic Meeting
10	<p>Completed warm-up phase and exercise phase of exercise routine.</p> <p>Played one game:</p> <p>musical pillow</p>
11	Completed entire exercise routine, at low intensity
12	<p>Completed exercise routine, at low intensity</p> <p>Concentrated on the form and technique, with regards to execution of exercises and activities</p>
13	<p>Completed exercise routine</p> <p>Concentrated on form and technique of exercises and activities</p>
14	Completed exercise routine, at an increased intensity
15	Completed exercise routine, at the increased intensity
16	<p>Completed exercise routine and maintained increased intensity</p> <p>Focused on form and technique of exercises</p>
17	<p>Played one game:</p> <p>bean bag shuttle walk</p> <p>Completed the exercise routine</p>
18	<p>Completed the exercise routine</p> <p>Played one game:</p> <p>bean bag relay</p>

<b>ACTIVITY SCHEDULE</b>	
<b>WEEK NO.</b>	<b>LIST OF ACTIVITIES</b>
19	Completed one novelty event: obstacle course Completed exercise routine
20	Completed one novelty event: obstacle course Completed exercise routine
21	Completed musical pillow game and exercise routine
22	Completed bouncing ball relay and exercise routine
23	Completed go-tag game and exercise routine
24	Completed bean bag shuttle walk and exercise routine
25	Completed bean bag relay and exercise routine
26	Completed Corner Spray and exercise routine
27	Completed obstacle course and exercise routine
28	Completed bouncing ball relay and exercise routine
29	Completed bean bag relay and exercise routine
30	Completed hot potatoes and exercise routine

### 3.8 Description of games and activities played

#### a. Go-tag

Everyone stands in a line. Alternate players face opposite directions.



**Figure 3.1** Diagrammatic representation of the go-tag game

**Rules** the person at one end of the line was be the first runner. He/she ran in any direction. Person at the other end of the line was the first chaser. Neither switched direction once started. Chase works with others who are stood in a line. The runner tapped the back of the person in the line and shout "GO". The tapped player stepped forward and began the chase. Once the chaser tapped the runner, the chaser became the runner. The person at the other end of the line became the chaser (refer to figure 3.1).

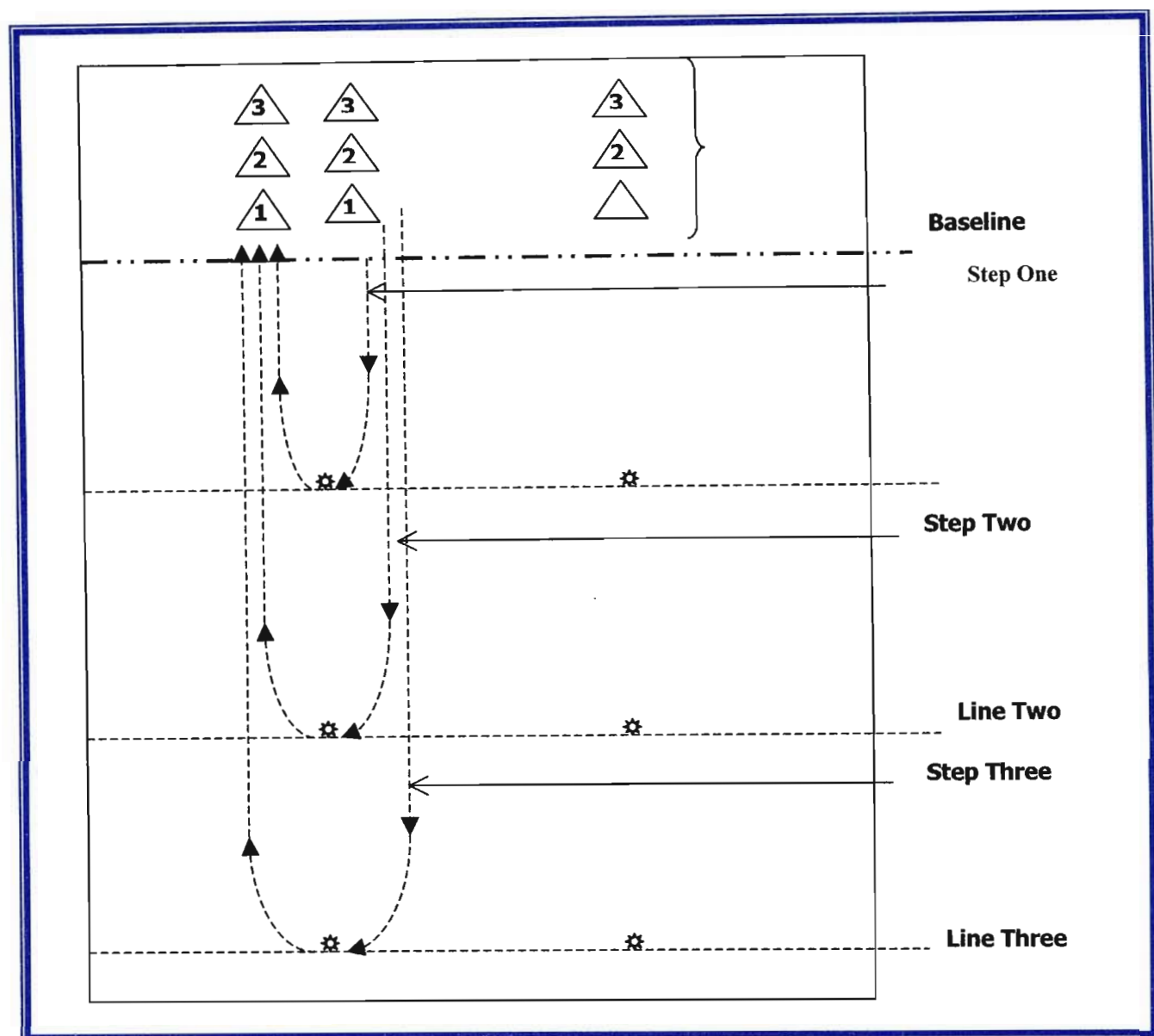
**Objective** to tag the runner.

#### b Hot Potatoes

**Rules** participants were seated in a small circle close enough, so that the hot potatoes could be handed from one to another, around the circle. Balls or beanbags were passed around the circle, a few being introduced at a time.

**Objective** the objective of the game was to pass the equipment rapidly, so that no one gets stuck with more than one object when the whistle was blown. Anyone caught with two objects had a recorded score against him or her, and the game was continued.

Score	at the end of the designated number of cycles, scores of each player were calculated. The person with the lowest score was the winner.
c.	Bean Bag Shuttle Walk
Rules	all players stood in a single file, one behind the other. Player number one of each team, stood behind the baseline. On the blow of the whistle, player number one ran or walked to line number one and picked up the bean bag and returned it to the back of the baseline. This process continued, until player number one had returned bag number three to the back of the baseline. After player number one had returned beanbag number three, player number one moved to behind the last team member (refer to figure 3.2).
Objective	for each player to return the three bean bags behind the baseline.
Scoring	the team finishing first was the winner.

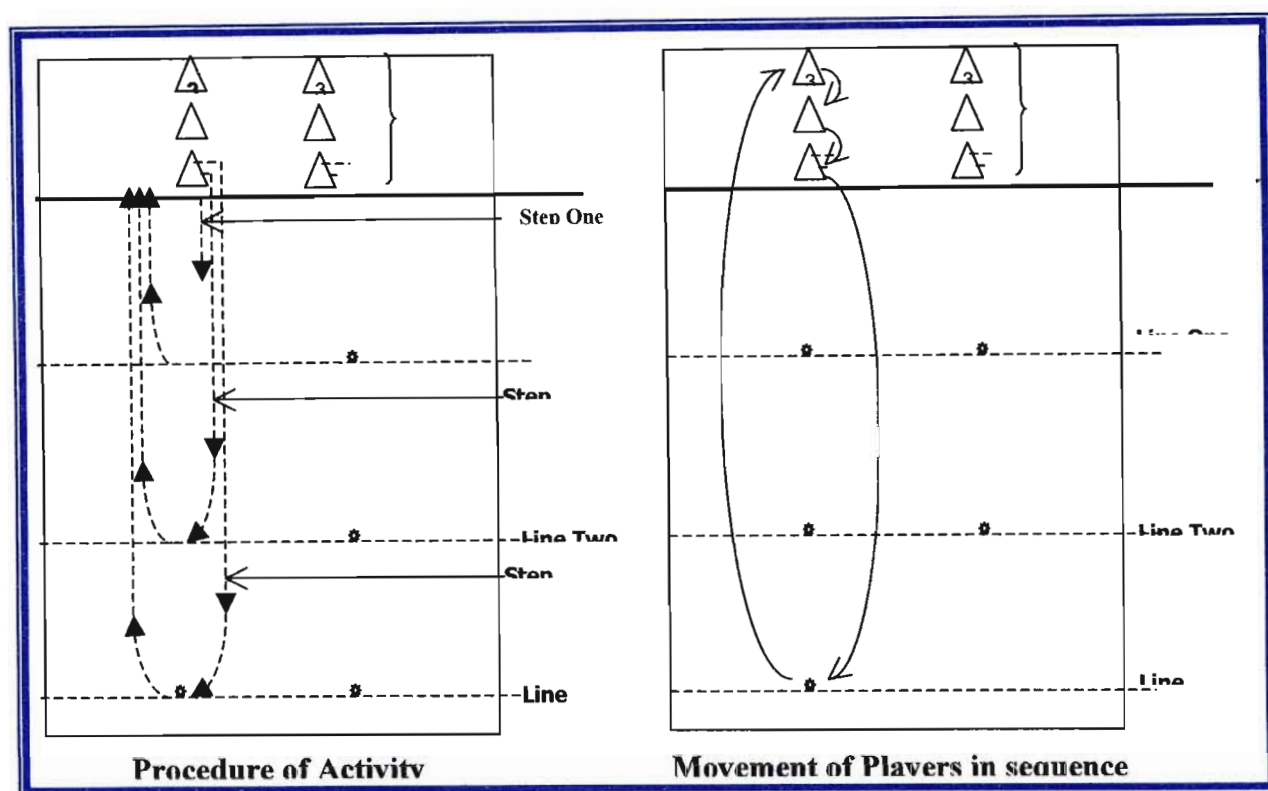


**Figure 3.2 Diagrammatic representation of the bean bag shuttle walk**

d. Bean Bag Relay

**Rules** each team stood in a single file, one behind the other. Player number one of each team stood behind the baseline. Once the whistle was "blown", the game began (refer to bean bag shuttle walk). Once player number one returned, beanbag number three behind the baseline, he/she also tagged player number two. Player number two continued the "bean bag shuttle walk" activity. This process continued, until each member of the team had an opportunity to perform the activity (refer to figure 3.3). All players had to walk briskly.

Scoring the team finishing first was the winner.



**Figure 3.3** Diagrammatic representation of the bean bag relay game

e. Corner Spray

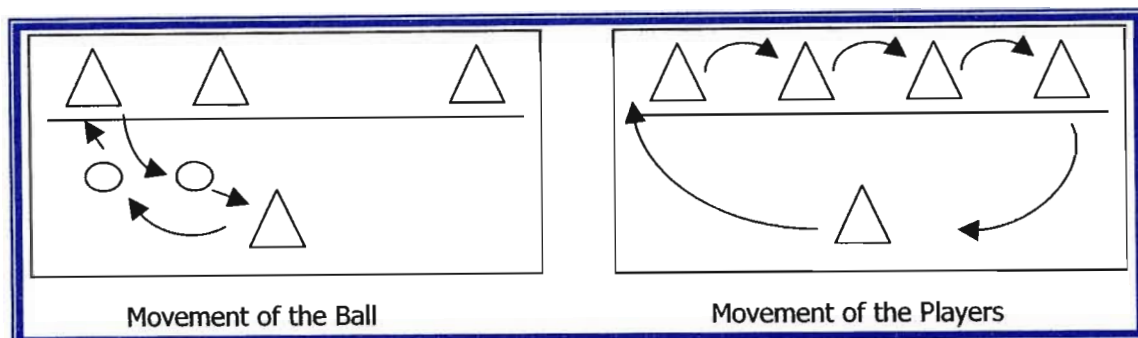
**Formation** each team stood behind a line, facing his/her respective player number one, who faced them. Player number one was situated at the centre of the line. Each player was 4 to 1.52 m apart.

**Apparatus** a ball for each team.

**Scoring** the team finishing first was the winner.

**Rules** player number one threw the ball to player number two, at the top of the line. Player number two returned the ball to player number one, who then threw it to every other player in succession (refer to figure 3.4).





**Figure 3.4. Diagrammatic representation of the corner spray**

On throwing it to the last player, he/she ran into the circle at the top of the line while the last player carried the ball, replacing player number one. The other players moved one place down. The game continues until each player had his or her turn to throw the ball to each player.

f. Bouncing Ball Relay

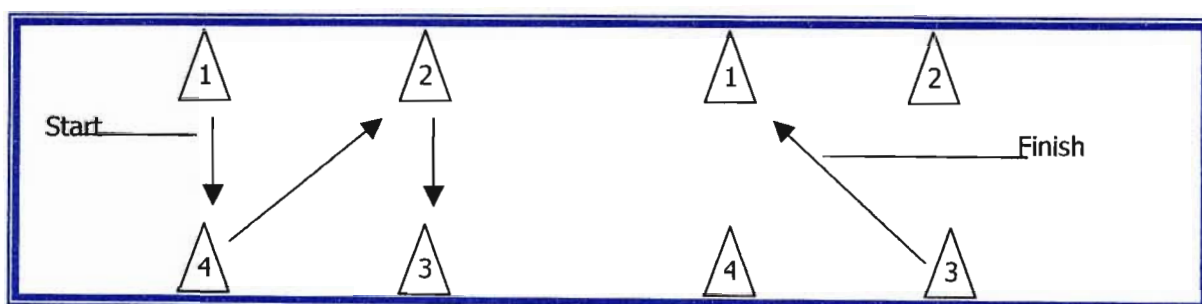
**Rules** player number one of each team had to bounce the ball on a signal, and run forward to player number four, who in turn took the ball on the bounce and proceeded to player number two, but in the opposite direction. Each player went to the end of the opposite side, and the team finished when the ball had been returned to player number one. Sequence of players' movements: player one to player four, player four to player two, player two to player three and player three to player one (refer to figure 3.5).

**Apparatus** a basketball for each team.

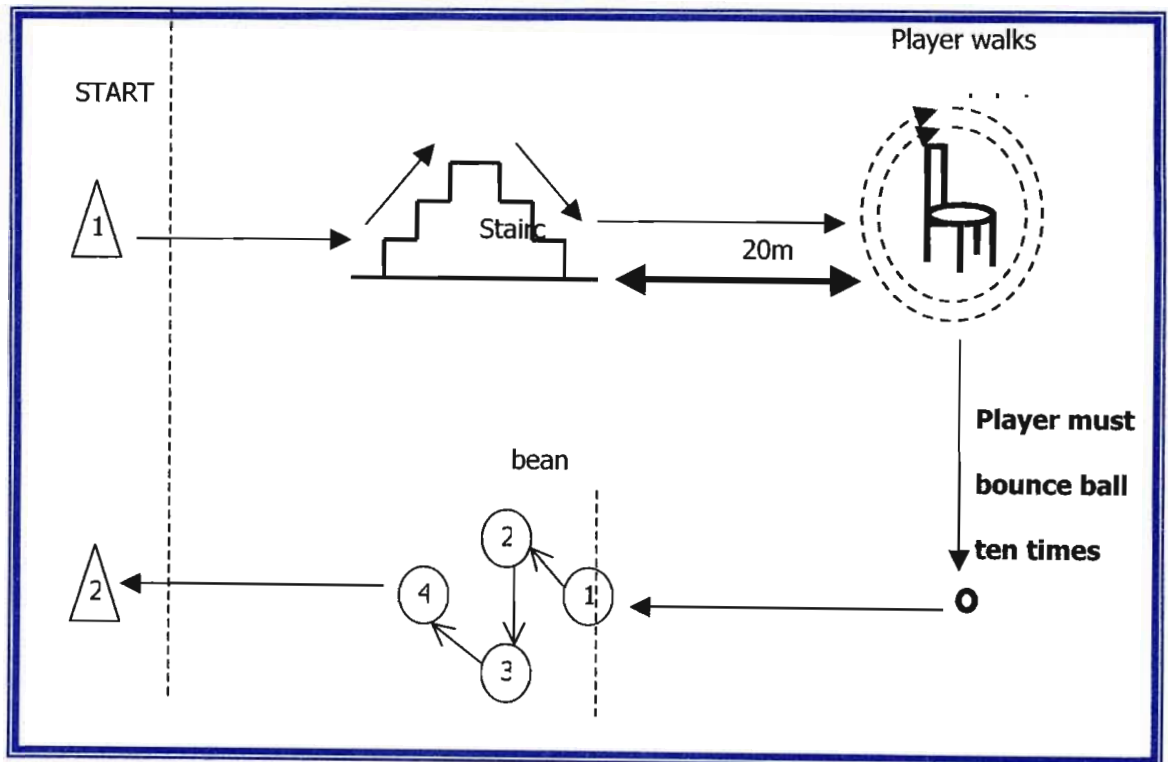
**Scoring** the team finishing first was the winner.

**Formation** each team to have an equal number of players. Players were arranged in a single line, facing each other 9.1 m apart, behind the starting line.

**Figure 3.5 Diagrammatic representation of the bouncing ball relay**



g	Obstacle Course
Rules	each player had to overcome the various obstacles along the course. Once the player passed the one obstacle, he/she moved on to the next. This activity was done as a team activity; as one player finished the course, he/she had to tag the next player who then started the course. Each obstacle was twenty metres apart.
Apparatus	a staircase, a chair, a ball and four beanbags
Scoring	the team finishing first was the winner.



**Figure 3.6 Diagrammatic representation of the obstacle course**

**3.9 Description of test protocols**

The testing protocols used in the study will be described and discussed.

**3.9.1 Demographic data**

Demographic data for this study refer to the following physical characteristics of the subject's body mass, height and chest circumference.

**3.9.1.1 Body mass (Coopoo, 1995)**

Equipment	a calibrated scale.
Method	the body mass was recorded with the male subject being only in his shorts and the female subject in thin, light weigh clothes. Both male and female subjects were weighed without shoes (refer to figure 3.7).
Scoring	the body mass was recorded in kilograms.



**Figure 3.7: Subject's body mass being measured**

### 3.9.1.2 Height (Coopoo, 1995)

Equipment        measuring tape and a ruler.

Method            subjects stood parallel to measuring tape, which was attached vertically to a wall. The tester then placed the ruler on top of subject's head (perpendicular to subject's head and parallel to the floor). The subjects removed their shoes. The ruler was extended to the measuring tape and the subject's height was then determined (refer to figure 3.8).

Scoring            subject's height was measured in metres.



**Figure 3.8:**        Subject's height being measured



**3.9.1.3 Chest circumference test (Coopoo, 1995)**

This test was used to determine the subject's chest circumference. Girth was taken at nipple level with chest at mid-tidal volume (halfway between inspiration and expiration) (refer to figure 3.9).

- Equipment            an anthropometric tape was used.
- Scoring              the unit of measurement for the test is centimetres.



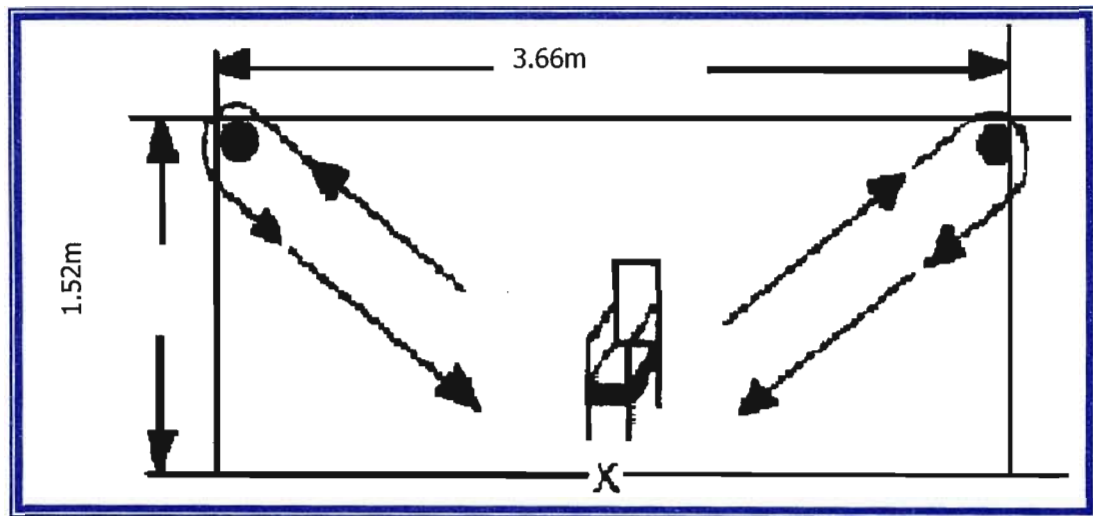
**Figure 3.9:            Subject's chest circumference being measured**

**3.9.2 Agility and dynamic balance test (Clarke, 1989)**

- Test item            agility and dynamic balance.
- Equipment           chair (average seat height 40.5 cm) masking or duct tape, measuring tape, two cones, and stopwatch.



Procedure            placement of the chair should be marked and legs should be taped to the floor, if possible (the chair tends to move during the test). Measure from



the spot on the floor (X) in front of the chair with their farthest edges 1.83m to the side and 1.5 m behind the initial measuring spot (see figure 3.10). The floor should be even, non-slippery and well lighted.

**Figure 3.10: Agility and dynamic balance test**



**Figure 3.11: Subject's positioning for agility and dynamic balance test**



**Figure 3.12: Subject performing the agility and dynamic balance test**

### **3.9.3 Muscle strength and endurance test (Clarke, 1989)**

Test item	muscle strength and endurance.
Equipment	two sets of dumbbells, 2 kg and 4 kg, stopwatch, straight back chair without arms.
Administration	the subjects sat with their backs as straight as possible against the back of the chair. Their eyes were focused ahead and their feet were flat on the floor. The non-dominant hand rested in the lap while the dominant arm hung straight and relaxed at the side. The dumbbell was placed on the subjects' dominant hand and held in the extended position. The 2 kg dumbbell was used for women and the 4 kg dumbbell was used for men. The stopwatch was placed in the non-dominant hand and faced the dominant side of the body.

The researcher stood on the side of the subject's dominant arm, placing one hand on the dominant biceps while the other helped support the dumbbell. The subject contracted his/her biceps until the lower arm touched the hand of the researcher. That was one total repetition. If the

subject could not bring the weight through the full range of motion, the test was terminated with a score of zero.

When the practice repetition was completed, the weight was placed on the floor for approximately one minute and then placed in the hand supported by the researcher. The researcher instructed the subject to make as many repetitions as possible in 30 seconds. The lower arm had to touch the researcher's hand on the biceps, unassisted.

Scoring                      the number of repetitions the subject completed in the 30 second period was counted.



**Figure 3.13 : Subject preparing to perform the muscular strength and endurance test**

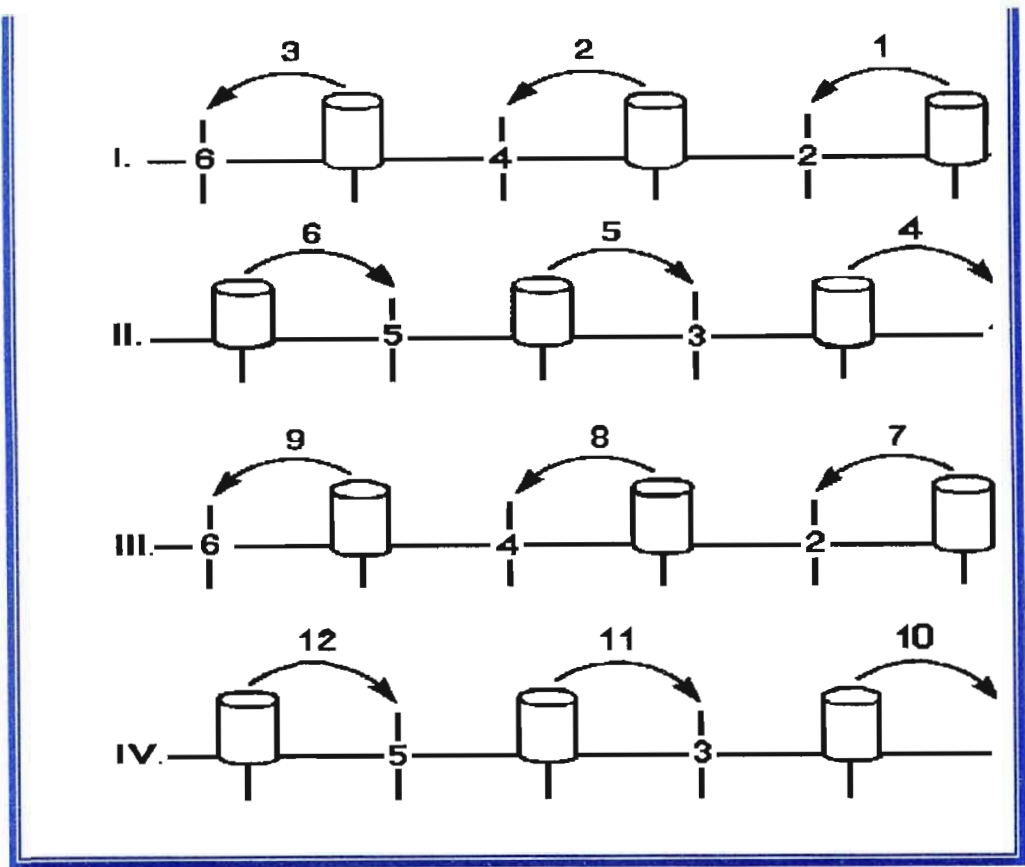




**Figure 3.14 : Subject performing the muscular strength and endurance test**

### **3.9.4 “Soda-pop” co-ordination test (Clarke, 1989)**

Test item	“soda-pop” co-ordination test.
Equipment	three cups, stopwatch, 8.5cm masking tape, a table and a chair.
Procedure	using the 8.5 cm masking tape, the researcher placed a 76.2 cm strip of tape on the table about 13 cm from the table’s edge. Six marks exactly 13 cm away from each other along the line of the tape were drawn, starting at 2.35 cm from either side of the tape. Six strips of tape were centered, each 7.62 cm long, on top of each of the six marks. Each “square”, formed by the crossing strips of tape was assigned a number starting with one for the first square on the right to six for the last square on the left (see figure 3.15).



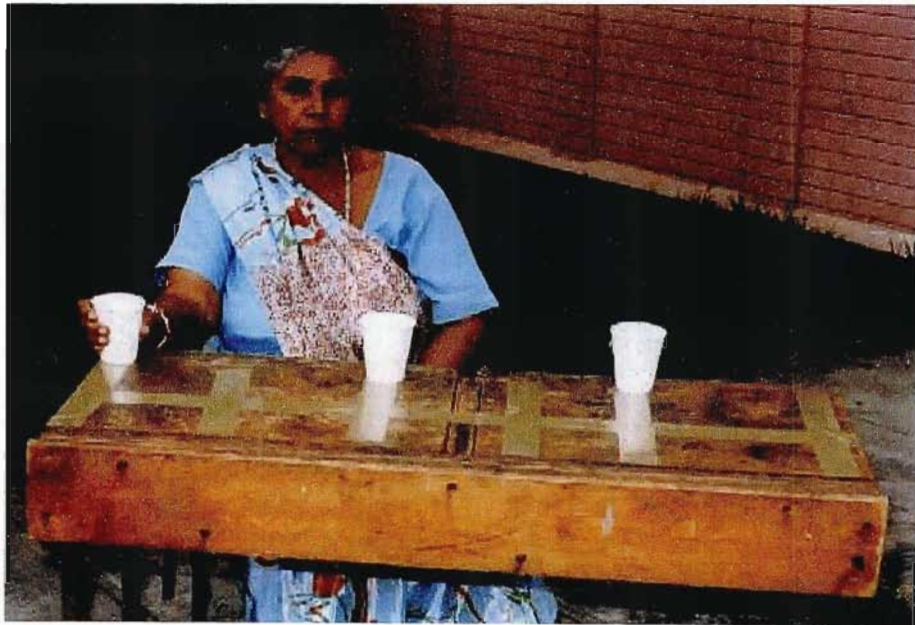
**Figure 3.15 : "soda-pop" co-ordination test movement sequence**

Directions      the subject sat comfortably in front of the table, body centred with the diagram on the table. The preferred hand was used for this test. If the right hand was used, one cup was centred on square one (farthest to the right) cup two on square number three, and cup three on square number five. The right hand was placed thumb up on can one with the elbow joint bent at between 100 to 120 degrees. When the tester gave the signal, the stopwatch was started and the subject turned each can upside down, placing cup one on square two, cup two on square four and cup three on square six. The subject immediately turned all three cups right side up, starting with cup one, while returning them to their original placement. On the return trip, the cups were grasped with the hand in a thumb down position. The entire procedure was completed twice without stopping and counted as one trial. The watch was stopped when the last cup was returned to its original position on the second trip back. The preferred hand (in this case the right hand) was used throughout the entire task. The test was performed as fast as possible. If a cup missed a square (did

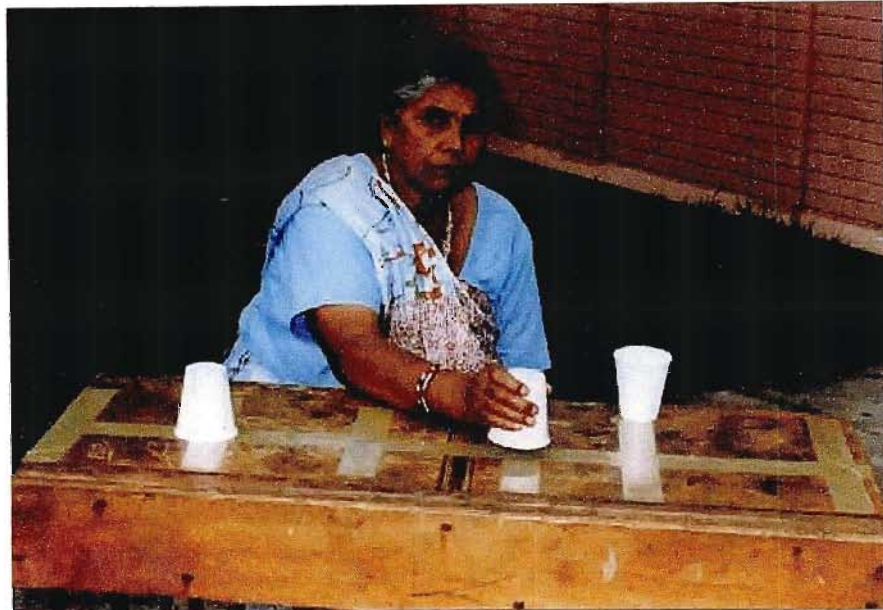
not completely cover the square) at any time during the test, the trial was repeated from the beginning.

If a participant used the left hand, the same procedure was followed except that the cups were placed starting from the left, cup one on square number six, cup two on square number four, and cup three on square number two. The procedure was initiated by turning cup one upside down onto square number five, cup two onto square number three and cup three onto square number one.

Scoring: the time of each test trial was recorded by the researcher to the nearest tenth of a second.



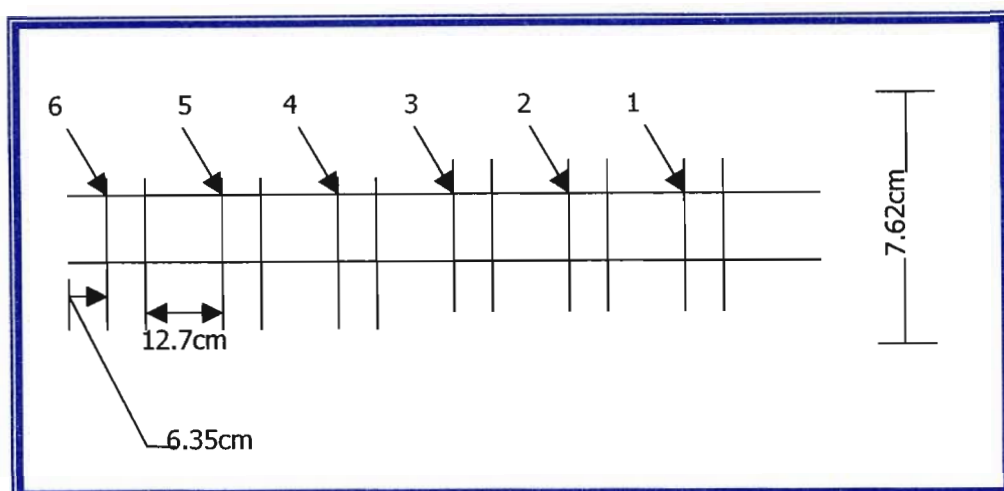
**Figure 3.16 : Subject preparing to perform the "soda-pop" co-ordination test**



**Figure 3.17 : Subject performing the “soda-pop” co-ordination test**

**3.9.5 Flexibility Test (Clarke, 1989)**

Test item	trunk/leg flexibility.
Equipment	metre ruler, chalk and masking tape.
Procedure	a line was created approximately 51 cm long on the floor (masking tape may be used). The metre ruler was taped on the floor perpendicular to the line, with the 63.5 cm mark directly over the line. The masking tape was used for the line the 63.5cm mark was positioned at the edge of the tape. The researcher then drew two marks on the line, each 15.25 cm away from the centre of the metre ruler (see figure 3.18).



**Figure 3.18 : Masking tape placement for flexibility test**

**Directions:** the subject removed their shoes for this test and sat on the floor with legs extended, feet 30.5 cm apart; toes pointing straight up and heels on the line at 63.5 cm mark, each heel centred at the 15.3 cm marks on the line. The metre ruler was between the legs, with the zero point toward the subject. With hands placed one on top of the other, the subject slowly reached along the metre ruler as far as possible holding the final position for at least two seconds. The test administrator placed a hand on the subject's knee to ensure that the knees were not raised during the test.

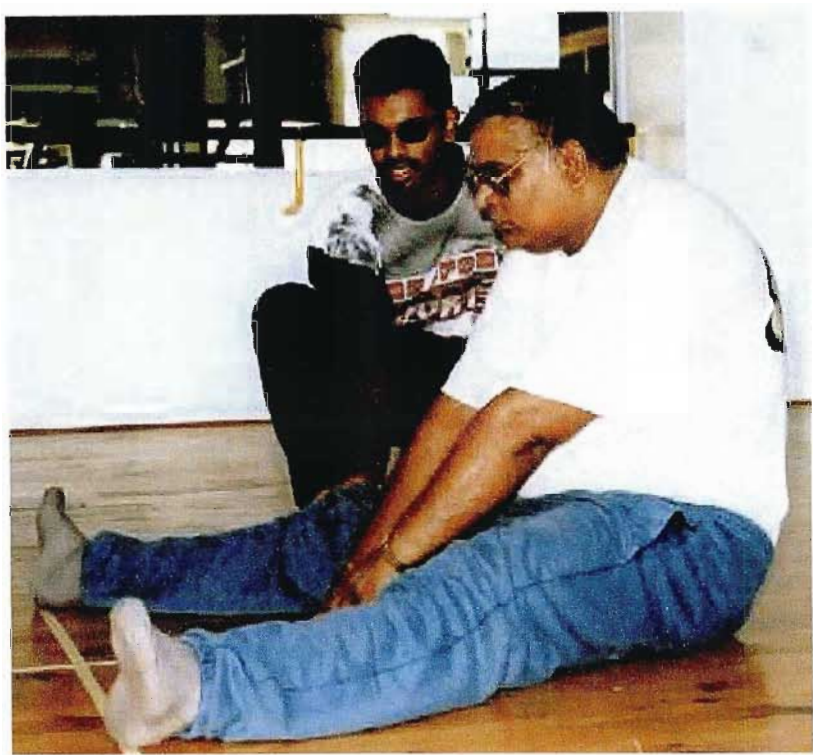
**Scoring:** the final number of centimetres reached to the nearest centimetre was recorded by the researcher.

**Trials** two practice trials were allowed followed by two test trials. Only scores for the two test trials were recorded. The score was the better of the two test trials.

**Considerations:** it was ensured that the subjects were warmed up prior to the test. All subjects were helped into the sitting position and when getting up from the floor. The forward reach was gradual along the top of the meter ruler; the tip of the middle fingers had to remain steady throughout the reaching action and the final position was held for a minimum of two seconds. The



researcher ensured the subject's toes were straight up and that the legs were kept as straight as possible. If feet turned outwards or knees rose during the reaching action, the subject was requested to maintain the correct position.



**Figure 3.19 : Subject performing the flexibility test**

**3.9.6 Dynamic hand grip strength test (Clarke, 1989)**

Test item	static strength of handgrip.
Equipment	hand-dynamometer.
Procedure	the subjects chalked their hand before the dynamometer was squeezed in the dominant hand. While squeezing the instrument, the subject was allowed any movement provided he or she did not hit any object or part of his/her body. Most common movement was the uppercut. The better of the two trials were counted.

**3.9.7 Rockport one-mile fitness walk test (ACSM, 1996)**

Test Item	indirect estimate of VO2max.
Equipment	athletic track/field, stopwatch and whistle.
Procedure	the test commenced on the blow of the first whistle. Subjects were required to walk/run one mile as fast as possible, but maintain a steady pace. Once the subject had completed the distance, the whistle was blown again. This had signalled the termination of test. The time taken to complete the one-mile was recorded. Immediately upon completion of walking, the individual's HR as measured using a 15 second-pulse count.
Scoring	maximum oxygen consumption was estimated from a regression equation based on body mass, age, gender, walk time and post-exercise HR.  $VO_2 \text{ max (in ml/kg/min)} = 132.853 - (0.0769 \times \text{body mass}) - (0.3877 \times \text{age}) + (6.315 \times \text{gender}) - (302649 \times \text{time}) - (0.1565 \times \text{HR})$

Body mass in kilograms; gender = zero for female and one for male; time in minutes and HR was taken at end of walk.

**3.10 Data analysis**

Inferential and differential statistical methods were used in order to analyze the data.

## **CHAPTER FOUR**

### **ANALYSIS OF DATA AND DISCUSSION**

#### **4.1 Data analysis of female subjects**

#### **4.2 Data analysis of male subjects**

#### **4.3 Data analysis of the combined group**



CHAPTER FOUR

4 ANALYSIS AND DISCUSSION OF DATA

Chapter four comprises the analysis and discussion of results. The data will be discussed in the following manner; firstly that of the female subjects, then data of the male subjects and finally the scores for the combined group.

4.1 Data analysis of the female subjects

Table 4.1 Changes in the female subjects’ demographic data ( $\bar{x}$ (SD)

Variables	Pre-test	Post-test	% difference	Significance
Age (yrs)	66	66	0	p>0.05
Height (m)	1.5	1.5	0	p>0.05
Body mass (kg)	64.2 (7.9)	63.9 (7.7)	0.5	P>0.05
Girth measurements (cm)	91.4 (8.6)	90.2 (6.7)	1.3	P>0.05
N=	60	37	38.3	

Sixty females started the study only 37 completed, due to a number of personal factors such as, flu, infections, etc. (see table 4.1). The mean age of the female subjects’ was 66 and average height was 1.5 meters. Their mean body mass decreased by 0.5%, which was statistically not significant. This finding is consistent with that of Adams & De Vries (1973). Adams & De Vries (1973) enjoyed a greater decrease in body mass (0.77%) as compared to this study. Differences in the study of Adams & De Vries (1973) compared to the current one is that, the Adam & De Vries study (1973) had a smaller sample size (n= 23), shorter study period (12 weeks), and its intervention was an aerobic based programme. The total sample

in this study was larger (n=58), had a longer study period (30 weeks), and used informal activity and a mixed aerobic and muscular endurance intervention exercise programme. Even with the small decrease in female subjects’ body mass it assisted in improving their ease of mobility and their functional capacity.

The participation in the intervention exercise programme may have increased the female subjects’ lean body mass thus increasing their metabolic rate, as the participants subjectively indicated that they were more energetic on a daily basis. Thereby impacting positively on their body girth measurements. This reduction in their girth measurements impacted on looser fitting clothes as indicated by the subjects. This increased their functional capacity, enhancing their quality of life. Female subjects enjoyed a 1.3% reduction in their girth measurements, which was found to be statistically not significant.

**Table 4.2 Changes in the fitness components of female subjects ( $\bar{x}$  (SD))**

<b>Fitness components</b>	<b>Pre-test</b>	<b>Post-test</b>	<b>% difference</b>	<b>Significance</b>
Agility & dynamic balance (sec)	30.9 (6.9)	28.1 (5.9)	9.1	P<0.05
Muscle strength & endurance (no)	26.4 (6.9)	31.9 (8.2)	20.8	P<0.05
Flexibility (cm)	30.8 (5.1)	33 (4.8)	7.1	P<0.05
Co-ordination (sec)	16.5 (5.5)	14 (4)	15.2	P<0.05
Dynamic hand grip strength (kg)	21.2 (5.1)	22.8 (3.5)	7.6	P<0.05
Rockport test (ml/kg/min)	30.9 (4.6)	33.1 (3.4)	7.2	P<0.05
N =	60	37	38.3	-

The results of the above selected fitness parameters will be discussed as indicated in table 4.2. Agility and dynamic balance of female subjects improved by 9.1%, which was found to be statistically significant ( $p < 0.05$ ). This finding reinforces the report of Chodzko-Zakjo (2000), which noted that regular physical activity improves older adults' agility and dynamic balance. Muscle strength and endurance of female subjects increased by 20.8%, which was statistically significant ( $p < 0.05$ ). The pre-test score showed that the female subjects had poor muscle strength and endurance before the intervention exercise programme. These pre-test scores were quite low thus providing greater opportunity for improvement. However the point to note is that the improvements can be achieved irrespective of age. Studies by Hartard, *et al.* (1996) indicated that regular strengthening exercise increase older adults' muscle strength and endurance. Hartard, *et al.* (1996) differed from this study in the following respects; they had a smaller sample size ( $n=31$ ) and shorter study period (24 weeks). This study indicates that use of small terrain games and a mixed aerobic and muscular endurance exercise programme can be effective in obtaining muscle strength and endurance gains.

Physical inactivity is one of the major causes of reduced flexibility among the aged. Older females often complain that poor flexibility limits their ability to perform daily tasks and chores, like sweeping, bending, lifting objects from the floor and cleaning their homes (thus reducing their functional capacity). This study assisted in the lengthening of those shortened muscles and increased the range of motion of their joints, thereby improving their flexibility. This improved flexibility in turn helped the female subjects' to accomplish their daily tasks and chores with greater ease and less pain. In this study the female subjects experienced a 7.1% increase in their flexibility, which was statistically significant ( $p < 0.05$ ). This study also showed that regular flexibility exercise improved a person's flexibility regardless of their age. The historical research review by Siegenthaler (1999) and ACSM (2001) confirmed these trends, as achieved by this study.

The dynamic hand grip strength of the female subjects increased by 7.6%, which proved to be statistically significant ( $p < 0.05$ ). This study indicates that regular strengthening exercise improves senior citizens' dynamic hand grip strength, thereby improving their quality of life. Older adults had subjectively indicated that they felt that the increased dynamic strength assisted them with minor tasks such as, carrying and lifting packets from the floor to their cars. This basic task was performed easier after the exercise programme, thus improving their functional capacity for work. The Fiatarone, *et al.* (1990) study used expensive laboratory equipment, had a smaller sample size ( $n=10$ ) and a shorter study period (8 weeks), but boasts an impressive 174% strength gain. In this study's defense the female subjects' enjoyed a 7.6% strength increase, by only using body resistance exercises, used as part of the intervention programme. This study aimed at being cost effective in producing increased strength gains.

Females generally have a lower aerobic capacity than males (McArdle, *et al.*, 1996). The female subjects' pre-test scores were low, thereby providing a greater opportunity for aerobic capacity improvement. The intervention exercise programme achieved an increase of 7.2% from pre to post exercise intervention, which was statistically significant ( $p < 0.05$ ). This finding is consistent with that of Adams & De Vries (1973) in that regular physical activity will increase older adults' aerobic capacity. However, this study possessed a lower increase in predicted  $VO_{2max}$  as compared to Adams & De Vries (1973). The Adams & De Vries (1973) study revealed that their subjects enjoyed a 21.3% increase in predicted  $VO_{2max}$ . The difference in the Adams & De Vries (1973) study was that their study implemented an aerobic intervention exercise programme exclusively. This study implemented a well-balanced intervention exercise programme, which yielded an increase in muscle strengthening, flexibility, co-ordination, agility and dynamic balance, beside an increase in aerobic capacity. In summary good results were achieved for the female subjects in this study.

## 4.2 Data analysis of male subjects

In this section the analysis and discussion of the data from the pre to the post study intervention programme for males will be discussed.

**Table 4.3 Changes in the male subjects' demographic data ( $\bar{x}$  (SD))**

<b>Variables</b>	<b>Pre-Test</b>	<b>Post-test</b>	<b>% difference</b>	<b>Significance</b>
Age (yrs)	71.6 (9)	71.6 (9)	0	P>0.05
Height (m)	1.8 (0.2)	1.8 (0.2)	0	P>0.05
Body mass (kg)	78.4 (10.8)	76.8 (9.7)	2	P>0.05
Girth measurements (cm)	96.9 (12.8)	90.2 (6.7)	1.5	P>0.05
N =	40	21	47.5	-

Forty males started the study and only 21 completed (47.5% drop out rate) due to personal reasons and the deterioration of health. The mean age of the male subjects' was 71.6. Male subjects' average height was 1.8 meters. Their body mass decreased by 2%, which was found to be statistically insignificant. The study by De Vries (1970) and Chodzko-Zakjo (2000) supports these findings. The De Vries's (1970) study showed similar trends in the reduction of body mass (1.2%). However, their sample size was 112 subjects compared to this study's post examination number of subjects (21). Male subjects enjoyed a 1.5% reduction in girth measurements. This reduction in girth measurements was found to be statistically not significant. The physical activity of the male subjects in the intervention exercise programme may have increased their metabolic rate, thereby increasing the energy-expended daily, thus having an effect on the body girth measurements. These reduced girth measurements

facilitated greater ease of mobility, thus increasing their functional capacity and enhancing their quality of life, which they subjectively indicated

**Table 4.4 Changes in the fitness components of male subjects ( $\bar{x}$  (SD))**

<b>Fitness components</b>	<b>Pre-test</b>	<b>Post-Test</b>	<b>% difference</b>	<b>Significance</b>
Agility & dynamic balance (sec)	28.1 (3.7)	26.2 (4.5)	6.8	P<0.05
Muscle strength & endurance (no)	25.7 (4.5)	31.8 (6.9)	23.7	P<0.05
Flexibility (cm)	27.6 (6.3)	30.1 (5.5)	9.1	P<0.05
Co-ordination (sec)	18.3 (3.7)	17.7 (4.2)	3.3	P>0.05
Dynamic hand grip strength (kg)	26.2 (4.9)	28.1 (4.5)	7.3	P<0.05
Rockport test (ml/kg/min)	37.1 (4.1)	33 (6)	4.7	P<0.05
N =	40	21	47.5	-

Poor agility and dynamic balance increases the incidence of falls amongst the aged. Falls are considered to be the leading cause of debilitating injury amongst the aged, as this is a result of the high incidence of osteoporosis (Katz & Sherman, 1998). Thus, improving agility and dynamic balance decreases this risk amongst the aged. The agility and dynamic balance of male subjects improved by 6.8%, which was statistically significant ( $p<0.05$ ).

Muscle strength and endurance of the male subjects increased by 23.7%, which was statistically significant ( $p < 0.05$ ). This finding concurs with the evidence produced by studies of Ades, *et al.* (1996) and Chandler, *et al.* (1998). Chandler, *et al.* (1998) recruited 100 subjects and the study period lasted for 10 weeks, but the execution of the intervention exercise programme was unsupervised, thereby providing opportunity for error in execution of exercises and increased risk of injury. Further, the compliance of the exercise programme may be questioned. However, Chandler, *et al.* (1998) yielded a 12.5% increase in muscle strength and endurance. This study has a longer study period (30 weeks) with personal supervision of a well-balanced intervention exercise programme (minimizing room for error in execution of exercises and risk of injury). Similarly, Ades, *et al.* (1996) possessed a similar sample size ( $n=24$ ), however, the study period was shorter and the use of expensive gym equipment yielded a 47% increase in muscle strength and endurance. The current study shows that an inexpensive, low cost programme, without using weight training equipment may yield results that are observed as beneficial increases in strength and endurance. This study further showed that strength may improve irrespective of age.

Reduced flexibility limits an older adult's ability to perform various tasks, such as bending, tying their shoelaces, and walking up and down staircases. This study's intervention exercise programme assisted these subjects by increasing their joints' range of motion, thus enabling them to perform daily activities more easily, thereby improving their quality of life (see table 4.4). If the subjects were given a more intensive flexibility programme, the results may have been better. This study's findings supports the literature of Foss & Keteyian (1998), which suggests that regular flexibility training can improve a person's flexibility regardless of their age and gender. The flexibility of the male subjects increased 9.1%. This increase in flexibility proved to be statistically significant ( $p < 0.05$ ).

Poor co-ordination contributes significantly to the increased incidence of falls in the aged. Falls amongst the aged are considered to be the leading cause of injury and hospitalization amongst this special population group. Therefore any modality that helps to reduce the

incidence of falls amongst the aged is perceived to have a positive impact on their lives. The co-ordination of male subjects increased by 3.3%, which was statistically not significant. This study's intervention exercise programme helped to increase the male subjects' co-ordination, thus enhancing their quality of life in a small, but significant way. The subjects indicated that pouring tea from a teapot into a cup was easier. The results showed similar trends to the scores of Barry, *et al.* (1993) study. Co-ordination in this study was assessed, by using the soda pop co-ordination test, which is a universally accepted assessment for this component.

The male subjects dynamic hand grip strength increased by 7.3%, which was statistically significant ( $p < 0.05$ ). Male subjects' subjectively indicated that they were able to perform tasks, which they were capable of doing when they were younger. These tasks included, washing their cars, repairing broken equipment, etc. all of which need strength and power to be repaired (tightening of nuts and bolts and turning screws). This study indicates that regular strengthening exercises can improve an older adult's dynamic hand grip strength, thereby improving their functional capacity for activities of daily living.

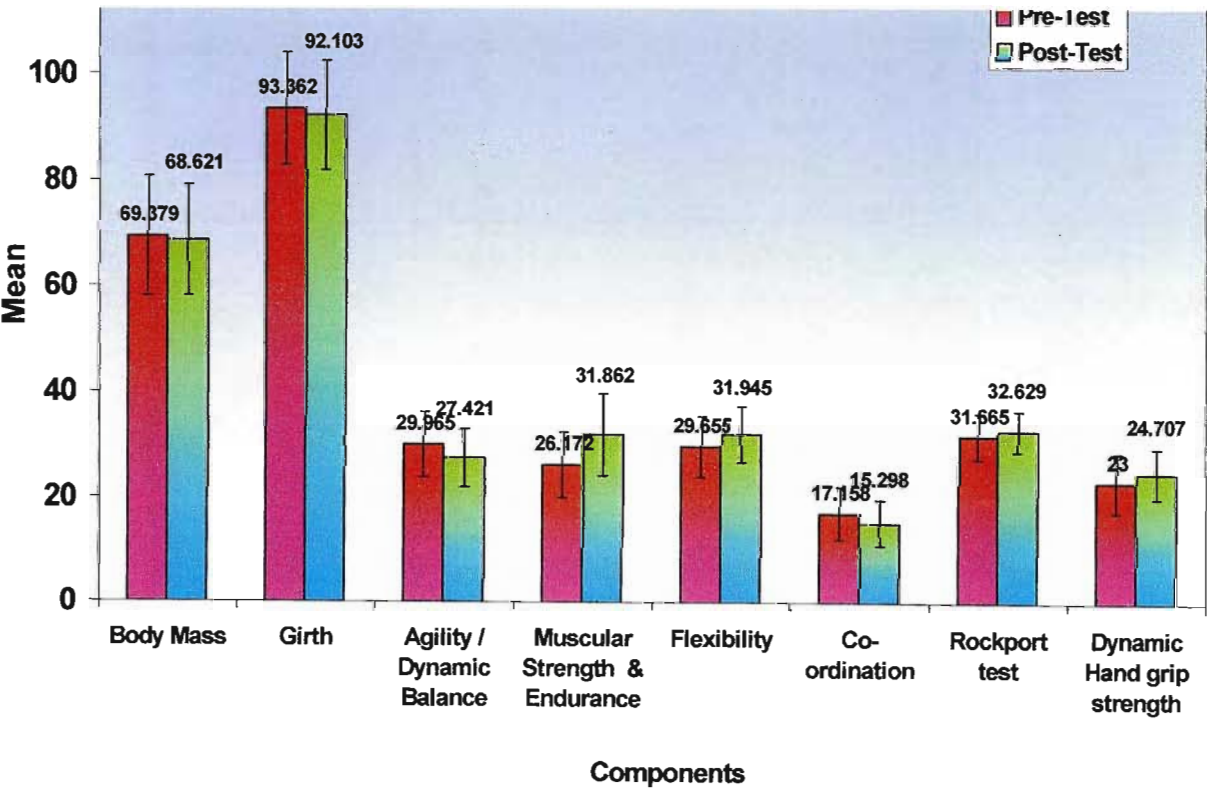
McArdle, *et al.* (1996) suggest that males have a higher haemoglobin concentration than females, which gives males a greater aerobic capacity advantage as compared to females. Male subjects' predicted  $VO_{2max}$  increased by 4.7%, which is statistically significant ( $p < 0.05$ ). This finding was similar to that of De Vries (1970) and Klebanoff, *et al.* (1998) in that regular exercise increases older adult's aerobic capacity. In the De Vries (1970) study, the subjects enjoyed an 8.3% increase in aerobic capacity, thus yielding similar results to this study. Male participants subjectively indicated that after the intervention exercise programme they were able to perform recreational pursuits for a longer period of time, including gardening and mowing the lawn for a longer period of time. Some indicated that they were able to garden larger areas in shorter time periods. Thus indicating that they were able to increase their physical activity intensity and sustain this intensity for a longer period of time. The exercise intervention programme had a positive influence on the functional



capacity of these subjects. Again, it is observed that the exercise intervention programme had an overall positive influence on the lives of these aged persons.

**4.3 Data analysis of the combined group**

In this section the scores of the total group will be discussed and analyzed as one group, irrespective of the gender differences. Figure 4.1 will provide a graphical display of the changes for the total group. Figure 4.1 illustrates the pre to post test results of males and females (mean).



**Figure 4.1 Pre and Post Test Results of the total group**

A hundred subjects started the study, but only 58 subjects completed the study (42% drop out rate). This is a common occurrence in research with older subjects. Espenschade, 1966; Fiatarone, *et al.*, 1990; Darby & Temple, 1992 and Ades, *et al.*, 1996 experienced similar drop out rates, although their lengths of studies were shorter than the current study.

As a person ages, their body mass progressively increases, due to physical inactivity, which results in them being overweight and even obese. This increased body mass impacts negatively on the health of the person, which increases the risk for diabetes, CHD, hypertension and lower back pain. The average mass of the total group decreased by 1% ( $p>0.05$ ). Although this study showed a small percentage decrease in body mass (1%) for the total group, it improved participants self esteem which impacted positively psychologically. This motivated them to continue with the programme and commit to exercise as a lifestyle change. Translated into practical terms, many male subjects indicated that they needed to tighten their belts a notch or two. The female participants indicated that their clothes became a loose fit.

Girth measurements' of all subjects' decreased by 1.2%, which was statistically not significant. Male subjects enjoyed a greater reduction in girth measurements (1.5% difference) as compared to the female subjects' (1.3% difference). Males have a naturally higher metabolic rate than females due to greater lean body mass, which has a positive effect on their energy expenditure. Both male and female subjects' increased their metabolic rates respectively in this study (see figure 4.1).

Loss of agility and dynamic balance leads to loss of balance, causing increased risk of injury to this susceptible group. The agility and dynamic balance of all subjects increased by 3.3%, which was statistically not significant. This improvement in agility and dynamic balance positively impacted on the quality of life of this particular population group (refer to figure 4.1). This finding was consistent with the findings of Parson, *et al.* (1992). Male subjects' agility and dynamic balance increased by 6.8%, whilst female subjects increased by 9.1% on

the same component. Female subjects experienced a greater agility and dynamic balance improvement in terms of percent difference. In spite of the greater improvement in agility and dynamic balance amongst female subjects, males still were more agile and had greater dynamic balance than females, as indicated by the results (see table 4.2 and 4.4). This is due to the fact that the males had better scores to start off with.

Advancing age results in a deterioration of muscle strength and endurance, which decreases the efficiency with which daily activities are performed and becomes progressively worse and more difficult for the senior citizen. All subjects' muscle strength and endurance increased by 21.8%, which was statistically significant ( $p < 0.05$ ). This finding lends support to the similar trends produced from studies by Fiatarone, *et al.* (1990) and Chandler, *et al.* (1998) which, showed improvements in muscle strength and endurance in the combined group. This study indicates that regular strengthening exercise can improve older adults' muscle strength and endurance. The results are contradictory to the belief that older persons cannot improve strength and that resistance training is dangerous for the elderly. Male subjects enjoyed greater muscle strength and endurance gains than female subjects. This greater percentage muscle strength and endurance increase however, was statistically not significantly greater. Also the strengthening exercises further enhanced the muscle strength and endurance difference between the genders, and this was achieved by using body resistance exercises and not sophisticated weight-training equipment.

Poor co-ordination is a key characteristic of advancing age, which contributes to the increased incidence of falls, injury and hospitalisation amongst this group. Co-ordination of the total group increased by 11.1%. This improvement was statistically significant ( $p < 0.05$ ). This finding lends support to the data obtained by the historical research review by Barry, *et al.* (1993); D'Arrigo (2001) and Wade (2000) indicating that regular physical activity can combat poor co-ordination, amongst the elderly. When the data of the combined group of subjects pre-test to post-test for their co-ordination was analyzed, it was statistically significant ( $p < 0.05$ ). This study shows that regular exercise can delay or retard poor co-

ordination, and improve the senior citizen's functional capacity. Subjective indications of subjects after the participation in the study indicated they felt that they possessed better co-ordination and had a better sense of balance. The female subjects had a greater increase in co-ordination, however they started at lower levels than the males (see tables 4.2 and 4.4).

Reduced flexibility amongst the aged can result in various conditions, such as: mechanical back pain, lower back pain, poor posture, kyphosis, lordosis and abnormal gait patterns. Subjective rating from the subjects' revealed that regular flexibility training assisted in the alleviation of pain produced from daily bending and other activities. The intervention exercise programme successfully increased the flexibility of the total group by 7.7%. This finding is consistent with that of the research studies by Siegenthaler (1999) and ACSM (2001). This improvement in flexibility was found to be statistically significant ( $p < 0.05$ ). This study indicates that regular flexibility training has a positive impact on the lives of senior citizens in improving activities of daily living. The female subjects showed better flexibility rating than the male subjects. This is a known relationship between the sexes and is consistent with the literature of McArdle, *et al.* (1996) and ACSM (2001).

The aged, are renowned for their deficits in overall body strength and hand grip strength was used as a measure of this component. This study's intervention exercise programme assisted in improving the total group's dynamic hand grip strength which enabled the participants to engage in more physical activity, and move away from their physically inactive lifestyles. The dynamic hand grip strength of all subjects' improved, however, it was not statistically significant. This study's findings reinforce those of Greendale, *et al.* (1995) and Brooke-Wavell, *et al.* (1997). These finding show that strength can be improved at any age, as long as the subjects undergo a supervised physical activity programme in order to achieve this benefit.

Predicted maximal oxygen consumption indicates a person's ability to sustain physical activity for a prolonged period of time. Predicted maximal oxygen consumption requires the

integrated high level, diverse response of most of the body's systems for efficient functioning. As a person becomes older their VO<sub>2</sub>max becomes progressively lower (Wells, et al., 1992 and McArdle, et al. 1996) however the fall in Vo<sub>2</sub>max is lower in trained older people than in physically inactive persons. With lower oxygen capacities, older subjects will not be able to sustain endurance activities for long periods of time. However, in this study where regular aerobic exercise was performed, the improvement in oxygen consumption increased by 7.4%, which was statistically significant, for this group ( $p < 0.05$ ). This finding is consistent with evidence produced by Souminen, et al. (1977); Kohrts, et al. (1991) and Wells, et al. (1992). Male subjects' mean aerobic capacity increased by 4.7%, whilst female subjects' enjoyed a greater increase in their mean aerobic capacity (7.2%). However male subjects still have a greater mean aerobic level at the start of the programme.

Generally, good results were obtained in this study for both males and females, which indicated that the intervention programme had a positive impact on this aged population. The benefits of the intervention programme were invaluable as indicated by the participants subjectively, when questioned after the study.

## **CHAPTER FIVE**

### **CONCLUSION AND RECOMMENDATIONS**

#### **5.1 Conclusions**

#### **5.2 Recommendations**

## **CHAPTER FIVE**

### **5 CONCLUSIONS AND RECOMMENDATIONS**

The summary of the conclusions and recommendations of this study will be listed.

#### **5.1 Conclusions**

As individual's age, they become less active, and as a result a number of physiological and psychological functions deteriorate. However, the results of this study indicate that with a regular supervised exercise programme, the many functions that normally deteriorate with inactivity are considerably reduced. The study showed the following positive changes brought about by exercise:

- Decreased body mass
- Decreased girth measurements
- Increased agility and dynamic balance
- Improved muscular strength and endurance
- Better co-ordination
- Better flexibility
- Greater aerobic capacity
- Improved functional capacity

#### **5.2 Recommendations**

These recommendations are suggested as an outcome of the study:

- Senior citizens should be educated about the benefits of regular physical activity, and its effects on their health and quality of life.
- That all retirement centres have regular supervised exercise programmes.

- That a programme of physical activity be incorporated as part of the daily activity of the residents of the retirement centres.
- That inter-home sports day's should be organized at least twice a year, in order to motivate these senior citizens to continue with their activity programmes.

The author is willing to be involved in the development and set up of these recommendations.



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## **APPENDICES**

APPENDIX A	Physical Activity Readiness Activity Questionnaire (PAR-Q)
APPENDIX B	Correspondence to Durban Association for the Aged (DAFTA)
APPENDIX C	Correspondence from Durban Association for the Aged (DAFTA)
APPENDIX D	Correspondence to Durban Association for the Aged (DAFTA)
APPENDIX E	Correspondence from Durban Association for the Aged (DAFTA)
APPENDIX F	Correspondence from Durban Association for the Aged

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# APPENDIX A      Physical Activity Readiness Activity Questionnaire (PAR-Q)

Physical Activity Readiness  
Questionnaire - PAR-Q  
(revised 1994)

# PAR - Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
<input type="checkbox"/>	<input type="checkbox"/>	1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?
<input type="checkbox"/>	<input type="checkbox"/>	2. Do you feel pain in your chest when you do physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	3. In the past month, have you had chest pain when you were not doing physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
<input type="checkbox"/>	<input type="checkbox"/>	5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
<input type="checkbox"/>	<input type="checkbox"/>	7. Do you know of <u>any other reason</u> why you should not do physical activity?

FIG. 2-1. PAR-Q form. Reprinted with permission from Reference 7.

Continued on Next Page

## YES to one or more questions

Talk with your doctor by phone or in person **BEFORE** you start becoming much more physically active or **BEFORE** you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want—as long as you start slowly and build up gradually. Or, you may need to limit your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

## NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active—begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal—this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

## DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness as a cold or a fever—wait until you feel better; or
- if you are or may be pregnant—talk to your doctor before start becoming more active.

**Please note: If your health changes so that you then answer YES to any of the above questions, tell your doctor or health professional whether you should change your physical activity plan.**

**Important Use of the PAR-Q:** The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity without first completing this questionnaire. Consult your doctor prior to physical activity.

**You are encouraged to copy the PAR-Q but only if you use the entire form.**

FIG. 2-1. Continued

Continued on Next Page

Page 1 of 2

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*NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes*

I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfac

NAME \_\_\_\_\_

SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_

SIGNATURE OF PARENT \_\_\_\_\_ WITNESS \_\_\_\_\_  
or GUARDIAN (for participants under the age of majority)

© Canadian Society for Exercise Physiology  
Société canadienne de physiologie de l'exercice

Supported by:  Health Canada Santé Canada

FIG. 2-1. Continued

**UNIVERSITY OF DURBAN-WESTVILLE  
SPORT SCIENCE DEPARTMENT**

**INFORMED CONSENT**

**Explanation of the tests**

You will perform a series of fitness tests, which includes body mass, height, girth measurements, agility, muscular endurance and strength, flexibility, co-ordination and a cardiovascular fitness test. You will then engage in a 30-week intervention exercise programme. The same fitness test battery will follow this. Participation is voluntary. It is important for you to realise that you may stop when you wish because of feelings of fatigue or any other discomfort.

**Risks and Discomforts**

There exists the possibility of certain changes occurring during the test. This includes abnormal blood pressure, fainting, irregular, fast, or slow heart rhythm. There is a slight possibility of straining a muscle and or a ligament during the muscle fitness and flexibility testing. In addition, you may experience muscle soreness 24-48 hours after testing. Every effort will be made to minimise these risks.

**Responsibilities of the patient**

Information you possess about your health status or previous experiences of unusual feelings with physical effort may affect the safety and value of your participation. Your prompt reporting of feelings with effort during the exercise test itself is also of great importance. You are responsible for fully disclosing such information when requested by the testing staff.

**Benefits to be expected**

The results obtained will assist in documenting the effects of regular physical activity on the aged.

**Enquiries**

Any questions about the procedures used in the exercise tests and study are encouraged. If you have any concerns or questions, please ask us for further explanations.

**Freedom of consent**

Your permission to perform this test is voluntarily.

I have read this form and I understand the test procedures that I will perform and the attendant risks and discomforts. Knowing these risks and discomforts, and having had an opportunity to ask questions, that have been answered to my satisfaction, I consent to participate in this test.

_____	_____	_____
SUBJECT	SIGNATURE	DATE
_____	_____	_____
TESTER	SIGNATURE	DATE
_____	_____	_____
WITNESS	SIGNATURE	DATE

## **APPENDIX B**

### **CORRESPONDENCE**

Letter sent to Durban Association for the Aged (DAFTA)

T.J. Ellapen  
61 - 30<sup>th</sup> Avenue  
Umhlatuzana Township  
Chatsworth  
4092

P. Pillay  
P.O. Box 56861  
Chatsworth  
4030

22 March 1999

Dear Sir/Madam,

RE: STRUCTURED EXERCISE PROGRAMMES OFFERED TO THE AGED AT YOUR INSTITUTION

I am currently conducting a study on the effects of exercise on the ageing process, and I am eager to discover the effects of regular exercise on the ageing process.

Could you please inform me, as to whether your organisation offers a regular structured exercise programme, of this nature to your members? If this does apply to your organisation, it would be sincerely appreciated if you could kindly forward information regarding the following:

Inception date of your exercise programme; and

The progress to date of the exercise programme, as well as any other information or literature you may consider relevant.

However, should your organisation not offer such an exercise programme, it would be a pleasure and honour to make my services available voluntarily. Please feel free to contact me on telephone numbers 4011709 (h) and 4019310 (w), or reply to the above-mentioned address.

Your co-operation and kind assistance is sincerely appreciated.

Yours faithfully

**T.J. ELLAPEN**



## **APPENDIX C**

### **CORRESPONDENCE**

Letter received from DAFTA

P. Pillay  
P.O. Box 56861  
Chatsworth  
4030

T.J. Ellapen  
61 – 30<sup>th</sup> Avenue  
Umhlatuzana Township  
Chatsworth  
4092

5 April 1999

Dear Sir/Madam

RE: STRUCTURED EXERCISE PROGRAMME OFFERED TO THE AGED

Your letter dated 22 March 1999 refers. Firstly we would like to thank you for considering our organisation, unfortunately we do not have a structured exercise programme in place to date.

However, we would like to accept your voluntary offer of co-ordinating and implementing a structured exercise programme. Please feel free to contact us and set up an appointment for discussion pertaining to this issue.

Thanking you for your time and consideration.

Yours faithfully  
P. PILLAY (MISS)

## **APPENDIX D**

### **CORRESPONDENCE**

Letter sent to DAFTA

T.J. Ellapen  
61 - 30<sup>th</sup> Avenue  
Umhlatuzana Township  
Chatsworth  
4092

P. Pillay  
P.O. Box 56861  
Chatsworth  
4030

6 April 1999

Dear Sir/Madam,

**RE: APPOINTMENT REGARDING STRUCTURED EXERCISE PROGRAMME**

Further to our appointment, I hereby request permission to conduct research at your retirement centres.

The study will deal with the effects of exercise and physical activity on the aged. The research procedure will be as follows:

Administration of tests;

Exercise programme and physical activity; and

Re-test.

Once I have obtained formal permission to conduct the study, I assure you, that the study will in no way inconvenience your co-ordinators, or disrupt the every day activities of your retirement centres.

Yours faithfully

T.J. ELLAPEN

## **APPENDIX E**

### **CORRESPONDENCE**

Letter received from DAFTA

P. Pillay  
P.O. Box 56861  
Chatsworth  
4030

T.J. Ellapen  
61 – 30<sup>th</sup> Avenue  
Umhlatuzana Township  
Chatsworth  
4092

12 April 1999

Dear Sir/Madam,

RE: STRUCTURED EXERCISE PROGRAMME

We wish to advise you that you have been granted permission to conduct your research at our retirement centres. You may do so at a time convenient to both you and the retirement centre personnel.

I would like to take this opportunity of wishing you well in your research.

Yours faithfully

P. PLLAY (MISS)

**APPENDIX F**  
**CORRESPONDENCE**

Letter received from DAFTA

**Durban Association for The Aged**

FR. No. 06 600329 000 2

PO BOX 56861  
CHATSWORTH  
4030

Your reference:

Our reference:

TEL/FAX: (031) 46 7734

Enquiries to: PRIYA PILLAY

11 April 2000

The Department Head  
Human Movement Studies Department  
University of Durban Westville

Dear Sir / Madam

**Re: Practical Work of Terry Ellapen**

I would like to confirm with you that the above-mentioned student of your department has conducted groupwork with our senior citizens of the Happy Hours Senior Citizens Club at 32 Business Square, Chatsworth.

It has been a pleasure working with Terry. He has been successful in conducting a suitable programme for the senior citizens. His enthusiasm and patience displayed during his sessions with the members has motivated them to continue their exercises.

The contribution you and your department has made is much appreciated.

Yours faithfully



Miss Priya Pillay  
Social Worker