THE IMPACT OF A SPECIFIC HOME BASED EXERCISE PROGRAMME ON FALL RISK FACTORS IN OLDER PORTUGUESE PEOPLE

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DECLARATION OF AUTHORSHIP

I declare that the research contained in this thesis, unless otherwise formally indicated within the text, is the original work of the author. The thesis has not been previously submitted to this or any other university for a degree, and does not incorporate any material already submitted for a degree.

ABSTRACT

The aim of the this study was to develop a moderate intensity, specific and safe home-based exercise programme and evaluate its effectiveness on fall risk factors in Portuguese people over the age of 65.

Eighty two older people, between the ages 65 and 84 years, from an Oporto Health Centre participated in the study. They were randomized into an intervention (n = 43) and a control group (n = 39). The participants were functionally independent in the community, and able to walk without aids. The intervention group undertook a moderate, specific, home-based exercise programme for nine months and the control group continued their normal activities. A number of validated tests were applied before the start of the programme, and at three and nine months, in order to measure functional activities, functional status and quality of life. Three months after the cessation of the exercise programme, the intervention group was reassessed. At the completion of the exercise programme twelve participants were invited to take part in a qualitative study, which aimed to explore the reasons for adhering or not adhering to the exercise programme. Two focus group discussions were conducted, one for the participants who adhered to the programme for nine months and another for the participants who discontinued the programme before the three months assessment.

After three months of exercise the intervention group showed statistically significant improvements ($p< 0.05$) in the sit to stand test, forward functional reach and voluntary stepping times in all directions and in the scores of the Instrumental Activities of Daily Living when compared with the control group. After nine months of exercise, improvement had also been achieved in the Timed Up and Go test ($p<0.05$), Lateral Functional Reach ($p< 0.05$), Active Range of Motion of both ankles ($p< 0.05$). The exercise programme had no statistically significant influence on reducing thoracic kyphosis, on improving Fear of Falling, Quality of Life, Basic Activities of Daily Living, Emotional Function, Social Activity and Quality of Social Interaction. Three months after the start of the programme there was a 79% adherence rate and at nine months the adherence was 74%. Participants were re-assessed three months after the end of the exercise programme, i.e. 12 months from the start, and at that time 35% of the intervention group did not continue the exercises. During follow up focus group interviews it became apparent that all the participants perceived health, prescription and home exercise as incentives as well as barriers to participate in the programme. Both groups referred to an increase in spine flexibility and a better posture as being physical benefits of the programme, contrary to the quantitative findings of the study.

CONCLUSION: A moderate, specific, home-based exercise programme, that was easy to administer, had a positive effect on the majority of risk factors associated with falls.

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INTRODUCTION

Average life expectancy has improved in the last century around the world. In Portugal, in 1960, older people represented 8% of the population and this had more than doubled by 2001 when 18.6% of the population was over the age of 65 years. In absolute values, the number of older people in Portugal has increased by almost 1 million since 1960 (INE 2002).

In the 2001 National Census the state of physical inactivity of the Portuguese older population was apparent, with 48.1% of the women and 40% of the men reporting that the only activities undertaken in the past year were "being seated and walking very short distances". This confirmed the subjective observations of the author who had noted a worrying lack of activity in both her family, elderly friends and patients. The need to see if it was possible to design and implement a home based exercise programme that might help improve the physical level of fitness of older people led the author to take the decision to undertake the present study.

Ageing is a complex process involving many interacting variables that greatly influence the manner in which people grow old. The overall reduction in physical activity with age parallels changes due to the ageing process itself on the level of cell, tissue, and organ systems. When the effects of the high incidence of inactivity indicated by the Portuguese Census are added to the normal effects of ageing, there are grounds for concern that health related problems already evident in older people will increase and have detrimental effects on society and older people themselves.

The consequences of falls are one of the main concerns of modern health care systems. The rate of Portuguese people, aged 85 years or more, admitted to hospital in 1995 due to falls was about 30.9 people/1000 habitants with high economical costs. The consequences of falls to the older people and their families can not only be expressed in monetary terms, but also have social and psychological consequences, needing a proactive approach based on evidence.

Age related changes in the musculoskeletal and neurological systems increases the risk of losing balance and falling and these effects are made worse by inactivity. The ability of a person to maintain a stable, upright position is complex, involves a number of systems, and requires extensive sensory input, central integration and musculoskeletal co-ordination in a highly integrated manner (Sakari-Rantala et al. 1998).

Ageing is also associated with changes in visual, proprioceptive, and vestibular systems that slow down the person's ability to detect and respond appropriately to safety hazards (Lord et al. 2001).

Most falls experienced by older people result from the complex interaction of intrinsic and extrinsic factors. Intrinsic factors are the characteristics that are inherent to each individual and are the result of changes related to aging, inactivity, disease or medication (Steinweg 1997). Most commonly reported intrinsic factors that are of interest here are; loss of muscle endurance and strength, loss of flexibility and loss of static and dynamic balance.

Extrinsic factors including environmental hazards e.g. loose rugs, slippery floors, uneven door thresholds, poor lighting, bathroom fixtures and home furnishing are also common contributors to falls (Steinweg 1997).

Falls with no resultant physical injury can also have serious social and psychological consequences (Vellas et al. 1997). Restriction upon daily activities has been reported in a third of older people two months following a fall (Tinetti and Williams 1998). Such a functional decline may be a consequence of a loss of confidence, a fear of falling and a restriction in mobility (Maki et al. 1994, Tinetti et al. 1994). Besides contributing to mental deterioration and cardiovascular disease, the loss of mobility is a significant cause of loss of independence among the older people (Buckwalter 1997).

For a population who tends to be inactive in their daily routine, exercise must be considered as a means to not only challenging the cardiovascular system, but also of maintaining flexibility, strength, co-ordination, balance, and motor problem solving ability. If older people are not physically active, a suitable and tailor made exercise programme may prevent the downward-spiral of decreased physical ability which often leads to physical losses and further immobility. Regular physical exercises can slow down or reverse the effects of decreased mobility that contributes to disease and disability in old age (Rothwell 1994).

Many studies (Schlitch et al. 2001, King 2001, and Kerse et al. 1999) involving the older population have shown that specific exercise programmes, e.g. resistance training or Tai-Chi could lower the risk of falls . Other studies from Yates and Dunnagan (2001), Robertson et al. (2001) and Campbell et al. (1997) using home based exercise programmes and resistive exercises seem also to have the desired effect of improving the fall risk factors. Home based exercise programmes to reduce falls in older people, might be an alternative to the specific exercise programmes provided in hospitals, health centres and sport centres as they are easy to implement and normally more cost effective(Yates and Dunnagan 2001).

Moderate intensity exercises without equipment, using the number of repetitions or speed as a progression, have been rarely used (Helboostad et al. 2004 and Johnson et al. 2003) in home-based programmes that focus on reducing some risk factors associated with falls in the older people population.

A large number of the Portuguese older people are not engaged in physical activity, as demonstrated by the results of the 2001 National Census and because health and fitness centres are not readily accessible to older Portuguese people. Thus it was hypothesized that a carefully designed, home based exercise programme might improve some of the risk factors associated with falls, e.g. muscle endurance, flexibility, strength of lower limbs, balance and lower limb voluntary stepping.

The specific programme designed for the current study was to be undertaken in the home without equipment. The programme consisted of moderate intensity exercises that specifically addressed the most commonly recognised fall risk factors.

The aims of this study were :

- To design and implement a home-based, moderate intensity, specific exercise programme for older people focusing on fall risk factors
- To establish the reliability of the physical tests used in the present study
- To assess the effect of a nine month, home-based, moderate intensity, specific exercise programme on the fall risk factors
- To explore the factors contributing to the adherence or non-adherence to the exercise programme.

This thesis is divided in two parts: Part I reports the quantitative study addressing the first two aims and Part II the qualitative study, addressing the last aim.

The first seven chapters relate to the quantitative study.

The first chapter contains a literature review of the effects of age on the musculoskeletal system that contributing to postural control and, in particular considers joint range of motion, spinal flexibility and muscle properties. The principles of training as well as the effect of specific exercises on these particular systems are critically reviewed.

Chapter Two focuses on the effect of age on neural mechanisms underpinning postural control as well as the effects of specific exercise interventions for balance, to prevent falling. The second part of the chapter reviews risk factors associated with falls, the influence of fear of falling on falls and the effect of exercising on falls in older people.

Chapter Three reviews home based exercise programmes reported in the literature from 1994 to 2005 and gives a description of the structure of the home based exercise programme used in the current study and the evidence behind the choice of each exercise.

Chapter Four includes the voluntary stepping pilot test and the intrarater reliability study of all the tests.

Chapter Five describes the methodology of the main study. It describes the sample recruitment and allocation to groups, the instruments and measures used, the procedures, and the statistics used to analyse the data.

Chapter Six contains the results of a randomised controlled trial to estimate the effects of a nine months home based exercise programme in persons aged 65 to 84 years. Participants were assessed at baseline, after 3 months and again at 9 months. To estimate residual effects of the programme the intervention group was again assessed one year after the programme start.

Chapter Seven discusses the methodology used and the results found in the randomised controlled trial as well as the conclusions of this quantitative study.

In Part II of this thesis the qualitative study is presented.

Chapter Eight reviews the relevant psychosocial theories and models related to adherence to exercise.

Chapter Nine explains the methodology of the phenomenological qualitative approach used to explore perceptions of older Portuguese participants of a home based specific exercise programme using focus groups.

Chapter Ten analyses statements from the participants, the formulated categories, and the different themes found from the focus groups sessions.

Chapter Eleven discusses the findings of the qualitative study and concludes the study.

Chapter Twelve provides a final overview of both studies and considers areas for future research as well as the possible limitations of both the studies.

PART I

QUANTITATIVE STUDY

CHAPTER 1

AGE EFFECTS ON POSTURAL CONTROL: MUSCULOSKELETAL SYSTEM COMPONENTS

The purpose of the research reported in this thesis was to design, implement and evaluate a home exercise programme and the exercises that were chosen were those that might reduce the risk of falling in older, sedentary Portuguese people. It was not within the remit of this research to evaluate the effectiveness of these exercises on reducing falling. In order to understand the rationale behind the design of the exercise programme it is necessary to be aware of the current knowledge of the influence of age on the systems that contribute to postural control, factors relating to falling and exercise interventions. To this end, this chapter reviews the effects of age on the musculoskeletal components that contribute to postural control and, in particular considers joint motion, passive extensibility of soft tissue and skeletal muscles (changes in muscle endurance, strength and power). The principles of training as well as the effect of exercise on these musculoskeletal components are critically reviewed.

1.1. Falls and Postural Control

Falls in older people are the result of age effects on the systems that contribute to postural control and balance as well as environmental factors. As systems become gradually more impaired, the risk of falling increases (Tinetti et al.1994).

Postural control is involved in standing one of the most used positions in daily life and involves arranging the body's position in space for two purposes: balance and orientation.

Postural orientation is *"the capacity to maintain an appropriate relationship between the body segments and between the body and the environment "*(Shumway-Cook and Woollacott 2001).

Balance is identified as the aptitude to maintain or move the position of the body particularly the centre of body mass within the stability limits in which the body can maintain its position. It also implies the aptitude to move the position of segments in standing as well as to be able to get out of the standing position. (Woollacott and Shumway-Cook 1990, McCollum and Leen 1989, Carr and Shephard 1987).

Postural control required for postural orientation and balance involves a complex relation of musculoskeletal and neural systems to assess the position and body movement in space, and the aptitude to produce forces to control body position (Shumway-Cook and Woollacott 2001) (Figure 1.1.).

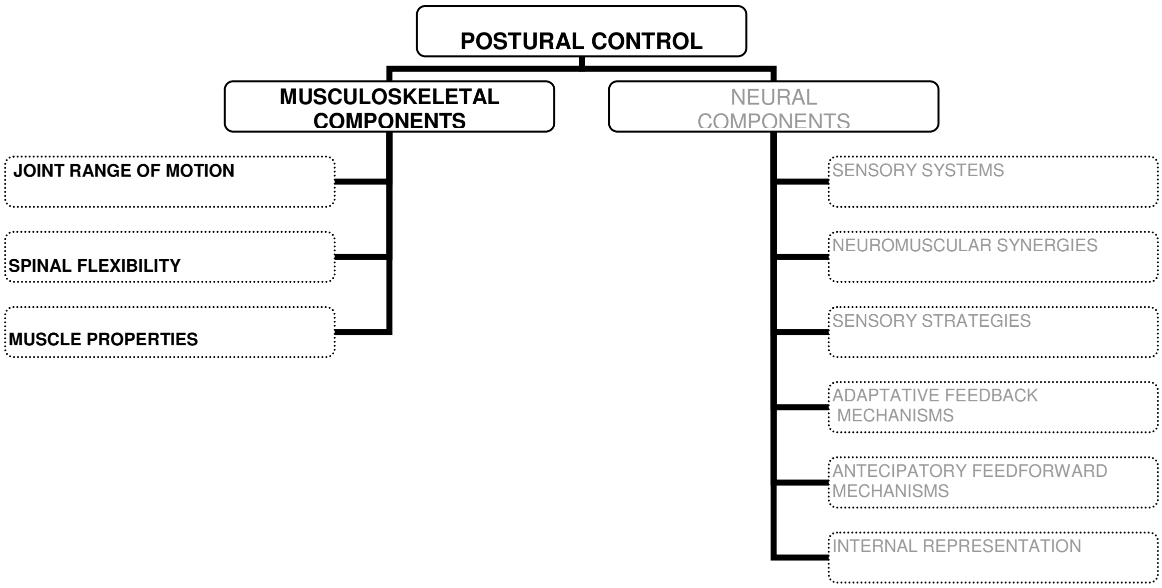

Figure 1.1. Conceptual Model representing systems contributing to postural control (adapted from Shumway-Cook and Woollacott 2001)

The musculoskeletal components that are involved in postural control include joint range of motion, spinal flexibility and muscle properties. These components however deteriorate with ageing.

1.1.1. Effects of aging on range of joint motion

Range of motion is related to joint flexibility being determined by the skin, ligaments, fascial sheets, articular cartilage and passive extensibility of muscles (defined as their ability to lengthen without muscle activation), surrounding the joint (Gajdosik 2001).

Johns and Wright (1962) studied the contribution of various structures on joint motion in five cats. They examined the rheological properties of the cat's wrist, as they are similar to those of the human's metacarpophalangeal joint. They calculated the degree to which specific soft tissues contribute to the joint range of motion, with the joint capsule accounting for 47% of the total resistance to joint movement, muscle and fascia 41%, ligaments and tendons 10%, and skin 10%. Their results showed that it is the non muscular tissue, that shows significant change with age, accounting for the majority of the resistance to passive joint motion.

Joint range of motion decreases with age. Bell and Hoshizaki (1981) in a sample of 190 participants (124 women and 66 men) ranging in age from 18 to 88 years old showed that there is a general decline in flexibility of joints with age for both genders. They measured the range of motion of eight joints and seventeen joint actions. A Leighton flexometer was used to measure neck rotation, lateral flexion, flexion-extension, and trunk flexion-extension. A universal goniometer was used to measure shoulder flexion-extension, abduction, rotation; elbow flexion-extension; arm supination-pronation; wrist flexion-extension, radial-ulnar flexion; trunk lateral flexion and rotation; hip flexion-extension, and abduction; knee flexion-extension; ankle dorsal-plantar flexion. The authors calculated intrarater reliability, using the r Pearson, from 0.71 to 0.94 for both instruments. Intrarater Reliability is "*the consistency with which one rater assigns scores to a single set off responses on two occasions"* (Domholdt 2000). Thus these results must be viewed with caution as the statistical tests were not ideal to calculate the intrarater reliability. The authors found significant decreases with age on: neck and trunk movements (except trunk rotation); shoulder flexion-extension, abduction; elbow flexion-extension; hip flexion-extension and abduction; knee flexion-extension; ankle dorsal-plantar flexion.

Much of the loss in flexibility as a manifestation of age is associated with changes in the elasticity and compliance of the connective tissue (the collagen and the elastic fibres) present in the articular cartilage, in synovium, in ligaments, and in muscles resulting in significant decreases in movement. Collagen is the major component of connective tissue, and ageing provokes strand disorganisation, a declining solubility and increased crosslinking of tropocollagen (Rothman and Levine 1992).

Buckwalter (1997) in his bibliographic review about "Decreased mobility in the elderly" stated: " *older people have decreased synthetic processes in chondrocytes, responsible for repairing the matrix, altering the mechanical properties of cartilage leading to a loss of range of motion. It is essential that there is regular joint loading and motion to maintain articular cartilage function*".

The lack of flexibility in the older population appears to contribute to a reduction in the capacity to do several activities of daily living. Reduced hip flexion and knee flexion can compromise putting on socks or reduced spinal, hip and knee flexion can compromise picking up a dropped object. Reduced ankle joint motion will reduce the functioning of the lower extremity during upright walking, and will contribute to an abnormal gait and postural control. (Spirduso 1995).

Ankle loss of flexibility in older people is considered a fall risk factor as it compromises the normal gait pattern. Moreover spine loss of flexibility decreases balance reactions and it can increase thoracic kyphosis moving the center of gravity forward increasing the risk of falling (Menz et al. 2006, Hinman 2004, Hirose et al. 2004, Balzini et al. 2003, Vandervoot 1999, Tinetti et al. 1988).

1.1.2. Ankle Flexibility

To maintain older peoples' independence and to avoid falls, an adequate joint motion at the ankle joint complex is essential. Its contribution to the functioning of the lower extremity during walking is important, as the swing phase requires approximately 10º of dorsiflexion for toe clearance. Furthermore during stance phase, ankle plantar flexion is needed for a quick forward motion of the body. An available ankle movement is also necessary for muscular reactions used to maintain balance, such as ankle strategy or rapid compensatory stepping movements. (Vandervoot 1999).

Nigg et al. (1992) examined the age effect on the foot range of motion. They measured 121 subjects with ages between 20 and 79 years old, using a laboratory coordinate system developed by one of the researchers. The authors included four age groups: the 20-39 age group, the 40-59 age group , 60-69 age group, all these 3 groups with 30 subjects (15 men and 15 women) and the 70-79 age group 31 subjects (16 men and 15 women). Dorsiflexion decreased by 3º while plantarflexion decreased by 7.6º between the youngest and the oldest group. When the results were observed as a function of gender and age, men did not reveal significant changes in dorsiflexion whilst women demonstrated a significant decrease in the same movement accounting for 7.5º of the difference between the youngest and the oldest group. The results for plantarflexion were analogous in men and women with a significant decrease as age increased. Nigg et al. (1992) suggest that the difference in dorsiflexion between genders is a result of high heel shoes normally used by women leading to shortened gastrocnemius muscles and consequently a restricted active dorsiflexion range. This study did not give any information about the reliability of the measuring instrument, perhaps limiting the validity of conclusions.

The relation between ankle range of motion and gait performance was demonstrated by Mecagni et al. (2000) who studied the importance of the ankle joint on gait in a sample of 34 women aged 64-87 years. Passive and active assisted dorsiflexion and plantarflexion measurements were obtained with a 360-degree goniometer, the intrarater reliability coefficients for dorsiflexion values were ICC=0.97 and for plantar-flexion ICC=0.99. Gait performance was measured using the gait subtest of the Tinetti Performance-Oriented Mobility Assessment (POMA), where the participant had to walk at a “usual” pace and at a “rapid, but safe” pace revealing an excellent interrater reliability properties with ICC=0.97. The authors found a positive and significant correlation (r=0.44) between bilateral ankle range of motion and POMA gait subtest. However in this study three things must be taken in consideration: first the ankle range of motion was measured passively or actively assisted, which might have given higher values than active movements and might have caused a bias in the results; the second consideration is the subjective way the POMA gait subtest is scored; the third is the fact that if the coefficient of determination r^2, was used to give the proportion of the variance of one variable that was predictable from the other variable (Bland 2000), it could be suggested that only 19% of the POMA gait subtest scores are explained by the ankle range of motion.

The following studies demonstrate the influence of the decreased ankle joint of motion observed in older people on falling as it is essential to walking and balance.

Menz et al. (2006) studied the association between ankle range of motion and falls in a sample of 176 old persons, aged from 62 to 96 years. They measured ankle range of motion in degrees of movement using the Weight-bearing Lunge Test, with an intrarater reliability coefficient of 0.87. Participants' falls risk was assessed using the Physiological Profile Assessment that calculates a fall risk score. Falls risk scores below 0 indicate a low risk of falling, between 0 and 1 indicate a mild risk of falling, between 1 and 2 indicate a moderate risk of falling, and above 2 indicate a high risk of falling. According to their results the authors concluded that reduced ankle range of motion is a fall risk factor. However the position used to measure ankle range of motion was not the best as the Modified Weight-bearing Lunge Test is more a measure for gastrocnemius length than an active ankle dorsiflexion measure. The conclusions of this study must be viewed cautiously.

Illustrating the influence of ankle motion on falls Morgan et al. in 2004 implemented an eight-week low intensity exercise programme in 119 old persons with a mean age of 81 years to evaluate its effect on the incidence of falls and the time to first fall. The 3 times a week exercise programme consisted of 12 seated exercises and standing exercises for arms, hip, knee and ankle muscles, joints and balance. The incidence of falls and not the improvement of ankle range of motion was the outcome of the study it can only be said that ankle exercises may have contributed to the decreased incidence of falls in older people with low levels of physical function.

Loss of ankle range of motion was already considered by Tinetti et al. (1988) in her earlier studies, to be one of the risk factors for falls because of its relationship with gait and balance. Nevertheless this assumption made by Tinetti et al. (1988) must be viewed cautiously as she used a subjective way to measure ankle range of motion. Active ankle range of motion was subjectively assessed, with all the lower limb joints, and was classified simply as "normal" and "abnormal".

These studies however showed that ankle range of motion does decrease with age and has a relation to falls.

Consequently exercise programmes to promote physical activity and reduce the fall risk factors among older people should emphasize proper stretching exercises for the ankle, with the exercises performed in full range of motion to maximize gains in all the structures already mentioned that influence range of motion.

1.1.3. Spinal Flexibility

The decreased age-related flexibility of the spine can be due to bone alterations, and/or a decrease in soft tissue passive extensibility. Alterations in thoracic spine are most prevalent in older people.

The lost of spine flexibility with age is illustrated by Hinman (2004) in a study where he observed the age-related lack of postural flexibility of 25 women aged from 21 to 51 years old, and of 26 women aged from 66 to 88 years, measuring changes in the thoracic curve of younger and older women when standing in their usual relaxed posture versus their maximally erect posture, with a flexicurve using the kyphotic index as the outcome measure. The interrater reliability of the kyphotic index measures was excellent among the three raters, with ICC= 0.93 for the relaxed position and an ICC=0.94 for the erect position. Interrater Reliability is defined as "*the consistency of performance among different raters or judges in assigning scores to the same objects or responses"* (Domholdt 2000). It must be mentioned that the use of the flexicurve implies palpation of different levels of the thoracic spine, because the levels T1 and T12 must be identified. Nevertheless these interrater reliability results of the kyphotic index do not agree with McKenzie and Taylor (1997) who argued that there is a lack of spine levels palpation accuracy (i.e. precision) due to a lack of standardisation of palpation techniques.

Hinman (2004) defined postural lack of postural flexibility as *"the inability to actively correct, or improve the alignment of the spine and reduce the size of the thoracic curve".* He concluded that both young and old women were able to actively reduce their kyphosis in the maximal erect posture, but the older participants had greater thoracic kyphosis than the younger and were less effective in correcting it.

An increased thoracic kyphosis in older people can be a result of compression fractures in persons suffering from osteoporosis. According to Keller et al. (2003) 7% of women in the United States may experience a compression fracture for the first time each year, due to osteoporosis. Araújo et al. (1997) in a study undertaken in the North of Portugal, provided evidence of the extent of osteoporosis by showing that there were 180.000 Portuguese women over the age of fifty with osteoporosis, confirmed by distal forearm absorptiometry.

The physiological thoracic kyphosis is the cause of an increased load on the anterior aspect of the vertebral bodies, as the line of gravity lies anterior to the vertebrae (Edmondston and Singer 1997, Milne and Williamson 1983). The mid thoracic region being the apex of the kyphosis where all the forces imposed on the thoracic spine are focussed. The shape and orientation of the vertebrae means that there is a gradual alteration in the form of these vertebrae. The transition area, composed of the lower thoracic spine, between the upper thoracic with its lack of flexibility characteristics and the lumbar segments characterised by their flexibility, maximises the compression forces within this area and enhances the risk of fracture or deformity in case of high loads when there is osteoporosis.

A single anterior wedge fracture will increase the thoracic kyphosis by 10° or more (Keller et al. 2003, Goh et al. 2000 b) (Figure 1.2.).

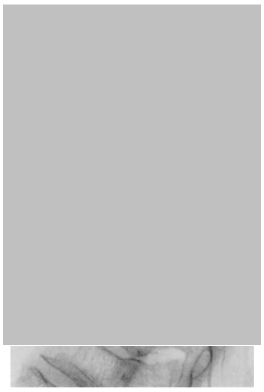

Figure 1.2. Radiograph of the thoracic spine of a 63-year old woman with an osteoporotic thoracic kyphosis (±80°) produced by T6-T7 vertebral wedge fractures (taken from Keller et al. 2003)

In addition to the presence of osteoporosis, the mid thoracic region is exposed to high rotational forces which may be related to the rate of disc degeneration; the thoracic discs together with the shape of the vertebral bodies have an influence on the kyphosis (Goh et al. 1999b, Edmondston and Singer 1997).

O'Gorman and Jull (1987) tried to determine a thoracic kyphosis profile from a population of 120 normal adult females, aged from 20 to over 70 years showing that the angle of the kyphosis measured by an inclinometer, with a good intra and interrater reliability, increased significantly with age, ranging from

41º in individuals in their thirties, to 65º in people over 70, the most significant changes occurring after the 5th decade. It is important to note that reliability studies were done using a t test and not with an intraclass coefficient (ICC) which affects the quality of this study.

In addition Pluijm et al. (2000) found, in a sample of 527 participants (260 males and 267 females) aged 65 years or over, that the prevalence of vertebral deformity increases with age in both genders. They measured the thoracic and lumbar spine (T4–L5) with lateral radiographs of each participant according to the protocol of the European Vertebral Osteoporosis Study. In females the prevalence of vertebral deformity was highest in the participants over 80 years whereas in males the prevalence was highest in the 75-79 years age group. Severe deformities, characterised by more than 30% of reduction in vertebral height, were more common in women than in men.

Goh et al. (1999b) in an ex vitro study used a database of sagittal computed tomography films and lateral spine radiographs of the thoracic spine from 63 individuals (22 females and 41 males) aged 15-95 years. The authors found that the extent of anterior vertebrae wedging was significantly greater in women, more importantly between T3 and T11, with a significant gender difference at T6 and T7. Females showed a significantly higher mean thoracic curvature and a higher positive correlation between age and thoracic curvature than males.

A study by Kado et al. (2005) looked at spinal posture in 1578 older persons (937 women and 641 men) aged 55 years and over. They measured thoracic kyphosis as the distance from the occiput to a table, with participants lying supine. The hyperkyphotic individuals that could not lie flat with their heads in a neutral position on a flat surface were compensated with 1.7 cm blocks under the head to achieve a neutral position (the participant's head neither hyperextended nor hyperflexed). The authors found that hyperkyphosis affected both genders but men were more likely to be hyperkyphotic than were women. This is in contrast to the literature that states that hyperkyphosis is more prevalent in older women than men. Nevertheless it is important to note that the neutral position required by the authors could be compromised as individuals with hyperkyphosis greater than 1.7 cm could not achieve an accurate neutral position. Moreover the authors didn't indicate any reliability studies related to the use of the blocks. The conclusions must then be accepted cautiously.

Despite the fact that the instruments used by O'Gorman and Jull (1987) and Kado et al. (2005) were less accurate than the radiographs used by Goh et al. (1999) and Pluijm and al. (2000), their findings agree that hyperkyphotic posture is prevalent in older people. The aging process modifies normal spine configuration, resulting in a flexed posture with an increased thoracic kyphosis and forward position of the head which is a characteristic of many older people.

It is important to consider if this postural alteration and decreased spinal flexibility affects physical and functional ability. A search of the literature between 1995 and 2005 revealed only a few studies showing a relationship between an increased thoracic kyphosis and function.

Kado et al. (2005), reported previously, measured the kyphotic curve in a sample of 1578 participants and evaluated self-reported functional status by enquiring of the participants whether they had any difficulty bending down to the floor, walking 2–3 blocks on level ground, or climbing a flight of stairs. This questionnaire was created by the authors with no validity (validity is defined as the degree to which a test measures what it was designed to measure) (Domholdt 2000) and reliability references. The authors found that participants with a hyperkyphotic posture demonstrated self-reported difficulty in functional activities with a significance level of $p<0.001$. These results must be considered with caution as there were no validity and reliability studies. Additionally self-reported measures must be considered with caution as they are subjective and can be influenced by emotions (Roberts 2005).

Hirose et al. (2004) classified the posture of 237 participants tagged over 65 years of age as normal, hyper thoracic kyphosis, lumbar kyphosis, flat back, and hyper lumbar lordosis. The posture classification was based on photographs taken and reviewed by three orthopaedic doctors operating independently. The authors accepted a similar classification given by two or three of these doctors. They analysed their gait pattern measuring stride length, step length, step width (in cm), time of stride, time of single stance, time of swing, time of double stance (s), and walking speed (in meters per second) normalising all distance parameters against height. Comparing gait parameters of the normal posture group (n =110) and the thoracic kyphosis group (n =47), the latter had significantly shorter stride, shorter step, greater step width, longer time of stride and of double stance and slower speed of walking.

In addition Balzini et al. (2003) in a study with 60 older people aged 70-93 years demonstrated that severe flexed posture (occiput-to-wall distance > 8cm) was associated with slowing gait and an increased base of support . Serious kyphosis leading to hip and knee flexion makes large steps impossible decreasing the speed of gait. It can be argued that these kyphotic changes may cause a perception of instability making older people more cautious.

A relationship between the degree of thoracic kyphosis and functional reach, the active range of motion of knee flexion and plantar flexion and rectus femoris and hamstrings length was found by Chow and Moffat (2004) in a sample of 13 women with a mean age of 67 years diagnosed with osteopenia or osteoporosis. They measured the thoracic kyphosis using a flexicurve and the kyphotic index. The authors measured the thoracic curve in “the most possible erect position” which did not reflect the “normal” position of each participant. In spite of this possible limitation and the small sample the authors found significant and negative correlations between the factors.

Lynn and al. (1997) studied the effect of osteoporosis and hyper kyphosis on balance measured by computerized dynamic posturography, in a sample of 21 women aged from 52 to 85 years. The sample was divided into three groups: one (ten participants) with osteoporosis, a second one (6 participants) with osteoporosis and hyper kyphosis (Cobb angle >54º) and a third group (5 participants) of “normal” women. Regardless of the small number of women in each group the authors found that women with osteoporosis, particularly those with kyphosis used more hip strategies than ankle strategies for balance, and demonstrated a greater postural sway when compared with the control group.

It seems that the functional activity of arm elevation is influenced by thoracic kyphosis. Arm elevation is an important movement for older people in their daily activities, i.e. combing their hair and reaching to high shelves.

Crawford and Jull (1993) studied 60 women, 30 aged 18-30 years and 30 aged 57-75 years old and measured the range of bilateral arm elevation with a goniometer in the sitting position and the range of thoracic extension and thoracic posture with two inclinometers. Both instruments showed excellent intrarrater reliability (the measurements of the goniometer and inclinometer remained stable when they were repeated under identical conditions by the same rater). They found that ranges of arm elevation and thoracic extension decreased with age. The thoracic spine contributed a mean value of 15º of extension to full arm elevation in young women (just over half of their available thoracic extension range), and a mean value of 13º in older women (representing 2/3 of their available range). The accuracy of the instruments used in these measurements is not known, and the extent of the kyphosis was calculated indirectly, using geometry and mathematical theories; this could cause bias in the results. The authors also found that there was a relationship between the increased thoracic kyphosis curvature in older people and a reduced arm elevation demonstrating the presence of a significant negative correlation. It would seem important to consider the relationship between the degree and lack of flexibility of thoracic kyphosis on shoulder mobility.

There was no reference in the studies outlined above to the participants' degree of activity, yet this could impact on the physical tests. It seems from the research that an increased thoracic curve in older people has an effect on gait parameters, on lower limb range of motion, on muscle extensibility, and on balance affecting function. Given the apparent importance of postural changes on functional activities and balance, exercises to prevent or ameliorate a thoracic hyper kyphosis should be incorporated into an exercise programme for older people.

In conclusion the evidence shows that a lack of spine flexibility is particularly prevalent in older people and decreased thoracic spine flexibility seems to be associated with significant decrease in physical and functional capacities. (Kado et al. 2005, Chow and Moffat 2004, Hirose et al. 2004, Balzini et al. 2003, Schenkman et al. 2000). Whilst there is limited research into the effects of changes in spinal flexibility on falls, Tinetti et al. (1988) suggested that it contributes to the increase in falling and must be considered as a fall risk factor.

It appears that physical training using specific exercises can reduce the effects of ageing on joint motion and soft tissue. To overview the evidence related to the impact of exercise programmes on range of motion and soft tissue it is first necessary to consider the general principles of training. The next section considers these principles in order to inform subsequent discussions on how exercise may improve age related changes.

1.1.4. Principles of training

Physical training involves exposing the body to a training load of sufficient intensity, duration and frequency to produce an improvement of the functions for which one is training (Stone et al. 2007, Mazzeo et al. 1998b, Plett et al. 1991).

The basic training principles used in the design of exercise programmes for older people are the same as used for younger people, but there will be some modifications according to the training level and age of the participants (Stone et al. 2007, Pollock et al. 1998).

The overload principle suggests that in order to see an improvement in strength the muscles must be obliged to work beyond their regular intensity, that is the intensity regularly encountered during every day life, and will result in a compensatory adaptation, which helps in the development of performance capacity. The training load is therefore relative to the level of fitness of the individual. The overload principle involves adjusting the training variables such as intensity, frequency, duration, sets, and repetitions. In terms of adaptations, the overload principle involves increasing these variables (Astrand et al. 2003).

The progression principle involves regularly adjusting the overload to account for improvements in muscle strength, endurance or power and this also involves making adjustments to frequency, duration, sets, repetitions and intensity of the load. At the same time this principle proposes that skills should be learned in a systematic progression, starting with the most basic set of skills increasing to the more complex ones, thus enhancing the difficulty (Pollock et al. 1998, Plett et al. 1991).

The specificity principle implies that if it is required that an old person becomes better at a particular exercise or skill, he/she must perform that specific exercise or skill to gain optimum improvement. Generic or non specific exercise will be less effective. It indicates that the exercise effect is specific to the individual, specific to the muscle fibres or joints involved in the activity, and specific to the anatomic site (Stone et al. 2007, Kraemer et al. 2002a). Trew and Everett (2001) note that task specificity involves a learning process in which the correct sequence of movements is laid down as a motor pattern in the Central Nervous System.

The variation principle purposes to accomplish training through different exercises, because if they are repetitious, participants can soon lose interest and motivation and consequently non adherence can become a danger (Stone et al. 2007, Pollock et al. 1998, Plett et al. 1991).

The reversibility principle suggests that any adaptations that take place due to physical activity are entirely reversible. In other words, “use it or lose it” This principle suggests that regularity and consistency of physical activity are important determinants of both fitness maintenance and continued improvement. It takes longer to build strength or endurance than it does to lose it (Stone et al. 2007, Pollock et al. 1998).

Diminishing return principle informs that improvements due to exercise have a biological ceiling. After exercise has been undertaken for some time a person must make a greater effort to attain minimal gains (Figure 1.3.) (Skinner 1993, Plett et al. 1991).

Figure 1.3. Principle of Diminishing Returns. The recent training history determines an individual's future responsiveness to physical training (taken from Skinner 1993)

The key quality to any training programme is the manipulation of the following programme variables: (i) intensity (or loading); (ii) volume (the number of sets and repetitions), (iii) exercises selected; (iv) the order of the exercises; (v) the rest intervals between sets, (vi) velocity of contraction; (vii) Frequency. All these factors need to be taken into account in any individualised exercise programme for older people (Kraemer et al. 2002b, Pollock et al. 1998).

Exercise intensity in aerobic training in older persons can be measured easily using the target heart rate, and perceived exertion rate (Mazzeo et al. 1998). To measure anaerobic training more sophisticated methods are used as measuring the concentration of blood lactate or the respiratory quotient.

There are several simple methods of calculating intensity level of the exercise, these include taking percentages of maximum heart rate using the "Karvonen Formula" or controlling exercise intensity using a scale of perceived exertion. Perceived exertion can be calculated using a subjective measure, the Rate Perceived Exertion scale (RPE) (Borg 1998). that also represents sensations such as: strain, aches and fatigue involving muscles, cardiovascular and pulmonary systems during exercise. It is employed to monitor exercise intensity and shows the participant's effort in the exercise at different levels. Level six rates the effort done at rest, level seven to nine rates a very light effort, from ten to eleven it rates a fairly light effort, from twelve to sixteen the effort raises, seventeen and eighteen levels mean a very hard effort, nineteen and twenty mean a tremendous effort. Due to its reasonably linear relationship with oxygen uptake and heart rate, RPE can be used to guide the intensity of an exercise (Utter et al. 2001).

The volume or the number of sets and repetitions depends on the goals of the exercise programme. The ideal volume of exercise recommended for muscle strength was 2-4 sets of 8-15 repetitions per exercise. For endurance 5 sets coupled with high repetitions (15–20), for power 2-3 sets 8-15 repetitions (Mazzeo et al. 1998b).

The order of the exercises must be such that the easiest ones must be performed at the beginning to promote a warm up, the more complicated, and the hardest at the end.

Warming up is commonly believed to assist performance and reduce injury risk. It increases muscle blood flow, enhances tissue flexibility as the muscle-tendon unit is believed to have temperature-dependent viscoelastic behaviour and improves muscle extensibility (Magnusson et al. 2000).

The rest intervals between sets must be related to the perceived exertion, heart rate or muscle fatigue of the participants in order to replenish the stores of Adosine triphosphate and Creatine Phosphate in the muscle. The amount of rest between sets has been considered an important factor that can be manipulated to fit the objectives of a programme. The time of rest significantly affects the metabolic, cardiovascular responses as well as performance of subsequent sets (Kraemer et al. 2002, Robinson et al. 1995). When training involves increasing strength, longer rest periods of 2 and 5 minutes have been recommended to allow for greater recovery and maintenance of training intensity (Willardson et al. 2005, Kraemer et al. 2002).

The velocity of muscle contraction is related to the goals of the exercise programme e.g. if muscle power is the main objective of the exercise then the velocity of the contraction must be increased (Mazzeo et al. 1998).

The frequency of exercises is related to the objectives of exercising, the needs, interests and functional capacity of the participants.

The duration of exercise sessions recommended for older people is about 20 to 30 minutes initially, increasing with short bouts of 5-10 minutes reaching the 45-60 minutes in order to progress with muscle and cardiovascular adaptations and avoid delayed onset muscle soreness (Pollock et al. 1998).

In conclusion, applying the principles of training will help in the design of exercise programmes that are specific and safe for any individual.

1.1.4.1. <u>Principles of Training and Exercise Prescription for decreased flexibility</u>

Most of the research relating to stretching techniques has been undertaken on younger people but there is no reason to believe that the same principles would not apply to older people, even though the loss in flexibility may be due to physiological changes associated with ageing.

For flexibility improvements in older people, active and static stretching of the connective tissue, are the most used methods as they are simple to execute and have very low risks of injury (Zakas et al. 2005) but there is controversy about the optimum duration of the stretch. This will be reviewed in this section.

Stretching exercises lead to a general increase in soft tissue length, and particularly in tendon length involving two main effects: mechanoreceptor mediated reflex inhibition and an increase in the viscoelastic properties of the tendon. The first effect implies an increased tension in the tendon that is detected by Golgi tendon organ and muscle spindle, which inhibit further agonist muscle contraction and induce relaxation in the antagonist unit. The second effect involves a temporary raise in the musculotendon unit length resulting from actin-myosin complex relaxation and a permanent increase through alteration in the surrounding extracellular matrix, decreasing the passive resistance of the muscles (Smith 2004, Gajdosik 2001).

The ideal duration of stretching to provoke an increase in soft tissue length varies between different authors.

Bandy et al. (1997) divided ninety-three younger participants (61 men, 32 women), aged 21-39 years old, who had limited hamstring muscle flexibility into five groups with different timing and sets of stretching. They undertook an exercise programme over 6 weeks, five days a week: group one performed three sets of one minute static stretches (10 seconds between stretches) of the hamstring muscles; group two did three sets of 30-second static stretches (10 seconds between stretches); group three did one static stretch for one minute; group four one static stretch for 30 seconds and the fifth group was used as a control group and did no stretching movements. Knee extension was measured using a goniometer. The values of the intrarater reliability goniometer measures was excellent (ICC=0.98). The authors found that the ideal time to improve knee extension and consequently hamstrings length, with the hip at 90º of flexion was about 30 seconds of one static stretching, and that undertaking the stretch more than one time per day did not increase flexibility.

Two studies were found on the use of the stretching technique as a way of increasing flexibility in older people.

Zakas et al. (2005) studied the consequences of stretching duration and frequency on hip flexion, hip extension, hip abduction, knee flexion and ankle dorsiflexion (with knee flexed) and on trunk flexion, in twenty sedentary participants aged 65–85 years old. They used a double protractor goniometer for hip abduction and for the other movements a modified Leighton flexometer. They demonstrated that acute gains in the range of motion were alike in all measured joints whether the passive static stretch was executed once for 60 seconds, twice for 30 seconds or four times for 15 seconds each. All stretching attempts appeared efficient in improving range whether they were executed once or in sets. This study was not ideal as the number of participants was small and the report of the reliability study for the goniometer measures was not clear. Another study from Feland et al. (2001) made an association between the duration of stretching and the long term gains in older people. Sixty-two participants with a mean age of 84.7 years with tight hamstring muscles (defined as the inability to make knee extension to less than - 20°, with a 90º hip flexion) were randomly assigned to one of four groups. Group one was the control group; group two was submitted to a passive static stretch that was sustained for 15 seconds; group three to a passive static stretch for 30 seconds; group four to a passive static stretch for 60 seconds. The static stretches were performed four times with a ten second rest between them, 5 days per week for 6 weeks. A reliability study of the goniometer used to measure range of motion, was performed and demonstrated excellent intrarater reliability properties (ICC=0.96). They found a 60 seconds stretch maintained more long term gains in knee extension range of motion for more than 4 weeks than stretches of 15 and 30 seconds. Nevertheless 15 seconds stretching showed long term gains in knee extension range of motion after 4 weeks when compared with the control group range of motion.

The previous studies used passive static stretch to improve flexibility and employed the same tool to measure the joint range (a goniometer). However even with acceptable reliability coefficients the goniometer uses skin landmarks; the estimation of the centre of rotation of a joint and placing the goniometer's centre over this point can be sources of error. Moreover there is always a danger of parallax errors and all these issues mean that the goniometer has the potential to be unreliable when used to measure joint range of motion (Gajdosik and Bohannon 1987, Balmer et al. 1984). The use of an electrogoniometer would be more appropriate as it is more reliable than the universal goniometer (Rome et al. 1996).

The study from Bandy et al. (1997) was the only one that used a younger sample and didn't use 15 seconds of stretching, leaving some doubt if this time would have any effect on range of motion. From the studies of Zakas et al. (2005) and Feland et al. (2001) it seems that 15 to 30 seconds of passive static stretching is the minimum time needed to provoke plastic muscle deformations to increase range of motion.

It would seem logical to ensure that as well as undertaking stretching exercises it is essential that older people continue or recover as active a lifestyle as possible in order that every day activities may reinforce and maintain the gains in flexibility achieved through exercise.

1.1.4.2. The effect of exercise on ankle range of motion in older people

As yet there are only a few studies on older people that have included ankle flexibility as an outcome of an exercise intervention or included ankle flexibility exercises in the intervention exercise programme.

Sohng et al. 2003 used the ankle range of motion as an outcome for a Falls Prevention Exercise Programme for 45 Korean participants aged 65 years or over. Ankle range of motion was measured using a goniometer but no reliability studies were done by the authors. They relied on a study by Gogia et al (1987) to show that the goniometer measures were reliable rather than testing reliability for themselves.Twenty two participants in the intervention group undertook an eight week programme where one of the components of the programme included ankle range of motion exercises. Unfortunately details of these exercises were not specified. The intervention group had supervised exercises 4 days a week and twice a week they used a videotaped exercise programme. After the 8 weeks of the programme the participants in the intervention group showed significant improvements in dorsi and plantar flexion when compared with the control group (23 participants). The mean improvement in the intervention group for dorsiflexion was 2º and 4º for plantarflexion.

The next two studies, using home-based exercise programmes, did not show improvement in ankle range of motion.

Yates and Dunnagan (2001) used dorsiflexion flexibility as an outcome of a 10 week home-based exercise programme. The intervention consisted of fall risk education, exercise programming, nutritional counselling and/or referral, and environmental hazard education. The intervention group of 18 older participants, aged more than 65 years old, performed a standing exercise to stretch the calf muscles, the stretch being held for 20-30 seconds. The rest of the programme, focused on improving strength, coordination, balance, and mobility through 19 chair based exercises. No references to the progression of the exercise were found. The homebased exercise programme was performed

3 times a week. The authors however did not find any significant improvements in the range of motion of ankle dorsiflexion, measured with a goniometer, after 10 weeks of exercise when compared with the control group. The authors did not mention any reliability studies; nor did they appear to progress the difficulty of the exercises, which may explain the results in part. The short intervention time could also be considered an explanation for the lack of improvement in the participant's ankle dorsiflexion.

Gras et al. (2004) undertook a non controlled study with 35 participants of 60 years and over. They divided the participants into two 8 week home-based exercise groups, one doing hip exercises and the other doing ankle exercises for strength and flexibility. Ankle exercises consisted of four sets of dorsiflexion stretching performed in standing for 60 seconds, 5 days a week; non resistive ankle dorsiflexion, and theraband resisted plantarflexion exercises all performed in a sitting position for 3 times a week. After 8 weeks of homebased exercises neither the ankle group nor the hip group showed any improvements in ankle range of motion (measured by a goniometer) or strength (measured by a hand-held dynamometer) when compared with baseline measurements. One of the reasons for these results may be the short duration of the programme. Another reason for the poor results could be the long duration of stretching asked of the older participants (240 sec. each time). King et al. (1997) state that the complexity and the intensity of an exercise is an adherence determinant in older people. This may have led to imprecision in the stretching movement and of the exercises and the non completion of the number of repetitions.

A further reason for the difference in outcomes of these three studies described above may be because Sohng's study was supervised, while the other two were not as they were home based, which may have influenced the motivation of the participants to perform the exercise.

The previous studies used stretching, increasing muscle strength and muscle endurance to improve ankle range of motion. The only study that used stretching as the sole exercise to improve ankle range of motion was Gajdosik et al. (2005). They studied the effects of an 8 week home stretching programme on ankle dorsiflexion of 19 older women (aged 65–89 years), and on a modified Timed Up-and-Go Test, on Fast 10-m walk and Functional Reach Forward in a randomised controlled trial. All the participants had an active dorsiflexion range of motion of less than 10 degrees measured by a goniometer. The Kin-Com ankle–foot attachment was used to measure the right ankle dorsiflexion range of motion and surface electromyography was used to observe the activity of the soleus, the medial head of the gastrocnemius, and the tibialis anterior muscles during the stretching to ensure that calf muscle activations were minimal. Maximal passive dorsiflexion angle was verified manually moving the ankle slowly into dorsiflexion, defining the end point of the range of motion immediately previous to the point that provoked pain or ache. The stretching group performed static stretches of the plantarflexor muscles in standing, for 15 seconds and completed 10 repetitions, for a total of 150 seconds of stretching during each session three times each week for eight-weeks. In all they undertook a total of 24 exercise sessions and kept an exercise log to record completed exercises. The authors found that an eight-week stretching programme of short calf muscles for older women increased significantly the maximal passive dorsiflexion range of motion by 5º when compared with the control group, indicating an increase in length of the calf muscles. The functional tests all improved with the stretching programme except the Functional Reach Forward. This test measures the forward distance a person can achieve with his arm, in the standing position without moving the feet. The test relies more on ankle muscle contractions than the range of motion and this is perhaps the reason improvement wasn't seen.

From the literature reviewed both stretching and exercises (resistive or not) are used to improve ankle range of motion. The success of these types of exercise is not yet clarified. Nevertheless as a reduction in ankle joint movement caused by the ageing process has been associated with falling (Menz et al. 2006, Tinnetti et al. 1988), it is appropriate to propose that exercises that increase ankle range of movement are included in the design of falls prevention programmes.

1.1.4.3. The effect of exercise on spine flexibility in older people

The spine with all its joints, ligaments and muscles is one of the human segments that suffer with ageing alterations. Lack of spinal flexibility in older people is an important contributor to postural control and its impairment can also contribute to falling.

There are very few studies about the effects of exercise programmes on spinal flexibility and postural alignment in older people. Nevertheless as age modifies normal posture resulting in a flexed posture with a hyper thoracic kyphosis and protraction of the head, scapula abduction, and a lower limb flexed position, it can be postulated that stretching exercises involving shoulder flexors and external rotators, neck retractors and hip and knee extensors as well as strength exercises for back extensor muscles might be effective in ameliorating the postural problems in older people.

Two studies were found where posture was used as an outcome of an exercise programme.

The first from Reno et al. (2005) was a pilot non controlled study, using a sample of 14 osteoporotic women aged above 65 years. The thoracic curve angle was measured using a photometric technique. This technique is non-invasive and consists of fixing cutaneous markers on the spinous processes of the vertebrae, which allows measurement of the degree of spinal curvature. The vertebrae were located by palpation and a cutaneous marker was fixed to the spinous processes of C7 and T12. A photographic image of each participant, in the saggital plane, was recorded and analysed using software which allowed the degree of thoracic kyphosis to be computed. However the authors did not record any reliability studies related to the photometric technique measures. The authors used the reliability values found by the creator of the technique. The eight weeks exercise programme consisted of lower and upper limb stretching exercises, strength exercises for back extensors by lifting a backpack with a load determined using one repetition maximum, and respiratory exercises. After eight weeks of exercises, the authors observed a decrease of

5º in the thoracic curvature that must be considered carefully as no reliability studies for the specific sample of this study were performed.

Sinaki et al. (1996) studied the influence of back extensor strength on thoracic kyphosis in a sample of 65 post-menopausal women during a two year back extensor exercise programme. This controlled trial used lateral roentgenograms of the thoracic spine to measure the kyphotic angles. No reliability studies of these measurements were recorded by the authors. The results showed that back extensor strength was a significant predictor of thoracic kyphosis curve, suggesting that back extensor strength is important in reducing thoracic kyphosis. However the authors were unable to show any cause-effect relationship between back extensor strength and thoracic kyphosis curve.

The previous authors did not provide information on the degree of accuracy of their measuring device and therefore it is not possible to judge if a change of 5 degrees is a real change or a measurement error. However, even if it was a true reflection of change, only a small reduction in thoracic curve was seen.

In spite of the limited evidence about the effect of exercises on reducing the thoracic spine curvature it seems an important component to include in any exercise programme for older people as it could influence their posture. They must be performed in full range of motion to maximize gains in flexibility and in muscle passive extensibility.

1.1.5. Musculoskeletal Properties

Musculoskeletal properties occupy a very important role in postural control and falls.

Human skeletal muscle fibres can be categorised as one of three basic fibre types (Bemben 1998): type I has good endurance qualities; type IIa have the capacity for both endurance and strength attributes and type IIb is usually related to both strength and power (Table 1.1).

If fibres are classified based on the time they take to get to their peak tension, which is related to the relaxation time, two main classes can be identified: those with a long time-to-peak tension, the slow twitch fibres or type I fibres, and the fibres with a short time-to-peak tension, the fast twitch fibres or type II fibres (Astrand et al. 2003) (Table 1.1).

If fibres are classified based on the histochemical differences, type I fibres have a low activity of myosin ATPase in the muscle fibre. The slow contraction attributes result from having a well developed oxidative capacity and a high potential for aerobic metabolism. These fibres are adapted for prolonged activity, and are therefore more fatigue resistant. Type II fibres have a high activity of myosin ATPase and short contraction time with a well-developed glycolytic enzyme system, having a low mitochondrial content and oxidative activity. They are quick to fatigue (Astrand et al. 2003) (Table 1.1).

Activities of daily living rely mostly on slow twitch fibres as they are recruited first. According to Henneman's size principle, small dimensions motor units are the first to be recruited in a muscle contraction (Table 1.1). This principle declares that the motor units are recruited in order of increasing size. When only a small amount of force is required from a muscle this force is provided exclusively by the small units. As more force is required, larger units are progressively recruited. (Henneman et al. 1957).

Table 1.1. Characteristics of muscle fibres types (adapted from Astrand 2003)

Fibre Type	Type I fibres	Type II a fibres	Type II b fibres
Contraction time	Slow	Fast	Very fast
Size of motor neuron	Small	Large	Very large
Resistance to fatigue	High	Intermediate	Low
Activity Used for	Aerobic	Long-term anaerobic	Short-term anaerobic
Force production	Low	High	Very high
Mitochondrial density	High	High	Low
Capillary density	High	Intermediate	Low
Oxidative capacity	High	High	Low
Glycolytic capacity	Low	High	High
Major storage fuel	Triglycerides	Creatine phosphate, glycogen	Creatine phosphate, glycogen

1.1.5.1. <u>The effect of ageing on skeletal muscles</u>

Age related changes occur in skeletal muscles leading to the decline in some of their properties. Sarcopenia can be defined as the age-related loss of muscle mass and it appears that from 25 to 50 years of age it decreases at an average rate of 4% for the first decade, and 10% per decade after that (Waters et al. 2000, Buckwalter 1997).

A complete understanding of sarcopenia is particularly difficult, since skeletal muscle, fibre type and tissue mass can be affected by several factors such as imposed load, blood supply, innervation pattern, type of fibre's used and cellular regeneration ability (Roubenoff 2003).

Frontera et al. (2000) proposed that there is a decline in percentage of type I fibres but no change in type I or II mean fibre area. This evidence came from a 12 year longitudinal study where they evaluated the changes in fibre type distribution, in mean fibre area and in capillarization in the vastus lateralis muscle in a sample of 9 men.

Thompson (2002), Proctor et al. (1995) and Larsson et al. (1979) suggested that type II fibres tend to decrease in size with age, especially type IIa, while type I fibres tend to stay relatively constant.

In addition it is thought that with ageing some motor units become larger and some present altered firing rates. This is probably related to the death of some nerve fibres. However the muscle fibres are often reinnnervated by one of the existing motor units through collateral sprouting. When there is denervation of the neuromuscular junction there is a motor unit remodelling that permits axonal expansion and reinnervation of the muscle. In younger adults, turnover occurs without any alteration in the fibre type or amount of innervation reaching the fibres. With age, it is common to observe an aggregation of type I fibres, reflecting some denervated type II fibres becoming reinnnervated by axonal developing from adjacent innervated type I fibres shifting into them (Thompson 2002, Brown 1972).

Greenlund and Nair (2003) in their bibliographic review stated that, to maintain and repair skeletal muscle, it is necessary to continuously synthesize structurally important proteins and to break down altered proteins. For muscle mass to be maintained, it is important that the breakdown rates of these proteins do not exceed the synthesis rates. The efficient synthesis of new structural proteins maintains not only muscle mass but also muscle quality. Several studies have shown that the synthesis of mixed muscle protein is reduced by about 30% with age.

Sarcopenia is also aggravated by age related neurological changes through a reduction in the number of nerve terminals, destruction of the neuromuscular junction, decline in the neurotransmitter liberation, and diminution in the number of acetylcholine receptors (Lexell, 1997).

Moreover reduction of age related growth hormone (GH), insulin like growth factor I (IGF-I) and sexual steroid hormones will possibly have an important role in the sarcopenic process, by deregulation of GH secretion and IGF-I levels (somatopause), testosterone secretion in men (andropause), and/or ovarian-steroid secretion in women (menopause) (Fulle et al. 2004, Perry et al. 2000 and Morley et al. 1997).

Recent evidence suggests that the use of appropriate hormonal therapies combined with a correct dietary plan may assist or hold-up, stop or overturn the effects of sarcopenia. (Fulle et al. 2004).

Baumgartner et al. (1999) in a study including 121 males and 180 females aged 65-97 years old found that variability in muscle mass and strength was explained by age-related differences in anabolic hormones, physical activity and dietary intake.

Another factor that can be responsible for activating sarcopenia is the accumulation of reactive oxygen species or free radicals (ROS). The ROS are by-products of the normal metabolism of oxygen, located in almost all tissues and are frequently produced in the mitochondrial respiratory chain. Such reactive elements can often damage other cellular components such as DNA, proteins, lipids, etc. which in turn result in subsequent damage to the cells and tissues. It is commonly believed that ROS is an important factor in the ageing process, particularly in skeletal muscle where the production of free radicals is more evident as a result of a high level of oxygen consumption (Fulle et al. 2004).

Conley et al. (2000) showed that older people had about 50% lower oxidative capacity per volume of muscle than younger adult participants, due to a reduction in mitochondrial content and a mitochondria's lower oxidative capacity with age.

In summary, sarcopenia is the consequence of a loss of motor units, a transfer to slower fibre types, a progressive denervation, a decreased capillarisation, mitochondrial modifications, an oxidative stress, a weakened metabolism and a progressive reduction in energy intake, as well as hormone and growth factor alterations. Sarcopenia effects are associated with decreased functional performance, physical ability and increased risk of falling in older people, but can be mitigated through specific exercise programmes. Besides the aged-related, physiological modifications of skeletal muscles, their contractile properties are also compromised.

1.1.5.2. Changes in muscle endurance, strength and power with age

As age increases muscle endurance, strength and power decrease.

Muscle endurance is the ability of a muscle to contract repeatedly against a resistance, to generate and to sustain tension and to resist fatigue over an extended period of time (Kisner and Colby 2002).

There is controversy about the influence of ageing on **muscle endurance**, but it seems that there are physiologic limits to the amount of oxygen that can be taken up by the body. Muscle capillarisation is representative of the potential for exchange of respiratory gases, energy and metabolites being related to endurance performance (Harris 2005).

Frontera et al. (2000) a twelve year longitudinal study found, using muscle biopsies taken from vastus lateralis muscles from nine men, a reduction in percentage of type I fibers, with no change in mean area in either fiber type and a significant decrease in the capillary-to-fibre ratio. The authors associated this with the decline in predominance of type I fibres, that have higher capillary-to-fibre ratio than type II fibres.

Another reason for the decrease in muscle endurance with ageing is the reduction in the oxidative capacity related to the loss of mitochondria (Buckwalter 1997). Tesch et al. (1978) suggested that one of the limiting aspects for dynamic endurance in older people is the lactate accumulation and lactate translocation from type II to type I fibres.

Bemben (1998) in his review article argued that ageing doesn't have any influence on muscle endurance. In fact, type I muscle fibres maintain fibre size with ageing despite a significant decrease in type II fibre size. The author suggested the enhanced oxidative capacity of type I muscle fibres when compared with type II fibres was the reason why muscular endurance is maintained or even enhanced with increased age. It is important to point out that Bemben's review article does not cover original research but rather collect the results of many different articles on both human and animal literature regarding changes in muscle morphology and muscle metabolism that may be responsible for age-related changes in muscular endurance. He offers no critical appraisal but indicates the state of research in that field. If we compare levels of evidence between Frontera et al.'s longitudinal cohort study and Bemben's review article it can be said that the former could be classified as a grade two and the latter a grade five on the Oxford scale for assessing scientific evidence (Oxford Centre for Evidence-based Medicine Levels of Evidence 2001).

On the other hand Lange et al. (2000) studied the influence of recombinant human growth hormone (rh GH) combined with endurance training on oxidative capacity, metabolism, and body fat. Sixteen healthy older women, aged 75 years in a controlled trial constituted the sample and completed a monitored endurance training on a cycle ergometer over 12 weeks. The authors found that the group administered with rhGH daily presented an increase in muscle oxidative enzyme activity compared with the effect of training alone. Nevertheless the small sample used in this study limits its external validity.

It can be said that there are not sufficient studies with strong evidence about the effect of ageing on muscle endurance. Nevertheless, intuitively, it would seem an essential property of skeletal muscles of older people in order to effectively perform the normal activities of daily life. Physical inactivity seems to decrease muscle endurance in older people, increasing the risk of falling. Specific muscle endurance exercises must be included as components of regular exercise programmes for older people.

Muscle strength refers to the ability of a muscle or group of muscles to produce tension and is commonly measured by the maximum load that can be lifted in one repetition (1-RM) (Kisner and Colby 2002, McArdle et al. 1996).

Several studies have found that muscle strength decreases with age. Age differences in the capacity to generate strength may be in part, a result of motor unit failures, a decline in their size, a reduction in exciTable muscle mass area and muscle excitation via descending motor pathways (Doherty and Brown 1997, Porter and Vandervoot 1995).

Buckwalter (1997) found that between the ages of 30 and 80, mean capacity of the muscles to produce strength drops as much as 60% in trunk, upper and lower limb muscles and Newman (1995) noted trunk and proximal muscles of the lower extremities are the first to lose strength, followed by the upper extremity muscles.

The ability to perform a maximal isometric muscle contraction is associated with age-related sarcopenia, showing a 20 to 40% decline in both proximal and distal musculature as well as a significant decrease in the performance of an isokinetic muscle contraction in healthy older individuals in their sixties and seventies (Vandervoot 2002, Frontera et al. 2000, Rotham and Levine 1992). Concentric muscle contractions will also produce lower values in middle-aged and older people than young adults and the very old may even fall below thresholds for some activities of daily living (e.g., rising out of a chair). (Vandervoot 2002) (Figure 1.4.).

There is, however, one important exception to the pattern of strength loss with aging: eccentric type of muscle action. It declines with age less than either isometric or concentric contractions (see Fig. 1.4.). Having a maximal isometric contraction as a reference of 100% of strength, a maximal eccentric contraction will produce more strength than a maximal isometric contraction. The shape and height of the schematic curves on Figure 1.4. depend on the type of force being measured: isometric, concentric or eccentric movements. Apparently, changes in muscle mass, contraction speed, and connective tissue with aging, while reducing strength when muscle shortens, enhance its performance when being lengthened (Vandervoot 2002).

Figure 1.4. Effect of age on maximal strength throughout the human lifespan. (taken from Vandervoot 2002).

The reduced strength observed in older people has repercussions on the capacity to do physical activities of daily living. The following studies demonstrated the importance of knee extensors and ankle strength, measured by concentric contractions or by maximal voluntary isometric contraction on gait and balance.

Kwon et al. (2001) demonstrated a relationship between knee extensor strength and timed gait. In a study with 344 participants (176 men and 168 women) aged from 20 to 93 years, it was found that gait time, measured by the Walk-Turn-Walk Test increased with age. Older women were slower than older men. The association between knee extensor concentric peak torque and gait time was linear until a point after which a plateau can be seen. It suggests that there is a plateau level above which increasing strength does not lead to faster gait times.

Daubney and Culham (1999) determined the degree to which ankle muscle strength contributed to balance in a sample of 50 older individuals aged 65-91 years, divided onto 2 groups: fallers and non fallers. The authors measured dorsi and plantar flexion concentric muscle strength with a handheld dynamometer. They used Functional Reach Test, Berg Balance Test and Get up and Go as outcome measures of balance. Using the multiple regression analysis using R squared the authors reported that the dorsiflexors and the evertor's strength accounted for 58% of the Berg Balance test scores and dorsiflexors strength could predict fall status. Plantar flexors and invertors strength explained 48.4% of the Get Up and Go scores.

Ikezoe et al. (1997) investigated the minimal knee extensor strength (evaluated as the percentage of body weight calculated from the maximal isometric strength on knee extension with the knee flexed at 90º) and endurance (measured by the number of sit to stand movements from a seated position during 30 seconds) required to walk independently in 72 older participants (29 males and 48 females) with a mean age of 81 years. The authors, using discriminatory analysis, reported that independent walking in older people is achieved when the knee extensors strength corresponds to 45.5% of their body weight and there is the ability to Sit and Stand 5.6 times in 30 seconds.

In addition Ringsberg et al. (1999) studied the influence of knee and ankle muscle strength on balance and gait performance (time to accomplish 30 meters) in 230 women aged 75 years. Voluntary maximal isometric muscle strength for knee flexion and extension was measured using a Biodex dynamometer. Isometric ankle dorsiflexion was measured using a kin-Com communicator. Balance was evaluated by time of one leg standing and static and dynamic balance using a Chattecx computerised balance system, consisting of independent force measure transducers for the toe and heel of each foot. The authors concluded that the isometric strength of the knee extensors and flexors and ankle dorsiflexors showed significant correlation with gait time ($r=-0.37$ $r=-0.26$ and $r=-0.22$ respectively for $p<0.001$) but not with balance. Nevertheless if the correlation coefficients were transformed into determination coefficients (r squared) it is noticed that the percentage of the variability of gait time that can be explained by knee and ankle strength variability is very low (13%, 7% and 5% respectively).

Beissner et al. (2000) investigated the musculoskeletal factors that best predicted functional limitations in older people. They showed that lower extremity strength and range of motion were predictors (using logistic regression) of function, measured by the Physical Performance Test, in a sample of 81 older adults with a mean age of 81 years.

One of the muscle groups that clearly decreases in strength due to age is the back extensors group (Sinaki et al. 2002). In fact, when this loss of strength is associated with a decrease in bone mineral density of the spine it increases thoracic kyphosis. The flexed posture leads to the activation of muscles not normally used and therefore to fatigue. Moreover the abnormal postural alignment and reduced spinal mobility and flexibility make the use of normal compensatory strategies for static and dynamic balance control in older people difficult, influencing the risk of falling (Balzini et al. 2003, Benvenuti 2001, Sinaki et al. 1996, Norkin and Lavangie 1992, Sinaki and Offord 1988, Basmajian 1985).

Lower limb strengthening is also particularly important for the prevention of falls and it is generally accepted that lower limb strength is lost at a faster rate compared with upper limb strength (O'Toole, 1997).

Increasing muscle strength must be one of the objectives of any exercise programme for older persons as it enhances physical function (the ability to climb stairs, to sit and stand from a chair, to walk) and quality of life in older individuals (Weiss et al. 2000).

Muscle power by definition is the product of force generation and speed of muscle contraction. The fibres responsible for muscle power are the fast-glycolytic and fast-oxidative glycolytic fibre types (fast-twitch fibres). It is the velocity of fibres shortening and the force-generating capacity of the muscle that regulates the power production (Thompson 2002).

As aging reduces the muscle peak forces at fast contraction speeds, in part due from a selective atrophy of type II fibres, it results in a reduction in the production of peak power (Evans 2000, Martin et al. 2000, Newton et al. 1999).

Foldvari et al. (2000) found in a study with 80 elderly women, with a mean age 75 years, that muscle power accounted for 22% for the variance of functional dependency. The relationship was found using the baseline data of their randomised controlled trial. Muscle power was calculated using specifically modified computer-interfaced pneumatic resistance machines (chest press, upper back, leg press). Each participant started at 40%, performing the lift at each established percentage of 1RM as fast as possible through full range of motion. They measured functional status of the participants using the functional status questionnaire Part C (Activities of Daily Living) of the NHANES I Epidemiological Follow-up Study, 1986. In spite of the low percentage the authors concluded that power training should be included in any exercise programme for older people as the capacity to produce force quickly is important in daily activities such as climbing stairs, or simply standing from a seated position (Foldvari et al. 2000).

1.1.5.3. <u>Principles of endurance, strength and power training in older people</u>

Training adaptations are dependent on the intensity, frequency, duration and mode of exercise and can result in slowing or reversal of age or sedentary related changes in the muscle (Williams et al. 2002).

Training muscular endurance can develop aerobic capacity if there is continuous and progressive training. Nevertheless specific exercises for muscular endurance may have such a low resistance level that they may be sufficient to improve local muscular endurance locally but not enough to improve cardiovascular endurance as there is no large muscle activity. (Dale and Ogletree 2005, Stone 1998).

It is suggested that training programmes targeting improvements in local muscular endurance use various sequences of exercises performed with light loads in 3-5 sets coupled with high repetitions (> 15) performed from 3 to 5 times a week (Kisner and Colby 2002, Newham 2001, Pollock et al. 1998).

In the opinion of Pollock et al. (1998) strength exercises must be performed with high intensity at 60 to 80% of a 1RM with a volume of 2-4 sets of 8-15 repetitions per exercise, 2 to 3 times per week. However Taaffe et al. (1996) found in a sample of women aged 65–79 years that undertook thrice weekly exercise during 52 weeks, at either 80 % of their 1RM for seven repetitions (high intensity) or 40 % of their 1RM for 14 repetitions (low intensity). At the end of the trial, both groups experienced significant and similar gains in muscle strength for the knee extensors (60–85 percent) and knee flexors (65–80 percent).

To improve **muscle power** Kraemer et al. 2002, Newton et al. 1999 suggest resistance exercise at high speed performed using 30% to 60% of 1 repetition maximum at maximal velocity throughout the full range of joint motion 2 to 3 times per week for 6-10 repetitions with high velocity. Skeletal muscles are influenced by ageing and inactivity and some of these changes can be reduced with regular physical exercises.

1.1.5.4. <u>Effect of exercise on endurance, strength and power</u>

Evidence now sustains the conviction that it is possible to produce cellular adaptation in both the muscular and nervous systems at all ages. In fact cellular regulation of contractile proteins can be stimulated to increase the production of myosin, actin and other muscle components in older people (Vandervoot 2002).

Physical training can improve muscle endurance, strength and power and improve functional abilities in older sedentary persons.

The majority of exercise programmes for older persons reviewed in this current study used cardiovascular endurance training and not specific muscle endurance perhaps because it is not yet established which is the better measure to use. (Bembem 1998).

Muscle endurance training can increase mitochondrial concentrations, oxidative enzyme capabilities and capillary density improving the potential for exchange of gases and substrates between blood and mitochondria in older men and women if the intensity and duration are sufficient (Proctor et al. 1995, Bemben 1998). It provokes a size increase in the oxidative muscle fibres, type I and type IIa (Coggan et al. 1993), and can convert type IIb to type IIa fibres (Andersen and Henriksson 1977). Nevertheless Ferketich et al. (1998) argue that muscle endurance training by itself does not induce any hypertrophy of type I fibres as the recruitment of muscle fibres to contract is not sufficient to provoke fibre hypertrophy.

Muscle endurance training can increase oxygen consumption, reducing muscle fatigability, and it is important to include it as a component of regular exercise programmes for older people (Ferketich et al. 1998).

Muscle strength increases as a result of resistance training, the improvements being attributed to an increase in neural activation, greater cross-sectional area, and changes in muscle architecture and morphology.

Strength training seems to include three phases: the first one related to motor learning with performance improvement with a duration of six to eight weeks; a second phase of an increasing synchronisation of motor unit firing and an increasing ability to recruit all available motor units; the last phase involves increasing muscle fibre size (hypertrophy), seen only after ten to twelve weeks of training (Newham 2001).

The intensity of strength training for older people is controversial among authors. Fiatarone et al. (1994), in a randomised controlled trial, demonstrated that a ten week high intensity strength training of the hip and knee extensors (80 percent of the one-repetition maximum), three days per week, improved strength but not functional capacity in a sample of twenty five 72-98 years older people. In fact from the twenty five older people, only four who had previously used a walking frame were able to use a walking stick after the study, suggesting the lack of specificity in the training programme.

Meanwhile Chandler et al. (1998) indicated that a ten-week low intensity strength training programme with light therabands ameliorated deterioration in the functional capacity and mobility in a sample of 100 older people aged 77 years. Bilateral knee extensor and flexor and dorsi and plantar flexor strength were measured isokinetically and isometrically using a Cybex 6000 isokinetic dynamometer. The authors used Functional Reach, and 6-minute Walking Test, Chair Rise from different seat heights ranging from 33 to 58 cm, a Mobility Skills Protocol (including sitting balance, sitting reach, transfer, rising from a chair, standing balance, picking up an object from the floor, walking, turning, stopping suddenly, stepping over a shoe box, reaching, and ascending and descending stairs) and SF-36 as functional capacity measures. The exercise programme, where the principle of progression was applied, consisted of hip extension and abduction, knee flexion and extension, ankle dorsiflexion, toe raises, chair rises and stair stepping. Most of the exercises were specific to the mobility skills protocol used to evaluate functional capacity. However the authors did not mention any reliability studies for the instruments they used to measure functional capacity.

Taaffe et al. (1996) examined the effects of high-intensity versus low-intensity resistance training of the knee extensors and flexors, where volume of training was kept constant on thigh muscle strength, fibre cross-sectional area (CSA), and tissue composition, during one year. Women aged 65-79 years undertook exercise 3 times a week, at either 80% of their 1 RM for seven repetitions (high intensity) or 40% of their 1-RM for 14 repetitions (low intensity). At the end of the study, both groups showed significant and analogous gains in knee extensor (60-85 %) and flexor (65-80 %) strength. that were related with Type I and Type II fibre hypertrophy of the vastus lateralis muscle. The authors argued that this showed that a low-intensity high-repetition training programme had the capacity to produce muscle strength gains in older adults.

Additionally Rubenstein et al. (2000) implemented a moderate intensity group exercise programme involving 59 older men with a mean age of 74 years with chronic impairments. The sample was randomly divided into a control group (n= 28) and an intervention group (n=31). The intervention consisted of 3 sessions of 90 minutes per week over 12 weeks. Lower limb strength exercises were performed using elastic bands or ankle weights; endurance training was performed on a cycle ergometer and treadmill; and balance exercises were included. Outcome measures included isokinetic endurance and strength for hip, knee and ankle extensor and flexor muscles (CYBEX 330 System), Sit to Stand Test (for lower limb strength), 6 minutes Walk Test (for endurance), an indoor obstacle course (for gait), Performance Oriented Mobility Index (for mobility) and 15 seconds One Leg Standing Test (for balance). All tools were shown to have acceptable reliability values. Nevertheless the authors did not include the protocol used to measure isokinetic strength where the angular velocity would be included. The intervention group showed significant improvements in isokinetic endurance, gait measurements and there was only significant group by time interaction for right knee flexors isokinetic strength when compared with control group. It is important to mention that these participants were selected because they demonstrated the presence of key fall risk factors and those with more fall risk factors had the most gains. Moreover taking into account that flexion of the knee is easier to perform than extension and that the participants in the study were older people, for whom movements done at a set angular velocity is not easy, this may explain the significant results found by the authors for isokinetic knee flexor strength. Moreover the right leg is the dominant leg (the one that presented significant improvements) for most people and movement would be easier with that leg.

There is some evidence that strength can be increased in older people without using resistive exercises (Robinson et al. 2004). The authors showed that it is possible to increase muscle strength without using external resistance. They implemented a 6 week muscle endurance exercise programme with seventeen participants. In the intervention group ten were considered fallers one or more falls in the past 6 months, a score lower than 45/56 on the Berg Balance Scale or less than 18cm on the Functional Reach Test) and seven participants who were non fallers. The control group had five “non faller” participants. The exercise programme was performed twice a week in a group setting and daily at home. As outcomes measures they used the maximal isometric force of hip abductors, adductors, flexors, extensors, medial and lateral rotators, knee extensors and flexors, ankle invertors, evertors, dorsi and plantar flexors (measured using a handheld dynamometer), Berg Balance Test, Functional Reach Test and Timed Up and Go. The results for the handheld dynamometer revealed excellent intrarater reliability with ICC ranging from 0.93 to 0.98. This intraclass coefficient was calculated from the results of the sample as whole and not by gender. As there were 6 males and 16 females in the sample the authors should have calculated the ICC’s by gender not by total group. There was not even a normalisation of the values to the body weight. The intervention consisted of specific exercises for shoulder, trunk, hip and ankle strength using only the number of repetitions as a progression and no equipment. After 6 weeks of intervention both faller and non faller groups showed significant improvements in lower limb strength and balance when compared with baseline measures. Nevertheless no interaction between groups was seen, perhaps because of the small number of participants in each group. Moreover this study presents a possible result bias as the control group was encouraged to continue with their normal activities, including exercise.

Intuitively it would seem that the preservation of muscle power into later life can greatly decrease the risk of disability and enhance functional independence and this is supported by Evans (2000).

Foldvari et al. (2000) in a 1-year randomised controlled trial of a combined programme of strength, power, and endurance training studied, in a sample of 80 older women (mean age 74.8 years), the association between peak muscle power and self-reported functional status (Activities of Daily Living). Participants were randomly assigned to either the combined exercise group or the control group. Muscle power testing was conducted using chest press, upper back, leg press, and hip abductor computer-interfaced pneumatic resistance. Following the measurement of the baseline 1 RM, its percentage of 40% to 90%, in increments of 10% up to 80% and then for 85% and 90%, were calculated for each of the four machines. Starting at 40% of 1RM, the participant performed the lift at each established percentage of her 1RM as fast as possible through full range of motion. The power test was performed once at each force setting with a 45-second to 1-minute rest between each repetition. For each repetition force done the computer interface calculated work and power. The highest mean power attained of all the repetitions performed was recorded as the peak power. Functional status was measured by the NHANES I Epidemiological Follow-up Study, but the authors only used Part C that evaluates both basic and instrumental activities of daily living. After one year and using a forward stepwise regression model the authors found that leg press power contributed independently to functional status accounting for 40% of the variance in functional status of the intervention group. Nonetheless the authors did not show in their study any reliability studies of the instruments leading to some lack of confidence in the veracity of the results.

Hruda et al. (2003) in their randomized controlled trial of 10 weeks duration, showed the influence of a simple and progressive lower body strength and power exercise training, on tests representing functional abilities (8-Foot Up-and-Go Timed Test, 30-s Chair Stand Test, 6-m Walk Timed Test) in twenty-five participants (75–94 years). Reliability studies of these tests were not presented by the authors. The eighteen participants in the exercise group were submitted to lower limb resistance exercises, specifically to improve muscle power, 3 times a week, whilst the seven participants in the control group maintained their usual daily activities. A Biodex multi-joint testing and exercise dynamometer was used to measure isokinetic knee extension contractions at an angular velocity of 180 °/s, peak torque and average power. The exercises were performed three times a week for a total of 10 weeks in groups. The exercise programme included warm-up and stretching exercises, seated and standing resisted lower limb exercises (one set of four to eight repetitions) with a progressive introduction of theraband followed by an increase in speed exercise performance. The authors, in spite of a small sample, found significant influence of the exercises on improvements in the average muscle power peak torque and in each functional test, in the intervention group when compared with the control group.

From the six previous studies only Robinson et al. (2004) did not use strength training with closed kinetic chain exercises.

Olivetti et al. (2007) suggested that the most successful strategy for strength training has yet to be found. Strengthening programmes frequently target individual muscles (for example the knee extensor muscles) without reference to the situation in which that muscle is required to function (as standing up from a chair, walking and stair climbing) where the foot is in contact with the ground and the muscles work to control the body over the foot or in closed kinetic chain.

Mayer et al. (2003) describe closed kinetic chain exercises as “a condition or environment in which the distal segment meets considerable external resistance that restrains free motion.” These authors have considered open versus closed kinetic chain exercises and argue that “these terms are confusing, erroneous, lead to polarizing discussions and should hence be relegated to the past”. They recommended the use of the term single-joint or multi-joint strength training, as it reflects the area of application. So, single-joint and multi-joint exercises should be appropriate both in isolation or in combination as designated by the principles of specificity.

The literature reviewed in this section has shown that the intensity and strategy of training to improve strength in older people is not yet established as improvements were observed in both high and low intensity training. In spite of a lack of evidence related to improvements in muscular endurance and power with training it seems that it is possible to accomplish it with appropriate exercises.

It appears that appropriate, specific exercises can be important to ameliorate endurance, strength and power, in older people and must be include in any physical activity programme.

Conclusion

In conclusion it seems that the effect of ageing and inactivity on those aspects of the musculoskeletal system that contribute to postural control, such as joint range of motion, spine flexibility and musculoskeletal properties, probably contribute to falls in older people.

Ageing effects on range of motion are mainly due to changes in elasticity and loss of compliance of soft tissue. Inactivity will increase the ageing effects.

The decreased ankle range of motion in older people appears to have an influence on gait by decreasing the clearance of the foot in the swing phase and consequently on dynamic balance turning it into a fall risk factor. But at the moment there is little clear evidence on the influence of static stretching, muscle endurance and strength exercises on improving ankle range of motion.

In older people there is decreased spinal flexibility and an increased thoracic kyphosis due to age related changes in bone, ligaments and muscles. This has an effect on functional capacities, static and dynamic balance increasing the risk of falling in older people. An increased thoracic kyphosis is more prevalent in older women than in older men. Specific exercises to improve spine flexibility and back muscle strength seem to reduce thoracic kyphosis.

Skeletal muscles in older people reveal a decline in their mass, in the percentage of type I fibres and a decrease in size in type II fibres loosing their endurance, strength and velocity of contraction, affecting functional abilities. A reduction in growth hormone, insulin like growth factor I reduction and the presence of free radicals appear to increase sarcopenia. All this is made worse if older people have a sedentary life style and these contribute to increase the risk of falling.

Due to age related muscle changes, muscular endurance, strength and power are reduced in older people. Studies have shown that they can be recovered by specific physical exercises.

It would therefore seem important to include muscle endurance, strength, power and flexibility exercises in the design of any physical activity programme for older people as these are all considered fall risk factors and are all important in maintaining older people's functional independence.

CHAPTER 2

AGE EFFECTS ON POSTURAL CONTROL: NEURAL COMPONENTS

This chapter will describe the neural mechanisms involved in postural control as well as the effect of age on them. The role of fear of falling in older people will be considered as well as review of the effect of exercise programmes on falls in older people.

2.1. Neural components of postural control and falling

Neural components contribute to postural control, assessing the position and movement of the body in space and the aptitude to produce forces to control body position (Shumway-Cook and Woollacott 2001). Natural ageing combined with inactivity leads to a decrease in the postural control neural components, function and consequently to the inability to stabilize the body prior to movement, potentially increasing the risk of falling (Shumway-Cook and Woollacott 2000).

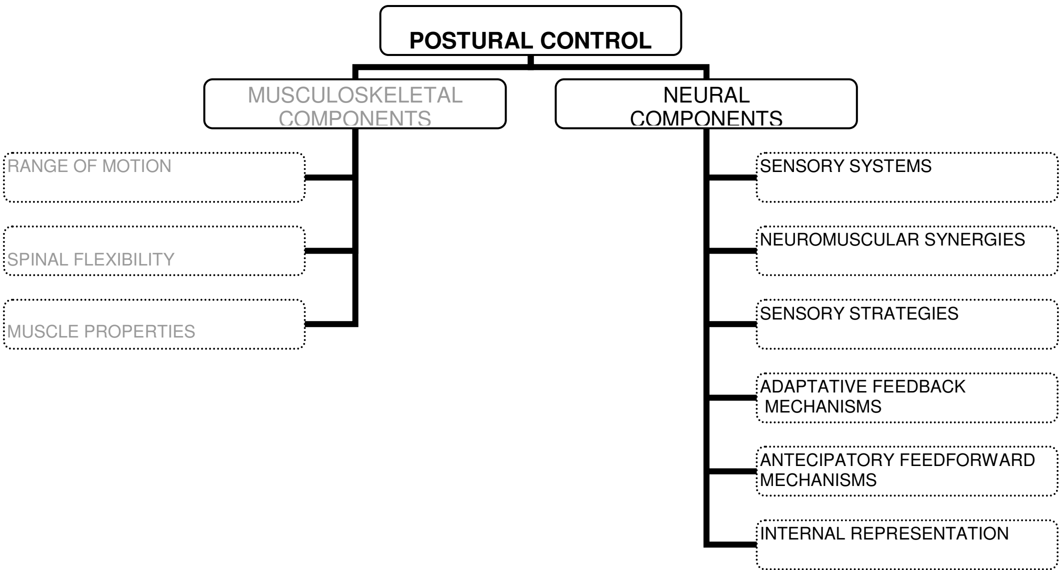

Figure 2.1. Conceptual Model representing systems contributing to postural control(Adapted from Shumway-Cook and Woollacott 2001)

2.1.1. Sensory systems

Sensory system inputs include those coming from the visual, vestibular and somatosensory systems, are essential in providing information about the body's position in space, position of the limbs and body and the tension of the respective muscles. Selection of the appropriate postural movement strategies is based on this information.

To guarantee proper postural control and balance, the sensory inputs must be integrated in the CNS and the outputs are sent to the muscles using the pyramidal and extrapyramidal systems (Figure 2.2.). The pyramidal system is a descending pathway, a large proportion of which is made up of corticospinal fibres. They have control over voluntary movements and the segmental reflexes required for balance (Horak 1987).

The extrapyramidal system with the cerebellum and basal ganglia helps to mediate visual, vestibular, and proprioceptive interactions and coordinate the proprioceptive reflexes serving balance (Nashner 2001. Allum and Keshner 1986).

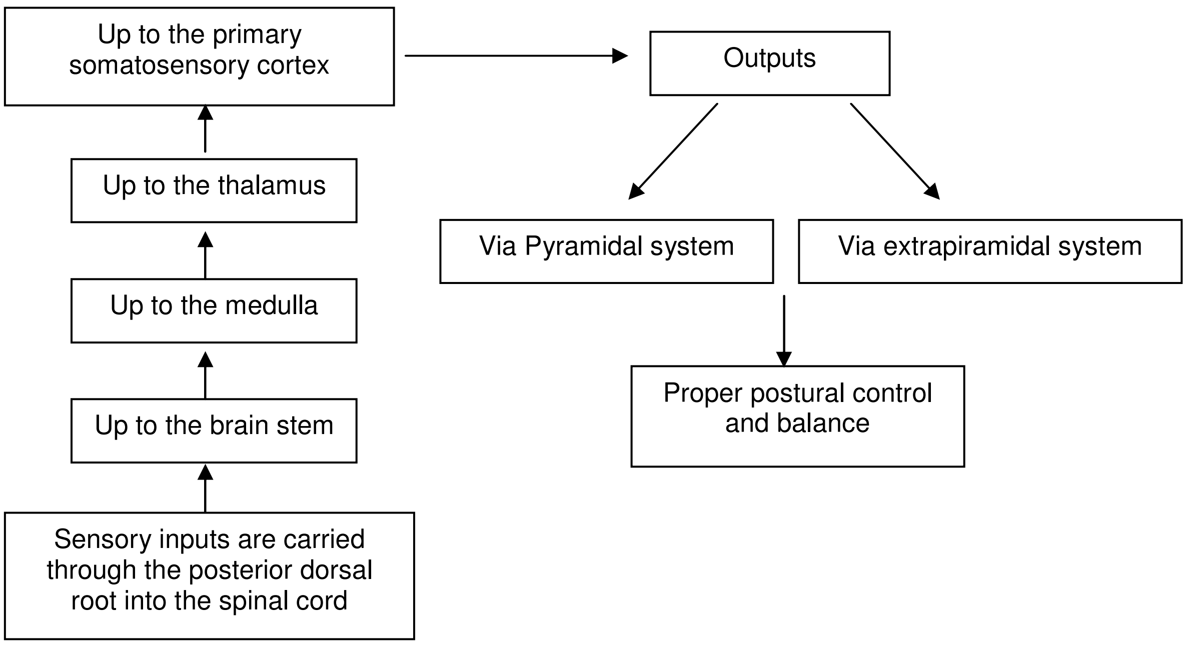

Figure 2.2. Sensory system

When somatosensory and visual information are adequate, the vestibular system plays a minor role in control of the centre of gravity position. Its role is dominant when there is a conflict between visual and somatosensory information and during ambulation (Rothwell 1994).

The state of an individual's balance is described in terms of the angular displacement of the centre of mass over its base of support because the larger the angle the greater the instability. The limit of stability is affected by the centre of mass sway frequency, since the faster it sways the smaller the limit of stability (Winter 1991).

Instability in human balance can be registered very early by the proprioceptive sensory systems responding to motion and muscle stretch at the ankle, knee and trunk joints, as well as by head linear and angular accelerations. At the spinal cord, afferent impulses trigger stretch reflexes, whereas at the higher levels in the central nervous system neural connections mediate more complicated motor responses in order to maintain posture.

Table 2.1. Properties of the three types of responses given by the motor system in balance movement control (adapted from Nashner 2001)

SYSTEM PROPERTY	**MOTOR SYSTEM**		
	RESPONSES		
	Reflex	**Automatic**	**Voluntary**
Pathways	Spinal	Brainstem/ subcortical	Cortical
Activation	External stimulus	External stimulus	External stimulus Self-generator
Response	Local to point of stimulus and stereotyped	Coordinated and stereotyped	Unlimited variety
Role in balance	Muscle force regulation	Resist disturbances	Purposeful movements

When balance must be corrected, after a perturbation, three types of responses can happen: reflex, automatic and voluntary (Table 2.1) (Nashner 2001, Schmidt and Lee 1999, Schmidt 1991). The first motor response to falling is an automatic reaction, coordinated and transmitted through vestibulospinal reflexes and affects all muscles of the legs, trunk and neck (Nashner 2001, Rothwell 1994, Allum and Keshner 1986).

2.1.2. Neuromuscular synergies and sensory strategies

Automatic responses rapidly respond to disturbances, being context-dependent and adaptable to the specific balance demands (Nashner 2001). These automatic responses used to recover stability in response to displacements use **muscle synergies**, which are associated with postural movement strategies. These movement patterns are referred to in Figure 2.3.:

- *Ankle strategy* that results when there is minimal instability, the response is a simple rotation at the ankle causing the body to behave as an inverted pendulum;
- *Hip strategy* that results when there is greater instability, and is more complex, as there is increasing translation of the body mass through an adjustment at hip joint;
- *Stepping strategy* occurring when there is maximum instability, this is the most complex and involves multiple segments (Shumway-Cook and Woollacott 2001, Patla 1997, Berger et al. 1984). Successful balance recovery, by means of stepping, requires rapid and accurate control of lower limb movement as well as the ongoing centre of mass (COM) motion in such a way as to arrest the COM within the boundaries of a new base of support (BOS) established by the step. In fact, compensatory stepping appears to be a prevalent strategy to preserve stability even when the perturbation is relatively small, yet the control of these reactions is complex and may well challenge the capacity of older adults. (Luchies et al.1999, Maki 1999, Thelen et al. 1997).

Figure 2.3. A- Ankle strategy; B- Hip strategy;
C- Stepping strategy (taken from Shumway-Cook and Woollacott, 2001)

2.1.3. Feedback and feedforward postural control mechanisms

Any movement performed in the standing position normally comes with compensatory postural mechanisms, which decrease or eliminate the postural disturbance generated by the movements and maintain the subjects' centre of gravity within the supporting base. These postural mechanisms are produced by either anticipatory and/or feedback control.

Adaptive or feedback postural control mechanisms involve modifying sensory and motor outputs in response to changing a task and to environmental demands, being a very quick mechanism and the time between the perturbation and the motor response is about 70-180 milliseconds (Shumway-Cook and Woollacott 2001).

Anticipatory or feedforward postural control mechanisms pre adjust sensory and motor systems for postural demands based on previous experience and learning. They are anticipatory because they are activated prior to the self induced disturbance.

Information from proprioceptive, visual, vestibular, auditory, tactile, and stretch receptors in various organs is integrated to create a picture of the position and movements of the body parts relative to each other and to the environment. This picture is stored and constantly upgraded. It is the essence for all body movements and the determinant for sudden and rapid corrective motor activity (Shumway-Cook and Woollacott 2001, Era et al. 1996).

In contrast to reflex and automatic reactions, voluntary movements used in anticipatory mechanisms, are based on our conscious attention and may vary with time and between individuals (Nashner 2001).

2.2. Age effects on Postural Control and Balance

To maintain balance in a dynamic environment, a person must accurately perceive any displacement of balance using the vestibular, somatosensory, and visual systems. To maintain or return the body to a stable position there must be flexibility of the joints, adequate muscular strength, good response speed, and effective motor planning ability. Many of these components are influenced by age and may be further impaired in sedentary older persons (Rothman and Levine 1992, Teasdale et al. 1991, Woollacott et al. 1986).

A slower rate of central processing and integrated sensory inputs within the central nervous system has been reported as reasons for difficulties in the coordination of reflexes and automatic responses in postural control in older age (Teasdale et al. 1991, Manchester et al. 1989, Woollacott et al. 1986).

Declining proprioception, loss of muscle strength and the more dominant proportion of slow-twitch fibres found in older people lead to postural control deterioration which may predispose the person to falling (Lord et al. 1991). The cumulative degenerative changes in sensory and musculoskeletal systems lead to an increased body sway after the age of sixty years which shrinks the limits of stability, as the centre of mass moves quickly and the momentum of the body acts as an additional destabilizing force (Allum et al. 1998, Winter 1991).

Furthermore degenerative ocular changes, such as macular degeneration and cataract, decrease the visual acuity acting on the visually guided postural reflexes so that they do not react quickly enough to prevent a fall (Hobeika 1999, Spirduso 1995, Schmidt 1991).

In addition, the presence of osteoporosis, decreased back muscle strength and joint motion carrying the older people to tend to walk with a curved posture, places the centre of gravity in a forward position that is, at or close, to the anterior periphery of the limits of stability. This makes them vulnerable to balance perturbations. This curved posture may also limit the visual field further impairing orientation. The protraction of the head associated with the hyper kyphosis alters the position of the statolabyrinth (utricle and saccule) relative to the gravitational axis, increasing the instability in older persons (Edmondston and Singer 1997).

The recovery of balance in response to a postural perturbation, involves the ability to detect the loss of balance, planning of a recovery strategy and the execution of compensatory stepping to prevent a fall, when a corrective response is insufficient (Maki et al. 2000, Medell and Alexander 2000, Thelen et al. 2000).

Older adults seem to require extra steps to recover equilibrium compared with younger adults i.e. the new base of support established by the initial stepping reaction in older people appears to be insufficient to capture and arrest the motion of the centre of mass. The reduction in the stability of the initial step and a consequent need to execute additional steps and/or undertake compensatory arm reactions could be a result of errors or inadequacies in the planning or execution of the initial step, because of the age related changes in the neural, sensory and musculoskeletal systems. In addition psychological factors, such as fear of falling can be a reason for the extra steps and arm movements (Hunter et al. 2001).

Thelen et al. (2000) studied the age-related differences in latency between release from a leaning position and the onset of muscular activity. They investigated the magnitude of the muscular activities as well as the timing of muscle activities during stepping in two groups: one composed of 14 younger participants (mean age of 24 years) and another group of twelve older participants (mean age of 72 years). All participants were supported by a horizontal lean-control attached to the back of a pelvic belt in a straight leaned forward position (Figure 2.4.). After a random time delay the lean control was released to induce a forward fall and consequent stepping.

Figure 2.4. Simulation of stepping following release from a forward lean (taken from Thelen et al. 2000)

Muscle activity of the soleus, medial gastrocnemius, tibialis anterior, vastus lateralis and biceps femoris of both lower limbs, was measured by electromyography. Muscle latency times were defined as the interval between the release of the subject and the onset of muscular activity. The authors, in spite of the small sample, demonstrated that latency times of young and older people were quite similar suggesting that nerve conduction, as a result of a central output processing, was not decreased in older people, agreeing with Peterka et al. (1990) and Woollacoot (1986). While the overall muscle activation patterns were similar between younger and older participants there were age differences in timing of some muscle activities during the stepping movement. Older adults were slower in deactivation some stance leg muscles (soleus, gastrocnemius and biceps femoris), and in activating the muscles of the stepping leg (vastus lateralis and rectus femoris).

In spite of the majority of studies focussing on control of balance in the antero-posterior direction, there is growing evidence that age related impairments are often pronounced in the lateral direction and that measures of lateral instability may be better predictors of falling, making lateral stepping as important as forward stepping (Maki, 1996).

From a clinical perspective, impaired control of lateral stepping reactions may be an early preclinical indicator of increased risk of lateral falls and hip fracture and should be an important consideration in the development of clinical approaches to predicting and preventing falls and related injuries.

Backward stepping ability seems important for recovering balance. Hsiao and Robinovitch (2001) found that older people's ability to recover balance with a single backward step depends on the backward inclined position at step contact.

Although stepping is an automatic response to disturbed balance and timing of muscle activity increases with age, the fact is that it can be initiated voluntarily to protect against a fall as a feedforward postural control (Rogers et al. 2003).

Voluntary forward stepping is also influenced by age as demonstrated by Patla et al. (1993). In their study they analysed the characteristics of voluntary stepping in younger and older persons, measuring the reaction time and weight transfer time during voluntary stepping forward, laterally and backwards, in response to a light cue. They analysed the vertical ground reaction force beneath the stepping foot and concluded that reaction time and weight transfer time increased with age. In fact the larger increase in weight transfer resulted in a slower stepping response. Voluntary lateral stepping compared with the other two directions was faster in older and younger participants as the weight shift to the side was less than in other directions. Older participants showed greatest age related speed decrements in voluntary forward stepping.

Voluntary backward stepping also appears to be affected by ageing effects as demonstrated by Takeuchi et al. (2007). The authors measured the shift in deflection velocity and maximum deflection velocity from the beginning of the centre of pressure (COP) movement to the onset of the stepping reaction, in a sample of 10 older people with a mean age of 75.6 years old and 13 younger people with a mean age of 22 years old, concentrating on the backward stepping reaction. The subjects were instructed to stand barefoot with their feet 10cm apart, on a force plate. They maintained this position for 20 seconds with arms folded. After 20 seconds, when indicated by one of the authors, they shifted their centre of gravity (COG) backward to the maximum possible, and then stepped out from this maximum shift position. The movement strategy and velocity during this task movement were left to the participants' judgment. In spite of a small sample, that can limit extrapolation of the results to the population and increase type I error, the authors concluded that the elderly group showed significantly lower values of the capacity to do, and velocity of a rapid shift in the position of the COP backwards than the younger group. However the movement used in this experiment to measure "backward stepping reaction" was not natural and only represented the timing of a voluntary movement, not an involuntary stepping strategy.

Voluntary and involuntary stepping requires different processing as demonstrated by Luchies et al. (1999). In a study involving younger (n=13) and older adults (n=11) with mean ages of 21 and 68 years respectively, the authors examined whether involuntary stepping performance was similar to voluntary stepping performance. For voluntary stepping, participants were instructed to step as quickly as possible in the direction of a little lateral waist pull; for involuntary stepping, participants were instructed to react naturally to a large waist pull. Measurements included the first step lift off time, first step landing time, weight shift time, step duration time and tibialis anterior onset time. The authors found that for involuntary stepping the measured variables were similar for younger and older participants. In voluntary stepping older people revealed more prolonged weight shift times than younger participants. The older people took more time, used a shorter step length and a smaller step height in voluntary stepping than in involuntary stepping. In spite of the small number of participants in the study the authors concluded that the performance of voluntary stepping did not reproduce the ability to undertake involuntary stepping in response to destabilizing disturbances in healthy older people.

The findings of Luchies et al. (1999) are reinforced by the work of Medell and Alexander (2000) who studied a sample of 34 women that they divided into three groups: one composed of 12 participants with a mean age of 21 years; a second with 12 unimpaired older women with a mean age of 69 years and a third group with ten balance impaired older women with a mean age of 77 years. they investigated age related changes in the maximal step length (MSL) and the rapid step test (RST) as well as their relationship with tandem and unipodal stance, tandem walk, knee extension and ankle plantar flexion maximum isokinetic torque and with the Activities Specific Balance Confidence Scale (ABC scale). The reliability tests for MSL and RST were calculated with the Pearson coefficient. It is usually considered that the use of Pearson coefficient is not the most appropriate method of evaluating reliability as it only measures an association between scores, not the level of agreement.

Medell and Alexander (2000) found lower values of MSL and RST for the unimpaired older women group when compared with the younger group, and for the balance impaired older women group when comparing with the unimpaired older women group. In spite of the small number of participants the results showed a strong relationship between rapid step test time an tandem stance time ($r= -0.60$ respectively for $p<0.02$), tandem walking time ($r= 0.61$ respectively for $p<0.02$), unipedal stance time ($r= -0.81$ respectively for $p<0.02$) and knee extension strength ($r= -0.70$ respectively for $p<0.02$) and plantarflexion strength ($r= -0.61$ respectively for $p<0.02$). As the determination coefficient was used (r^2) it could be seen that 66% of the unipedal stance time values variability and 49% of the knee extension strength values could be explained by the rapid step test time values. These results support the training of voluntary stepping in older people to increase balance and consequently reduce risk for falls.

All the previous studies show that age has an effect on involuntary stepping with a slower activation of the step leg muscles and on voluntary stepping. Older people step voluntarily with a slower response, a more prolonged weight shift times than young people. Older people take more time, use a shorter step length and a smaller step height when voluntary stepping is compared with involuntary stepping. One of the reasons for these differences can be the lack of muscle preparation as older people become more inactive resulting in a decrease of the contraction capacity of the muscles.

To effectively complete a step, when using the strategy of stepping, postural muscles must be active at the appropriate time and with appropriate force (Brauer and Burns 2002). Strength has also been shown to be an important contributor to voluntary stepping, for example in research undertaken by Medell and Alexander (2000) peak knee extension torque contributed 50% to rapid stepping timing.

The delay in lower limb muscular deactivation and activation during stepping seen in older adults, as well as their diminished ability to generate joint torques rapidly, is a good reason to introduce voluntary stepping in all directions as a component of any exercise programme for persons with 65 years old and over.

2.3. The effects of exercising on Postural Control and Balance

It would appear that postural control and balance can be improved in older persons by using appropriate exercises.

While the optimal frequency and intensity of balance exercises remains to be clearly identified, there are some studies that have shown significant positive effects on postural stability with a frequency of exercise perfomed three days a week (Gardner et al. 2001,Campbell et al. 1997).

The majority of reported studies include balance exercises together with strength or endurance exercises, so it is difficult to tell whether the improvements may be due to the whole programme or to individual exercises. This is the case with the study of Morgan et al. (2004) who implemented an exercise programme, with no equipment, in a sample of 229 participants (119 participants in the intervention group and 110 in the control group). There were 10 balance specific exercises and 12 upper and lower limb endurance exercises undertaken for 8 weeks, thrice a week in a randomised control trial of older persons aged 60 years old and over. After 24 sessions, the 119 participants of the intervention group presented significant improvements in gait and balance measured by the performance-oriented balance and mobility assessment (POMA), when compared with the control group who continued their usual activities during the study. No reliability values were given for the tools used in this study.

Nelson et al. (2004) implemented a 6 month home based exercise programme for 70 participants in a randomised control trial (32 participants in the intervention group and 38 in the control group) with balance, upper limb and lower limb strength exercises among others. Progression of balance exercises was made in 3 levels of turns (each step 45º, 90º, or 120º), 3 levels of plantar flexion (on both feet using hands for support: using little or no hand support: on one foot with little hand support), ankle dorsiflexion, and tandem walk (forward tandem walk with hand support: forward tandem walk without hand support: and backward tandem walk with hand support). However, it is not clear if the authors undertook reliability studies prior to the experiment. Balance outcome measures (timed forward tandem walk test over a 6 meter course for dynamic balance, and one leg standing for static balance) improved significantly after 6 months of intervention showing the importance of specificity in exercise programmes for older people.

The study by Shimada et al. (2003) was the only study found, that evaluated the effects of a balance exercise programme on a sample of 34 older people with a mean age of 80.8 years. The study comprised three groups, a control group with 9 participants, a gait exercise group with 12 participants and a balance exercise group with 11 participants. Gait exercises included 10 minutes of continuous walking, 10 minutes of return trips of stair climbing and descending, five minutes of tandem and five minutes of sideways walking. The balance exercises included 30 repetitions of forward reaching, five minutes of one leg standing, five minutes of tandem standing exercises and ten minutes of centre of mass movement using a balance board. As outcome measures the authors used a battery of balance and gait tests: One Leg Standing Test, Functional Reach Test, Manual Perturbation Test, Functional Balance Scale (FBS) and Performance-Oriented Mobility Assessment (POMA) for mobility and gait. It must be mentioned that most of the exercises were specific, indicating that the movements used in the exercises were the same for some tests used as outcome measures. After 12 weeks of intervention supervised by a physiotherapist, and in spite of the small sample, the balance exercise group showed significant improvements, in Functional Reach, in FBS and POMA for mobility and gait when compared with the control group. The gait exercise group showed significant improvements in POMA when compared with the control group. Comparing the balance and gait exercise groups, the former demonstrated significant improvements in Functional Reach which would be expected as there was a specific exercise in the balance exercise group. Nevertheless it could have been expected that the gait exercise group would also improve balance as their programme also included exercises that challenged balance ability.

It is thought that to step effectively, postural muscles have to be active at the appropriate time and with appropriate force (Brauer and Burns 2002) but there are only a few published studies related to stepping training.

Rogers et al. (2003) examined the influence of stepping training on the timing characteristics of voluntary step initiation in younger and older adults before and after a three week training programme twice a week. The sample was composed of 12 younger adults (mean age 24 years) and 8 older participants (mean age 70 years). It consisted of induced stepping (using a small forward waist pull) and a voluntary stepping (using an electronic beep). Each participant took part in six training sessions, each session consisting of 53 trials with seated rest periods every ten trials and when needed. In spite of the small sample and no control group, the initiation time, defined as the interval from the onset of the reaction stimulus until the vertical ground reaction force under the stepping limb equalled zero at foot lift-off, measured by a pressure-sensitive contact mat, was significantly lower in older adults than in younger participants. However stepping training methods significantly improved the initiation time in the young adults as well as in the older participants reinforcing the value of specificity in a training programme for any age group.

Stepping training was used also by Barnett et al. (2003) in their community-based exercise programme with 137 older participants aged 65 years and over. The programme (once a week) was composed of functional exercises such as sit to stand practice, weight transference and reaching; balance and co-ordination exercises including modified Tai Chi exercises; stepping practice; change of direction; dance steps and catching/throwing a ball; sit to stand and wall press-ups training and resistive upper and lower limb exercises using resistance bands for strength and fast walking practice including change of pace and direction for aerobic activity. Physical performance measures covered knee extension and ankle dorsiflexion strength, a simple sway test, a stability test, the Berg alternate step-up test, the Sit To Stand Test, the 6 meters Walking Speed Test and Simple Reaction Time (SRT). SRT was measured in milliseconds with participants seated using a light as the stimulus and a foot-press as the response. After 12 months of the programme (37 sessions) the intervention group (n=67) performed significantly better than the control group (n=70) in three of the six components of sway test but stepping training didn't improve reaction time. The lack of specificity of the exercise programme could be a possible explanation for the non improvement of simple reaction time, in addition the low frequency of the exercises may not have been enough to cause improvement.

In conclusion postural control involves controlling the body's position in space for balance and orientation. To achieve balance, the body's centre of mass must be kept perpendicular over the centre of the support base. This is accomplished through the integration of information received from sensory systems and through the execution of coordinated and synchronized movements.

Visual, vestibular and somatosensory functions diminish with normal ageing decreasing sensory inputs and increasing consequently postural instability. The slower rate of central processing and slower integrated sensory inputs within the central nervous system make both induced postural reactions and perceptual responses decline with age. The slower adaptive postural responses of older people may also contribute to the onset of voluntary responses.

The challenges to balance during daily activity life are often likely to demand rapid changes in the base of support to control stability, i.e. stepping, a protective strategy, that deteriorates with age, as the delays in muscular deactivation and activation and the diminished ability of healthy older adults to generate joint torques rapidly may reflect a problem in a recovery strategy.

It has been shown that measures of maximal and rapid stepping correlate with measures of fall risk, gait, and mobility in older people. Nevertheless it is not yet clear what the influence of stepping training is on some physical performance outcomes and involuntary stepping activity.

An exercise intervention with a focus on stepping and balance training might thus be useful in an exercise programme focussed on reducing fall risk factors.

2.4. Falls risk factors

Earlier in this thesis various components of postural control were highlighted that suffer age-related changes and can turn into fall risk factors. As they are characteristics that are inherent to each individual and are the result of changes related to aging (or inactivity), they are called intrinsic fall risk factors.

It has already been mentioned that reduced lower extremity muscle endurance and strength as well as ankle range of motion and spinal flexibility, problems of the sensory systems that are involved in posture, loss of proprioception, loss of visual field and decline in visual acuity are considered fall risk factors. Moreover the different stages of information processing and response programming are influenced by ageing. The reduction in reaction to a loss of balance has been verified in older persons as being very important to maintain stability and can also contribute to falling. Furthermore, dizziness, cognitive impairment and problems adapting to environmental aspects affects the risk of falling (Graafmans et al. 1996, Salthouse 1993, Studenski et al. 1991, Tinetti and Speechley 1989).

Most falls in older people result from the interaction of intrinsic and extrinsic factors that affect balance systems. Extrinsic factors include environmental hazards as well as activity-related factors (Walker and Howland 1992).

Extrinsic factors have an important role in falls leading to different fall “accidents”. The homes of older people often contain environmental hazards such as loose rugs, slippery floors, irregular floor surfaces, irregular doorsteps, poor lighting, inappropriate bathroom fixtures without arm supports, inappropriate furniture that may be too low or too high, and unsafe stairs (lack of adequate hand rails) (Salthouse 1993). Assessing these factors will help in evaluating the safety of a home and prevent falls.

Effective assessment of fall risks requires a holistic approach involving many complex and interrelated factors. The complexity lies in determining what factors contribute to falls and what factors can be modified to reduce future falls. (Tinetti et al.1994).

Speechley and Tinetti (1990) defined some important steps in reducing the risk of falls in older people including eliminating environmental hazards, improving home support, providing opportunities for socialisation and support, modifying medication, providing balance training, modifying limits of stability, involving the family and providing follow-up. Falls normally lead to situations of injury, which then cause a fear of falling in older people.

2.4.1. Fear of falling as a fall risk factor

Most fallers admit that they are extremely fearful of falling again and avoid activities due to this fear, leading potentially to social isolation and physical inactivity. Some older persons believe that falling is inevitable and unpreventable leading to feelings of helplessness and even greater fear of falling (Gallagher and Brunt, 1996).

Tinetti et al. (1990) considered fear of falling as indicative of a low, perceived self efficacy. Self efficacy can be defined as "*a person's self confidence that he or she can successfully take part in a new behaviour or do a specific task (i.e. self efficacy expectations) and achieve desirable results (i.e. outcome expectations/realization)".*

Low self efficacy may be related to functional decline since people with low perceived efficacy in an activity tend to avoid it (Bandura 1982).

Mendes de Leon et al. (1996) observed in a sample of 1103 older people (aged 72 years or over) that high self-efficacy (measured by the Falls Efficacy

Scale) was protective against functional decline. Low scores in self-efficacy related to falling were associated with a decline in the abilities associated with activities of daily life; this functional decline being directly related to fear of falling.

Furthermore, fear of falling can affect balance and gait resulting in a loss of function and independence leading to low levels self perception of health (Vellas et al. 1997, Arfken et al. 1994, Piotrowski and Cole 1994, Tinetti et al.1990).

Further supporting the link between low self efficacy and reduced ability to cope was a prospective study by Cumming et al. (2000). They observed in 528 participants with a mean age of 77 years and low self efficacy (measured by the Falls Efficacy Scale) an increased risk of falling and a decrease in the capacity to perform Activities of Daily Living. These participants also had a greater risk of institutionalization than those who presented with high self efficacy.

In the same vein, Howland et al. (1998) demonstrated, in a sample of 266 older people with a mean age 76.3 years, that the fear of falling was associated with female gender, low levels of self perception of health (measured by SF-36) and with previous falls. Nevertheless, the authors affirmed that the impact of fear of falling on activities could be attenuated by social support, as individuals that trusted each other and spoke with friends concerning the fall reported less reduction of activity.

One of the greatest consequences of fear of falling is considered to be the restriction of activity that will transform into a loss of independence and in turn make older people more inactive. Fear of falling is a big health problem that needs more attention and must be considered as a fall risk factor (Tinetti et al. 1990, Arfken et al. 1994, Howland et al.1998). Thus, it is important to motivate older people to do physical exercise in order to break down this negative cycle.

2.5. The effects of exercise programmes on the number of falls

Exercise programmes appear to have an impact in reducing fall risk factors and consequently the number of falls, although there is not total agreement between authors about this. A direct intervention in extrinsic fall risk factors is also considered to reduce the number of falls.

Perell et al. (2001) in their systematic review of fall risk assessment measures stated that it is important to link interventions with specific fall risk factors, including fear of falling. They reinforced the statement from Campbell et al. (1999) who highlighted that tailored exercise programmes could reduce the number of falls in a study with 213 community-dwelling women, aged 80 and over. These women were randomized either to usual care and social visits at home (n=110) or to a 2-year home based exercise programme (n=103) consisting of muscle strengthening, balance retraining, and walking, each to be carried out at least 3 times a week, following 4 home visits made by a physiotherapist. At the end of the second year the exercise group patients had a self-reported 31% reduction in falls, and a 37% reduction in serious falls, compared with the usual care group. The authors noted that minimal ongoing contact with a physiotherapist was needed to keep the exercise group patients active, but did not define the duration of “minimal contact”. Nevertheless the adherence rate for the intervention group dropped by 43% in the beginning of the second year of follow up. One possible reason of this drop could be that the “minimal contact” was not enough to motivate adherence to the home based programme.

To reinforce the beneficial effects of exercise programmes on falls, the study of Barnett et al. (2003) demonstrated that they were able to reduce by 40% the rate of falling in the intervention group when compared with the control group after 12 months of an exercise programme. The authors implemented a weekly group exercise programme in a sample of 163 older participants aged over 65 years in order to prevent falls. The programme was designed to improve balance and coordination (Tai Chi, step training, dance steps, catching and throwing a ball) muscle strength (sit to stand, wall press-ups, therabands) and aerobic capacity (walking). Falls were measured at baseline and after 12 months of programme.

There have been reports of other exercise programmes which did not have a positive impact on the falls rate. Reinsch et al. (1992) studied 230 older adults with a mean age of 60 years, looking at the effectiveness of four interventions (an exercise programme, a cognitive-behavioural programme, an exercise-cognitive programme and a discussion control programme) in reducing falls. The exercise programme consisted of standing up from a sitting position and stepping up to a 15 cm stool. The cognitive-behavioural programme covered health and safety concepts to prevent falls, relaxation training and a videogame to train reaction time. The exercise-cognitive programme consisted of one meeting per week following the previous cognitive-behavioural programme and two meetings centred on the exercise programme. The discussion control group talked about health, but not specifically related to falls. All the interventions had a duration of one year. After one year there was no difference in the number of fallers, and fall rate among the four groups. This study by Reinsch et al. (1992) may demonstrate that exercise programmes need to be specific to fall risks if they are to decrease the number of falls.

MacRae et al. (1994) also assessed the effectiveness of a stand up and step up exercise programme on falls rate in 80 older individuals aged 60 years and over. After one year of follow up the exercise group did not show any reduction in the incidence of falling when compared with the control group. These two studies demonstrated that using the stand up and step up exercises are not enough to improve fall risk factors and decrease the number of falls. This reinforces the importance of the principle of specificity in any design of exercise programmes for older people.

Exercise programmes to reduce falls seem to be efficient when using exercises that target more than one fall risk factor and are specific to the needs of the individual.

In conclusion it seems falls are a serious health problem resulting from a complex interaction of intrinsic and extrinsic factors, reducing general health status and quality of life. Fear of falling is considered a fall risk factor. Fortunately, many of the factors that contribute to falls can be modified. The role of specific exercises as a method of reducing fall risk factors and fall incidence rates in the older population is very important.

CHAPTER 3

HOME BASED EXERCISE PROGRAMMES

This chapter describes the design of exercise programmes as well as a review of all the home based exercise programmes for older people found in the literature between 1994 and 2005. It will finish with details concerning the design and implementation of the home based exercise programme applied in the quantitative study of this thesis. It particularly focuses on the use of exercises that do not require equipment, as this will make the exercises more feasible to be undertaken in the homes of older Portuguese people.

Ageing is a world wide social phenomenon and Portugal is no exception to the problems of demographic ageing affecting not only older people but also their families. In 2001 statistics showed that there were sixty nine older men for hundred of older women in the retirement age is around 65 years old.

In Portugal, since 1980, some social policies have been developed that have led to the establishment of institutions to take care of older people. Nevertheless access to these social policies is still reduced and the family is still the main support mechanism for older Portuguese people. The family members are not professional carers and so in order to minimise the burden on them and also to minimise the effect of isolation in older people that often leads to a sedentary lifestyle it was felt important to involve the health centres in supporting the exercise programme described in this research. It was hoped that this exercise programme for older people would improve their physical ability and fight against sedentarism.

It is generally accepted that exercise programmes *“may prevent the downward-spiral cycle of decreased activity leading to physical losses and further immobility”* (Buckwalter 1997). It is considered that exercises for older people must focus on minimizing biological changes of ageing and inactivity, maintaining or increasing flexibility, strength, endurance, coordination, balance, and motor problem solving ability, and hopefully, increasing their quality of life by avoiding physical inactivity (Mazzeo et al. 1998, Buchner et al. 1997).

Regular exercise sessions emphasizing moderate intensity training with longer duration are recommended for most older adults, because a high proportion of the older population is sedentary.

3.1. Home Exercise Programmes

The potential physical benefits from regular physical activity include improved muscle endurance and strength, flexibility and balance leading to a reduced risk of falling (Tinetti et al. 1994, Fiatarone et al. 1994). Physical activity is also associated with reduced utilization of health services (Pronk et al. 1999, Harris et al 1989), thus for older adults, physical activity is an effective strategy for improving health, independence and quality of life, and reducing health costs associated with chronic disease.

While the benefits of regular physical activity for older adults are well recognized, the challenge in this present study was to encourage Portuguese older adults to adopt and sustain a physically active lifestyle. Exercise preference is one of the major factors affecting adoption and adherence patterns of older adults to specific exercise programmes, and older adults tend to prefer activities that can be done in their own home or community (King et al. 1990).

According to Asworth et al. 2004 home based programmes appear to be superior to centre based programmes in terms of the adherence to exercise (especially in the long term) and can reduce the number of falls by improving their risk factors.

From some online databases (PubMed, Ingenta Connect, Science Direct, Sport Discus, and Scopus) searched from 1994 until 2005, sixteen studies were found where intervention consisted of home-based exercise programmes with participants of 65 years or over (Table 3.1, page 94).

From the sixteen studies regarding home based exercise protocols only three were not controlled trials, the exceptions being Helbostad et al. 2004, Gill et al. 2003 and MacMurdo and Johnstone 1995.

From Table 3.1 it can be seen that the studies with the largest number of participants were by Campbell et al. (1997) and Tinetti et al. (1994) and four studies had a follow up of between 9 to 12 months (Helbostad et al. 2004, Gill et al. 2004, Robertson et al. 2001 and Campbell et al. 1997) while one had a follow up of 24 months (Allen and Simpson 1999).

Half of them had participants aged more than 80 years (Helbostad et al. 2004, Gill et al. 2004, Johnson et al. 2003, Gill et al. 2003, Gill et al. 2002, Robertson et al. 2001, Campbell et al. 1997 and McMurdo and Johnstone 1995) (Table 3.1.), most of the exercises involved lower limb strength and balance with only one study (Johnson et al. 2003) including spinal exercises (Table 3.1.).

Ten studies involved physiotherapists as supervisors of the interventions and almost all of the studies used an external resistance to improve strength (therabands, ankle cuff weights). The home based exercise programme in the study by Johnson et al. (2003) was delivered by home-support workers, without equipment and it achieved significant improvements in Timed Up and Go, Sit to Stand Test, speed of gait, balance and well being only using increasing time, number of repetitions and degree of difficulty as a progression (Table 3.1.)

Not all the studies provided information on the adherence rate to the programme but for those who did the values varied from 58% to 87%, with the studies by Nelson et al. (2004) and Johnson et al. (2003) having the highest rates of adherence (Table 3.1.).

In order to classify the level of evidence of the sixteen studies they were classified using PEdro Scale (Table 3.1.). Criteria two to nine on this scale are related to the internal validity, and criteria ten and eleven relate to statistical information and ability to interpret results. The maximum PEdro score is 10/10. The criteria used to classify the studies are listed below:

1- Eligibility criteria were specified (not used to calculate PEdro score)
2- Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received) (Yes/No)
3- Allocation was concealed (Yes/No)
4- The groups were similar at baseline regarding the most important prognostic indicators.
5- There was blinding of all subjects (Yes/No)

6- There was blinding of all therapists who administered the therapy (Yes/No)
7- There was blinding of all assessors who measured at least one key outcome (Yes/No)
8- Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups (Yes/No)
9- All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat" (Yes/No)
10- The results of between-group statistical comparisons are reported for at least one key outcome (Yes/No)
11- The study provides both point measures and measures of variability for at least one key outcome (Yes/No)

The majority of exercise programmes for older people have been designed and implemented in Japan, United Sates, Norway, Canada, New Zealand and England. There is no knowledge about their use in Portugal and not sufficient evidence to know whether the cultural differences between countries would be sufficient to influence the effectiveness of programmes if used in a country other than that of their origin (Table 3.1).

All studies reviewed randomly allocated subjects to groups, confirming that manipulation of the variables brought about effected the changes in outcome (Torgerson and Roberts 1999).

Allocation was concealed in all out four studies (Helbostad et al. 2004, Robertson et al. 2001,Campbell et al. 1997 , MacMurdo and Johnstone 1995). Concealed allocation means that the person who decided if a participant was eligible for inclusion in the trial was unaware, to which group the participant would be allocated. If allocation is not concealed, it may be possible to manipulate allocation to specific group producing systematic bias (Schulz et al. 1995).

The study from Gill et al. (2003) was the only one that did not present similar groups at baseline (criterion 4) possibly revealing an inadequate randomisation (Domholdt 1999).

None of the studies presented any blindness of the participants nor of the therapists that participated in the intervention, increasing respectively the

Hawthorne effect and the influence of the therapist motivation or lack of motivation for the intervention or control conditions (Domholdt 1999).

Johnson et al. (2003), Gill et al. (2003), Yates and Dunnagan (2001) and Allen and Simpson (1999) studies did not mention any blindness of the assessors, increasing the possibility of subjective bias of the results (Domholdt 1999).

Five studies (Gill et al. 2003, Gill et al. 2002,Yates and Dunnagan 2001, Allen and Simpson 1999) did not demonstrate that at least one key outcome was obtained from more than 85% of the subjects initially allocated to groups (criterion 8). Gill et al. 2003 only followed up 2/3 of the intervention group. Gill et al. (2002) only followed up 65% of the intervention group. Yates and Dunnagan 2001 followed up 55% of the intervention group. Allen and Simpson (1999) mentioned a follow up of only 70% of the intervention group. Participants that are not followed up may differ significantly from those who stayed in the study introducing a bias (Domholdt 1999).

Nine studies reviewed (Yamauchi et al. 2005, Nelson et al. 2004, Gill et al. 2003, Yates and Dunnagan 2001, Allen and Simpson 1999, Krebs et al. 1998, Chandler et al. 1998, Jette et al. 1996 and MacMurdo and Johnstone 1995), did not accomplish criterion 9. These studies did not mention that everyone who began the treatment was considered to be part of the trial, whether they finished it or not. Intention to treat analysis provides information about the potential effects of treatment policy rather than on the potential effects of specific treatment (Hollis and Campbell 1999).

Allen and Simpson's (1999) study was the only one that did not mention any results for between group statistical comparisions (criterion 10).

Four studies (Gill et al. 2004, Gill et al. 2003,Yates and Dunnagan 2001, Allen and Simpson 1999) did not show any measure of the size of the intervention effect or any measures of variability (standard deviations, standard errors, confidence intervals, ranges) of at least one outcome.

Of all the studies, three of them (Helbostad et al. 2004, Robertson et al. 2001, Campbell et al. 1997) showed the highest scores on the PEdro scale of

8/10 and consequently higher levels of evidence. Gill et al. (2003) and Allen and Simpson (1999) revealed the lowest scores, 2/10.

In conclusion, the information in Table 3.1 indicates that it seems possible to develop and implement a home-based exercise programme that maintains good adherence by older people, with acceptable outcomes related to decreased fall risk factors and consequently the number of falls in the older population. Utilising exercises that don't rely on equipment makes the exercise programme cost effective and easy to implement.

Table 3.1. Summary of home based exercise programmes trials

AUTHOR (COUNTRY)	NUMBER OF PARTICIPANTS	AGE	PROGRAMME DESIGN AND DURATION	BASELINE ASSESSMENT	SUPERVISOR AND INTERVENTION	USING OF EQUIPMENT	ADHERENCE RATE *	INTERVENTION EFFECTS	PEdro SCALE CLASSIFICATION
Yamauchi et al. 2005 (Japan)	IG= 19 CG= 17 IG- 12 M; 11 F CG - 5 M; 12 F	IG - 69.2 y CG - 70.1 y	RCT 12 Weeks Centre and Home-Based WREP (well rounded exercise programme) 1 X week exercise in the centre supervised Home exercises at least 3 X a week Book and videotape 3 months (12 weeks)	1- 30 sec arm curl test 2- Sit To Stand Test 3- 8 foot- Up and Go Test 4- Back Scatch TestChair Sit and Reach 5- 12 min Walk test	TRAINED EXERCISE INSTRUCTORS Flexibility : Upper Limb and Lower Limb Resistance : Therabands 9 seated exercises Llimb 8 seated exercises for Upper limb	therabands	only in the centre (83%) not at home	Significant improvements on baseline Measurements	2-Yes 3- No 4- Yes 5- No 6- No 7- No 8-Yes 9- No 10-Yes 11- Yes **5/10**
Nelson et al. 2004 (United States)	IG n= 34 CG n=38 IG- 7 M; 27 F CG - 8 M; 30 F	IG - 77.7 y CG - 77.8 y	RCT 6 months 3 Times a week 25 page booklet strength balance	1- Physical Performance Test (PPT) 2- EPESE (Short physical performance battery) 3- Tandem Walk 4- One leg stand 5- Maximal gait speed over 2 meters 6- Six min walking test hand grip strenght 7- one repetion maximum (1RM) SF-36 8- Geriatric Detression Scale	EXERCISE PHYSIOLOGIST STS exercise Muscle ankle strength knee extension Standing hip extension Standing hip abduction Upper body strenght training with dumbbells Plantar flexion ankle dorsi flexion Tandem walking	Dumbells 9,07 kilograms Adjustable ankle weights	82%	Significant improvements in tandem walk and one leg stand	2-Yes 3- No 4- Yes 5- No 6- No 7- Yes 8-Yes 9- No 10-Yes 11- Yes **6/10**
Helbostad et al. 2004 (Norway)	Home training (HT) n=38 Combined training (CT) n= 39 HT - 7 M; 31F CT - 8 M; 31 F No control group	CT- 81.3 y HT - 80.9 y	9 months 2x per day home exercises	1- HRQoL SF-36 2- fast walking - speed - walked back and forth along a 6 m walkway	PHYSIOTHERAPIST Rise from a chair without support Rise to a tip-toe position One leg standing One leg standing Maximal hip flexion of the non WB leg Classes 2/week for 12 weeks 10 mn warm up and 10 mn relaxation and stretch at end. At the middle, 20 mn of functional strength training and 20 mn functional balance training	NO EQUIPMENT	CT - 67.5% HT 64.5%	Significant dif at 3 months: Physical Function Role physical Vitality Mental Health Significant dif at 9 months: Mental Health	2-Yes 3- Yes 4- Yes 5- No 6- No 7- Yes 8-Yes 9- Yes 10-Yes 11- Yes **8/10**

AUTHOR (COUNTRY)	Nº OF PARTICIPANTS	AGE	PROGRAMME DESIGN AND DURATION	BASELINE ASSESSMENT	SUPERVISOR AND INTERVENTION	USING OF EQUIPMENT	ADHERENCE RATE *	INTERVENTION EFFECTS	PEdro SCALE CLASSIFICATION
Gill et al. 2004 (United States)	IG n=94 CG n=94 IG- 80 F; 18 M CG- 70 F; 24 M	IG- 82.8 y CG - 83.5 y	RCT 12 months	1- 3 self-reported IADLs, mobility assessment: 2- timed rapid gait (walking back and forth over a 3,05 m course as quickly and safe as possible) 3- timed chair stands (standing and sitting from a standard chair 3 times as quickly and safely as possible) 4- Performed Oriented Mobility Assessment (POMA) 5- Physical Performance Test (PPT)	PHYSIOTHERAPIST PREHAB Protocol Exercises for balance Exercises for lower and upper limb strength	Theraband elastic bands	NO REFERENCES	AT 7 months assessment signif improv. IADL disability signif. Improv. Time rapid gait signif improv Modified POMA At 12 MONTHS signif improv. Timed chair Stands signif. Improv. Integrated physical performance modified PPT	2-Yes 3- No 4- Yes 5- No 6- No 7- Yes 8-Yes 9- Yes 10-Yes 11- No **6/10**
Johnson et al. 2003 (Canada)	IG n =40 CG n=36 IG -29 F; 11 M CG- 33 F; 3 M	IG=81.7 y CG=82.8 y	Controlled Trial 4 months	1- Timed Up and Go test (TUG) 2- 6 min walk Test 3- Functional Reach Test(FRT) 4- Sit to Stand Test 5- Falls Efficacy Scale (FES) 6- ABC test 7- ten item Vitality Plus Scale	HOME SUPPORT WORKERS Marching on the spot to walking from room to room Wall push-ups Lifting up on toes Toe tapping Seat walk Getting up from a chair Leg lifts to the front, back and sides Reaching up and to the front and sides Calf stretching Hamstring stretching	NO EQUIPMENT	86.6%	Significant Improvements in TUG Sit to Stand, 6-min walk ABC specific Balance Confidence Scale Vitality Plus Scale in IG	2-No 3- No 4- Yes 5- No 6- No 7- No 8-Yes 9- Yes 10-Yes 11- Yes **5/10**
Gill et al. 2003 (United States)	N=94 only an intervention group 80 F 14 M	82.8 y	6 months	1- Maximal strength of the non dominant knee extensor muscles using a hand-held dynamometer 2- Short version of PPT test 3- Modified version of the Established Populations for the Epidemiologic Studies in older people (EPESE) 4- Performed Oriented mobility 5- Assessment POMA (gait component)	PHYSIOTHERAPIST PREHAB protocol: Interventions for bed mobility Exercises for balance Exercises for lower and upper limb strength Indoor gait outdoor gait Progressive exercises for range of motion, balance and muscle strengthening	Theraband elastic bands	NO REFERENCES	3/4 progressed in balance training levels, from level 1 to level 4 Most of the participants didn't progress on theraband colour	2-Yes 3- No 4- No 5- No 6- No 7- No 8-No 9- No 10-Yes 11- No **2/10**

AUTHOR (COUNTRY)	Nº OF PARTICIPANTS	AGE	PROGRAMME DESIGN AND DURATION	BASELINE ASSESSMENT	SUPERVISOR AND INTERVENTION	USING OF EQUIPMENT	ADHERENCE RATE *	INTERVENTION EFFECTS	PEdro SCALE CLASSIFICATION
Gill et al. 2002 (United States)	IG n= 94 CG n=94 IG = 80 F; 14 M CG= 70 F; 24 M	IG= 82.8 y CG= 83.5 y	RCT 6 months	7 activities of daily living: 1- walking 2- bathing 3- upper and lower body dressing 4- transferring from a chair to a standing position 5- using the toilet 6- eating 7- grooming	PHYSIOTHERAPIST Interventions for bed mobility Exercises for balance Exercises for lower and upper limb strength Indoor gait Outdoor gait Progressive exercises for ROM, balance and muscle strengthening	Theraband elastic bands	NO REFERENCES	Overall, participants in the intervention group had less disability than those of the control group at 3, 7 and 12 months (signif between 7 and 12 months)	2-Yes 3- No 4- Yes 5- No 6- No 7- Yes 8-No 9- Yes 10-Yes 11- Yes **6/10**
Robertson et al. 2001 (New Zeeland)	IG n= 121 CG n= 119 IG - 82 F 39 M CG- 80 F 39 M	IG= 80.8 y CG= 81.1 y	RCT 12 months	1- Nº of Falls 2- Nº of injuries resulting from falls	NURSE A set of progressive leg muscle strengthening and balance retraining and a walking plan	ankle cuffs	NO REFERENCES	46% reduction in nº of falls in IG	2-Yes 3- Yes 4- Yes 5- No 6- No 7- Yes 8-Yes 9- Yes 10-Yes 11- Yes **8/10**
Yates and Dunnagan 2001 (United States)	IG n= 18 CG n= 19 IG= 13 F; 5 M CG= 13 F; 6 M	IG= 76 y CG= 77y	RCT 10 weeks	1- Falls Efficacy Scale 2- Biceps endurance 3- Timed Up and Go 4- Scratch Test 5- Ankle dorsiflexion 6- Lower extremity power 7- Tinetti Balance Assessment	INVESTIGATOR Fall risk education MOVEMENT MATERS PROGRAMME 19 chair based exercises focusing on: -strength -coordination -balance -mobility Nutrition education	Adjustable weights	NO REFERENCES	Changes for the intervention group on balance, biceps endurance, lower extremity power, falls efficacy, reduction of environmental hazards and nutrition food behaviour	2-Yes 3- No 4- Yes 5- No 6- No 7- No 8-Yes 9- No 10-Yes 11- No **4/10**

AUTHOR (COUNTRY)	Nº OF PARTICIPANTS	AGE	PROGRAMME DESIGN AND DURATION	BASELINE ASSESSMENT	SUPERVISOR AND INTERVENTION	USING OF EQUIPMENT	ADHERENCE RATE *	INTERVENTION EFFECTS	PEdro SCALE CLASSIFICATION
Allen and Simpson 1999 (England)	N=26 No number of participants in each group	65 Years or over	RCT 24 months	1- Timed Up and Go 2- Functional Reach Forward 3- One leg Balance 4- Falls Efficacy Scale	HEALTH CARE ASSISTANT Chair based exercises Simple rhythmic movements Gentle movements in leg joints including trunk rot. and flexion Pulse-raising activities such as brisk alternate arm and leg movements Stretching exercises involving major muscle groups Resisted exercises to improve muscle strength in the knee and trunk extensors	Therabands	NO REFERENCES	No improvements	2-Yes 3- No 4- Yes 5- No 6- No 7- No 8-No 9- No 10-No 11- No **2/10**
Krebs et al. 1998 (United States)	IG n= 54 CG n= 66 IG- 35F; 19 M CG- 54F; 12 M	IG= 74.8 CG= 74.2	RCT 6 months	1- Isometric strength assessment of hip abduction, hip extension and knee extension by a dynamometer 2- Gait analysis by a kinematics system	PHYSIOTHERAPIST The “Strong for Life” programme a 35 minute videotape programme of 11 exercises for upper and lower limb muscles. Each exercise incorporate diagonal and rotational motions associated with functional movement patterns. The exercises are performed in a progressive weight-bearing sequence from prone lying to standing.	Therabands	NO REFERENCES	Mediolateral stability in gait improved and moderate strength gains were observed in the intervention group	2-Yes 3- No 4- Yes 5- No 6- No 7- Yes 8-Yes 9- No 10-Yes 11- Yes **6/10**
Chandler et al. 1998 (United States)	IG n= 50 CG n= 50	IG= 77.5 y CG= 77.7 y	RCT 10 weeks	extensors and flexors, ankle dorsi and plantar flexors strength measured by Cibex 2- FRF 3- FES 4- Six min walk test 5- mobility skills protocol to assess 13 mobility skills 6- SF 36 7- Depression Scale	PHYSIOTHERAPIST Resisted hip extension and abduction Knee flexion and extension ankle dorsi flexion Toe raises Chair rises Stair stepping	Therabands body weight	NO REFERENCES	Participants in IG had significantly greater strength gain than control group. Strength was significantly associated with gain in mobility skills performance, gait velocity and FES	2-Yes 3- No 4- Yes 5- No 6- No 7- Yes 8-Yes 9- No 10-Yes 11- Yes **6/10**

AUTHOR (COUNTRY)	Nº OF PARTICIPANTS	AGE	PROGRAMME DESIGN AND DURATION	BASELINE ASSESSMENT	SUPERVISOR AND INTERVENTION	USING OF EQUIPMENT	ADHERENCE RATE *	INTERVENTION EFFECTS	PEdro SCALE CLASSIFICATION
Campbell et al. 1997 (new Zeeland)	IG N=116 CG N=117	IG= 84.1 y CG= 84.1 y	RCT 12 months	1- Functional Reach Test 2- Four Test Balance Scale 3- Strength of knee extensor muscle on dominant side with electronic dynamometer 4- Chair Stand Test (time to perform 5 sit to stands) 5- Time to walk 2,44 m and 20 m 6- Time taken to climb up and down a set of 4 steps 7- 6 Minutes walking test	PHYSIOTHERAPIST Hip extensor and abductor muscles, knee flexors and extensors, inner range of quadriceps, dorsiflexors and plantar flexor muscles. Tandem standing; Tandem gait; Walking on toes and heels Walking backwards, sideways and turning around Stepping over an object Bending and picking up an object Stair climbing in the home Rising from a sitting position to a standing one Knee squat Active range of movement Exercises involving all the joints	Ankle cuff weights(0.5 to 1Kg)	NO REFERENCES	Reduction of the nº of falls Improvements on balance and Chair Stand Test	2-Yes 3- Yes 4- Yes 5- No 6- No 7- Yes 8-Yes 9- Yes 10-Yes 11- Yes **8/10**
Jette et al. 1996 (United States)	IG N=42 CG N=51 IG= 23F; 19 M CG= 36F; 15 M	IG= 71 y CG= 73 y	RCT 12 to 15 weeks	1- Peak Torque in knee extensors and flexors, shoulder extensors and flexors using a Cybex II isokinetic dynamometer Profile of Mood States Battery (POMS) 2- SF-36	PHYSIOTHERAPIST "Strong for Life" Programme 10 exercise routine using elastic bands 5 mn warm up, 20 mn strengthening exercises, 5 mn cool-down with music the exercises were performed in a progressive weight bearing sequence from prone lying to standing. associated with diagonal and rotational motions associated with PNF	Therabands	58%	Significant improvements in knee extension peak torque when compared with CG	2-Yes 3- No 4- Yes 5- No 6- No 7- Yes 8-Yes 9- No 10-Yes 11- Yes **6/10**
MacMurdo and Johnstone 1995 (England)	Group1- Home Strength N=25 --19F:2M G2- Home mobility EN=31 --17F;.3M Group 3- Home health Education N=30 --25F; 3M	IG1= 81.4 y IG2= 82.9 y IG3= 81.9 y	6 months	1- Timed Up and Go 2- Sit to Stand Test (lower limb strength) 3- Grip strength by dynamometer 4- Functional Reach Forward Spinal mobility (distance between finger tips and floor on spine flexion) 5- Barthel Index	PHYSIOTHERAPIST G1 and G2- initial stretching exercises of the hips, lower spine and calf. Range of movement exercises of the arms, hips, knees and ankles, hip flexion, extension and abduction exercises. G1 used therabands to do the exercises	Therabands for strength exercise programme	NO REFERENCES	NO SIGNIFICANT RESULTS This study failed to demonstrate an effect of a home exercise programme on functional outcome measures in older people.	2-Yes 3- Yes 4- Yes 5- No 6- No 7- Yes 8-No 9- No 10-Yes 11- Yes **6/10**

AUTHOR (COUNTRY)	Nº OF PARTICIPANTS	AGE	PROGRAMME DESIGN AND DURATION	BASELINE ASSESSMENT	SUPERVISOR AND INTERVENTION	USING OF EQUIPMENT	ADHERENCE RATE *	INTERVENTION EFFECTS	PEdro SCALE CLASSIFICATION
Tinetti et al. 1994 (United States)	IG n=153 CG n=148 IG= 106 F; 47 M CG= 102F; 46M	IG= 71.8 y CG= 77.5 y	RCT 4.5 months	Falls Efficacy Scale AssessMt of risk factors impairment in gait impairment in transfer skills impairment in leg or arm muscle strength or range of motion (hip, ankle, knee, shoulder, hand elbow) another risk factor as hypertension, medication, impairment in the toilet	NURSE PHYSIOTHERAPIST gait training: balance or strengthen exercises Balance exercises: training transfer skills and do environment alterations exercise with resistive bands and putty: resistance was increased when the subject was able to complete 10 repetitions through the full range of motion	resistive bands and putty	73%	there was a risk reduction associated with the intervention	2-Yes 3- No 4- Yes 5- No 6- No 7- Yes 8-Yes 9- No 10-Yes 11- Yes **6/10**

F- Female; M- Male; IG- Intervention Group; CG- Control Group; RCT- Randomised Control Trial; nº exe- number of exercise done
Adherence rate was defined as the number of exercises completed relative to each participant's schedule and calculated as a percentage: Nº of exercises performed / Nº of exercises scheduled *100

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3.2. Designing the Home Based Moderate Intensity Exercise Programme

This section describes the underpinning evidence and design a specific home based moderate intensity exercise programme focusing on lower limb strength, balance, muscle endurance and flexibility of spine and ankles, and voluntary stepping. This programme was designed without the use of any equipment and planned to measure improvement by using the movements of the specific exercises as baseline tests.

According to the results of 2001 National Census showing that 48.1% of the older women and 40% of the older men reported that the only activities undertaken in the past year were "being seated and walking very short distances, it can be said that Portuguese older people seem to have little expectation of undertaking any physical exercise. It was thought that it was appropriate to this population to design a home based moderate intensity exercise programme which was simple, and for which no equipment would be required (Jonhson et al. 2003), so that it could be undertaken in any home. It was designed to specifically address the following fall risk factors (Rubenstein et al. 2000, Alexander et al. 1997, Alexander 1994, Tinetti et al. 1994, Speechley and Tinetti 1990) (Table 3.2.).

Programme design took into account the following principles of training: specificity, progression and overload (see page 36). Specificity was assured by using, as exercises, the movements used in most of the physical tests, for example the sit to stand movement, the forward and lateral reach movement and the voluntary stepping in all directions.

Steps were taken to attempt to motivate participants by talking about the benefits of exercise, assuring them that all exercises were safe, meeting them regularly, encouraging them verbally to do the exercises regularly and continue the programme, as this is crucial for effective exercise programme adherence (Newham 2001).

The Home Exercise Programme was based on the following premises:

- to be easy and containing easily understood exercises that did not require equipment;
- to be individually tailored because older people will differ considerably in their physical capacity and health and in their response to exercise;
- to increase in difficulty, progressing in motor skills as improvements in flexibility, muscle endurance, balance and strength were achieved;
- to improve functional activities;
- To include a walking programme to increase cardiovascular endurance and balance.

Table 3.2. Fall Risk Factors considered in the home based exercise programme

Fall Risk Factors	Focus on	Exercises
Loss of Flexibility	Spine Ankle	Neck Retraction Neck Rotation Extension of thoracic spine Upper limb elevation Ankle Movements
Muscle endurance decline	Spinal muscles Ankle dorsal and plantar muscles	Neck Retraction Neck Rotation Extension of thoracic spine Upper limb elevation Ankle Movements Sit to stand
Muscle strength decline	Lower limb muscles	Sit to stand
Muscle power decline	Lower limb muscles	Sit to stand
Balance decrease	Static and dynamic balance	Sit to stand Single leg stance Reaching forward and laterally Walking
Voluntary Stepping Time decline	Lower limb muscles	Stepping forward, laterally and backwards
Decreased Gait Mobility	Dynamic balance	Ankle Movements Sit to stand Single leg stance Walking

3.2.1. Programme implementation

In Portugal the National Health System is run by the Health Ministry and comprises all the public institutions that provide health care named hospitals, local health units and health centres.

The National Health System has regional departments that are required to guarantee the local population access to health care. These regional departments are the Northern, the Central, the Lisbon, the Alentejo and the Algarve Health Regional Administrations.

Primary health care is the core of the Portuguese health system with the health centres being the institutional basis of this provision.

The Portuguese Health Plan for 2005-2009 has, amongst other areas, identified as a priority the need to promote good health in older people. As the health system is designed around health centres these were identified as the best place to implement the home based exercise programme.

The introduction of a personalised flexibility, endurance, strength, balance and voluntary stepping training exercise programme is a new concept for many older people in Portugal It was crucial that the underlying principles and benefits of retraining were understood so that participants could confidently carry out the exercises prescribed. The programme also had to meet the physical capabilities of different individuals.

3.2.2. The Home Based Moderate Intensity Exercise Programme

A booklet with all the exercises to be included and their progression was designed and is incorporated in Appendix 1.

Participants were taught to exhale during effort while doing the exercises, to prevent exercise-induced blood pressure elevations, which may happen if holding breath during the exercises (Valsava maneuver).

All the participants were given an explanation about levels of the Borg's Perceived Exertion Scale. They were told that they could progress with exercise repetitions until they felt a hard effort (between level 14 and 16 of the scale) and not reach the "very hard" (level 17 and 18 of the scale).

The exercises that comprised the home based programme as well as and their supporting evidence are described in the following pages.

EXERCISE 1 - NECK RETRACTION

Evidence	Cervicothoracic spinal curvature undergoes progressive change through the lifespan with a subsequent cranial migration accompanied by a similar shift in the cervical curve apex (Boyle et al. 2002). Cervical or neck retraction is the position where the head is maximally translated posteriorly into a position in which the head is lined up with the thorax, while the head and eyes stay level. It involves a maximum flexion of the Occiput to C2 (Penning, 1992) and extension at the lower cervical segment (C6-C7) (Ordway et al. 1999). For Edmondston and Singer (1997), during neck retraction exercises in normal participants, the thoracic kyphosis reduces slightly, possibly due to some extension and posterior translation of the upper thoracic segments. The deep cervical short flexor muscle group (Longus Capitis, Rectus Capitis Anterior and Lateralis and Longus Colli) is considered to be an important stabiliser of head-on-neck posture (Janda 1988). Poor performance of this muscle group has been associated with poor cervical resting posture and for Watson and Trott (1993) the forward head posture is related significantly to a poor, deep, short cervical flexor endurance problem. Pearson and Walmsley (1995) demonstrated that asymptomatic individuals change their resting neck posture significantly after repeated neck retractions movements, perhaps because they became more aware of their neck posture. The movement is done using a concentric contraction until the end of free range followed by a voluntary isometric contraction for the count of 10 followed by 10 counts of rest (Troisier 1984).
Target and Goal	The neck retraction exercise had the purpose of correcting neck and upper thoracic posture improving flexibility of the cervical and upper thoracic spine, stretching the ligamentum nuchae, the posterior longitudinal ligament and the spinal dura mater along with semispinalis cervicis, multi-segmental portions of the multifidus muscle (Pearson and Walmsley 1995) and to improve endurance of the flexor muscles responsible for neck retraction (Longus Capitis, Rectus Capitis Anterior and Lateralis, and Longus Colli) (Palastanga et al. 2002).

The exercise	  **A** **B** **A.** Sit on a chair with the buttocks 5 cm from the back of it, maintaining an erect sitting posture **B.** Pull the chin backwards as far as possible and hold this position for the count of 10 The movement is done using a concentric contraction until the end of free range followed by a maximal voluntary isometric contraction for 10 counts.
Repetitions	Beginning with 1 set of 10 repetitions (ACSM, 1991)
Progression	Progression consisted of increasing the number of repetitions as the perceived exertion levels reduced

EXERCISE 2 - NECK ROTATION

Evidence	The physiological alterations of muscles and joints in old persons can result in lack of flexibility of the cervical spine. Balance consists of the perfect and automatic interaction of the main systems: the visual, the vestibular and the somatosensorial. The eyes are constantly sending information to the brain about movements. The vestibular system is influenced by the visual system. It is the coordination of the vestibular and visual systems that permits the brain to recognize and interpret that the head is turning to the left or right (Guyton and Hall 2000). Neck rotation range of motion is important because of the interaction between environment and consequently to balance (Shumway-Cook and Woollacott 2001). The movement is done using a concentric contraction until the end of free range followed by a voluntary isometric contraction for the count of 10 (for flexibility) followed by 10 counts of rest (Troisier 1984).
Target and Goal	The neck rotation exercise had the purpose of improving axial cervical rotation range of motion by stretching the contralateral rotator muscles. It also developed endurance of the ipsilateral rotator muscles of the neck (Semispinalis Cervicis,

Multifidus, Scalenus Anterior, Splenius Cervicis, Sternocleidomastoid, Splenius Capitis) (Palastanga et al. 2002).

A B C D

The exercise

A. Sit on a chair with the buttocks 5 cm from the back of it, maintaining an erect sitting posture

B. Look to the right, hold this position for the count of 10, doing a maximum voluntary isometric contraction

C. Return to starting position A

Rotation to the left, hold it for the count of 10

*If the participant has vertebral artery syndrome she/he **must not** perform this exercise

Repetitions

Beginning with 1 set of 10 repetitions (Mazzeo et al. 1998, ACSM, 1991)

Progression

Progression consisted of increasing the number of repetitions as the perceived exertion levels reduced

EXERCISE 3 - EXTENSION OF THE THORACIC SPINE

Evidence

The thoracic kyphosis increases with age and postural correction is achieved largely through compensatory changes in the lumbar and cervical regions, and the shoulder girdle.

The evidence shows that the loss of spine flexibility and a consequent reduced spinal flexibility leading to an increased thoracic curve (see 1.1.3.) is particularly common in older people (Kado et al. 2005, Chow and Moffat 2004, Hirose et al. 2004, Balzini et al. 2003, Schenkman et al. 2000). The increased kyphosis make the use of normal compensatory strategies for static and dynamic balance control in older people difficult, influencing the risk of falling (Balzini et al. 2003,

	Benvenuti 2001, Sinaki et al. 1996, Norkin and Lavangie 1992, Sinaki and Offord 1988, Tinetti et al. 1988, Basmajian 1985). Participants with thoracic kyphosis show short and strong neck flexors, abducted scapulae with weakness of the middle and lower fibres of trapezius and rhomboids major and minor and strong hip flexors. Serratus anterior, pectoralis major and minor and upper fibres of trapezius will be short and strong (Howe and Oldham 2001). There is little evidence about the influence of shoulder and scapular movement on thoracic spine movement. It is hypothesised that the muscles connecting the upper limb and the spine, like trapezius (middle and lower fibres), Rhomboids, performing retraction and depression of the scapula, stretch the serratus anterior, pectoralis major and minor, contributing to correction of the kyphosis (Nordin and Frankel 2001). Severe kyphotic changes may be a problem for older people, it is important to maintain maximum range of movement, using stretching exercises of the shoulder girdle, of the thoracic and cervical spine and hips and prevent further postural changes (Sinaki, and Mikkelsen 1984). The movement used in this exercise involves an extension, external rotation and abduction of the shoulder with the contraction of supra spinatus, teres minor, middle and posterior deltoid synergists of scapula retraction muscles (Rhomboids major and minor, middle and lower fibres of trapezius). During the movement there is an active stretch of serratus anterior, pectoralis major and minor (Nordin and Frankel 2001) repeated several times contributing to muscle endurance. The movement is done using a concentric contraction until the end of free range followed by a voluntary isometric contraction for the count of 10 (for flexibility) followed by 10 counts of rest (Troisier 1984).
Target and Goal	Improve range of motion of scapula, shoulder and thoracic spine stretching serratus anterior, pectoralis major and minor and improve muscle endurance of the trapezius (middle and lower fibres) and Rhomboids major and minor to attempt and improve posture.

The exercise

A **B**

A. Sit on a chair with the buttocks 5 cm from the back of it, maintaining an erect sitting posture, with arms abducted and external rotated and hold this position for the count of 10, doing a maximum voluntary isometric contraction

B. Concentric contraction of the Rhomboids major and minor, middle and lower fibres of trapezius

Sustained contraction during 10 counts at the end of the range, doing an isometric contraction.

Repetitions

Beginning with 1 set of 10 repetitions (ACSM, 1991)

Increase 5 repetitions as perceived exertion permits

Progression

Progression consisted of increasing the number of repetitions as the perceived exertion levels reduced. Also modification of the initial position to standing against a wall pushing against it.

Standing against a wall pushing it with the shoulders

Exercise 4 - Upper Limb Elevation

Evidence

Shoulder range of motion normally decreases as part of the aging process (Nordin and Frankel 2001). In addition either reduced thoracic mobility or an increased thoracic kyphosis may directly contribute to a lack of potential for full range of arm elevation (Hollingshead and Jenkins, 1981).

According to Magee (2007) thoracic extension has an active range of motion of 25-45º. Bilateral arm elevation is associated with thoracic and lumbar extension and Crawford and Jull (1993) advocate approximately 15º of thoracic extension is associated with full bilateral arm elevation, regardless of the age of the subject.

Back extensor strength is an important determinant of posture in healthy women, the stronger they are, the smaller the thoracic kyphosis and the larger the lumbar lordosis and sacral inclination. (Sinaki 1996, Itoi and Sinaki 1994).

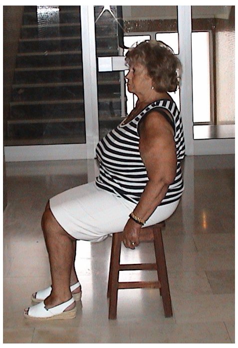
The movement of this exercise comprised upper limb elevation involving the anterior fibres of the deltoid, coraco-brachialis and the clavicular fibres of pectoralis major muscles (from 0º to 60º). Between 60º and 120º of flexion the shoulder girdle participates, with 60º rotation of the scapula and an axial rotation at the sterno-clavicular and acromion-clavicular joints with a contraction of trapezius and serratus anterior. From 120º to 180º the total flexion is accomplished by means of the spinal extensors muscles.

The movement is done using a concentric contraction until the end of free range followed by a voluntary isometric contraction for the count of 10 (for flexibility) followed by 10 counts of rest (Troisier 1984).

Target and Goal

Improve range shoulder flexion and extension of the thoracic spine, stretch shoulder extensor muscles and improve muscle endurance of shoulder flexors and back extensors.

The exercise



A

B

A. Sit on a chair with the buttocks 5 cm from the back of it or a stool, maintaining an erect sitting posture, with arms alongside.

B. Arm elevation until end of free range holding this position for the count of 10, doing a maximum voluntary isometric contraction

Sustained contraction during 10 counts at the end of the range doing an isometric contraction.

Repetitions

Beginning with 1 set of 10 repetitions (ACSM, 1991)

Increase 5 repetitions as perceived exertion permits

Progression

Progression consisted on increasing the number of repetitions based on the perceived exertion

Modification of the initial position to standing against a wall trying to touch the wall with the arms

Initial Position **End Position**

EXERCISE 5 - ANKLE MOVEMENTS

Evidence

There is a decrease in active ankle dorsiflexion and plantar flexion with age in men and women. As the ankle must rotate into substantial dorsiflexion during activities such as stair climbing and walking, loss of dorsiflexion flexibility in aging may predispose the older people to accidental falls (Mecagni et al. 2000, Saltzman and Nawoczenski 1995).

On the other hand active forces responsible for dorsiflexion (tibialis anterior and extensor digitorum longus) and for plantar flexion (Triceps surae) decrease with increasing age, resulting in less strength available to perform the movement. In addition the ligaments the capsule apparatus and articular cartilage are becoming stiffer and changed with ageing, allowing less movement in the joints (Nigg et al. 1992). Loss of strength and movement is a risk factor for falls.

The movements done in this exercise comprise a dorsi flexor concentric contraction until the end of free range followed by a voluntary isometric contraction for the count of 10 (for flexibility) followed for the count of 10 of rest and a plantar flexor concentric contraction for the count of 10 followed for the count of 10 of rest (Troisier 1984).

Target and Goal

Improve active range of motion of the ankle joint, stretching triceps surae when doing active dorsiflexion and tibialis anterior and extensor digitorum longus when doing an active plantar flexion, and improve their endurance and strength.

The exercise

A B C

A. Sit on a chair with the buttocks 5 cm from the back of it or a stool, maintaining an erect sitting posture with the feet resting on the floor

B. Active dorsiflexion and hold this position for the count of 10, doing an isometric contraction

C. Active plantar flexion and hold this position for the count of 10, doing an isometric contraction

Sustained contraction during 10 counts at the end of the range, doing an isometric contraction

Repetitions

Beginning with 1 set of 10 repetitions (ACSM, 1991)

Increase 5 repetitions each time based on each subject's perceived exertion

Progression

Progression consisted on increasing the number of repetitions based on the perceived exertion levels

Modification of the initial position to seating at the edge of the chair after the first 3 months

A B

	A. Sitting on the edge of the chair and take the feet as far as possible under the chair, without taking the heels off. **B.** Sitting on the edge of the chair full extend the knees and try to pull the feet onto the floor.

EXERCISE 6 - SIT TO STAND

Evidence	The sit-to-stand movement, one of the most common functional tasks of daily living, is also one of the most mechanically demanding manoeuvres. Studies have shown that rising from a chair creates greater torques about the knee joint and higher pressures at the hip joint than activities such as walking and stair-climbing (Gross et al. 1998, Riley et al. 1991). Rising from a chair requires specific sequential coordination and positioning of joints and body segments so that the balance needed to successfully complete the movement is maintained (Bahrami et al. 2000). •Lower extremity strength and postural control are both important contributors to successful rise from a chair (Gross et al. 1998, Alexander et al. 1997, Ikeda et al. 1991). In fact Alexander et al. 1997 found that lower limb strength was one of the factors that best predicted whether a subject was able or unable to complete the chair rise task. Low quadriceps femoris muscle force will affect the performance of the Sit to Stand movement, and the time to complete the movement will increase (Corrigan and Bohannon 2000, Scarborough et al. 1999, Gross et al. 1998, Alexander et al. 1997, Hughes et al. 1996). Alexander et al. (1994) and Fiatarone et al. (1990) reported good results from a progressive training programme of rising from a chair in older adults.
Target and Goal	Improve strength of lower limb muscles and balance

The exercise

A
Initial position

B
Final position

Repetitions

Baseline number of repetitions of Sit to Stand movement was tailored to each subject and calculated using the Target Heart Rate (THR) (ACSM, 1991). The height of the chair, 42 cm, was used for all the participants. The baseline number of Sit to Stand movements was the number of manoeuvres needed to reach THR.

Progression

Participants had to do increments of 10 repetitions based on the perceived exertion of each subject.

After 3 months of retraining the number of repetitions was recalculated and the height of seat was decreased 5 cm. Whilst there is no research to support a reduction in seat height as a progression of this exercise, simple biomechanical calculations show that the knee extension moment increases with decreasing chair height (Rodosky et al. 1989).

When the subject could perform the required number of repetitions with little exertion, the Sit to Stand Movement was changed by performing a rapid concentric contraction of knee extensors when standing (for power retraining). Evans (2000) states that increasing muscle power in older people should be seen as a very high priority. This quick standing was followed by a slow sitting (counting until 5 to sit) in order to retrain eccentric contraction of knee extensors. Winter (1991) states the preservation of eccentric capabilities of the knee extensors is functionally useful particularly in gait and descending stairs or slopes.

EXERCISE 7 - SINGLE LEG STANCE

Evidence	Single leg stance occurs frequently within many activities of daily living such as dressing, turning, walking and climbing stairs. Postural instability increases during single-leg stance, as a result of the required reorganization of the centre of gravity over a short and narrow base of support. (Riemann et al. 2003). Hertel et al. (2002) states that during single leg stance control of upright posture is accomplished largely through corrective movements at the ankle joint. Hoogvliet et al. (1997) described 2 frontal plane strategies for fixed surface, single-leg stance: the first, the foot-tilt strategy, refers to the tilting movements of the foot resulting from movements of the subtalar joint; the second the hip strategy, coincides with the previously described hip strategy (Horak and Nasher 1986), with the exception that it occurs in the frontal plane. Similar observations of hip strategy during single-leg stance, under identical support surface conditions, were made by Tropp and Odenrick (1988) in their comparison of normal participants and patients with functionally unstable ankles. Jonsson et al. (2004) revealed age-related changes in postural control during one leg stance. Older people presented difficulties in maintaining a one leg static position, because of an inability to compensate for the postural disturbance caused by the weight shift, and because of muscle weakness. The first 5 seconds are crucial for one leg stance.
Target and Goal	Improve steadiness in single leg stance
The exercise	 **One Leg Standing**
Repetitions	Beginning with 10 seconds in one leg standing

Progression	The progression of this exercise consisted of increasing the period of time in one leg standing until a count of 30 can be achieved. Further progression involved performing a second task when in one leg standing. Older people may be unable to walk and simultaneously talk or carry objects without prejudicing their balance (Lundin-Olsson et al. 1997). Balance requires adequate sensory input, efficient central processing and a strong effector system of muscles and joints with the purpose of facing the biomechanical challenges of task and environment, (Horak et al. 1989). A dual-task paradigm is a process that requires an individual to perform two tasks simultaneously. When performance is lower when they are done simultaneously compared to separately, it is thought that the two tasks are interfering with each other. It is assumed that both tasks compete for the same information processing resources in the brain. (Huxman et al. 2001). The second task insert in this exercise was counting from 30 to 0 or singing, or talking to another person etc. When the subject could perform 30 seconds one leg stance doing a second task the progression consisted of performing the exercise with closed eyes as peripheral visual information about limb position is very important for balance (Patla 1997). This final exercise was only permitted in the presence of another person in order to avoid the danger of a fall.

EXERCISE 8 - REACHING FORWARD AND LATERALLY

Evidence	Dynamic balance is the ability to predict changes and synchronize muscle activity in response to stability perturbations. Dynamic balance is used during forward, sideways, and backward leaning (Rogers et al. 2003). The ability to control intentional movements of the centre of gravity when leaning forward is critical to the successful performance of various functional tasks associated with activities of daily living (ADL) in older people (Topp et al. 1998). As 30-70% of all falls in older people are due to slips, trips and misplaced footing dynamic balance is likely to be of prime importance. Duncan et al. 1990 developed the Functional Reach Test, which assesses limits of stability by measuring the maximum distance an individual can reach forward while standing in a fixed position. Maki et al. (1994) identified medial-lateral postural stability as being a significant factor in identifying older people individuals at risk for falling. As a result, Brauer et al. (1999) developed a clinical measure similar to the functional reach test,

the lateral reach test, which assesses limits of lateral stability.

Functional Reach Forward and Lateral were used as exercises in this Programme based on the principle of exercise specificity as training programmes should be tailored to target balance systems (Page 2003, Rogers et al. 2003).

Target and Goal

Improve limits of forward and lateral stability

The exercise

A
Forward Reach

B
Lateral Reach

Repetitions

Sets of ten repetitions were used for each arm (University of Otago 2002)

Progression

Like other types of exercise, balance training should progressively overload the physiological systems, becoming more challenging (Page 2003, Rogers et al. 2003).

The overload chosen for this exercise was to increase the distance between the subject and the wall so as to cause an increased displacement of the whole body (Kaminiski and Simpkins 2001).

EXERCISE 9 - STEPPING FORWARD, LATERALLY AND BACKWARDS

Evidence

The recovery of balance after a trip requires the sensation of a loss of balance, the planning of a recovery strategy and the execution of compensatory stepping by the musculoskeletal system. Successful balance recovery, by means of stepping, requires rapid and accurate control of lower limb movement and control of centre of mass motion in such a way as to maintain the centre of mass within the boundaries of a new base of support established by the step (Maki 1999).

Therefore age related changes in sensory performance, motor control, muscular strength and flexibility could all affect abilities to regain balance (Thelen et al. 2000). Compensatory stepping appears to be a prevalent strategy to preserve stability even when the perturbation is relatively small; however the control of these reactions is complex and may well challenge the capacity of older adults (Maki et al. 2000).

There is a strong relationship between the stepping performance (measured by maximal step length) and balance (measured by unipedal stance time and tandem walk) with a pearson product moment respectively of 0.84 and 0.76 as discussed earlier (see page 72). Voluntary stepping performance has some similarity to involuntary step responses to an external postural perturbation (Medell and Alexander 2000).

Brauer and Burns (2002) demonstrated that older adults have a greater delay in postural muscle activation than young adults during voluntary movements, in addition to a further delay in muscle activation due to lack of preparedness to move and to effectively step, postural muscles must be active at the appropriate time and with appropriate force.

Target and Goal

Improve performance and increase the speed of the forward, lateral and backwards stepping in order "to react" better to imbalance.

The exercise

A
Stepping Forward

B
Stepping laterally

C
Stepping Backwards

Repetitions

Baseline number of repetitions of the Stepping Exercise were tailored to each subject and calculated as the number of repetitions in 30 seconds. This was done for both feet and in all directions. The subject was encouraged to increase the repetitions in the same amount of time.

Progression

After 3 months of retraining the number of repetitions was recalculated. The subject was encouraged to increase the repetitions in the same amount of time.

EXERCISE 10 - WALKING

Evidence	Cross sectional studies indicate that gait speed declines at a rate of 12 to 16% per decade after the age of 60. In addition reduced walking velocity has been identified as a risk factor for falls (Hinman et al. 1998, Campbell et al. 1989). This Home Based Programme recommended walking as an exercise as it is the best cardiovascular endurance exercise for older people (ACSM, 1991).
Target and Goal	To improve cardio respiratory endurance
The exercise	The exercise consisted of walking with comfortable shoes at a usual pace.
Repetitions	It was suggested to begin with 30 minutes of walking
Progression	It was advised to do increments of 10 minutes every week. When completing 60 minutes of walking at a usual pace, velocity was increased.

3.2.3. Starting the exercise programme

At the beginning of this study (2003) the researcher presented an ethical approval request to the regional health administration that supervise all the health centers. As there was no ethical committee there the researcher was advised to seek ethical approval from Hospital de S. João where there was an ethical department. The researcher is still waiting for an answer, nevertheless ethical approval was obtained from the health centre ethics committee.

All the participants of the intervention and control groups were contacted by phone for a first appointment in the Health Center. On their first attendance the participants had their baseline measurements taken (physical tests and self-reported scales and questionnaires), met the researcher and steps were taken to establish a good working relationship. Factors that could modify the programme were assessed and then the exercise programme was started. This first session lasted more or less an hour.

The researcher took participants through the exercises ensuring that they were safe and confident with each one and could understand the aims of each exercise. An exercise booklet (with the instructor's contact telephone number) and/or a DVD/VHS were delivered to the participants, with additional notes for some of the exercises.

Where possible, family members (wives/husbands) were involved in the programme; this being an effective way of encouraging participation, particularly for more frail people (Mills et al. 1996).

More details about recruitment and procedures will be found in chapter five.

3.2.4. Dosage, duration and frequency of the Programme

The number of repetitions (ten) chosen for the first five exercises in the present study, were based on the training principles targeting improvements in local muscular endurance and muscle strength defended by Kisner and Colby (2002), Newham (2001), Pollock et al. (1998) and Mazzeo et al. (1998b) (see page 52). The researcher decided to reduce the initial recommended number of repetitions (>15) taking into account the sedentarism of the participants and the need to preserve adherence to the programme, as too many repetitions at the beginning of an unknown exercise programme may not be interesting for older people.

According to Pollock et al. (1998) the recommended frequency of exercise for older people varies from daily sessions, to 3 to 5 periods per week according to the needs, interest and functional capacity of the participants.

In the literature reviewed, the duration of home based exercise programmes was between 2.5 and 24 months. No relationship was identified between duration and significance of improvements. In the current home based programme it was decided to implement the programme for 9 months as most of the sixteen home-based exercise programmes reviewed were more than six months in duration.

The participants were advised to do the exercises seven days a week, for nine months; as it was hoped this would set up a routine of exercising every day and ensure responsibility and continuation in the programme's exercises.

Weekly log books with date and a list of the exercises performed were distributed to each participant so that they could record their activity. Three and nine months after the beginning of the programme, coinciding with the reassessments, the log books were collected in by the researcher.

3.2.5. Follow up visits

Follow up visits with the researcher took place every month to monitor adherence to the programme, to ensure that the exercises were being performed correctly and motivate the participants to continue to do the exercises. A major follow up every 3 months was used for reassessment and to increase the difficulty of the exercises.

3.2.6. Pilot studies

Two pilot studies were done. The first to validate a stepping test was designed by the researcher and performed in younger people. The second pilot study was performed with a sample of older people to be assured that the proposed measurement tools were reliable.

CHAPTER 4

PILOT STUDIES

This chapter contains a description of a pilot study to validate a stepping test designed by the researcher. The nature and procedures of all the other tests had already been validated and the results published so they were thought acceptable to be used without any changes.

An intrarater reliability study of all the tests was performed in a sample of older people, in order to test the degree of stability exhibited when each measurement was repeated under identical conditions by the same rater.

All the exercises in this home based exercise programme were designed to take into account the falls risk factors, and outcome measures for each risk factor are shown in Table 4.1.

Table 4.1. Outcome measures used for each Fall Risk Factor

Fall Risk Factors	Focus on	Outcome Measure
Loss of Flexibility	Ankle Spine	Ankle range of motion using an electrogoniometer Spinal curve using a flexicurve
Muscle endurance decline	Spinal muscles Ankle dorsal and plantar muscles	Not measured
Muscle strength decline	Lower limb muscles	Sit to Stand Test
Muscle power decline	Lower limb muscles	Sit to Stand Test
Balance decrease	Static balance Dynamic balance	Sit to Stand Test Functional Reach Forward and Laterally Timed Up and Go
Voluntary Stepping Time decline	Lower limb muscles	Stepping Test using a photoelectric system
Decreased Gait Mobility	Dynamic balance	Timed Up and Go

As the stepping test using a photoelectric cell system to measure the time taken to undertake voluntary stepping was designed by the researcher, and had never been used before, it had to be piloted in order to determine reliability and to avoid any bias in the measurements.

As the study was longitudinal, involving repeated measurements by the same rater only an intrarater reliability study was performed in a sample of older people recruited from the population of the health center, in order to test the consistency of the measurements.

4.1. Voluntary Stepping Pilot Study

For safety reasons it was not possible to train involuntary stepping reactions but Brauer and Burns (2002) note that older adults should be able to activate their muscles at the appropriate time and with appropriate force in order to prevent falls, and this can be achieved by training voluntary stepping. To measure the effect of a voluntary stepping exercise it was decided to measure the time taken for a fast voluntary step (forwards, to the side and backwards).

There is little evidence about practical devices to measure the time of stepping in older people. The literature mentions switches to press with the foot at a verbal or a light signal, stepping onto a surface (on same or upper level) with a switch embedded in an inflexible surface (Brauer et al. 2000), or a mat with two switches inside and a clock to measure the time. These devices were not feasible with the design of the study. The researcher devised a system using a touch pad, a timer and two photoelectric cells with two tripods in order to time the stepping (Brower Timing Systems, Speed Trap 2). The resolution of the timer (the smallest time interval that the device could measure) was related to the number of digits on the device's display. The timer display used in the present study displayed data to two decimal points. This resolution of 0.01s (10 ms) was considered sufficiently accurate to measure stepping time (Gust et al. 2004). This timing system was completely wireless (radio controlled) and portable (Figure 4.1.).

Figure 4.1. Photoelectric cells system (Brower Timing Systems, *Speed Trap 2)*

4.1.1. Participants

As a result of a meeting that the researcher had with all the third year students, thirty Physiotherapy students (21 females and 9 males) of the Physiotherapy Course of the Escola Superior de Tecnologia da Saúde in Oporto, volunteered, in, to take part in this pilot study. It was considered a convenience sample.

They had a mean age of 19.7 (±1.28), a mean weight 61.9 (± 9.21) kg, a mean height of (169cm) and 83.3% were not physically active.

4.1.2. Procedures

For Forward Stepping the subject stood in front of a horizontal tape placed on the floor. The tape was 60 cm long (first line), and 5 cm wide. A touch pad was incorporated into the tape and the participants' right foot rested on the touch pad. At this moment timing system was set at 0.

A second tape, also 60 cm long, parallel and 35cm in front of the first was marked on the floor. At its ends there were two photoelectric cells that, as soon as the foot reached this line, it calibrated the time taken to go from the 1st to the 2nd line.

The distance between the two tapes (35cm) was calculated on the values of maximal rapid step length performed by younger people (mean age of 21 years) in a study done by Medell and Alexander (2000). Their mean value was

109 cm, and this was reduced to less than half in order to preserve balance. Even so participants revealed lost of balance. The distance was decreased by trial and error until the ideal distance – 35cm was found. The same length was used to perform stepping in all directions.

At a verbal command the subject moved his/her right foot, as fast as possible, crossing the second line (forward movement) (Figure 4.2.). The movement was performed 4 times, following Medell and Alexander's (2000) protocol in order to reduce intra subject variability. This movement was repeated with the left foot. The best three measures were taken.

Figure 4.2. Photoelectrical system to measure Forward Stepping time

For Lateral Stepping the participants stood sideways to the first line position, with the left foot on the switch. At a verbal signal they moved their left foot, as fast as possible, to cross the second line (lateral movement) (Figure 4.3.). The movement was performed 4 times with both lower limbs. The best three measures were taken.

Figure 4.3. Photoelectrical system to measure Lateral Stepping time

For Backward Stepping subjects stood with their backs to the first line, with the right heel on the switch and at a verbal signal moved the right foot, as fast as possible, to cross the second line (backward movement) (Figure 4.4).The movement was performed 4 times with both lower limb. The best three measures were taken.

For intrarater reliability the procedures in all directions were repeated after 36 hours.

Figure 4.4. Photoelectrical system to measure Backwards Stepping time

4.1.3. Ethics

All the thirty physiotherapy students signed an informed consent sheet according to the Declaration of Helsinki to participate in the study. The school gave a blanket ethical approval for students to take part in research as part of their education (see appendix 9 for consent forms).

4.1.4. Statistics

The intrarater reliability was calculated using an Intraclass correlation coefficient (ICC). $ICC_{3,1}$ was the most appropriate ICC model for the experimental design used in this study, as it used an average of three measurements and a single rater (Shrout and Fleiss 1979).

The standard error of measurement (SEM) is a statistical procedure that serves as a precision indicator of a test. It is an estimate of error used in interpreting an individual's test score that is an estimate of a person's "true" test performance.

The standard error of measurement (SEM) was calculated for all reliability coefficients and is a facet of the reliability of the measurement. The interpretation of SEM is dependant on the type of reliability coefficient. As the type of reliability was based on test-retest reliability (ICC[3,1]), then the SEM is indicative of the range of error scores that can be expected on retesting (Harris et al. 2005).

Using the reliability coefficient and the test's standard deviation, this value can be calculated:

$$SEM = \sqrt{\sigma^2(1-\rho)}$$

σ = the error standard deviation

ρ = the reliability coefficient

The smaller the standard error of measurement, the greater the accuracy of the test scores (Portney and Watkins 1993).

To evaluate ICC values Fleiss (1986) criteria were used:

- 0.76-0.99 = Excellent reliability
- 0.41-0.75 = Fair to good reliability
- ≤ 0.40 = Poor reliability

4.1.5. Pilot test intrarater reliability results

Stepping in all directions revealed excellent intrarater reliability with $ICC_{3,1}$ with values between 0.90 and 0.94 (Table 4.2.).

The standard errors of measurement were between 0.008 and 0.013.

Table 4.2. Mean values, intraclass coefficient and standard error of measure of Stepping

Stepping*(Seconds)*	**Mean ± SD**	**F**	**p**	**ICC**	**95%CI of ICC**	**SEM**
Forward Right Foot	0.22± 0.05	21.2	0.001	0.90	0.84-0.95	0.008
Forward Left Foot	0.24± 0.01	14.0	0.001	0.91	0.84-0.95	0.011
Backwards Right Foot	0.40± 0.06	20.6	0.001	0.94	0.90-0.97	0.012
Backwards Left Foot	0.40± 0.07	11.2	0.001	0.94	0.90-0.97	0.013
Laterally Right Foot	0.31± 0.06	6.2	0.001	0.94	0.89-0.97	0.011
Laterally Left Foot	0.31± 0.06	11.7	0.001	0.92	0.87-0.96	0.010

4.1.6. Discussion and Conclusion

As a possible clinical measure of fall risk, the reliability of the stepping test as a measure of protective balance response was studied.

The stepping test was quickly understood by the participants, the device was easily assembled and shown to be a feasible test that could be performed easily anywhere.

According to Fleiss (1986) intrarater reliability of the voluntary step test measurements were shown to be excellent. These results are better than those achieved by Medell and Alexander (2000) in their study that measured the rapid voluntary step time from younger and older people (ICC from 0.80-0.91).

The values found in the reliability study showed that the device yielded equivalent results when used by the same rater on different occasions. In fact it presents a band of high values with 95% confidence contains the true reliability (Valentine and Lewis 2006).

To be clinically meaningful, voluntary stepping test reliability statistics need to include a combination of intraclass correlation coefficients, their 95% confidence intervals and standard error of measurement.

It is important for researchers to understand the amount of error associated with voluntary stepping test measurements measured by the standard error of measurement. In the present study the standard error of measurement was small (between 0.008 and 0.01 in milliseconds) for the same rater.

As the intention was to use this device with an older population it was decided to decrease the distance between the two lines to 30 cm, as the maximal rapid step in older people (mean age 69 years) was said to be 83% of the younger people's value (Medell and Alexander 2000).

Verbal command in spite of being more clinically applicable could be a source of error, although participants in the present study had no significant hearing or cognitive deficits, the speed of the verbal stimuli can vary, influencing the response of the participants. This measuring system was then subjected to an intrarater reliability study in a sample of older people in order that it could be used in the main study as an outcome measure.

4.2. Intrarater Reliability of the Physical Tests

In order to measure the efficacy of the home based moderate intensity specific exercise programme for older people on fall risk factors, it was necessary to be assured that the proposed measurement tools were reliable and acceptable for the target population in which the tools would be used. To accomplish this purpose it was decided to undertake a pilot study in a sample of older people.

For ease of exposition, a structured diagram illustrating the preliminary study undertaken for each measurement is displayed below (Figure 4.5.).

As the longitudinal study involved repeated measurements by the same rater, the Intrarater Reliability and the Standard Error of Measurement were tested.

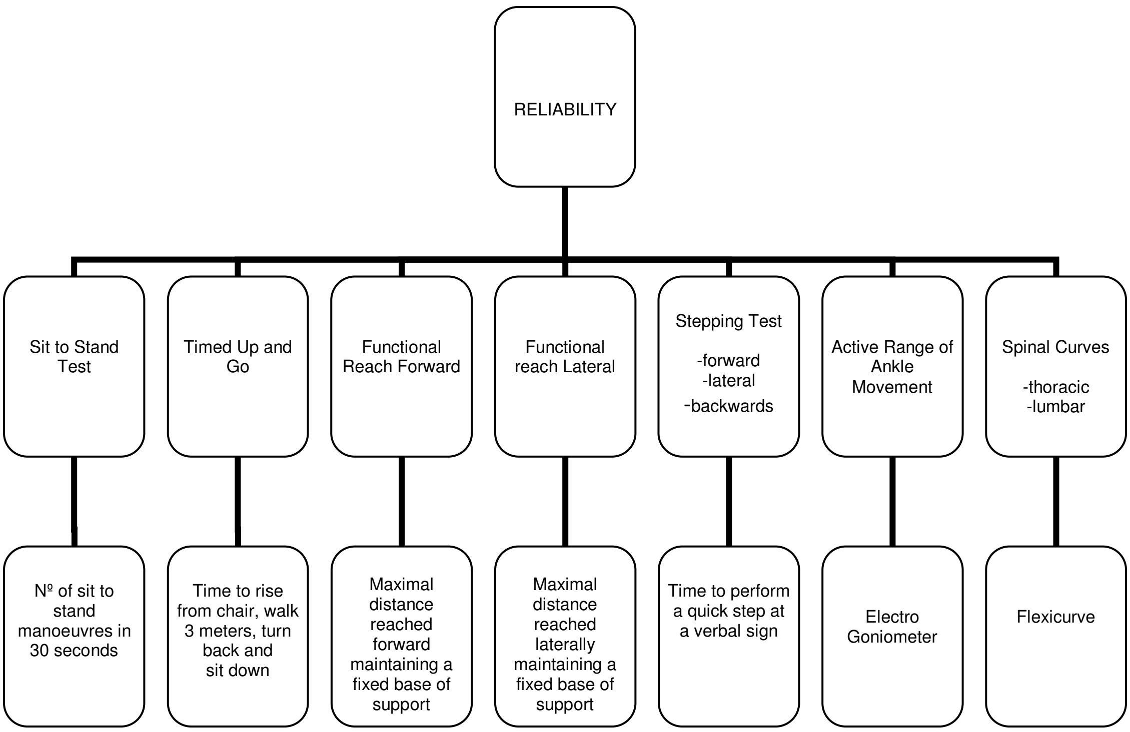


Figure 4.5. A structured diagram illustrating the preliminary study undertaken for each measurement

4.2.1. Participants

A pilot study to test the intrarater reliability of the instruments was performed with 12 participants, six females and six males, with a mean age of 70.3 years (±4.3), a mean weight of 73.8 Kg (±12.2) and a mean height of 1.67 meters (±0.04) were randomly selected from the Health Centre older population. The randomisation was done using the health center clients' code numbers. The first six females and males that had the number two in their code number were recruited for the pilot study by phone. All twelve participants immediately agreed to participate in the pilot study.

The inclusion criteria required the participants to be between 65 to 84 years old, not participating in the main research programme, functionally independent in the community, and not using walking aids. Excluded were people with lower extremity amputation, neurological disease, severe musculoskeletal disease, unstable cardiovascular disease and blindness.

There were no physical test scores statistical differences between gender at the first trial of the pilot study confirming the homogeneity of the sample.

The retest was performed 72 hours after the first trial, in the same physical and environmental conditions.

4.2.2. Methods

4.2.2.1. Sit to Stand Test (STS)

The 30 second STS test provides a valid indicator of lower limb strength in older people (Jones et al. 1999). It involves recording the number of sit and stand manoeuvres an individual can complete in 30 seconds.

The seat height was calculated using 120% of the knee height (defined as the length between the lateral condyle of the femur and the floor) (Weiner et al. 1993). A height-adjustable stool was used to ensure the correct height for each subject.

The length of the leg of each barefoot subject was measured in sitting, from the external condyle of the femur vertically to the floor. The length was recorded and then 120% of that length was calculated, and the seat height was adjusted for each subject (Weiner et al. 1993).

Participants were seated on an adjustable stool, with their trunk vertical and with the seat horizontal, used comfortable flat shoes, and their feet were in their preferred position (Stevens et al. 1989).

The use of the upper extremities was restricted by asking the participants to fold their arms.

Participants were asked to rise from the chair at their normal speed, at a verbal signal (GO) given by the researcher, and then sit down. This manoeuvre was repeated for 30 seconds and the number of complete manoeuvres was recorded.

Only activities including standing with the knees in a completely extended position and returning to sitting counted as one complete movement, confirmed by the researcher.

The 30 second duration of the test was measured with a stop-watch and timing commenced at the instant of lift-off from the chair, as soon as buttocks lifted off.

No encouragement was given during the test but at the end of the test participants were rewarded with a verbal “Well done”.

Before the trial, participants performed five stand-to-sit movements, in order to warm up and to resolve any misunderstandings about the activity.

Each subject performed three trials (with 2 minutes of rest between each) of the sit to stand manoeuvre, and the highest score of the three trials was recorded as the final score, evidencing the best performance.

4.2.2.2. Timed Up and Go (TUG)

TUG is a measure of self selected gait speed, which measures balance and gait manoeuvres used in everyday life – it is a functional mobility test (Podsiadlo and Richardson 1991). This test consisted of one multiphase task in which the participants began seated in an armchair. They were asked to rise, walk 3 meters at their own pace, turn, return to the chair and sit down. A score higher than 20 seconds indicates functional-mobility impairment (Lazowski et al. 1999, Podsiadlo and Richardson 1991).

Timed Up and Go was measured using a standard armchair (seat height 44cm) (Siggeirsdóttir et al. 2002). A line was marked on the floor to ensure that the armchair was always in the same initial position. Participants were encouraged to wear their usual footwear. A second line, 3 meters away from the first one, was marked on the floor.

The participants were instructed to rise from the chair, walk to the second line, at their own pace, turn around, return to the chair and sit back down.

The time was registered in seconds, with the timer used with the photoelectric cells device, from the moment the subject's buttocks lifted from the seat until the buttocks retouched the chair, confirmed visually by the researcher.

After a practice walk, 3 trials were timed, of which the shortest timed trial (best performance) was recorded as the final score.

4.2.2.3. Functional Reach Test (FRT)

Functional Reach was defined by Duncan et al. (1990) as the maximal distance one can reach forward beyond arm's length, while maintaining a fixed base of support in the standing position. It is a clinical measure of the margin of anterior stability that is related conceptually to the centre of pressure.

Functional Reach Test was calculated using a horizontal measuring tape fixed to the wall at the height of the acromion of the dominant limb. The participants were asked to stand sideways to the wall with the dominant limb next to, but not touching the wall. Flat shoes were worn. In order to maintain identical foot position during each test a line was drawn on the floor and the participants were asked to start with their toes against the line, and feet comfortably apart.

Participants were asked to make a fist and flex the shoulder joint of the dominant limb to 90º. The position of the 3rd metacarpal head in relation to the measuring tape was recorded (1st position). Then they had to reach forward as far as possible, in a plane parallel with the measuring tape, making a movement in the sagittal plane, not touching the wall, and without raising the heels or taking a step. The position of the 3rd metacarpal was then recorded (2nd position). Participants were allowed 2 practice trials and the data of the next 3 trials were registered. If the subject touched the wall or took a step the trial was repeated. During the test a research assistant was near the subject in case of loss of balance.

Functional reach was considered to be the difference between position 1 and position 2. The mean of the 3 trials was used.

4.2.2.4. Functional Reach Laterally (FRL)

Functional Reach Laterally (FRL) (Brauer et al. 1999) is a clinical test that reflects the ability to move to the lateral limits of stability.

The same device used for measuring Functional Reach was used to measure the Lateral Reach.

The participants stood with their backs to the wall (not in contact), with the measuring tape at the level of the scapula spine. Feet were placed comfortably apart. In order to maintain the same initial position the foot on the same side as the dominant arm was aligned with a line on the floor.

To ensure accurate recording of the initial hand position, participants stood for 10 seconds with both arms abducted to 90º and making a fist, maintaining equal weight bearing. The position of the head of the 3rd metacarpal was registered (1st Position).

Participants were given standardized instructions and encouragement to reach directly sideway, with the dominant arm, as far as possible without over balancing, taking a step, rotating the trunk, flexing the knees or touching the wall. The position of the 3rd metacarpal was registered (2nd position). The contra lateral arm remained by their side during the reach.

Participants were allowed two practice 2 trials and the data of the next 3 trials were registered.

Lateral Reach was considered to be the difference between position 1 and position 2. The mean of the 3 trials was used.

4.2.2.5. Stepping Test (ST)

A 60cm horizontal tape placed on the floor (first line), on the tape was a touch pad. The subject stood with one foot on the pad. A second line of the same length and parallel to the first, but at a distance of 30 cm was marked on the floor, and not of 35 cm as used in the stepping pilot test with younger people. The decision to decrease by 5 cm was made in order to avoid any loss of balance in the older participants. At each end of this line was a photoelectric cell. Each subject performed a forwards, lateral and backwards rapid step with both feet at a verbal signal, crossing the second line, working within their capabilities in any all directions (Figure 4.6.).

Figure 4.6. Circuit of photoelectric cells to measure the time of a quick forward stepping

This test measured the time taken to perform a quick step in three directions (forwards, laterally, and backwards) at a verbal sign.

In the standing position, each subject had both feet on a 60 cm horizontal tape placed on the floor; the touch pad of the photoelectric device was inserted in this line. The participants started with one foot on the touch pad and the subjects were instructed by the researcher to step as fast as possible in a given direction to touch a second line on the floor, 30 cm apart from the first one, and to transfer their weight on it. Embedded in this second line were two photoelectric cells and these recorded the time taken to complete the voluntary step. The participants then returned to the initial starting position.

Following a set of practice steps (four steps in each direction) both legs were tested in a series of randomly ordered directions, four steps for each leg in each direction (24 repetitions). An error was defined as a) loss of balance, b) failure to return to initial position, c) multiple steps and d) non-compliance with direction or side. The best three measures were taken.

The time was registered by a "timer" connected to the photoelectric cell system.

4.2.2.6. Active Range of Ankle Movement (AROM)

Measurements of active range of movement (ROM) of the ankle (dorsi and plantar flexion) were taken using an ankle specific electrogoniometer (Biometrics Ltd) (Figure 4.7).

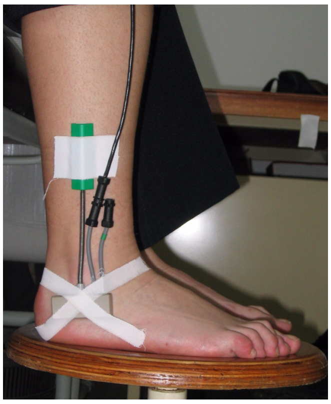


Figure 4.7. The position of the ankle specific Electrogoniometer (Biometrics Ltd).

The subject sat on a high stool, barefoot, with the feet supported on a flat surface. One sensor of the flexible electrogoniometer was positioned under the lateral aspect of the external malleolus, and then attached to the skin with tape. The other sensor was attached with tape, perpendicular to the first one, between the fibular head and the external malleolus. The flat surface was then removed, in order to have the feet free of any contact. The electrogoniometer was calibrated at 0 in a relaxed position, away from the flat surface.

Then the subject was asked to “pull the foot upwards as far as you can, and hold it there” for dorsiflexion measurement and then asked to relax. Two practice movements were done, and the mean of three trials was used.

For the measurement of plantar flexion they were instructed “to push the toes downwards to the floor, as far as you can, and hold it there”. This was the same procedure as for dorsiflexion. The mean of the 3 trials was used.

The active integral ROM of the ankle was calculated by adding the measurements of dorsiflexion to plantar flexion.

4.2.2.7. Thoracic and Lumbar Curves

The flexicurve was used to measure the spine as it is reported as a clinically feasible, non-invasive tool central to the assessment of thoracic kyphosis and lumbar lordosis (Lundon et al. 1998).

Consisting of a strip of lead covered with plastic, typically 60 cm in length, which can be bent in one plane, the flexicurve is designed to retain the shape to which is moulded (Milne and Williams, 1983) (Figure 4.8.).

Figure 4.8. Flexicurve used for measurement of the spinal curves

Spinal configuration was quantified for the thoracic and lumbar curves, in standing, using the flexicurve. The subject stood barefoot with the weight equally distributed between both feet, with both arms and shoulder girdle relaxed. The spine was fully exposed, and the midpoint of the T1 spinous process, the midpoint of T12 spinous process and the L5-S1 junction were marked using an appropriate skin marker pen.

To mark the midpoint of T1 spinous process the subject was asked to flex the neck in standing. The two prominent spinous process' were identified and the lower one was marked as T1 (Field 1995).

To mark the midpoint of T12 spinous process, first the inferior border of the scapula was palpated as this corresponded to T7 level (Field, 1995). Then the tips of the spinous processes were counted, marking the upper spinous process with the fingers of one hand while seeking the spinous process below with the other. The spinous process of T12 has a flattened appearance being similar to that of a lumbar spine and this was used to confirm that the correct spinous process had been identified.

The lumbosacral junction was located by palpating at the level of the posterior superior iliac spine and verified by identifying the L4 spinous process as the bisection of a line joining the highest points of the iliac crests and counting down to L5/S1 and marked with the skin marker pen. (Burton 1986).

The flexicurve was then adjusted to the thoracic spine in the sagittal plane (one end at T1 and the other at T12) and moulded to the skin sufficiently to contour the spine closely. This moulded shape from T1 to T12 was moved carefully to a sheet of A3 white paper, without distorting its shape. The curvature was traced with a pen along the length of the contact face of the flexicurve marking the position of the T1 spinous process and T12.

The same process was used for the lumbar spine contour, moulding from T12 to L5-S1 junction. Only one measure of the thoracic and lumbar curves was taken by the researcher.

After this procedure was performed, the pen marks were removed from the skin and the participants were given a one-minute rest.

To quantify the thoracic and lumbar curves the Kyphotic and Lumbar Indexes were used (Caine et al. 1996) as well the Kyphotic and Lumbar Theta Angles (Lovell et al. 1989).

To calculate the Kyphotic Index and the Theta Angle a line (L) was drawn from point A to point B and this length was measured to the nearest millimetre. The length of a perpendicular line (H) drawn from the mid point of L to the curve was then measured with a ruler to the nearest millimetre representing the height (Figure 4.9.).

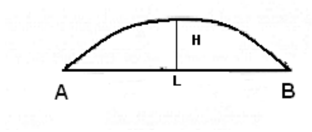


Figure 4.9. Calculation of the Kyphotic Index. A- Beginning of the curve; B- End of the curve

The index of kyphosis measures the kyphosis through the ratio of L/H multiplied by 100 to enable differences to be observed more readily.

IK= H/Lx100

The same procedure was taken to obtain the index of lordosis.
The theta angle was calculated using the same curves and lines as the index of kyphosis and Lordosis and the equation:

Theta= [arc tang (2H/L)]

where theta represents the magnitude of the thoracic and lumbar curve in radians, then transformed in degrees (Figure 4.10).

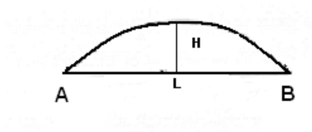


Figure 4.10. Calculation of the Kyphotic Tetha Angle. H- The length of a perpendicular line drawn from the mid point of L of a line that joins the ends of the curve.

Higher indices indicate greater degrees of thoracic kyphosis and vice versa (Hinman 2004).

4.2.2.8. <u>Ethics</u>

Each of the twelve participants of this pilot study signed an informed consent form, according the Declaration of Helsinki, to participate in this pilot study (see appendix 9 for consent forms).

4.2.2.9. Statistics

Test-retest reliability, which measures stability over time, requires the administration of the same test to the same participants at two points in time.

The intrarater reliability was calculated using an Intraclass correlation coefficient (ICC). $ICC_{3,1}$ was the most appropriate ICC model for the experimental design used in this study, as it used an average of three measurements and a single rater in two assessment moments (Shrout and Fleiss 1979).

The standard error of measurement (SEM) of the measures was computed using the equation SEM = $\sqrt{\sigma^2(1-\rho)}$, where σ is the error standard deviation and ρ is the reliability coefficient (Portney and Watkins 1993).

The following criteria were used to evaluate the reliability of measures using ICC (Fleiss, 1986):

- 0.76-0.99 = excellent reliability
- 0.41-0.75 = fair to good reliability
- ≤0.40 = poor reliability

It was decided by the researcher that only the tests with excellent reliability would be accepted.

4.2.3. Results of the intrarater reliability studies

Full results of these pilot studies, with the values of the first and second moments are described in Table 4.3.

Table 4.3. Values of reliability pilot study variables

MEASUREMENT VARIABLE	1st Moment	2nd Moment
Sit to Stand Test (nº of times in 30 seconds)	15.0 (4.5)*	14.7 (3.6)
Timed Up and Go (Seconds)	7.6 (1.0)	7.6 (0.9)
Functional Reach Forward (Centimetres)	30.6 (9.5)	30.7 (5.2)
Functional Reach Lateral (Centimetres)	26.7 (5.0)	31 (5.1)
Stepping Forward Right Foot (Seconds)	0.25 (0.04)	0.25 (0.05)
Stepping Forward Left Foot (Seconds)	0.26 (0.04)	0.24 (0.05)
Stepping Lateral Right Foot (Seconds)	0.28 (0.06)	0.27 (0.05)
Stepping Lateral Left Foot (Seconds)	0.28 (0.06)	0.26 (0.04)
Stepping Backwards Right Foot (Seconds)	0.30 (0.05)	0.28 (0.06)
Stepping Backwards Left Foot (Seconds)	0.31 (0.05)	0.27 (0.05)
Range of Motion of Right Ankle (Degrees)	45.4 (11.5)	45.1 (12.5)
Range of Motion of Left Ankle (Degrees)	46.4 (11.1)	49.7 (11.5)
Kyphotic Index	9.0 (3.2)	9.2 (3.2)
Kyphosis Theta Angle (Degrees)	10.2 (3.5)	10.4 (3.6)
Lumbar Index	8.2 (2.3)	8.3 (3.2)
Lumbar Theta Angle (Degrees)	9.3 (3.6)	9.4 (3.5)

*** mean (standard deviation)**

4.2.3.1. Intraclass Coefficient and Standard Error of Measure

Almost all the tests revealed excellent intrarater reliability coefficients (Table 4.4.) Nevertheless Functional Reach Test showed a good intrarater reliability, with an ICC of 0.71, with a SEM of 5.1cm (Table 4.4.). As it was near the boundary value of “excellent” criteria used by Fleiss (1986) (0.76) the researcher decided to accept it.

Lumbar Index results also showed good reliability with an ICC of 0.65 and a SEM of 1.84 as well as Lumbar Theta angle that revealed a good intrarater reliability with an ICC of 0.66 and a SEM of 2.02º (Table 4.4.).

Table 4.4. ICC and SEM values of the Tests

MEASUREMENT VARIABLE	ICC	95% Confidence Interval	SEM	Men	Women
Sit to Stand Test	0,98	0,93-0,99	0,89 repetition	0.96	0.99
Timed Up and Go	0,96	0,84-0,99	0,30 seconds	0.92	0.97
Functional Reach Forward	0,71	0,701-0,92	5.1cm	0.72	0.75
Functional Reach Lateral	0,79	0,27-0,94	3 cm	0.61	0.88
Stepping Forward Right Foot	0,78	0,21-0,93	0,03 sec.	0.96	0.85
Stepping Forward Left Foot	0,78	0,22-0,94	0,02 sec.	0.85	0.95
Stepping Lateral Right Foot	094	0,77-0,98	0,03 sec.	0.95	0.80
Stepping Lateral Left Foot	0,84	0,45-0,95	0,02 sec.	0.94	0.80
Stepping Backwards Right Foot	0,89	0,60-0,97	0,02 sec.	0.75	0.96
Stepping Backwards Left Foot	0,89	0,61-0,97	0,02 sec.	0.76	0.93
Range of Motion of Right Ankle	0,97	0,89-0,99	3.18 º	0.90	0.95
Range of Motion of Left Ankle	0,91	0,65-0,97	4.72 º	0.90	0.97
Kyphotic Index	0,98	0,93-0,99	0,67	0.97	0.96
Kyphosis Theta Angle	0,98	0,92-0,99	0,74º	0.97	0.97
Lumbar Index	0,65	0,15-0,88	1.84	0.79	0.87
Lumbar Theta Angle	0,66	0,28-0,94	2.02º	0.80	0.87

4.2.4. Discussion and Conclusion

An intrarater reliability study was performed to verify the stability of measurements over time. Reliable measurement instruments are acknowledged essential for research and clinical practice in Physiotherapy (Kerbs 1987).

In a bibliographical search three authors were found who had defined the criteria used to evaluate the reliability of measures. The first set of criteria from Fleiss, 1986 was described earlier in this chapter in the section 4.2.2.8. on statistics (page 128). The second were the criteria used by Currier (1990), that defines 0.90-0.99 as high reliability; 0.80-0.89 as good reliability; 0.70-0.79 as fair reliability and <0.69 as poor reliability. The third set of criteria found was by Portney and Watkins, 1993 who defined <0.50 as poor reliability, from 0.50 to 0.75 a moderate reliability and from 0.76 to 0.99 a good reliability.

The criteria used by Fleiss were chosen in this study as they were most frequently of the most cited in the literature.

The interpretation of the Standard Error of Measure (SEM) is dependent on the type of reliability coefficient (ICC) that is used in its computation. In the pilot study, as it was based on test-retest reliability (ICC 3,1), SEM was indicative of the error in the range of scores that could be expected on retesting. It is valuable for researchers because it provides guidance as to whether the measured change on retesting after an intervention is due to measurement error or to real change.

Using Fleiss's criteria for assessing reliability, the results showed that the Sit to Stand Test achieved excellent intrarater reliability (ICC= 0.98) higher than that found by Jones et al. 1999 (ICC=0.89) in a sample of 30 older people, independent and ambulatory, with a mean age of 70.5 years.

The Timed up and Go intraclass coefficient value (0.96) in this reliability study showed higher consistency of the measures than those published by Rockwood et al. (2000). These authors found in a sample of 2305 old persons with a mean age of 78.1 years (range 69-104) a fair intrarater reliability with an ICC= 0.56. Nevertheless Podsiadlo and Richardson (1991) in a study with 10 older participants found a intrarater ICC coefficient of 0.99, Hughes et al. (1996) found an ICC for Timed up and Go measures of 0.92 and Shumway-Cook and Woollacott (2000) showed an ICC of 0.98 somewhat above the results of this study.

The reliability levels established in this study for the Functional Reach Forward Test (ICC=0.71) were not similar to those determined by Duncan et al. (1990) who reported an excellent intrarater reliability with ICC of 0.92, by Franzen et al. (1998) with a value of 0.90 (but using the Pearson Product Moment instead of Intraclass Coefficient) and Mecagni et al. (2000) with an ICC value of 0.92. The Pearson Product Moment has a restriction as a measure of reliability as it characterizes only an association between scores, not the level of agreement. The ICC is a commonly used reliability coefficient that presents a measure of correspondence between scores based on an analysis of variance model. The ICC differs from Pearson Product Moment in that it describes overall agreement (i.e., random and systematic error combined). Moreover the Pearson Product Moment is a bivariate statistic and should not be used for reliability which is a univariate analysis (Vinicombe et al. 2001). The Functional Reach Forward Test had a SEM of 5,1cm. This signified that after an intervention real improvements could only be accepted if they were more than 5,1cm.

The Functional Reach Lateral test revealed excellent intrarater reliability (ICC=0.79) but not as high as Brauer et al. (1999) who found an ICC=0.92 and Nitz et al. (2004) with ICC>0.86, both with samples of older persons. In this study a SEM of 3 cm indicates that changes must be attributed to the intervention when differences are greater than 3cm.

The Stepping Test was evaluated for both legs being felt that leg dominance was not important. The intraclass coefficient results showed that intrarater reliability was excellent (ICC from 0.78 to 0.94). SEM varied between 0.03 and 0.03 seconds. There is no literature about this test against which to make a comparison.

Active Range of Motion of both ankles showed excellent intrarater reliability. This is in accordance with Rome et al. (1996) who argued that the flexible electrogoniometer demonstrated better reliability in measurement of ankle movement than a hand held goniometer. Tesio (1995) reported that electrogoniometers adapt better to all body parts and are more reliable with respect to the rigid conventional goniometers. In this Portuguese study both ankles showed a high SEM in the active range measurements (3.2º for the right and 4.8º for the left ankle). Given this SEM, if the intervention was to be accepted as showing real changes, then an improvement of more than the value of the SEM was needed.

The intrarater reliability of the Kyphotic Index and Kyphotic Theta Angle were excellent (0.96 and 0.98 respectively). These results are better than studies conducted by Lundon et al. (1998) (ICC=0.88) and by Arnold et al. (2000) (ICC=0.91) both using samples of postmenopausal women. Lovell et al. (1989) reported an intrarater reliability of 0.91 for kyphotic Theta Angle using a sample of young participants (mean age 30 years).

The Lumbar Index and Lumbar Theta Angle intrarater reliability values found were good, but lower than those of Lovell et al. (1989) (ICC=0.78).

Furthermore, these variables presented very low ICC lower boundary values of 95% Confidence Interval, representing the variability of the values.

As the Kyphotic Index and Theta Angle of the spinal curves were obtained by linear combination of the same measurement, it was decided to only use the Kyphotic Index in the main study as it showed higher intrarater reliability and greater values for confidence of real changes. On the other hand as the results for the Lumbar Index and Theta Angle reliability coefficients were not rated as excellent it was decided not to use these variables in the main study.

CHAPTER 5

MAIN STUDY
METHODS

This chapter describes the methodology of the randomised controlled trial. It includes the sample recruitment and allocation of participants to the intervention or control groups, the instruments and measures used in addition to those described in the previous chapter, the data collection procedures, and the statistics used to analyse the data (Figure 5.1.).

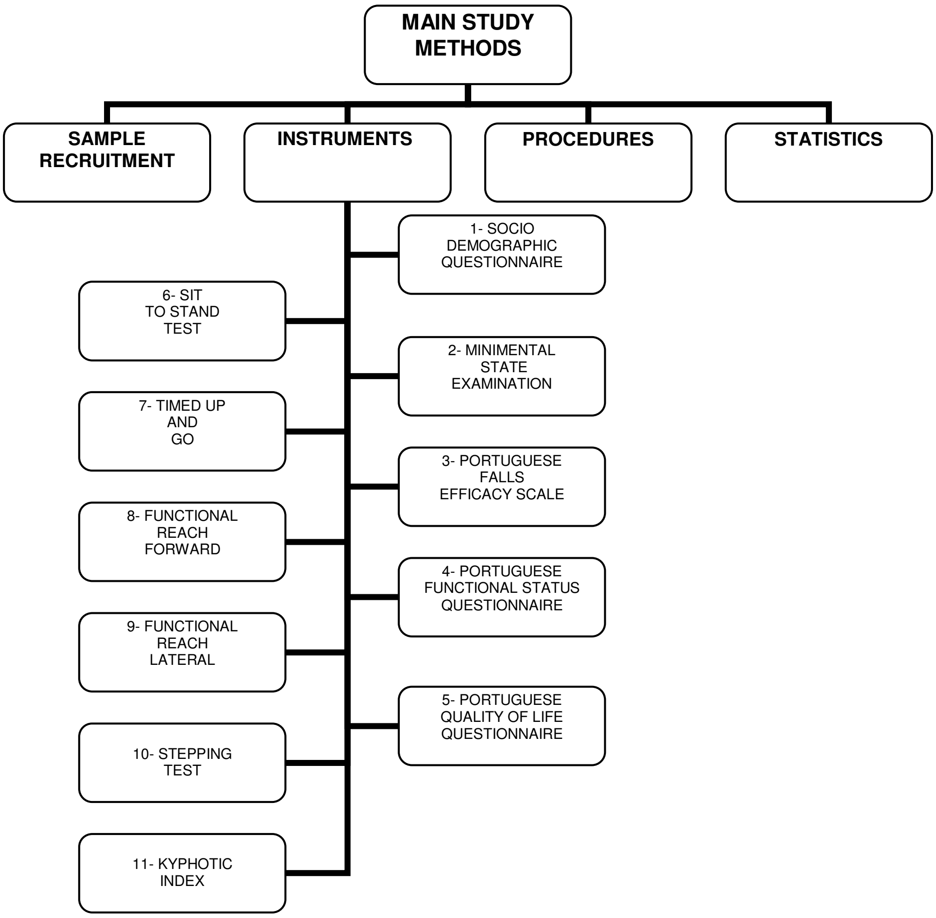


Figure 5.1. Diagram representing methodological aspects of the main study. Numbers before the instruments' name show the order of application

5.1. Sample Recruitment

The participants in this study were recruited from the general practitioners (GP) lists for two health centres in the city of Oporto, the Foz and Lordelo health centres. Inclusion and exclusion criteria were as follows:

Inclusion criteria:	Age between 65 to 84 years
	Functionally independent
	Walking without aids
Exclusion criteria:	Lower extremity amputation
	Neurological disease
	Disabling musculoskeletal disease
	Folstein Mental Status score <15
	Unstable cardiovascular disease
	Vertebral arterial syndrome
	Blindness

The department of informatics at the health centres provided a list of users within the age range, grouped according to the twenty two health centers' GP. Each GP deleted from the list the names of those who did not conform to the criteria above.

After receiving the GPs amended lists, the informatics department provided further information on those to be included, namely their address and phone number. A letter signed by the researcher, explaining the benefits of specific moderate intensity exercise and the aim of the home based programme was sent to all of them. Attached to this letter was a postcard addressed to the researcher for them to choose from three options:

1. I agree to participate in the home based programme, and I give permission to contact me by phone
2. I want more explanation about the programme, and I give permission to contact me by phone
3. I do not want to participate in the Programme.

All the postcards returned with option 1 chosen, were numbered by order of receipt in order to give a number to each participant. Persons choosing option 2 were contacted by telephone, and a full explanation about the proposed research and the exercise programme was given. Those who then agreed to participate were transferred to option 1, and given a sequential number. Using the numbers previously attributed all participants were randomly allocated by permuted blocks of four to the intervention and control groups.

5.2. Power and sample size for study completion

A sample size estimation was carried out to determine the sample required to detect a significant difference between the two groups, intervention and control groups (a=0.05, power=0.80). Sample size estimation was performed with the Power and Sample size calculation (PS) software, version 2.1.30 (Dupont and Plummer 1997). Sample size was calculated assuming that $\mu_2 - \mu_1$ was the difference between the mean of the two moments for each physical test of the pilot study (Table 5.1.). It was decided a significance level of α =0.05 that would have a probability (power) of $1-\beta=0.80$ of rejecting the hypothesis of equal improvements in the two groups. It can be seen that Functional Reach Forward is the test that requires most participants.

Table 5.1. Estimation of sample sizes needed for minimal detectable changes with a probability β=0.80 and limitation of α =0.05

Parameter	$\mu 2 - \mu 1$	σ	Sample size
STS	4.1	4.5	**20**
TUG	1	1.0	**6**
FRF	7	9.5	**30**
FRL	4	5	**26**
SFRF	0.05	0.04	**11**
SFLF	0.06	0.04	**3**
SLRF	0.02	0.06	**5**
SLLF	0.06	0.06	**17**
SBRF	0.05	0.05	**17**
SBLF	0.05	0.04	**4**
ROMR	9	11.5	**27**
ROML	9	11.1	**25**
KI	5	3.2	**8**
TTA	5.2	3.5	**6**
LI	3.5	2.3	**6**
LTA	3.6	2.9	**6**

$\mu 2 - \mu 1$- difference between intervention and control groups; σ - common standard deviation;

5.3. Instruments

The instruments used in this study can be divided in two types: those related to physical tests and those related to self reported measures included in questionnaires.

A questionnaire was used to collect personal details. Other instruments were used; The Portuguese version of Falls Efficacy Scale (Tinetti 1990) to evaluate fear of falling; the Portuguese Functional Status Questionnaire, developed by Gomes da Silva (2002), because it was already adapted and validated for older Portuguese persons; the Quality of Life of the Portuguese Older Person Questionnaire developed by Gomes da Silva (2002) because it was already adapted and validated for Portuguese older people and was an easy and quick tool to use.

The participants completed all the questionnaires and scales in the presence of the researcher. Explanations to ensure an adequate response were given when required. The information was collected in the following order:

1- Administration of questionnaires and scales
    a) Socio demographic questionnaire
    b) Minimental State Examination
    c) Portuguese Falls Efficacy Scale
    d) Portuguese Quality of Life of the Old Person questionnaire
    e) Portuguese Functional Status Questionnaire
2- Measurement of height and weight
3- Sit to Stand Test
4- Timed Up and Go Test
5- Forward Reach Test
6- Lateral Reach Test
7- Stepping forward, lateral and backwards test
8- Dorsi and plantar flexion range of movement
9- Kyphotic Index measurement

5.3.1. Personal Questionnaire (Appendix 2)

This questionnaire includes socio-demographic details such as age, gender, literacy level, marital status, home amenities and, questions related to falls (at least one fall in the past 12 months), fear of falling, feeling of loss of balance, current medication and a brief illness history. These two last questions were included for confirmation of inclusion criteria and not as study variables.

A fall was defined and explained to the participants as 'an event, which results in a person coming to rest unintentionally on the ground or other lower level, not as result of a major intrinsic event or overwhelming hazard, (Tinetti et al. 1988). Falls that had occurred due to fainting, illness, during unusual activities in which a fit active person might fall, or in an unusually hazardous environment were excluded.

5.3.2. Anthropometric measurements

Measurements of height and weight were obtained for each participant. Weight was measured using digital equipment (automatic register). Height was registered on a vertical measuring tape stuck on a wall and for that, the participants stood with their backs touching the wall, with a rigid bar perpendicular to the wall on the top on their head. Body mass index was calculated as: BMI = weight (kg) / [height (m) $]^2$

5.3.3. Minimental State Examination (MMSE) (Appendix 3)

The Minimental State Examination was used to confirm the presence of exclusion criteria and it was not part of the main study. It was used to exclude participants with cognitive impairment. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language (Folstein et al. 1975). The maximum score is 30. Scores less than 22 indicate cognitive impairment and for illiterate people this value decreases to 15 (Guerreiro et al. 1993). It is hoped that if this exercise programme proves successful for individuals without cognitive impairment, then in the future it could be adapted for individuals with signs of dementia.

5.3.4. Portuguese Falls Efficacy Scale (PFES) (Appendix 4)

The Portuguese version of the Falls Efficacy Scale (Melo, 2002) was used to assess the impact of fear of falling on a person's confidence to perform everyday tasks (Tinetti et al. 1990). This is a 10-question scale for assessing the person's self-confidence to avoid a fall during each of 10 non-hazardous activities of daily living:

- Taking a bath or shower
- Reaching into cupboards
- Preparing a meal (not requiring carrying heavy or hot objects
- Walking around the house
- Getting in and out of bed

- Answering the door or telephone
- Getting in and out of a chair
- Getting dressed or undressed
- Doing light housekeeping
- Doing simple shopping

The scores range from 0 to 100, higher scores indicating higher self efficacy. The scale showed a good internal consistency (α=0.88) and an excellent test-retest reliability (ICC= 0.95) in its adaptation and validation process for the Portuguese population (Melo 2002).

5.3.5. Portuguese Functional Status Questionnaire (Appendix 5)

The Functional Status Questionnaire (FSQ) is a brief, standardized, self-administered questionnaire designed to provide a comprehensive assessment of physical, psychological, social and role function (Jette et al. 1986).

The Portuguese Functional Status Questionnaire was adapted and validated for the older Portuguese population by Gomes da Silva (2002). It was based on the Functional Status Questionnaire from Jette et al. (1986).

When compared with the FSQ originally designed by Jette et al. (1986) the PFSQ has 13 fewer items. Deleted items are concerned with issues related to the Portuguese society and culture. An example of this is the question related to the satisfaction with sexual life which, in Portugal, is considered a taboo subject for people over 65 years old and therefore not included. Another example is the items related to work as after 65 years old Portuguese people are retired and so these questions were irrelevant. Another alteration by Gomes da Silva (2002) was in relation to the request to recall the last month and this was changed to a recall of the last week when answering the questionnaire, due to memory implications. A further change related to the overall social and financial situation of this population group and centred on the item “driving a car”, which was changed to “using a bus or other public transport” as it is more common for the older Portuguese people to use public transport. This relates to financial problems that characterize a large percentage of older retired Portuguese people.

Content validity studies of the PFSQ were undertaken by a survey which called upon the judgement of experienced professionals working in the field of the care of the elderly, and also involved consultation with older people. Face validity was evaluated jointly with content validity. Gomes da Silva (2002) suggests a satisfactory to good validity. The values of internal consistency (used as a measure based on the correlations between different items on the same test) varied from $\alpha=0.75$ to 0.92. In statistics internal consistency is a measure based on correlations between different items on the same test (Domholdt 2000). It presented very good interrater reliability (ICC=0.82), and intrarater reliability (ICC=0.81), with a confidence Interval of 95%.

The PFSQ includes nine main question areas, 5 single item questions covering sick days, feelings about health and interpersonal relationships and 4 other questions sub divided into 21 items. These four questions, with five and six-point ratings, cover:

- The physical domain of functioning (question 6 – 9 items), with 2 sub domains:
    - Physical function 1, basic Activities of Daily Living (question 6 a, b, c)
    - Physical function 2, Instrumental Activities of Daily Living (question 6 d, e, f, g, h, i)
- The psychological domain of functioning (question 7– 4 items)
- The social domain of functioning (questions 9 and 8– 8 items)
    - Social function 1, social activity (question 8)
    - Social function 2, quality of interaction (question 9)

The following linear transformation is used to calculate the scores of each sub-domain, domain and total score in the 0-100 scale, where 0 refers to the absence of overall functional ability and 100 stands for the absence of any functional impairment:

$$SS = \frac{\Sigma (yi) - n}{n} \times \frac{100}{k}$$

SS –scale score
yi –individual questionnaire response score
n –number of questions for which there is valid information
k –is the maximum minus the minimum valid response score for that question or domain

Valid information is all the answers different from 0 (Gomes da Silva 2002)

5.3.6. Quality of Life of the Portuguese Older Person Questionnaire (Appendix 6)

The "Quality of Life of the Older Person" (QOLOP) questionnaire was developed by Gomes da Silva (2002), and was developed based on the literature in the field and the experience of professionals caring for older people.

Content and face validity were assessed by the author (Gomes da Silva 2002) through the consultation with experienced professionals and elderly people living in different areas in Portugal. Several changes were introduced at the level of language, and one item was withdrawn. This process allowed the establishment of satisfactory to good content validity of the QOLOP. It presented good reliability (ICC= 0.87) and good internal consistency (α=0.78).

It consists of 23 items divided into four main domains:

1- Health in general and functional status (questions 1 to 5)
2- Emotional and spiritual well being (questions 6 to 11)
3- Family and social life (questions 12 to 19)
4- Financial status and environment (questions 20 to 23)

This questionnaire uses two classification systems (Likert Scales) for the scoring of each item according to "satisfaction" and "importance" (Table 5.2).

Table 5.2. Classification system for responding to the QOLOP

Classification	Importance	Satisfaction
1	Not Important	Very unsatisfied
2	Slightly important	Unsatisfied
3	Indifferent	Indifferent
4	Important	Satisfied
5	Very Important	Very Satisfied

The formula presented below represents the scoring system used, and was adapted by Gomes da Silva (2002) from the one suggested by Raphael et al. (1997). The formula was designed based on the theoretical assumption that when measuring quality of life it is essential to assess satisfaction with certain aspects of life, weighting the importance of each item against the circumstances of individual subjects. The formula allows the importance of each item to be weighted against the respective satisfaction, including the individual differences:

$$\mathbf{SQOLOP} = \frac{\sum \left(\frac{IS}{3}\right) \times (SS-3) + 4}{n}$$

SQOLOP – Quality of life score; IS – Importance Score; SS – Satisfaction Score; n – number of valid answers

The score varies between 0.7 and 7.3, the latter score representing maximum quality of life.

All the physical tests, Sit to Stand Test, Timed Up and Go Test, Forward Reach Test, Lateral Reach Test, Stepping forward, lateral and backwards test, Dorsi and plantar flexion range of movement, thoracic measurements were performed after the self reported measures in the same order and following the same procedures already described in chapter four.

5.4. Procedures

Three months before the beginning of the study 2000 brochures were delivered to Foz Health Unit focusing on the benefits of specific physical activity on falls prevention in older people and the role the Physiotherapists (Figure 5.2) (Appendix 7).

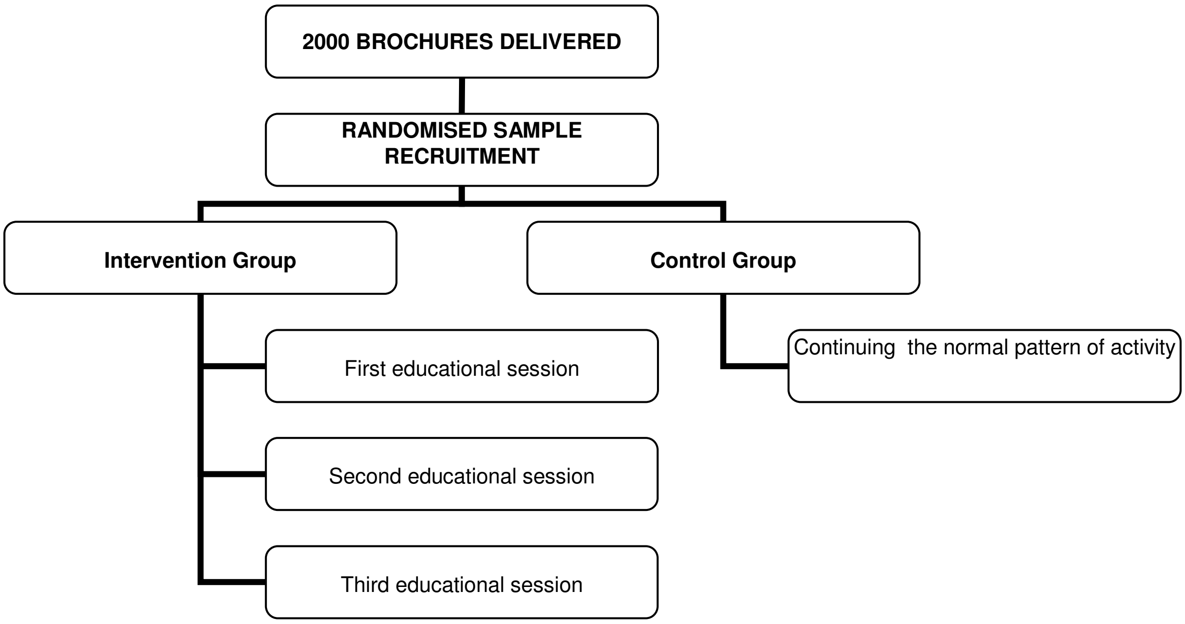


Figure 5.2. Diagram representing methodological aspects of the procedures of study.

After recruitment of the sample, all persons that agreed to participate were contacted by phone for an appointment in the Foz Health Centre, where the researcher had a room for interview and assessment.

After the baseline assessment, the Control Group was instructed to continue their normal pattern of activity and not to begin any new physical activity programmes during the course of the study. Nevertheless, they were given priority to enter the programme after the study.

The participants in the Exercise Group had three appointments for the next three educational sessions in groups of four. The appointments took place in the Health Centre with a interval of one day between each appointment. The sessions included the following procedures:

First session:

- A general explanation was given to the group about physiological changes in muscles, joints, nervous system and spine due to ageing, using pictures and a spine model;
- An explanation about several medical, environmental and behaviour factors that potentially influencing falls, followed by accident prevention education;
- Exercises were explained and carried out for the first time by all participants.

Second session:

- Review of the exercises;
- Measurement of the number of stepping forward, lateral and backwards repetitions (maximal nº in 30 seconds) to measure a baseline for exercise progression;
- Because Sit to Stand was considered a stressful exercise, heart rate was used as a measure, specifically the Target Heart Rate, based on the Karvonen formula, in order to prescribe the initial repetitions of the Sit to Stand exercise, and to measure a baseline for exercise progression;
- Delivery of the exercise booklet and a VHS cassette or DVD demonstrating the exercises in the programme performed by the researcher.

Third session:

- Any doubts related to the exercise booklet were explained or clarified;
- The way the exercises should be progressed was clarified;
- The way the participant was performing the exercise was checked;
- A weekly log book was handed to all participants;
- Future appointments to encourage exercise adherence (once monthly) were scheduled for the next 3 months

After 3 months in this home based moderate intensity exercise programme the intervention and control group participants were invited to come to the health centre for the first reassessment, including completion of all the questionnaires and all measurements (this appointment was postponed only in case of illness).

After the reassessment, the intervention group had a new appointment scheduled at which they were informed about the progression of the exercises to be done for the following 6 months. A monthly meeting with the researcher at the health centre was arranged in order to encourage adherence to the programme.

Six months later all participants (intervention and control groups) had an appointment for a second reassessment. The home based moderate intensity exercise programme was planned to cover a period of nine months. Nevertheless all participants belonging to the intervention group had an appointment booked for a final reassessment one year after the start of the programme in order to assess how long the improvements were maintained.

All participants in the intervention group registered the amount of exercises performed between reassessments in the weekly log books. Log books were considered appropriated as Arts et al. (1996) found an agreement of 96% between observation and self-registration for reporting activities among home help services. They were advised to do the 10 exercises seven days a week during the nine months. The adherence rate was defined as the number of exercises completed relative to each participant's schedule and calculated as a percentage: Nº of exercises performed / Nº of exercises scheduled *100.

5.5. Ethics

Ethical approval was obtained from the health centre ethics committee (Appendix 8) and the returned postcards with option 1 ticked (I agree to collaborate with the study) were considered as informed consent.

5.6. Statistical Methods

The Chi-square goodness of fit test was used to compare distributions of population and sample characteristics.

Measures of central tendency and spread were used to describe the study sample and measurements at the baseline. These included frequencies and proportions, mean and standard deviation or alternatively median and interquartile deviation for asymmetrical distributions.

Correlations among the continuous variables were calculated using the Pearson correlation coefficient. For dichotomous variables a similar measure was used, phi correlation coefficient and for correlations between continuous and dichotomous point biserial coefficient was used based on the chi-square distribution. To ascertain differences among specific subgroups of the population sampled on qualitative variables the standard Chi-square test was used; for quantitative variables that were normally distributed, the t-test was used and for asymmetrical distributions the Mann-Whitney test or the median test was used.

Analysis of the effects of the Exercise Programme involved the General Linear Model approach to repeated measures analysis of variance (SPSS Inc., Chicago, Illinois, 14.0 version), with time as a within subject factor (baseline, 3 and 9 months) and the group as a between-subject fixed factor (intervention and control). Assumptions for modelling application were tested, using Levene's test or error variance. For multiple comparisons, the significance level was adjusted for the number of comparisons. For three comparisons a $p<0.016$ was defined .

Two tailed tests were used and statistical significance was set at $p<0.05$.

CHAPTER 6

MAIN STUDY
RESULTS

This chapter presents the results of a randomised controlled trial to estimate the effects of a nine months home based exercise programme in persons aged 65 to 84 years. Participants were assessed immediately before starting the programme (baseline), after 3 months and again at 9 months. To estimate residual effects of the programme the intervention group was again assessed one year after the programme started.

The results are presented in the following order:

(1) Target population and sample

(2) Description of sample characteristics and measurements at the baseline

a) Comparison by age, gender and randomised groups

b) Association between sample characteristics and measurements at baseline

c) Correlation among measurements at baseline

(3) Comparison of randomised groups after dropouts at the baseline

(4) The effects of the home based exercise programme on studied variables

(5) Analysis of trial adherence

(6) Residual effects of the programme three months after termination

6.1 Population and sample

The initial intention of this study was to enrol most of the persons aged 65-84 who were registered in the GP lists in two health centres.

From a target population of 6476 persons registered in 2003, only five GPs out of twenty two collaborated in the study and the 815 persons registered on their lists were contacted by mail. From this group 92 agreed to participate and were enrolled in the study. They were randomly allocated to the intervention group (n= 47) and control group (n=45) (Figure 6.1.). Four potential participants were excluded from the intervention group (one failed to appear and three did not meet the inclusion criteria) and six from the control group (two participants failed to appear and four did not meet the inclusion criteria, three women assigned to the control group were illiterate). Baseline assessments were performed on **82 participants, 43 randomized to the intervention group and 39 to the control group.**

During the first three months of the programme 22 participants abandoned the trial, seventeen dropouts from the intervention group (ten stated lack of time to perform the exercises and seven participants did not appear) and 5 from the control group. The number of the intervention withdrawers was worrying and the researcher took the decision to explore the factors that contributed to abandonment of the programme which will be considered in the qualitative study of this thesis.

The remaining 60 participants were reassessed at three and nine months after the programme start.

To estimate residual effects and long term adherence to the programme, the intervention group was again assessed 12 months after the start of the programme.

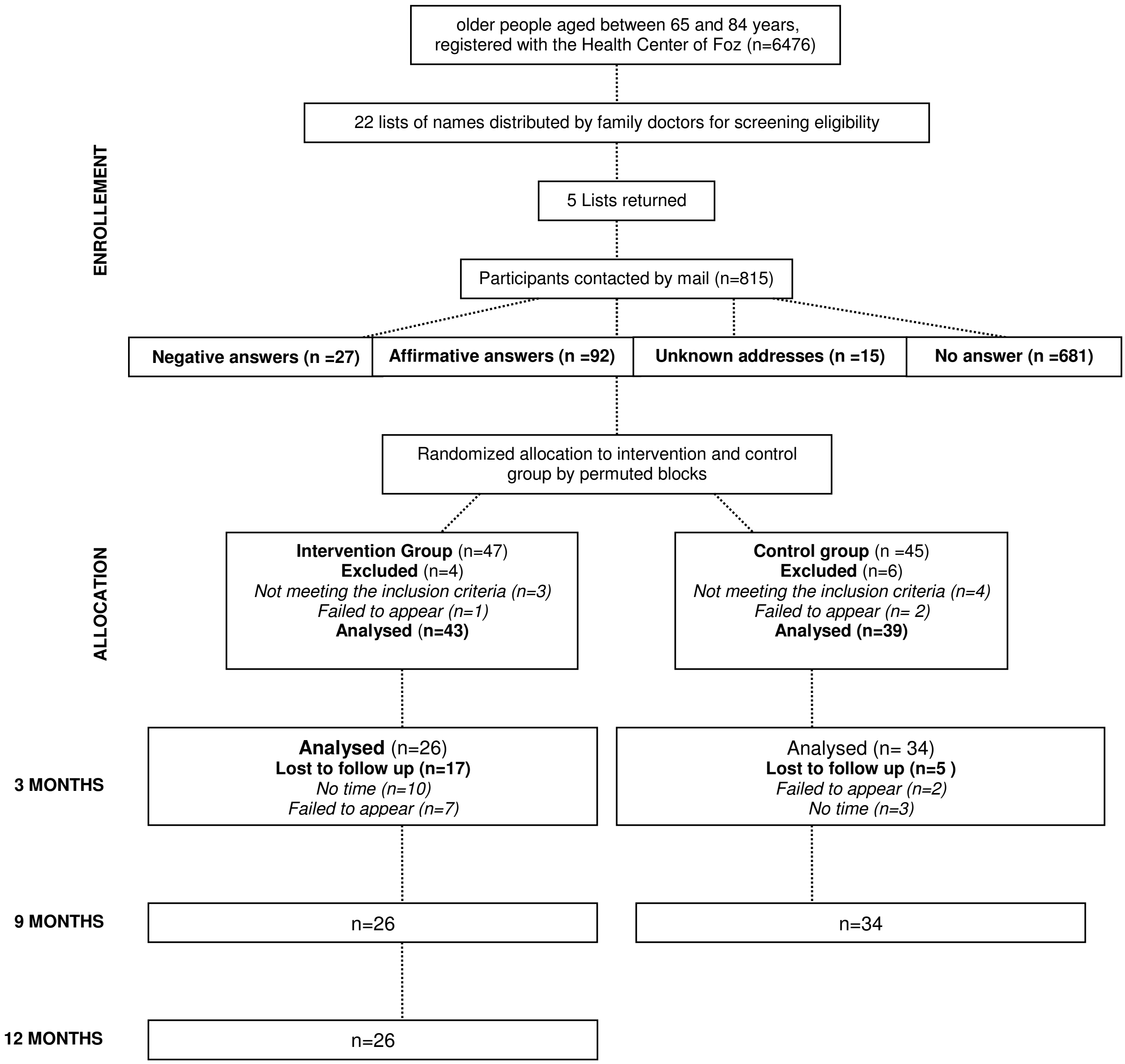


Figure 6.1. Profile of the study population and sample

6.2. Description of sample characteristics and measurements at the baseline

The distribution by gender in those 82 participants who “intended to participate in the programme”, 39 (42.4%) males and 53 (57.6%) females was not significantly different from those who remained in the trial, 33 men (40.2%) and 49 women (59.8%) (χ^2 = 0.1, df=1, p>0.7). The mean age of the participants was 71.2 years (±4.5). Table 6.1. shows the overall distribution of socio-demographic characteristics at the baseline (Appendix 10).

Table 6.1. Description of socio-demographic characteristics of the 82 participants

Socio-demographic characteristics	N	%
All	82	
Gender (%)		
Males	33	40.2
Females	49	59.8
65-69 age group	34	41.5
70-74 age group	30	36.6
≥75 age group	18	22.0
Nº years of full time education (%)		
≤ 4	32	39.0
5-10	20	24.4
11-12	11	13.4
> 12	19	23.2
Marital Status (%)		
Married	46	56.1
Widowed	30	36.6
Others	6	7.3

Table 6.2. describes the socio demographic characteristics related to living situation, falls, fear of falling, feeling of loss of balance of the 82 participants.

Table 6.2. Socio demographic characteristics related to living situation, falls, fear of falling, feeling of loss of balance of the 82 participants.

Socio-demographic characteristics	N	%
Living Alone (% yes)	28	34.1
Doing regular walking (% yes)	36	43.9
Falls in the past year (% yes)	28	34.1
Fear of falling (% yes)	26	31.7
Feeling Loss of balance (% yes)	30	36.6

Table 6.3. describes baseline measurements of all the trial participants.

Table 6.3. Baseline measurements for trial participants

Measurements	Mean	SD
Weight (kg)	69.1	14
Height (m)	1.64	0.1
Body Mass Index	25.7	4.2
Sit to Stand (Nº in 30 sec.)	13.4	3.5
Time up and Go (sec.)	8.8	2.2
Functional reach (cm)		
Forward	26.4	6.9
Lateral	18.3	6.5
Stepping (sec.)		
Forward Right Foot	0.30	0.09
Forward Left Foot	0.30	0.09
Lateral Right Foot	0.30	0.06
Lateral Left Foot	0.30	0.07
Backwards Right Foot	0.30	0.07
Backwards Left Foot	0.30	0.07
Active Range Of Motion (degrees)		
Right Ankle	34.7	12.2
Left Ankle	32.5	13.6
Kyphotic Index	10.1	2.7
Falls Efficacy Scale$^{(a)}$ # (%)	100	
Functional Status Questionnaire #		
Activities of Daily Living$^{(a)}$ (%)	100	
Instrumental Activ. of Daily $^{(a)}$ (%)	100	
Emotional Function$^{(a)}$(%)	100	
Social Activity$^{(a)}$(%)	100	
Quality of Social interaction$^{(a)}$	100	
Quality of Life Of The Old Person$^{(a)}$ Φ (%)	6.4	

scale 0-100; Φ scale 0.7-7.3 ; (a) mode

6.2.1. Characteristics and measurements by age

The participants were divided into three age groups: the 65-69 years group with 34 participants (41.5%), the 70-74 years group with 30 participants (36.6%) and the 75 years and over group with 18 participants (22%). Using the point biserial coefficient, based on Chi-squared results, no significant relationships between age and other socio-demographic variables were observed, except for marital status (Table 6.4.). As expected those aged 65-69 years are predominantly married (64.7%) and the oldest were widowed (66.7%).

Table 6.4. Socio-demographic, living situation, falls, fear of falling, feeling of loss of balance characteristics by age groups

Variables	65-69 years (n=34)	70-74 years (n=30)	≥ 75 years (n=18)	Sig. Level
Gender (%)				NS
Females	18 (52.9)	19 (63.3)	12 (66.7)	
Nº years of full time education (%)				NS
≤ 4	11 (32.4)	13 (43.3)	8 (44.5)	
5-10	9 (26.5)	4 (13.3)	7 (38.9)	
11-12	4 (11.8)	5 (16.6)	2 (11.1)	
> 12	10 (29.4)	8 (26.7)	1 (5.6)	
Marital Status (%)				0.04
Married	22 (64.7)	18 (56.3)	6 (37.5)	
Widowed	9 (26.5)	9 (30.0)	12 (66.7)	
Others	3 (8.8)	3 (10.0)	0 (0)	
Living Alone (% yes)	10 (29.4)	8 (26.7)	10 (55.6)	NS
Doing regular walking (% yes)	17 (50.0)	12 (40.0)	7 (38.9)	NS
Falls in the past year (% yes)	8 (23.5)	13 (43.3)	7 (38.9)	NS
Fear of falling (% yes)	7 (20.6)	11 (36.7)	8 (44.4)	NS
Feeling Loss of balance (% yes)	12 (35,3)	9 (30.0)	9 (50,0)	NS

Table 6.5 shows the measurement characteristics of the sample. It was used one way Anova with Sheffé Post-hoc test to observe differences between age groups.

Table 6.5. Measurement characteristics by age groups

Variables	65-69 years (n=34)	70-74 years (n=32)	+ 75 years (n=16)	Sig. Level
Sit to Stand (No in 30 sec.)●	13.6(3.4)	13.8(3.5)	12.3(3.7)	NS
Time up and Go (sec.)	7.9(1.4)	9.3(2.8)	9.6(1.9)	**0.006**
Functional reach (cm)				
Forward	28.2(7.2)	26.3(6.1)	23.1(6.8)	**0.04**
Lateral	19.4(6.7)	18.8(6.5)	15.3(5.6)	NS
Stepping (sec.)				
Forward Right Foot	0.27(0.07)	0.32(0.09)	0.30(0.09)	NS
Forward Left Foot	0.28(0.08)	0.32(0.10)	0.30(0.10)	NS
Lateral Right Foot	0.28(0.04)	0.31(0.06)	0.33(0.09)	**0.03**
Lateral Left Foot	0.28(0.05)	0.30(0.05)	0.33(0.10)	**0.03**
Backwards Right Foot	0.31(0.06)	0.31(0.09)	0.31(0.06)	NS
Backwards Left Foot	0.31(0.04)	0.30(0.08)	0.32(0.08)	NS
Active Range Of Motion (degrees)				
Right Ankle	40.3(10.3)	29.2(11.6)	33.0(12.3)	**0.001**
Left Ankle	37.5(13.7)	28.6(12.6)	29.7(12.4)	**0.02**
Kyphotic Index	10.1(2.7)	10.4(2.8)	9.6(2.5)	NS
Falls Efficacy Scale(a) #	98.5 (3.0)	98.0 (3.2)	95.5 (4.1)	NS
Functional Status Questionnaire #				
Activities of Daily Living(a)	100 (5.6)	100 (0)	100 (5.6)	NS
Instrumental Activ. of Daily Living(a)	100 (6.7)	97.2 (9.6)	100 (6.7)	NS
Emotional Function(a)	70.0 (20.0)	80.0 (21.9)	75.0 (12.5)	NS
Social Activity(a)	100 (0)	100 (0)	100 (10.4)	NS
Quality of Social interaction(a)	96.0 (4.5)	92.0 (8.0)	100 (5.5)	NS
Quality of Life Of The Old Person(a) Φ	98.5 (3.0)	98.0 (3.2)	95.5 (4.1)	NS

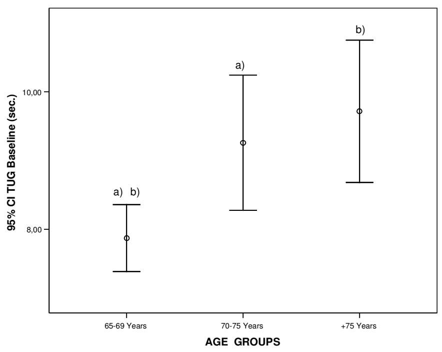
●mean (standard deviation); # scale 0-100; Φ scale 0.7-7.3 (a) median (interquartile deviation)

In relation to Timed Up and Go Test, the younger group walked 3 meters significantly more quickly than the 70-74 age group (p=0.03) and the ≥ 75 years group (p=0.02), when one way Anova with the post-hoc Sheffé test was employed (Figure 6.2.).

Again, as might be expected, the youngest age group reached forward significantly further when compared with the ≥75 years group (p= 0.04) (Figure 6.3.).

Stepping laterally with right and left foot was performed quicker (p= 0.04 and p= 0.04 respectively) by the 65-69 years group when compared with ≥ 75 years group (Figure 6.4.)

Active range of motion for both ankles was significantly higher in the 65-69 years group when compared with the 70-74 years group (p=0.01 and p=0.03 respectively) (Figure 6.5.).



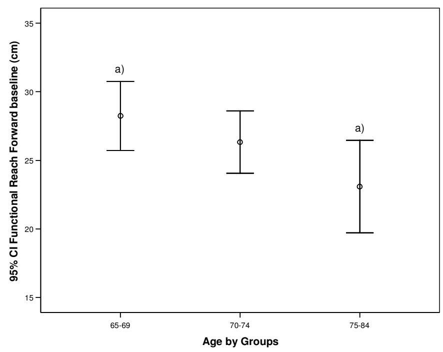
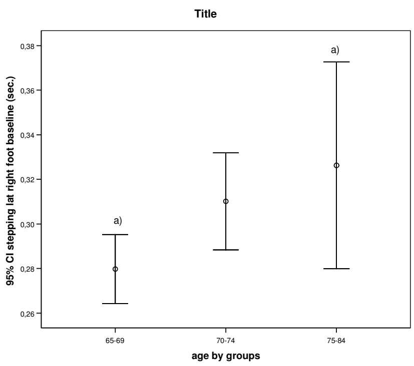


Figure 6.2. 95 % Confidence Interval of Time Up and Go test between age groups. a) p=0.03 b) p=0.02

Figure 6.3. 95 % Confidence Interval of Functional Reach Forward test between age groups a) p=0.04



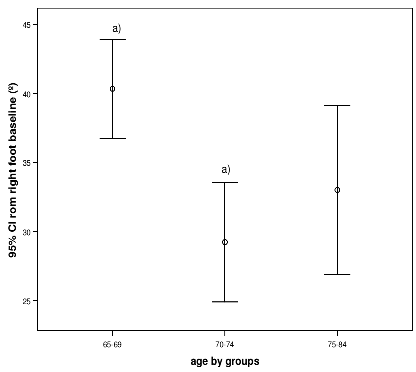


Figure 6.4. 95 % Confidence Interval of Stepping laterally with right foot between age groups a) p= 0.04

Figure 6.5. 95 % Confidence Interval of Right ankle active range of motion between age groups a) p= 0.001

6.2.2. Characteristics and measurements by gender

The sample consisted of 33 male participants and 49 female participants. As all the continuous variables of the physical tests presented a normal distribution of the values, using the One-Sample Kolmogorov-Smirnov Test, the independent sample t test were used to analyse the differences between genders. To obtain the differences by gender within the self reported measures, as they didn't present a normal distribution, a median test was applied. Applying the standard Chi-squared test it was observed that there were more married men (84.8%) than women (36.7%), more women living alone (51% vs. 9.1%), more men walking regularly (60.6% vs. 32.7%) and more women having a fear of falling (46.9% vs. 9.1%) (Table 6.6.).

Table 6.6. Socio-demographic, living situation, falls, fear of falling, feeling of loss of balance characteristics by gender

Variables	Males (n=33)	Females (n=49)	Sig. Level
Weight (Kg)	76.8 (12.6)	63.9 (11.5)	**0.001**
Height (m)	1.72 (0.06)	1.58 (0.06)	**0.001**
Nº of years in full time education (%)			NS
≤ 4	11 (33.3)	21 (42.9)	
5-10	9 (27.3)	11 (22.4)	
11-12	7 (21.2)	4 (8.2)	
> 12	6 (18.2)	13 (26.5)	
Marital Status (%)			**0.001**
Married	28 (84.8)	18 (36.7)	
Widowed	4 (12.1)	26 (53.1)	
Others	1 (3)	5 (10.2)	
Living Alone (% yes)	3 (9.1)	25 (51.0)	**0.001**
Doing regular walking (% yes)	20 (60.6)	16 (32.7)	**0.012**
Falls in the past year (% yes)	6 (18.2)	22 (44.9)	**0.012**
Fear of falling (% yes)	3 (9.1)	23 (46.9)	**0.001**
Feeling Loss of balance (% yes)	10 (30.3)	20 (40.8)	NS

Baseline measurements of physical tests (Table 6.7.) were for the most part significantly different and better in males than in females. Females didn't present any significant differences on Sit to Stand Test, stepping backwards, ankle range of motion, Falls Efficacy Scale, Quality of Social interaction (from FSQ) and Quality of Life of the Older Person when compared with men (Table 6.7.).

Table 6.7. Sample characteristics of physical tests and scale measurements by gender

Variables	Males (n=33)	Females (n=49)	Sig. Level
Age (years)	71 (4.5)•	71.3 (4.5)	NS
Weight (kg)	76.8 (12.8)	63.9 (11.5)	NS
Height (m)	1.72 (0.07)	1.58 (0.07)	NS
Body Mass Index	25.9 (4.2)	25.5 (4.2)	NS
Sit to Stand (No in 30 sec.)	14.2 (3.6)	12.8 (3.4)	NS
Time up and Go (sec.)	8.1 (1.6)	9.2 (2.5)	**0.036**
Functional reach (cm)			
Forward	29.7 (6.9)	24.2 (6.0)	**0.000**
Lateral	21.0 (7.1)	16.5 (5.5)	**0.002**
Stepping (sec.)			
Forward Right Foot	0.26 (0.08)	0.32 (0.08)	**0.01**
Forward Left Foot	0.26 (0.09)	0.32 (0.09)	**0.001**
Lateral Right Foot	0.27 (0.05)	0.32 (0.07)	**0.000**
Lateral Left Foot	0.27 (0.05)	0.32 (0.07)	**0.003**
Backwards Right Foot	0.30 (0.08)	0.32 (0.07)	NS
Backwards Left Foot	0.30 (0.06)	0.31 (0.07)	NS
Active Range Of Motion (degrees)			
Right Ankle	33.6 (13.8)	35.4 (11.1)	NS
Left Ankle	31.1 (14.9)	33.5 (12.6)	NS
Kyphotic Index	9.6 (2.6)	10.44 (2.7)	NS
Falls Efficacy Scale(a) #	97.0 (2.5)	98.0 (2.5)	NS
Functional Status Questionnaire #			
Activities of Daily Living(a)	100 (0)	100 (5.6)	**0.009**
Instrumental Activ. of Daily Living(a)	100 (4.9)	93.3 (13.3)	**0.025**
Emotional Function(a)	80.0 (15)	77.0 (20.0)	**0.028**
Social Activity(a)	100 (constant)	100 (9.7)	**0.005**
Quality of Social interaction(a)	96.0 (5.0)	96.0 (8.0)	NS
Quality of Life Of The Old Person(a) Φ	6.3 (0.18)	6.2 (0.22)	NS

- mean (standard deviation); (a) median (interquartile deviation); # scale 0-100 ; Φ scale 0.7-7.3; NS ($p>0.05$)

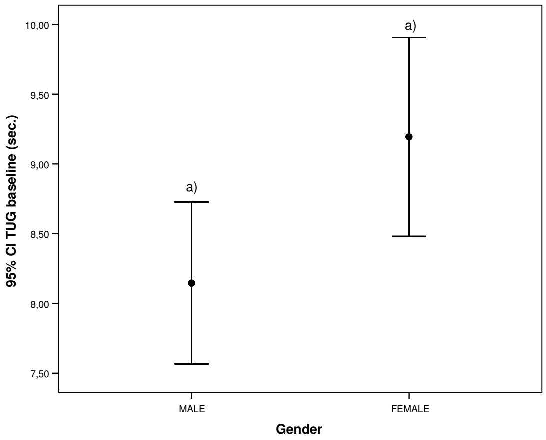


Figure 6.6. 95 % Confidence Interval of Timed Up and Go between gender; a) $p<0.05$

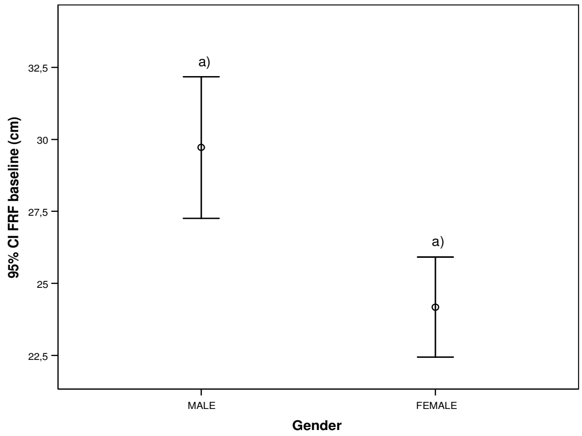


Figure 6.7. 95 % Confidence Interval of Functional Reach Forward between gender; a) $p<0.05$

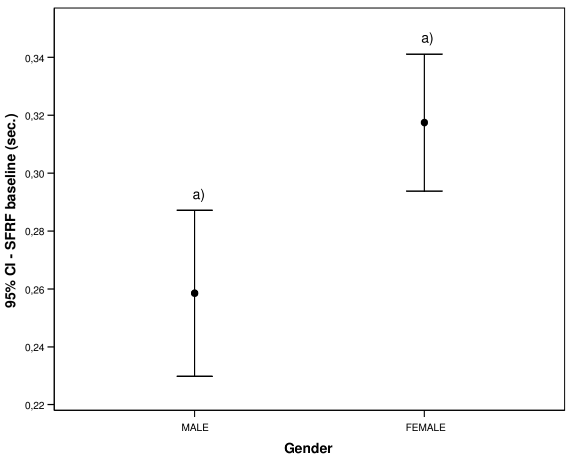


Figure 6.8. 95 % Confidence Interval of Stepping Forward with right foot between gender; a) $p\leq 0.01$

6.2.3. Characteristics and measurements by randomised groups

The proportion of participants from the intervention group that walked regularly (55.8%) was significantly higher than that for the control group (30.8%) ($p<0.05$) when analysed by the Chi squared test (Table 6.8.).

As all the continuous variables of the physical tests presented a normal distribution of the values (tested by One-Sample Kolmogorov-Smirnov Test with a $p>0.05$) the independent sample t test was utilized to analyse the differences between the intervention and control group. As self reported measures didn't present a normal distribution, a Mann-Whitney test was applied. In two of the five sub dimensions of the Functional Status Questionnaire, Emotional Function (Z=-2,211 $p<0.05$) and Social Activity (Z= -2,205 $p<0.05$), the randomized groups were significantly different, with higher scores attained in the intervention group than in the control group (Table 6.9.).

Table 6.8. Socio-demographic, living situation, falls, fear of falling, feeling of loss of balance characteristics by randomized groups

Variables	Intervention (n=43)	Control (n=39)	Sig. Level
Gender			NS
Males (%)	18 (46)	15 (35)	
Females (%)	21 (54)	28 (65)	
Nº of years in full time education (%)			NS
≤ 4	12 (27.9)	20 (51.3)	
5-10	13 (30.2)	7 (17.9)	
11-12	7 (16.3)	4 (10.3)	
> 12	11 (25.6)	8 (4.0)	
Marital Status (%)			NS
Married	25 (58.1)	21 (53.8)	
Widowed	16 (37.2)	14 (35.9)	
Others	2 (4.6)	4 (10.3)	
Living Alone (% yes)	14 (32.6)	14 (35.9)	NS
Doing regular walking (% yes)	24 (55.8)	12 (30.8)	**0.022**
Falls in the past year (% yes)	14 (32.6)	14 (35.9)	NS
Fear of falling (% yes)	13 (30.2)	13 (33.3)	NS
Feeling Loss of balance (% yes)	14 (46.7)	16 (53.3)	NS

Table 6.9. Physical and psychological measurements by randomized groups

Variables	Intervention (n=43)	Control (n=39)	Sig. Level
Age (years)	71.0 (4.6) ●	71.4 (4.5)	NS
Weight (kg)	70.4 (11.9)	67.6 (15.1)	NS
Height (m)	1.65 (0.10)	1.63 (0.09)	NS
Body Mass Index	25.9 (3.8)	25.4 (4.5)	NS
Sit to Stand (No in 30 sec.)	13.1 (2.7)	13.7 (4.3)	NS
Time up and Go (sec.)	8.5(1.8)	9.1 (2.7)	NS
Functional reach (cm)			
Forward	27.4 (6.0)	25.3 (7.8)	NS
Lateral	18.4 (5.2)	18.2 (7.9)	NS
Stepping			
Forward Right Foot	0.29 (0.08)	0.30 (0.09)	NS
Forward Left Foot	0.29 (0.09)	0.30 (0.10)	NS
Lateral Right Foot	0.30 (0.05)	0.30 (0.08)	NS
Lateral Left Foot	0.29 (0.05)	0.31 (0.08)	NS
Backwards Right Foot	0.31 (0.07)	0.31 (0.07)	NS
Backwards Left Foot	0.31 (0.06)	0.30 (0.07)	NS
Active ROM (degrees)			
Right Ankle	35.5 (12.6)	33.8 (11.9)	NS
Left Ankle	34.1 (14.1)	30.9 (12.9)	NS
Kyphotic Index	10.3 (3.0)	9.92 (2.3)	NS
Falls Efficacy Scale #	96.4 (4.5)	94.3 (7.8)	NS
Functional Status Questionnaire #			
Activities of Daily Living	97.2 (6.1)	94.8 (8.5)	NS
Instr. Activ. of Daily Living	93.4 (9.5)	86.6 (19.2)	NS
Emotional Function	77.2 (20.2)	64.0 (28.0)	**0.03**
Social Activity	94.0 (22.8)	87.3 (26.8)	**0.03**
Quality of Social interaction	93.1 (11.3)	91.3 (8.7)	NS
Quality of Life of the old person Φ	6.2 (0.3)	6.1 (0.4)	NS

● mean (standard deviation); # scale 0-100; Φ scale 0.7-7.3; NS (p>0.05)

6.2.4. Association between sample characteristics and measurements at baseline

For the physical tests values an independent sample t test was employed and for self reported measures the Mann-Whitney test was used. When the sample was divided into those who were living alone (n=28) and those who were not (n=54) it was observed that Functional Reach (forward and lateral) (t=-3.77, df=80, $p<0.05$; t=-2.83, df=80, $p<0.05$ respectively) (Table 6.10. and Figure 6.9.) and Stepping Forward (t=-2,056, $p<0.05$ for the right foot; t= 3.08, df=80, $p<0.05$ for the left foot) were better performed by those not living alone. Basic Activities of Daily Living (BADL) (U=572, $p<0.05$), Instrumental Activities of Daily Living (IADL) (U=557, $p<0.05$) and Emotional Function (U=546, $p<0.05$) scores were lower for participants living alone.

The participants who walked regularly (n=36) reached further laterally (t=2.23, df=80, p= 0.028), had more ankle movement (t= 2.10, df=80, p< 0.05 for the right ankle, t= 2.18, df=80, $p<0.05$ for the left ankle), a straighter thoracic spine (t= 2.57, df=80, $p<0.05$) (Figure 6.10.) and were less disabled in IADL and a better Social Activity (U= 627.5, df=80, $p<0.05$, U= 684.5, df=80, $p<0.05$ respectively) than those who didn't walk regularly (n=46) (Table 6.10.).

The participants who didn't fall in the last year (n=54) walked quicker over a 3 meters distance (t=2.37, df=80, $p<0.05$) (Figure 6.11.) and were less disabled in the IADL (U=532.5 $p<0.05$) than those who fell (n=28) (Table 6.10).

Fear of falling (n= 26) negatively influenced the performance of Timed Up and Go (t= 2.94, df=80, $p<0.05$) (Figure 6.12) Functional Reach Forward (t= -2.70, df=80, $p<0.009$), Self Efficacy (U= 387.5 $p<0.05$) (Figure 6.10.) and the basic activities of daily living (BADL) (U=556.0 $p<0.05$) (Table 6.10).

Feeling loss of balance (n=30) had a negative effect on Timed Up and Go, on Reaching Forward (FRF) and Laterally (FRL) decreasing significantly their performance (t= 2.46, df=80, $p<0.05$; t= -2.24, df=80, $p<0.05$; t= -2.11, df=80 $p<0.05$ respectively) (Figure 6.14.), which was reflected in their BADL and FES scores (U=508.0 $p<0.05$ and U=573.5 $p<0.05$ respectively) (Figure 6.15.) (Table 6.10).

Table 6.10. Variable comparison between group's characteristics

Variables	Living Alone			Walking Regularly			Falls last year			Fear of Falling			Feeling loss of balance		
	Yes (N=28)	No (N=54)	Sig. Level	Yes (N=36)	No (N=46)	Sig. Level	Yes (N=28)	No (N=54)	Sig. Level	Yes (N=26)	No (N=56)	Sig. Level	Yes (N=30)	No (N=52)	Sig. Level
Sit to Stand (No in 30 sec.)	13.07•	13.54	NS	13.75	13.09	NS	12.96	13.59	NS	12.92	13.59	NS	12.93	13.63	NS
Time up and Go (sec.)	8.82	8.75	NS	8.30	9.15	NS	9.56	8.36	**0.02**	9.79	8.30	**0.004**	9.55	8.33	**0.02**
Functional Reach Forward (cm)	22.69	28.34	**0.000**	27.62	25.46	NS	24.33	27.49	NS	23.48	27.76	**0.008**	24.20	27.68	**0.03**
Functional Reach Lateral (cm)	15.59	19.72	**0.006**	20.09	16.92	**0,03**	16.46	19.27	NS	16.35	19.22	NS	16.34	19.45	**0.04**
Stepping Forward Right Foot (sec.)	0.32	0.28	NS	0.28	0.31	NS	0.32	0.28	NS	0.31	0.29	NS	0.31	0.29	NS
Stepping Forward Left Foot (sec.)	0.32	0.29	NS	0.28	0.30	NS	0.32	0.29	NS	0.31	0.29	NS	0.32	0.28	NS
Stepping Lateral Right Foot (sec.)	0.32	0.29	NS	0.29	0.31	NS	0.32	0.29	NS	0.31	0.29	NS	0.31	0.30	NS
Stepping Lateral Left Foot (sec.)	0.33	0.28	**0.003**	0.29	0.30	NS	0.30	0.30	NS	0.31	0.29	NS	0.31	0.30	NS
Stepping Backwards Right Foot (sec.)	0.32	0.31	**0.007**	0.30	0.32	NS	0.33	0.30	NS	0.31	0.31	NS	0.32	0.30	NS
Stepping Backwards Left Foot (sec.)	0.32	0.30	NS	0.29	0.32	NS	0.32	0.30	NS	0.31	0.30	NS	0.32	0.30	NS
Active Range of Motion Right Ankle (º)	34.50	34.80	NS	37.79	32.21	**0.04**	33.07	35.48	NS	31.50	36.13	NS	32.47	35.93	NS
Active Range of Motion Left Ankle (º)	32.50	32.60	NS	36.15	29.73	**0.03**	30.98	33.36	NS	29.25	34.08	NS	29.66	34.22	NS
Kyphotic Index	10.05	10.14	NS	10.94	9.46	**0.01**	10.30	10.01	NS	10.22	10.05	NS	10.07	10.13	NS
Falls efficacy Scale #(a)	98.00	98.00	NS	98.00	98.00	NS	98.00	98.00	NS	92.50	96.93	**0.000**	94.50	99.00	**0.007**
Quality of Life of the old person*(a)	6.15	6.30	NS	6.20	6.30	NS	6.30	6.20	NS	6.15	6.30	NS	6.30	6.20	NS
Basic Activities of Daily Living(a)	100.00	100.00	**0.02**	100.00	100.00	NS	100.00	100.00	NS	93.16	100.00	**0.03**	100.00	100.00	**0.03**
Instr. Activ. of Daily Living(a)	87.78	100.00	**0.03**	100.00	93.33	**0.04**	86.67	100.00	**0.02**	93.33	100.00	NS	91.11	100.00	NS
Emotional Function(a)	65.00	80.00	**0.04**	80.00	75.00	NS	65.00	80.00	NS	75.00	75.00	NS	72.50	80.00	NS
Social Activity(a)	100.00	100.00	NS	100.00	100.00	**0.04**	100.00	100.00	NS	100.00	100.00	NS	100.0	100.00	NS
Quality of Social interaction	96.00	96.00	NS	96.00	96.00	NS	92.00	96.00	NS	96.00	96.00	NS	94.00	96.00	NS

●mean; (a) median (interquartile deviation); # scale 0-100 ; NS (p>0.05)

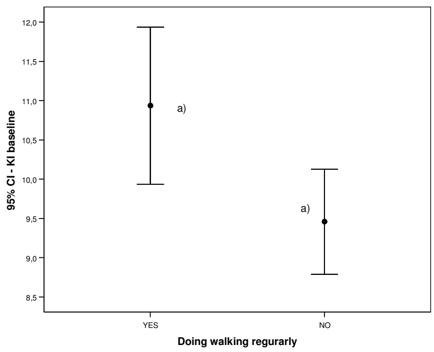


Figure 6.9. 95 % Confidence Interval of Functional Reach Forward between participants living alone; a) p=0.001

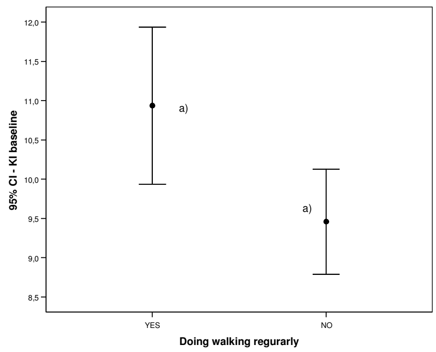


Figure 6.10. 95 % Confidence Interval of Kyphotic Index between participants walking regularly; a) p=0.028

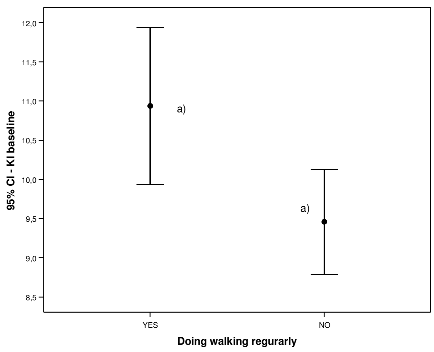


Figure 6.11. 95 % Confidence Interval of Timed Up and Go between participants that fell and did not fall last year; a) p<0.03

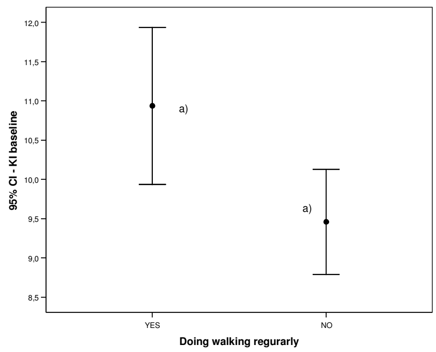


Figure 6.12. 95 % Confidence Interval of Timed Up and Go between participants that had fear of falling; a) p<0.005

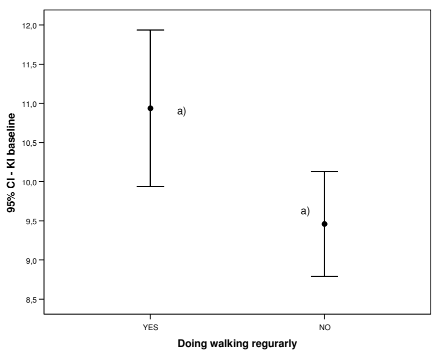


Figure 6.13. 95 % Confidence Interval of self efficacy between participants that had fear of falling; a) p<0.001

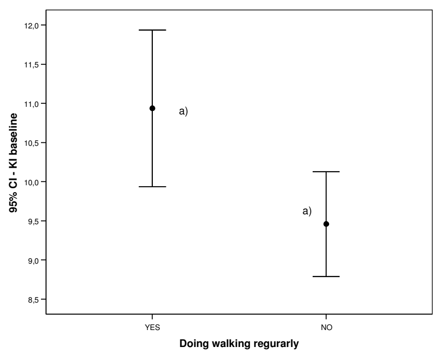


Figure 6.14. 95 % Confidence Interval of Functional Reach Lateral between participants feeling loss of balance; a) p<0.04

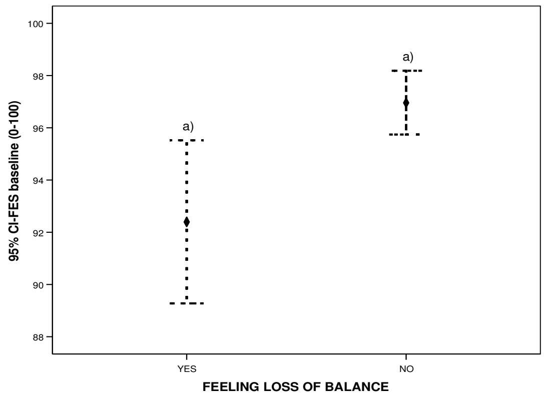


Figure 6.15. 95 % Confidence Interval of self efficacy between participants feeling loss of balance; a) p<0.008

6.2.5. Linear correlations among measurements at baseline

When analysing the correlation matrix between test measurements and scales/questionnaires scores, as might be expected some of the variables are highly correlated using the Pearson Correlation Coefficient (Table 6.11.).

Age was significantly correlated with TUG, Functional Reach Forward, Stepping Lateral with both feet, and active range of motion of both ankles.

The time to walk 3 meters increased with age (r=0.32 p<0.05), the distance to reach laterally decreased (r=- 0.26 p= <0.05), the time to step laterally increased both with the right and left foot (r=0.31 p<0.05and r=0.30 p<0.05, respectively) and, the mobility of the ankles decreased with age (r= -0.27 p= <0.05 for the right ankle r= -0.24 p= <0.05 for the left ankle (Table 6.11.).

A better performance in the Sit To Stand Test (STS) was associated with a better performance in Timed Up and Go (r= -0.55 p<0.05), in Stepping Forward (r=-0.32 p<0.05and r=-36 p<0.05) and Stepping Laterally (r=-0.40 p<0.001 and r=-0.44 p<0.05), in Functional Reach Forward and Lateral (r=0.32 p<0.05and r=0.50 p<0.05, respectively), and in ankle mobility (r= 0.24 p<0.05 and r=0.22 p<0.05) (Table 6.11.).

High values in STS were also associated with high scores in the Falls Efficacy Scale ($r=0.45$ $p<0.05$), and high independence scores in BADL and IADL ($r=0.23$ $p<0.05$ and $r=0.36$ $p<0.05$respectively) (Table 6.11.).

A better performance in Time Up and Go was associated with a greater distance achieved in Functional Reach Forward and Laterally ($r= -0.50$ $p<0.05$and $r=0.40$ $p<0.05$ respectively); a quicker Stepping Forward and Laterally ($r= 0.40$ $p<0.05$ to $r=0.55$ $p<0.05$); an increased ankle mobility (ROMRF $r=-0.30$ $p<0.05$and ROMLF $r=-0.32$ $p<0.05$) and with better scores in the Falls Efficacy Scale ($r=-0.56$ $p=<0.001$). TUG test scores were also associated with better performance in the Basic and Instrumental Activities of Daily living ($r=-0.44$ $p<0.05$and $r=-0.54$ $p<0.05$, respectively) and with Social Activity ($r=-23$ $p<0.05$) (Table 6.11.).

A negative correlation was observed between the Functional Reach Forward and Functional Reach Lateral and Stepping, particularly stepping forward and stepping laterally ($r=-0.30$ to $r=-0.35$ $p<0.05$) and also with the Falls Efficacy Scale ($r=-0.28$ to $r=0.30$ $p<0.05$) (Table 6.11.).

There was a significant negative association between the distance reached in Functional Reach Forward and the Kyphotic Index ($r=-0.27$ $p= <0.05$), BADL, IADL and Emotional Function ($r=0.36$ $p<0.05$, $r=0.36$ $p<0.05$ and $r=0.24$ $p= <0.05$, respectively). (Table 6.11.).

There were significant correlations between Stepping with both feet in all directions. A good performance in Stepping Forward and Lateral was associated with a higher score in Falls Efficacy Scale ($r=-0.28$ to $r=-0.46$ $p= <0.05$), with good performances in Basic Activities of Daily Living and Instrumental Activities of Daily ($r=-0.32$ to $r=-0.49$ $p= <0.05$). Self-Efficacy was strongly correlated with Basic Activities of Daily Living ($r=0.61$ to $p<0.05$), Instrumental Activities of Daily Living ($r=0.58$ to $p<0.05$) and Emotional Function ($r=0.34$ to $p<0.05$) (Table 6.11.).

Table 6.11. Linear correlations among tests and scales at the baseline

Variables / Variables	Height	Age	STS	TUG	FRF	FRL	SFRF	SFLF	SLRF	SLLF	SBRF	SBLF	ROMF	ROMLF	KI	PFES	QOL	ADL	IADL	EF	SF
Sit to Stand	-0.05	-0.08																			
Time up and Go	-0.15	**0.32****	**-0.55****																		
Functional Reach Forward	**0.50****	**-0.26***	**0.32****	**-0.50****																	
Functional Reach Lateral	**0.28****	-0.21	**0.50****	**-0.40****	**0.62****																
Stepping Forward Right Foot	**-0.34****	0.16	**-0.32****	**0.48****	**-0.30****	**-0.31****															
Stepping Forward Left Foot	**-0.35****	0.08	**-0.36****	**0.55****	**-0.35****	-0.21	**0.83****														
Stepping Lateral Right Foot	**-0.42****	**0.31****	**-0.40****	**0.53****	**-0.34****	**-0.33****	**0.73****	**0.68****													
Stepping Lateral Left Foot	**-0.30****	**0.30****	**-0.44****	**0.48****	**-0.32****	**-0.34****	**0.65****	**0.61****	**0.85****												
Stepping Backwards Right Foot	-0.13	0.03	-0.16	0.20	-0.10	-0.13	**0.39****	**0.43****	**0.48****	**0.38****											
Stepping Backwards Left Foot	-0.10	0.13	-0.17	**0.24***	-0.17	-0.20	**0.37****	**0.30****	**0.48****	**0.36****	**0.78****										
Range of Motion Right Ankle	-0.15	**-0.27***	**0.24***	**-0.30****	**0.24***	**0.36****	-0.01	0.02	0.04	-0.01	0.19	0.10									
Range of Motion Left Ankle	-0.22	**-0.24***	**0.22***	**-0.32****	0.21	**0.35****	-0.04	0.01	-0.02	-0.08	0.19	0.03	**0.88****								
Kyphotic Index	-0.10	-0.05	-0.14	0.11	**-0.27***	-0.16	-0.07	0.02	-0.03	-0.09	-0.02	0.03	0.02	0.10							
Falls efficacy Scale		-0.20	**0.45****	**-0.56****	**0.30****	**0.28***	**-0.28***	**-0.31****	**-0.41****	**-0.46****	-0.10	-0.10	0.13	0.15	-0.08						
Quality of Life of the old person		-0.02	0.05	-0.13	-0.07	-0.22	-0.13	-0.16	-0.12	-0.18	-0.18	-0.21	-0.05	-0.10	-0.11	0.01					
Activities of Daily Living		-0.02	**0.23***	**-0.44****	**0.36****	0.13	**-0.28***	**-0.32****	**-0.39****	**-0.37****	-0.19	-0.19	-0.05	-0.06	-0.09	**0.61****	0.15				
Instr. Activ. of Daily Living		-0.01	**0.36****	**-0.54****	**0.36****	0.20	**-0.42****	**-0.49****	**-0.37****	**-0.40****	**-0.25***	-0.10	0.09	0.08	-0.16	**0.58****	0.05	**0.69****			
Emotional Function		0.08	0.12	-0.20	**0.24***	0.13	-0.21	**-0.27***	**-0.26***	**-0.25***	-0.21	-0.16	-0.12	-0.07	-0.17	**0.34****	0.21	**0.50****	**0.49****		
Social Activity		-0.14	0.04	**-0.23***	0.07	0.04	**-0.25***	**-0.26***	**-0.24***	**-0.26***	-0.18	-0.03	0.02	-0.07	0.15	0.16	0.15	**0.25***	**0.38****	0.15	
Quality of Social interaction		0.06	-0.07	-0.14	-0.13	-0.09	**-0.25***	**-0.24***	-0.03	0.02	-0.06	0.04	0.02	0.00	0.02	0.12	0.01	**0.23***	**0.35****	**0.32****	0.18

**. Correlation is significant at the 0.01 level 2-tailed. *. Correlation is significant at the 0.05 level 2-tailed.

In spite of the significant correlations between the studied variables if the determination coefficient (r^2) is used it can be seen that Sit to Stand Test scores only explain 30% of the variability of the Time Up and Go Test scores. The same value was found between Time Up and Go Test scores and two physical tests scores: Stepping Forward with right foot and Falls Efficacy Scale. The other r^2 values were too low to be mentioned.

6.3. Comparison of randomised groups and dropouts at the baseline

In the first 3 months of the home based exercise programme 22 participants, out of the initial 82 withdrew from the study, 17 out of the 39 in the Intervention group and 5 out of the 43 from the Control group. There were no significant differences in the socio-demographic characteristics of those who remained in the home based programme and the dropouts ($p>0.05$) examined by the Chi-squared test (Table 6.12.) (Appendix 11).

Table 6.12. Socio-demographic, living situation, falls, fear of falling, feeling of loss of balance characteristics of participants and dropouts

Variables	Participants (n=60)	Dropouts (n=22)	Sig. Level
Gender (%)			NS
Male	26 (78.8)	7 (21.2)	
Female	34 (69.4)	15 (30.6)	
Nº of years in full time education (%)			NS
≤ 4	21 (65.6)	11 (34.4)	
5-10	16 (80.0)	4 (20.0)	
11-12	7 (63.6)	4 (36.4)	
> 12	16 (84.2)	3 (15.8)	
Marital Status (%)			NS
Married	36 (78.3)	10 (21.7)	
Widowed	20 (66.7)	10 (33.3)	
Others	4 (66.7)	2 (33.3)	
Living Alone (% yes)	18 (64.3)	10 (35.7)	NS
Doing regular walking (% yes)	29 (80.6)	7 (19.4)	NS
Falls in the past year (% yes)	21 (75.0)	7 (25.0)	NS
Fear of falling (% yes)	16 (61.5)	10 (38.5)	NS
Feeling Loss of balance (% yes)	18 (60.0)	12 (60.0)	NS

Using the Mann-Whitney test it was observed that in relation to the measurement characteristics the participants who became dropouts performed the sit and stand significantly less times in 30 sec. ($U= 450.5$ $p<0.05$) and reached laterally less (U= 410,5 $p<0.05$). Participants who dropped out had significant less ankle mobility than the group that was followed up (U= 422.5, $p<0.05$ for the right ankle and U=422.0, $p<0.05$ for the left ankle). The social interaction of the participants that gave up was significantly higher that those who remained in the study (U= 403.0 $p<0.05$) (Table 6.13.).

Table 6.13. Physical and psychological measurements of participants and dropouts

Variables	Participants (n=60)	Dropouts (n=22)	Sig level
Age •	70.8	72.3	NS
Sit to Stand (No in 30 sec.)	13.9 (3.3)	12.0 (3.9)	**0.03**
Time up and Go (sec.)	8.4 (1.6)	9.8 (3.2)	NS
Functional reach (cm)			NS
Forward	27.2 (6.5)	24.3 (7.8)	NS
Lateral	19.4 (6.4)	15.3 (6.1)	**0.009**
Stepping (sec.)			
Forward Right Foot	0.28 (0.08)	0.32 (0.10)	NS
Forward Left Foot	0.29 (0.08)	0.32 (0.12)	NS
Lateral Right Foot	0.29 (0.05)	0.33 (0.09)	NS
Lateral Left Foot	0.29 (0.05)	0.33 (0.10)	NS
Backwards Right Foot	0.31 (0.07)	0.31 (0.07)	NS
Backwards Left Foot	0.30 (0.06)	0.33 (0.08)	NS
Active ROM (degrees)			
Right Ankle	36.7 (11.7)	29.2 (12.0)	**0.01**
Left Ankle	34.7 (12.9)	26.6 (13.7)	**0.01**
Kyphotic Index	10.1 (2.7)	10.3 (2.6)	NS
Falls Efficacy Scale #[(a)]	98 (6)	95.0 (10)	NS
Functional Status Questionnaire #			
Activities of Daily Living[(a)]	100 (11)	100 (11)	NS
Instr. Activ. of Daily Living[(a)]	100 (17)	100 (15)	NS
Emotional Function[(a)]	75 (40)	75 (48)	NS
Social Activity [(a)]	100 (0)	100 (4)	NS
Quality of Social interaction[(a)]	92 (14)	100 (5)	**0.03**
Quality of Life of the old person Φ[(a)]	6.3 (0.4)	6.1 (0.4)	NS

• mean (standard deviation); # scale 0-100; NS ($p>0.05$), Φ scale 0.7-7.3

When comparing the experimental and control groups at baseline, after excluding dropouts (Tables 6.14. and 6.15.) the socio-demographic characteristics (using the Chi-square test) and physical/psychological measurements (using the independent sample t test or the Mann-Whitney test) presented no significant differences ($p>0.05$).

Table 6.14. Socio-demographic, living situation, falls, fear of falling, feeling of loss of balance characteristics in the randomised groups

Variables	Intervention (n=26)	Control (n=34)	Sig. Level
Gender (%)			NS
Male	13 (53.8)	12 (35.3)	
Female	13 (46.2)	22 (64.7)	
Nº of years in full time education (%)			NS
≤ 4	5 (19.2)	16 (47.1)	
5-10	9 (34.6)	7 (20.6)	
11-12	4 (15.4)	3 (8.8)	
> 12	8 (30.8)	8 (23.5)	
Marital Status (%)			NS
Married	18 (69.2)	18 (52.9)	
Widowed	8 (30.8)	12 (35.3)	
Others	0 (0)	4 (11.7)	
Living Alone (% yes)	7 (26.9)	11 (32.4)	NS
Doing regular walking (% yes)	16 (61.5)	13 (38.2)	NS
Falls in the past year (% yes)	8 (30.8)	13 (38.2)	NS
Fear of falling (% yes)	5 (19.2)	11 (32.4)	NS
Feeling Loss of balance (% yes)	6 (23.1)	12 (35.3)	NS

Table 6.15. Distribution of physical and psychological measurements by group after dropouts

Variables	Intervention (n=26)	Control (n=34)	Level Sig
Age	71.1 (3.8)•	70.53 (4.4)	NS
Sit to Stand (No in 30 sec.)	14.0 (2.6)	13.7 (3.8)	NS
Time up and Go (sec.)	8.1 (1.4)	8.6 (1.8)	NS
Functional reach (cm)			
Forward	28.2 (5.3)	26.4 (7.3)	NS
Lateral	19.5 (4.6)	19.0 (7.6)	NS
Stepping (sec.)			
Forward Right Foot	0.30 (0.09)	0.28 (0.07)	NS
Forward Left Foot	0.29 (0.08)	0.29 (0.08)	NS
Lateral Right Foot	0.30 (0.06)	0.29 (0.05)	NS
Lateral Left Foot	0.28 (0.05)	0.29 (0.04)	NS
Backwards Right Foot	0.30 (0.07)	0.31 (0.07)	NS
Backwards Left Foot	0.30 (0.06)	0.30 (0.06)	NS
Active ROM (degrees)			
Right Ankle	38.6 (11.6)	35.2 (11.5)	NS
Left Ankle	36.8 (14.8)	32.7 (11.7)	NS
Kyphotic Index	10.6 (3.2)	9.65 (2.2)	NS
Falls Efficacy Scale [(a)] #	98 (6)	95.0 (10)	NS
Functional Status Questionnaire #			
Activities of Daily Living [(a)]	97.4 (4.42)	95.0 (6.45)	NS
Instr. Activ. of Daily Living [(a)]	96.6 (6.86)	95.8 (7.24)	NS
Emotional Function [(a)]	93.0 (10.26)	87.8 (16.48)	NS
Social Activity [(a)]	74.8 (20.02)	68.1 (26.40)	NS
Quality of Social interaction [(a)]	94.9 (20.42)	87.1 (29.36)	NS
Quality of Life of the old person $\Phi^{(a)}$	6.3(0.3)	6.1 (0.4)	NS

•mean (standard deviation); [(a)] median (interquartile deviation); # scale 0-100; NS (p>0.05), Φ scale 0.7-7.3

6.4. Home-based exercise programme effects on studied variables

The effects of the programme at 3 and 9 months were studied using a series of ANOVA models, including the 3 moments for evaluation (baseline, 3 and 9 months) (Appendix 12). Table 6.16. shows the descriptive statistics for the physical tests and psychological scores at the three time points and the differences between the control and exercise groups at baseline, 3 and 9 months using the independent sample t test for the physical tests measurements and the Mann-Whitney Test for the self reported measures.

The results are described in terms of a profile across time of the control and exercise groups and cross-sectional comparisons at 3 and 9 months between the two groups were made with the significance level adjusted for the number of comparisons performed (3). The results of the ANOVAs and General Linear Model repeated measures, and the tests for the interaction between group and time, are shown in Appendix 12. Estimated marginal means of the dependent variable are predicted, not observed means. The overall mean was used to estimate marginal mean calculations. As mentioned in chapter five in the statistics items for multiple comparisons, the significance level was adjusted for the number of comparisons. For three comparisons a $p<0.016$ was defined .

The average difference in the number of times participants performed Sit to Stand (STS) between the intervention and control groups increased as the time of intervention increased ($F(2,116)=36.2$, $p<0.001$). Significant differences among the intervention and control group were found at 3 and 9 months (Figure 6.16.).

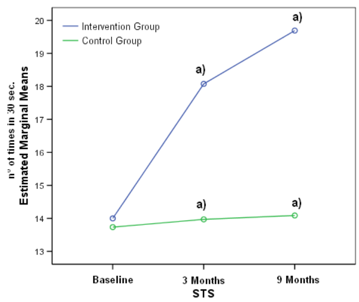


Figure 6.16. Profile Plot of Sit to Stand Test (STS); STS significantly different at 3 and 9 months a) p<0.001

This exercise (STS) was the most physiologically stressful exercise in the home based programme, particularly for the oldest participants. In order to plan the initial number of repetitions and monitoring its performance after 3 months, the participants target heart rate was calculated and the number of times they could sit and stand before it was reached was measured. It was observed, after using Wilcoxon Signed Ranks Test (as the values were not normally distributed) that there was a significant improvement after three months in the mean number of Sit to Stand movements that could be performed before the target heart rate was reached, from 29 to 34 movements (Z=-3.26, p<0.02).

There was a significant difference between the intervention and control groups in the time taken to walk 3 meters; the intervention group always being quicker at Time Up and Go (TUG) than the control group (F(1,58)=30.4, p=0.017). Nevertheless the profile plot of TUG demonstrates that there is a constant difference in the mean values for the two groups on the three evaluations (Figure 6.17.). Only at 9 months did the intervention group perform better than the control group (t=3.67, df= 58, p<0.001).

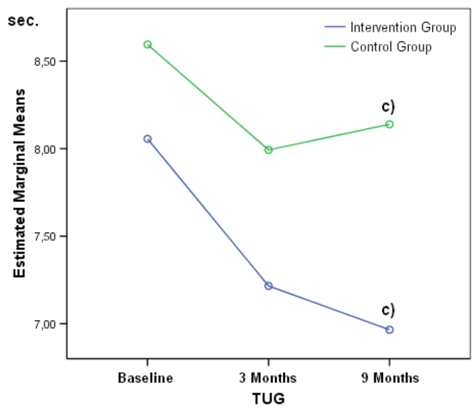


Figure 6.17. Profile Plot Time Up and Go (TUG); significant difference at 9 months c) p<0.001

Table 6.16. Performance in physical tests and psychological scales, scores at baseline, three and nine months after the programme started

	Intervention Group			**Control Group**			**Difference Intervention-Control**		
Variables	**Baseline (n=26)**	**3 Months (n=26)**	**9 Months (n=26)**	**Baseline (n=34)**	**3 Months (n=34)**	**9 Months (n=34)**	**Baseline**	**3 Months**	**9 Months**
Sit to Stand (No in 30 sec.)	14.0 (2.6)•	18.1 (3.0)	19.7 (3.9)	13.7 (3.8)•	14.0(3.1)	14.1 (3.2)	**0.3▲(0.9)**	**4.1 (0.8)*****	**5.6 (0.9)*****
Time up and Go (sec.)	8.1 (1.4)	7.2 (1.2)	7.0 (1.0)	8.6 (1.8)	8.0 (1.8)	8.1 (1.4)	-0.5 (0.4)	- 0.8 (0.4)	**-1.2 (0.3) ****
Functional reach (cm)									
Forward	28.0 (5.3)	32.1 (5.3)	32.9 (5.0)	26.4 (7.3)	28.1 (5.9)	27.4 (6.1)	1.5 (1.7)	**4.0 (1.5)***	**5.5 (1.5) *****
Lateral	19.5 (4.6)	23.7 (7.0)	27.8 (6.0)	19.0 (7.6)	22.2 (5.9)	21.6 (5.8)	0.5 (1.7)	1.5 (1.7)	**6.2 (1.5)*****
Stepping (sec.)									
Forward Right Foot	0.30 (0.09)	0.24 (0.03)	0.23 (0.03)	0.28 (0.07)	0.29 (0.07)	0.29 (0.06)	0.02 (0.02)	**-0.05(-0.05)*****	**-0.06 (-0.06)*****
Forward Left Foot	0.29 (0.08)	0.24 (0.03)	0.23 (0.04)	0.29 (0.08)	0.30 (0.07)	0.30 (0.05)	0 (0.02)	**-0.06 (0.02)*****	**-0.06 (0.01)*****
Lateral Right Foot	0.30 (0.06)	0.28 (0.04)	0.27 (0.05)	0.29 (0.05)	0.30 (0.004)	0.31 (0.04)	0.01 (0.01)	**-0.02 (0.01)***	**-0.04 (0.01)*****
Lateral Left Foot	0.28 (0.05)	0.27 (0.03)	0.27 (0.03)	0.29 (0.04)	0.31 (0.04)	0.32 (0.04)	-0.01(0.01)	**-0.04 (0.01)*****	**-0.05 (0.01)*****
Backwards Right Foot	0.30 (0.07)	0.28 (0.04)	0.28 (0.04)	0.31 (0.07)	0.33 (0.07)	0.32 (0.06)	-0.01 (0.2)	**-0.05 (0.02)***	**-0.05 (0.01)****
Backwards Left Foot	0.30 (0.06)	0.28 (0.04)	0.27 (0.04)	0.30 (0.06)	0.33 (0.06)	0.32 (0.05)	0 (0.016)	**-0.05 (0.01)****	**-0.05(0.01)*****
Active ROM (degrees)									
Right Ankle	38.6 (11.6)	47.1 (11.0)	47.8 (9.1)	35.2 (11.5)	43.5 (9.8)	41.7 (9.3)	3.0 (3.9)	3.6 (2.7)	**6.1 (2.4)***
Left Ankle	36.8 (14.8)	45.9 (11.1)	48.2 (8.4)	32.7 (11.7)	42.4 (9.0)	41.4 (8.8)	4.1 (3.2)	3.5 (2.6)	**6.7 (2.2)***
Kyphotic Index	10.6 (3.2)	9.5 (3.2)	8.3 (2.5)	9.65 (2.2)	9.5 (2.3)	9.5 (2.5)	0.9 (0.7)	-0.08 (0.07)	-1.2 (0.7)
Falls Efficacy Scale [(a)] #	97.4 (4,4)	98.8 (2,5)	99.1 (2.5)	95.0 (6.5)	96,7 (6,0)	96.6 (5.5)	2.4 (1.5)	2.1 (1.3)	**2.5 (1.2)***
Functional Status Questionnaire #									
Activities of Daily Living	97.4 (6.9)	97.9 (7.0)	98.7 (4.8)	95.8 (7.2)	94.4 (9.6)	97.9 (6.7)	1.7 (1.7)	3.4 (2.2)	1.3 (1.6)
Instr. Activ. of Daily Living	71.3 (10.3)	73.9 (9.8)	74.8 (9.6)	67.0 (16.5)	63.2 (21.4)	67.5 (12.9)	4.3 (4.7)	**10.7 (4.5)***	**7.3 (3.0)***
Emotional Function	76.7 (20.0)	69.2 (21.1)	70.8 (15.2)	68.1 (26.4)	63.2 (25.9)	66.5 (25.0)	8.6 (6.2)	6.0 (6.2)	4.3 (5.6)
Social Activity	49.6 (20.4)	55.6 (41.7)	52.1 (41.6)	35.3. (29.4)	41.8 (42.6)	36.3 (42.3)	14.3 (10.2)	13.8 (11.0)	15.8 (10.9)
Quality of Social interaction	90.2 (12.8)	92.9 (6.6)	93.2 (7.9)	91.8 (7.3)	90.5 (9.9)	91.6 (8.3)	-0..7 (2.6)	2.4 (2.2)	1.6 (2.1)
Quality of Life of the old personΦ	6.3 (0.3)	6.1 (0.3)	6.1 (0.3)	6.1 (0.4)	5.9 (0.4)	5.9 (0.4)	0.2 (0.1)	0.2 (0.09)	**0.2 (0.09)***

●mean (standard deviation); ▲mean differences (Standard error); # scale 0-100; Φ scale 0.7-7.3; * p<0.02; ** p<0.001; *** p<0.0001

The average distance reached forward by the Intervention Group at 3 and 9 months was greater than the distance reached by the Control Group ($t= 2.70$, $df=58$, $p< 0.05$ at 3 months and $t=3.76$, $df=58$, $p<0.001$ at 9 months) (Figure 6.18.). Analysing the profile plot of Functional Reach Forward there was a linear increase in the average difference reached forward as the time of intervention increased.

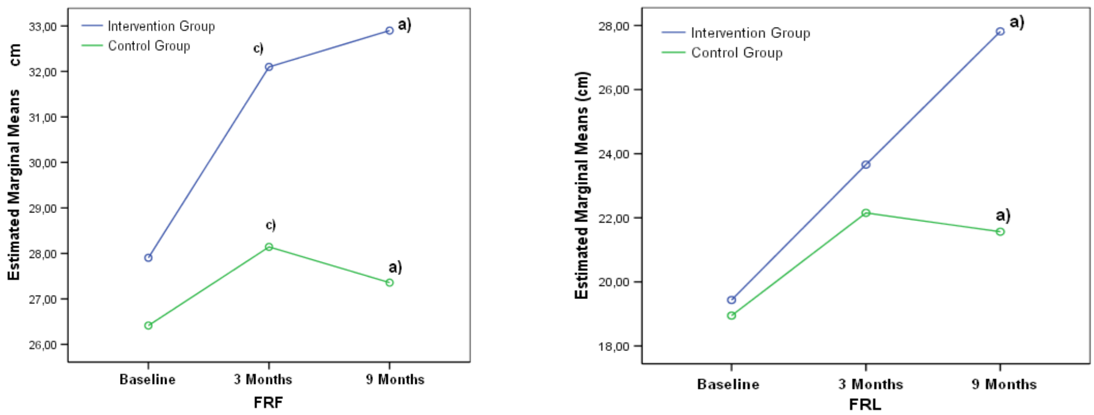


Figure 6.18. Profile Plots of Functional Reach Forward (FRF) and Laterally (FRL); significant differences in FRF at 3 and 9 months; FRL significantly different after 9 months; a) $p<0.001$ c) $p<0.05$

The average distance reached laterally by the experimental groups was not significantly different at 3 months, but at nine months the Intervention Group reached laterally further than the Control Group ($t=4.05$, $df=58$, $p<0.001$) (Figure 6.20.). The profile plot of Functional Reach Laterally demonstrated that there was a steep increase in the intervention group at 9 months.

Stepping voluntarily in all directions (forward, laterally and backwards) was quicker in the Intervention Group when compared with the Control Group both at 3 and 9 months after baseline assessment ($t= -3.60$ to $t=-5.51$, $df=58$, $p<0.05$ to $p<0.001$) (Figures 6.19 to 6.21.). Examining the profile plots of stepping in all directions with both feet it can be seen that as intervention time increased the absolute mean difference in the time taken to step quickly between the experimental groups increased linearly.

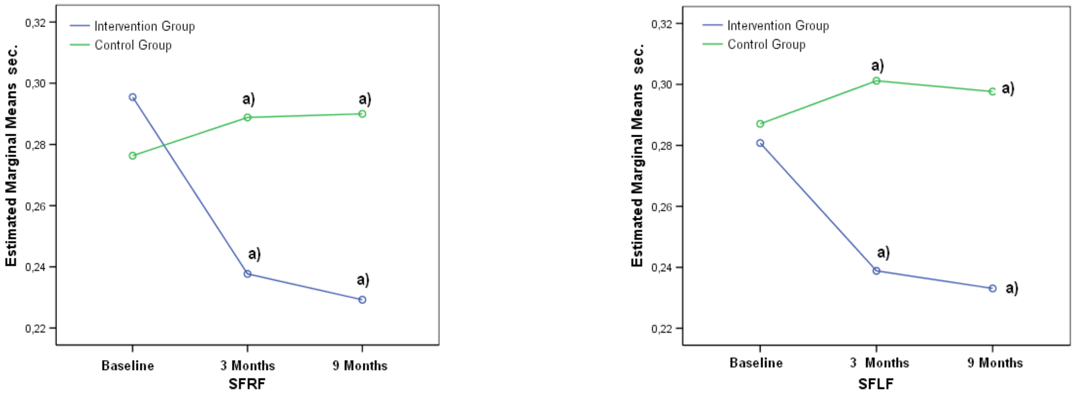


Figure 6.19. Profile Plots of Stepping Forward with Right Foot (SFRF) and Left Foot (SFLF); significant differences at 3 and 9 months; a) p<0.001

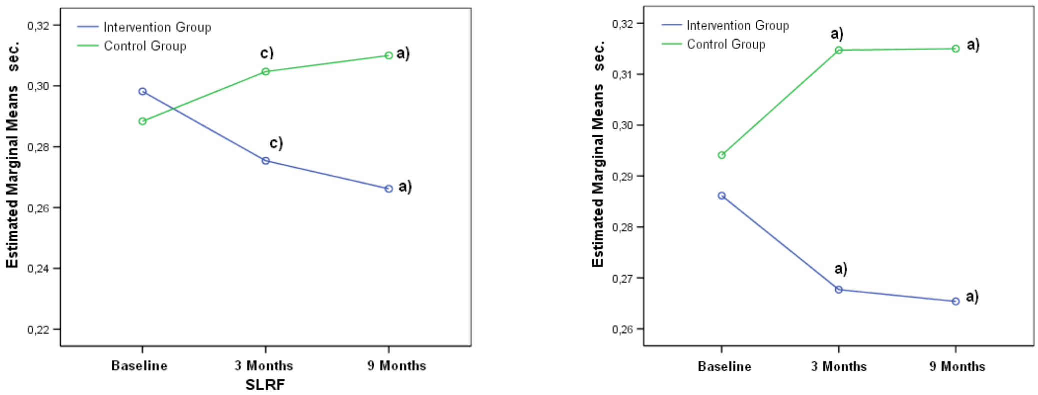


Figure 6.20. Profile Plots of Stepping Laterally with Right Foot (SLRF) and with Left Foot (SLLF); significant differences at 3 and 9 months; a) p<0.0001;c) p<0.05

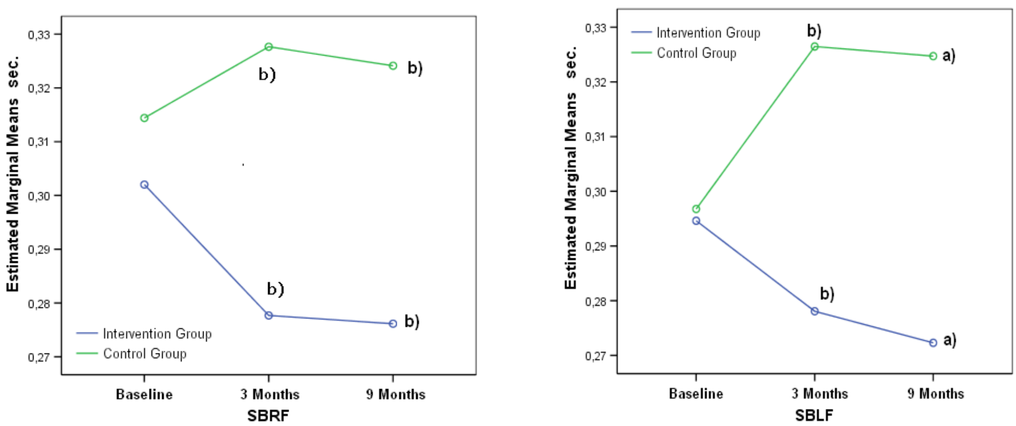


Figure 6.21. Profile Plots of Stepping Backwards with Right Foot (SBRF) and with Left Foot (SBLF); significant differences at 3 and 9 months; a) p<0.001; b) p<0.01; c) p<0.05

Overall the mobility of the both ankles was not significantly different in either of the groups (F(1,58)=3.1, p=0.08), improving in both groups during the first three months (Figure 6.22.). There was only a significant difference among the experimental groups in the mobility of both ankles only at 9 months (t= 2.5 to t= 3.0, df=58, p<0.05).

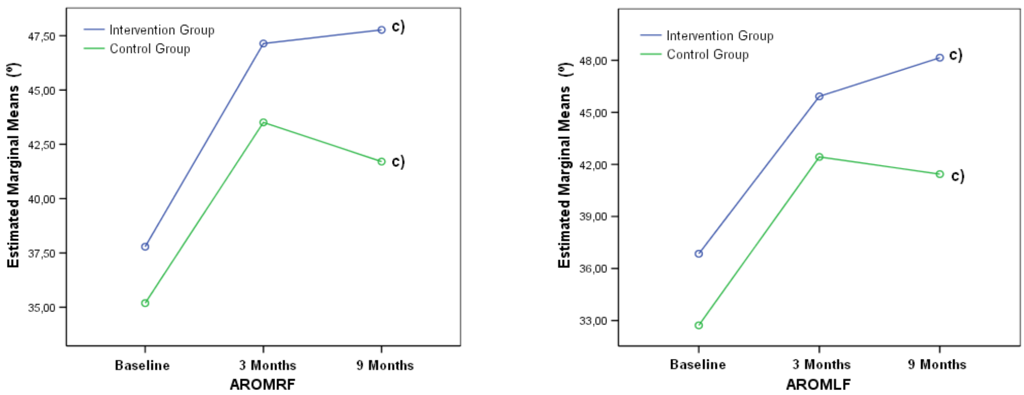


Figure 6.22. Profile Plots of the active range of movement of right ankle (AROMRF). Intervention group improved significantly between 3 and 9 months when compared with the control group; c) p<0.05

In general the average values of the Kyphotic Index were not significantly different in the two groups over the intervention time (F(1,58)=0.04, p=0.08), nevertheless there was a significant interaction between the group and time (F(2,116)=16.5, p<0.001). In the intervention group there was a decrease in KI mean values as the time of intervention increased whereas in the control group KI was almost constant, resulting in a linear decrease in the KI mean difference between groups across intervention time (Figure 6.23.).

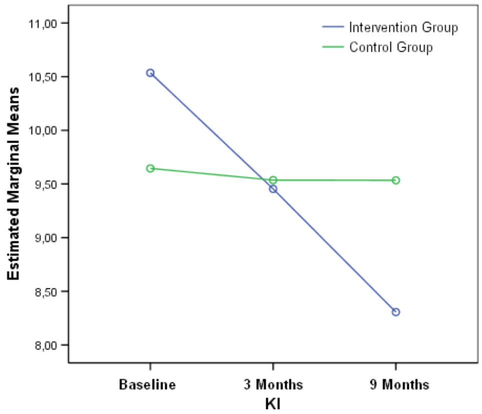


Figure 6.23. Profile Plot of Kyphotic Index (KI)

The average value of Falls Related Self Efficacy (FES) was significantly different in the experimental groups, the intervention group always showing better self efficacy (F(1,58) =4.66, p=0.035). During the intervention time there was a similar increase in mean values of the FES in both experimental groups (Figure 6.24.), resulting in a constant difference across the intervention time.

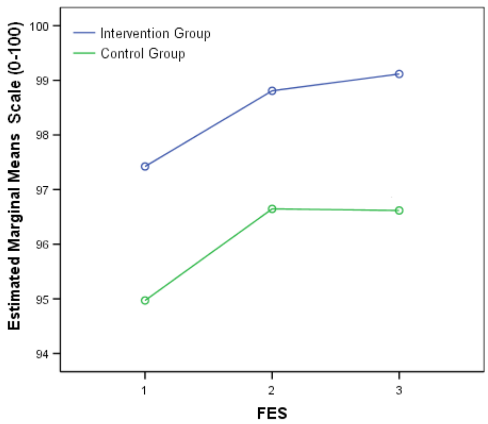


Figure 6.24. Profile Plot Falls related Self Efficacy (FES)

When comparing Intervention and Control groups in the Instrumental Activities of Daily Living there was an overall significant difference (F(1,58)=6.3, p=0.015). Observing the profile plot of the mean values of the Instrumental Activities of Daily Living in the two groups the parallelism of the two lines is visible and no significant time effect was detected (F(2,116)=0.58, p=0.56 (Figure

6.25.). Nevertheless, there was a significant difference between the experimental groups at 3 and 9 months (z=-2.8, p<0.05).

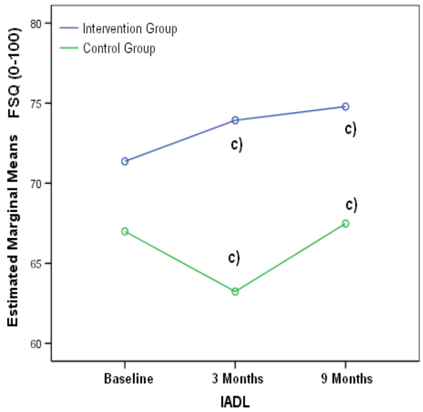


Figure 6.25. Profile Plots of Instrumental Activities of Daily Living. Significant differences at 3 and 9 months c) p<0.05

In the four sub-domains of the Functional Status Questionnaire, Basic Activities of Daily Living (BADL), Emotional Function (EF), Social Activity (SA), and Quality of Social Interaction (QSI) there were no overall significant differences among experimental groups (Figure 6.26.).

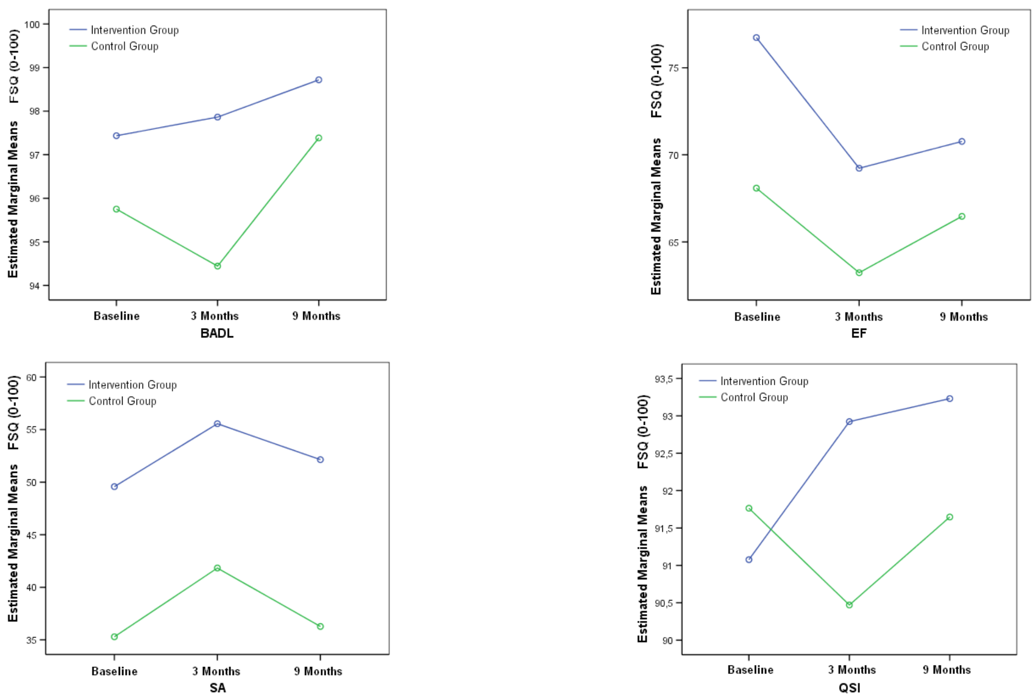


Figure 6.26. Profile Plots of Basic Activities of Daily Living (BADL), Emotional Function (EF), Social Activity (SA) and Quality of Social Interaction (QSI)

When comparing Intervention and Control groups there was an overall significant difference in the mean Quality of Life(QoL) ($F(1,58)=5.4$, $p=0.023$) and for both groups, an overall decrease over the intervention time ($F(2,116)=15.4$, $p<0.001$). Observing the profile plot of the mean values of QoL in the two groups, the parallelism is apparent (Figure 6.27.).

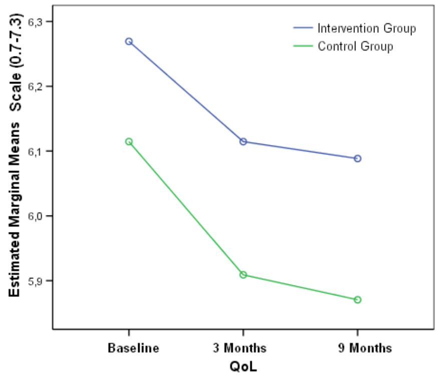


Figure 6.27. Profile Plot Quality of Life (QoL)

6.5. Trial adherence

The mean adherence rate (Number of exercises performed/ Number of exercises scheduled x 100) in the Intervention Group three months after initiation of the home based programme was 79% (median=83% and mode=81%) and after 9 months was 74% (median=76% and mode=74%) (Table 6.17.). No significant differences were found in the mean adherence rate at three and nine months according to the exercises scheduled and performed, after being analysed by the independent sample t test (Table 6.17.) In Figure 6.28. it can be seen that confidence intervals of the mean differences of the exercise adherence rate at 3 and 9 months show a better description of the trends.

Table 6.17. Adherence rate at 3 and 9 months by type of exercise

Programme Exercises	3 Months adherence rate (%) (n=26)	9 Months adherence rate (%) (n=26)	Sig. Level
Total	79.0 (15.0)	74.0 (15.87)	NS
Neck Retraction	80.0 (15.1)	77.3 (15.6)	NS
Neck Rotation	76.9 (20.5)	73.4 (21.4)	NS
Extension Thoracic Spine	79.4 (15.2)	75.6 (15.7)	NS
Upper Limb Elevation	79.1 (15.2)	73.5 (16.5)	NS
Ankle Dorsi and Plantar Flexion	80.2 (15.6)	75.1 (16.2)	NS
Sit to Stand	77.52 (17.8)	72.97 (17.7)	NS
Single Leg Stance	79.8 (17.6)	74.4 (18.5)	NS
Reaching Forward And Laterally	78.7 (16.8)	73.6 (17.7)	NS
Stepping (in 4 directions)	77.1 (17.5)	71.5 (21.6)	NS
Walking	81.1 (14.2)	72.4 (21.1)	NS

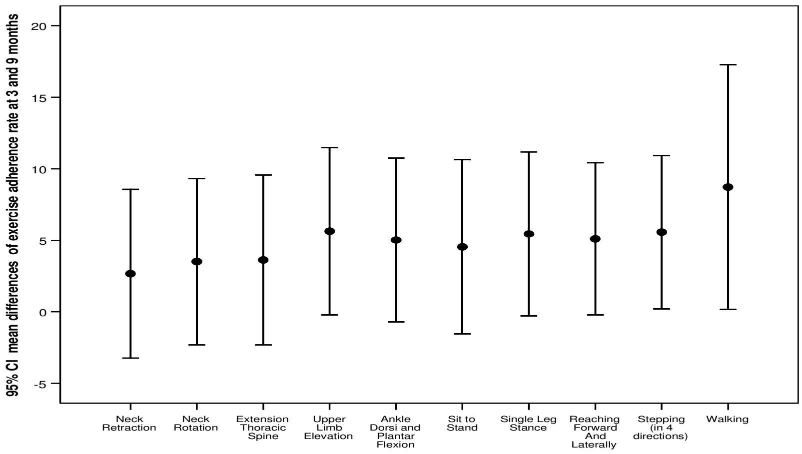


Figure 6.28. Confidence intervals of the mean differences of the exercise adherence rate at 3 and 9 months

No significant differences were found in adherence rates at 3 and 9 months by gender (U = 78.0 p>0.05 and U= 77.5 p>0.05) examined by the Mann-Whitney test. Using the one way Anova and the Post Hoc Sheffé test, it was observed that those aged 70-74 years had higher adherence rates (3 and 9 months), but this was not significant at 3 months. At 9 months the 70-74 years group showed higher adherence when compared with the 65-69 years group ($p<0.05$) (Table 6.18, Figure 6.29).

Table 6.18.. Adherence rate at 3 and 9 months by gender and age

Variables	3 Months adherence rate (%) (n=26)	Sig.	9 Months adherence rate (%) (n=26)	Dif 3-9 Months (%)	Sig. Level
Gender					
Male	80.7 (12.4)•	NS	75.2 (11.0)	5.5	NS
Female	77.3 (17.6)	NS	72.8 (20.0)	4.5	NS
Age (years)					
65-69	71.8 (17.4)	NS	65.4 (16.0)	6.4	**0.035**
70-74	84.8 (12.2)	NS	82.4 (9.8)	2.4	
+75	76.3 (13.0)	NS	65.5 (20.6)	10.8	NS

● mean (standard Deviation)

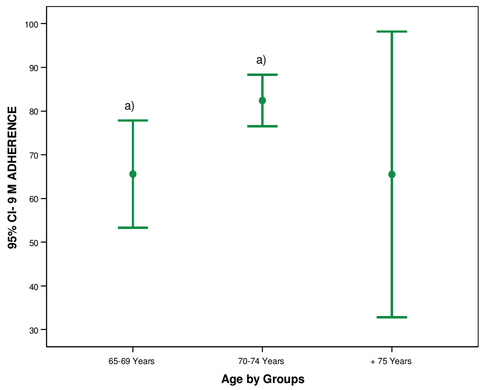


Figure 6.29. Adherence rate at 9 months by age group. a) Significant differences ($p=0.035$)

6.5.1. Relationship between the adherence rate of each exercise and the outcome measures at three and nine months

The correlation between the adherence rate for each exercise and the performance in the tests at 3 and 9 months was analysed by the Spearman Correlation Coefficient (as the distribution of the values was not normal), indicating a negative relationship between the Sit to Stand exercise (exercise 6) and the Stepping exercise (exercise 9) with Time up and Go outcomes at 3 months ($r_s=-0.39$ $p<0.05$ and $r_s=-0.42$ $p<0.05$ respectively) no longer existing at 9 months (Figure 6.30.). One leg standing exercise (exercise 7) was directly related to a better performance of Stepping Laterally with Left Foot (r_s=-0.40 p<0.05). Adherence rate at 3 months for retraction and rotation of the cervical spine exercises (exercises 1 and 2 respectively) was also significantly and positively correlated with Basic and Instrumental Activities of Daily Living (r_s=0.39 p<0.05 and r_s=0.46 p<0.05 respectively).

Stepping Exercise (exercise 9) adherence rates at 3 months showed a significant and positive relationship with Basic Activities of Daily Living (r_s=0.45 p=0.023) and Walking Exercise adherence rates had a significant and positive relationship with Falls Related Efficacy Scale (r_s=0.48 p<0.05).

At 9 months performance of the Sit to Stand Exercise had a significant correlation with Instrumental Activities of Daily Living (r_s=0.39 p<0.05).

As Spearman Correlation Coefficient was used the calculation of the determination coefficient (r^2) was not applicable.

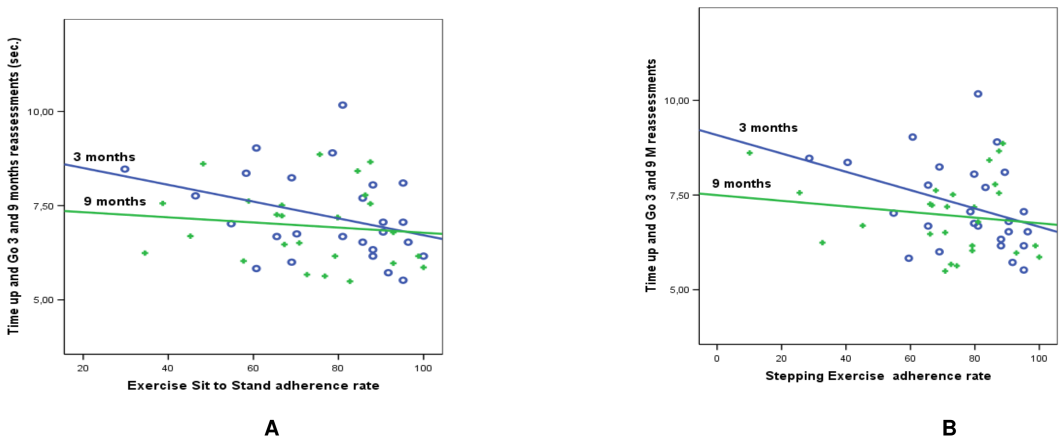


Figure 6.30. A- Correlation between Timed Up and Go and the mean adherence rate of Sit to Stand exercise (exercise 6) at 3 (p<0.05) and 9 months (p>0.05); **B-** Correlation between Timed Up and Go and the mean adherence rate of Stepping exercise (exercise 9) at 3 (p<0.05) and 9 months (p>0.05).

6.6. Effect on studied variables three months after the end of the Home Based Exercise Programme

Three months after ending the Programme (12 months from baseline), the Intervention Group was reassessed a fourth time. During this time they were free to continue the exercises or not.

Not all participants continued exercises. Among the 26 participants, 17 continue the exercises at home and 9 gave up. For the group who continued the exercises, 15 continued exercising on a regular basis and 50% of them did the exercises three or more times a week.

The within group analysis, using the Wilcoxon Test, revealed that the participants that did not continue the exercises presented significant differences at 12 months when compared with their baseline assessment Sit to Stand Test ($Z=-2.6$ $p<0.05$). The other variables did not show any changes.

Comparing the outcomes of the “Continue Exercising Group” at 9 and 12 months a decrease in TUG values was observed, nevertheless remaining as better scores than baseline measures (Table 6.19.).

In the “Continue Exercising Group” Functional Reach Laterally at 12 months was significantly higher when compared with baseline assessment ($Z= -2.2$ $p<0.05$ and $Z= -3.2$ $p<0.05$ respectively) as well stepping forward with right foot ($Z= -2.3$ $p<0.05$), active range of motion of the right and left ankle ($Z= -2.8$ $p<0.05$ and $Z= -2.8$ $p<0.05$ respectively), Kyphotic Index ($Z= -2.2$ $p<0.05$) and Falls Related Self Efficacy (FES) ($Z= -2.5$ $p<0.05$). Nevertheless Quality of Life decreased significantly at 12 months when compared with baseline measurements ($Z=-3.0$ $p<0.05$) (Table 6.19).

The capacity for stepping quicker was maintained in the “Continue Exercising Group” as well as the domains of the Functional status Questionnaire not being affected by the 3 months following the end of the Exercise Programme (Table 6.19).

From all the studied variables, using a Mann-Whitney test, only Stepping Forward with both feet and Stepping Laterally with the left foot decreased significantly in the “Not Exercising Group” when compared with the “Continuing

Exercise Group" three months following the end of the programme (U=24.0 p<0.005, U=29.5 p<0.009 and U=31.0 p<0.02 respectively).

Table 6.19. Variable measurements within the "Continuing Exercise Group" and the "No Exercise Group"

	CONTINUE EXERCISING GROUP					NO EXERCISING GROUP				
Variables	**Baseline (n=17)**	**9 Months (n=17)**	**12 Months (n=17)**	**Diff 12 M Baseline**	**Diff 12-9 M**	**Baseline (n=9)**	**9 Months (n=9)**	**12 Months (n=9)**	**Diff 12 M Baseline**	**Diff 12-9 M**
Sit to Stand (No in 30 sec.) •	14.9 (2.2)	20.6 (3.7)	19.1 (3.6)	**4.2****	-1.5	12.3 (2.6)	18.0 (3.8)	16.2 (2.9)	**▲3.9***	**- 1,8***
Time up and Go (sec.)	8.1 (1.3)	6.9 (1.0)	7.3 (0.9)	**-0.8***	**0.4****	8.0 (1.7)	7.2 (1.0)	7.8 (1.0)	-0.2	**0.6***
Functional reach (cm)										
Forward	27.8 (5.5)	33.1 (5.1)	31.7 (6.2)	3.9	-1.4	28.1 (4.3)	32,4 (4,9)	27.3 (2.7)	-0.8	**-5,1****
Lateral	19.3 (3.6)	26.9 (5.9)	25.9 (6.5)	**6.6****	-1	19.7 (6.0)	29,6 (6,2)	22.9 (3.8)	3.2	**-6,7****
Stepping (sec.)										
Forward Right Foot	0.27 (0.09)	0.22 (0.03)	0.22 (0.04)	**-0.05***	0	0.34 (0.09)	0,24 (0,02)	0.29 (0.07)	-0.05	0.05
Forward Left Foot	0.26 (0.08)	0.22 (0.04)	0.23 (0.04)	-0.03	0.01	0.32 (0.07)	0.25 (0.02)	0.28 (0.04)	-0.04	0.03
Lateral Right Foot	0.28 (0.05)	0.25 (0.04)	0.26 (0.05)	-0.02	0.01	0.33 (0.06)	0.29 (0.05)	0.30 (0.03)	-0.03	0.01
Lateral Left Foot	0.27 (0.06)	0.26 (0.03)	0.26 (0.04)	-0.01	0	0.31 (0.04)	0.27 (0.028)	0.30 (0.04)	-0.01	0.03
Backwards Right Foot	0.29 (0.07)	0.27 (0.05)	0.29 (0.03)	0	0.02	0.32 (0.07)	0.28 (0.04)	0.29 (0.05)	-0.03	0.01
Backwards Left Foot	0.28 (0.05)	0.27 (0.04)	0.29 (0.05)	0.01	0.02	0.32 (0.07)	0.27 (0.04)	0.29 (0.04)	-0.03	0.02
Active ROM (degrees)										
Right Ankle	35.1 (11.4)	46.2 (8.3)	46.0 (8.8)	**10.9****	-0.2	42.9 (8.9)	50.8 (10.4)	49.7 (11.1)	6.8	-1.1
Left Ankle	33.1 (13.2)	45.7 (7.1)	45.5 (9.8)	**12.4****	-0.2	44.0 (10.8)	52.8 (9.2)	51.4 (9.9)	7.4	-1.4
Kyphotic Index	10.9 (3.4)	8.7 (2.7)	8.6 (2.9)	**-2.3****	-0.1	9.8 (2.9)	7.6 (1.9)	9.2 (2.1)	-0.6	**1.6***
Falls Efficacy Scale #(	97.8 (3.8)	98.8 (3.0)	99.4 (1.4)	**1.6***	0.6	96.7 (5.6)	99.8 (0.7)	99.4 (1.4)	2.7	-0.4
Functional Status Questionnaire #										
Activities of Daily Living	98.0 (4.4)	98.0 (5.9)	99.3 (2.7)	1.3	1.3	96.3 (7.9)	100.0 (0)	100.0 (0.0)	3.7	0
Instr. Activ. of Daily Living	74.2 (12.3)	73.2 (11.7)	74.2 (11.3)	0	0	66.0 (23.3)	77.8 (0)	77.8 (0.0)	11.8	0
Emotional Function(a)	76.8 (21.4)	74.1 (15.8)	72.6 (23.7)	-4.2	-1.5	76.7 (18.2)	64.4 (12.4)	66.1 (23.8)	-10.6	1.7
Social Activity(a)	42.5 (37.7)	45.1 (40.2)	45.1 (36.9)	2.6		63.0 (38.5)	65.4 (43.2)	70.4 (49.7)	7.4	5
Quality of Social interaction(a	89.9 (14.8)	93.4 (9.5)	91.8 (9.0)	1.9	-1.6	93.3 (9.2)	92.9 (3.7)	91.6 (8.1)	-1.7	-1.3
Quality of Life of the Old PersonF(a)	6.3 (0.2)	6.1 (0.3)	6.0 (0.4)	**-0.3****	-0.1	6.2 (0.4)	6.1 (0.3)	6.0 (0.2)	-0.2	-0.1

●mean (standard deviation); # scale 0-100; NS (p>0.05), Φ scale 0.7-7.3 ; ***p<0.02, **p<0.005**

To calculate the percentage of gains from nine to twelve months, taking into account the values at nine months the relative variation was calculated. It can be seen that the percentages of variation were very low in the “Continuing Exercise Group”. In the “No Exercising Group” with functional reach and social activity showing the highest percentages (Table 6.20.).

Table 6.20. Comparison between the “Continuing Exercise Group” and the “No Exercise Group” after three months of the end of the programme

Variables	Continue Exercising Group		No Exercising Group		Sig Level
	9 Months (n=17)	Relative Variations 12- 9 months/9	9 Months (n=9)	Relative Variations 12- 9 months/9	
Sit to Stand (No in 30 sec.)	20.6 (3.7)	-0,17	18.0 (3.8)	0,20	NS
Time up and Go (sec.)	6.9 (1.0)	0,04	7.2 (1.0)	0,07	NS
Functional reach (cm)					
Forward	33.1 (5.1)	-0,16	32,4 (4,9)	-0,57	NS
Lateral	26.9 (5.9)	-0,11	29,6 (6,2)	-0,74	NS
Stepping (sec.)					
Forward Right Foot	0.22 (0.03)	0,000	0,24 (0,02)	0,006	**0.004**
Forward Left Foot	0.22 (0.04)	0,001	0.25 (0.02)	0,003	**0.008**
Lateral Right Foot	0.25 (0.04)	0,001	0.29 (0.05)	0,001	NS
Lateral Left Foot	0.26 (0.03)	0,000	0.27 (0.03)	0,003	**0.013**
Backwards Right Foot	0.27 (0.05)	0,002	0.28 (0.04)	0,001	NS
Backwards Left Foot	0.27 (0.04)	0,002	0.27 (0.04)	0,002	NS
Active ROM (degrees)					NS
Right Ankle	46.2 (8.3)	-0,02	50.8 (10.4)	-0,12	NS
Left Ankle	45.7 (7.1)	-0,02	52.8 (9.2)	-0,16	
Kyphotic Index	8.7 (2.7)	-0,01	7.6 (1.9)	0,18	NS
Falls Efficacy Scale (#	98.8 (3.0)	0,07	99.8 (0.7)	-0,04	NS
Functional Status Questionnaire #					NS
Activities of Daily Living	98.0 (5.9)	0,14	100.0 (0)	0	NS
Instr. Activ. of Daily Living	73.2 (11.7)	0	77.8 (0)	0	
Emotional Function	74.1 (15.8)	-0,17	64.4 (12.4)	0,19	NS
Social Activity	45.1 (40.2)	0	65.4 (43.2)	0,56	NS
Quality of Social interaction	93.4 (9.5)	-0,18	92.9 (3.7)	-0,14	NS
Quality of Life of the old person Φ	6.1 (0.3)	-0,01	6.1 (0.3)	-0,01	NS

In summary the nine months home based exercise programme showed very good adherence and positive results relating to those fall risks factors that were targeted. After 3 months of exercise there were significant differences in lower limb strength, balance, stepping in all directions between intervention and control groups. Ankle Flexibility took nine months to improve significantly, but spine flexibility was not influenced by the exercise programme. From the self related measures, Instrumental Activities of Daily Living, a sub domain of the

Functional Status Questionnaire appeared to be improved significantly by the exercise programme.

Three months after the end of the Programme, the gains obtained from the exercise programme were still obvious even in those who had withdrawn. For those who continued with the exercises, significantly better performances in Stepping Forward with both feet and Stepping Laterally with left foot were the only positive changes found, when comparing with “No Exercising Group”.

CHAPTER 7

DISCUSSION AND CONCLUSION

This randomised controlled trial had the aim of analysing the influence of a specific home based exercise programme for older Portuguese people on a range of physical parameters. The parameters chosen were those that have been identified in the literature as being fall risk factors. To accomplish this aim a specific exercise programme was designed, in which every exercise was justified by research evidence. In order to make it uncomplicated and simple to implement in the participants' homes, no equipment was used.

This study had several points worth highlighting. According to the literature from 1994 until 2005, it was only the second home based exercise programme undertaken without equipment, designed as a randomised controlled trial, and it resulted in significant improvements in almost all the physical tests. An extensive review literature failed to reveal any other home based exercise programmes for older people that included thoracic spine exercises and voluntary stepping training. The whole exercise programme was innovative within the Portuguese Health System. Furthermore the programme protocol ensured that the principles of specificity were utilised and exercises specific to the older person's needs and to the physical tests were included. It is a well accepted motor learning principle that in order to become better at a particular exercise or skill, the participant must perform that specific exercise or skill repeatedly to gain optimum improvement.

This chapter includes a discussion of the results of this randomised controlled trial in a Portuguese population belonging to an Oporto Health Centre.

7.1. Sample

The inclusion and exclusion criteria were designed specifically to meet the needs of this research, but the selection of the participants was undertaken by doctors using the predetermined criteria. The use of doctors to select participants was a condition imposed by the Director of the Health Centre and it is thought that this played a major part in limiting the sample size. There were difficulties in persuading these busy professionals to find time to select participants according to the criteria and unfortunately not all the doctors cooperated. Even after the doctors had selected suitable participants, the baseline assessment identified that some participants had to be excluded for not meeting the inclusion criteria and this reduced the sample size even more.

At the three month reassessment point, the number of participants lost from the intervention group (seventeen) was three times more than those lost from the control group. This gives rise to the question as to why this occured, given the regular contact time with the researcher and efforts to maintain participant motivation in the intervention group. The second part of this thesis reports a qualitative study using focus group interviews that was undertaken in an attempt to understand the reasons for adherence and non adherence to the exercise programme.

The sample size in the current study (26 participants in the intervention group and 34 in the control group) was not very large but taking into account the values calculated in chapter four, for a power of 80%, the sample size was considered sufficient to detect significant differences between the intervention and control group. A review of the literature showed that only the study by Campbell et al. (1997) refered to information about statistical power calculation. All other published research about home based exercise programmes omits this information and therefore readers cannot be confident about interpreting their results.

The baseline measurements included the socio-demographic characteristics, physical tests and self-reported measures of the initial 82 participants. The perceived physical state of participants was evaluated by the inclusion of four questions in the socio-demographic questionnaire: (1) “Do you walk regularly?”: to determine the level of physical activity; (2) “Did you fall in the past 12 months”: to determine history of falls; (3) “Do you have fear of falling?”: to analyse the perceived state related to fear of falling; (4) and for perception of balance “Do you feel loss of balance?”. Howland et al. (1998), Mendes de Leon et al. (1996), Tinetti et al. (1988), also included these questions in their studies in order to determine participants’ falls history and related psychosocial issues.

7.2. Description of sample characteristics and measurements at the baseline

The sample consisting of 82 participants presented a high percentage of females (60%) which was in accordance with the results of the National Statistics Institute that indicated “more than a half of the Portuguese old population aged over 65 are females”. It is also consistent with controlled home based exercise interventions in some other countries (Yamauchi et al. 2005, Nelson et al. 2004, Gill et al. 2004, Johnson et al. 2003, Gill et al. 2003, Gill et al. 2002, Robertson et al. 2001, Yates and Dunnagan 2001, Krebs et al.1998, Jette et al. 1996, Tinetti et al. 1994).

It is important to note that a high percentage of participants (39%) had only up to four years of education and this is indicative of the level of literacy of Portuguese women. According to the results of the 2001 Portuguese Census (INE) and using the International Standard Classification of Education (ISCED) it can be seen that more than half of the Portuguese population over 65 (55.1%) was at the level 0 of the ISCED (no education) with women registering lower levels than men. It is important to note that the mean duration of education for the participants in this Portuguese study was 4 years. This is low when compared with other home based interventions for older people. For example, a mean of 11 years of education was reported in Gill et al. (2004), 12 years in Yates and Dunnagan (2001), 10 years in Chandler et al. (1998) and in Jette et al. (1996), all studies from United States, only 2% of the 93 participants had only elementary school education. Gazmararian et al. (2003) state that lower levels of education are related to poorer health literacy and this can influence the adherence to physical exercise programmes. It is therefore possible that this is one of the reasons for the relatively large loss of participants in the first three months of the exercise programme.

It is difficult to compare the baseline values of this study with other published studies with similar samples because their baseline values before dividing into groups are not always presented.

The baseline mean values of the Sit to Stand Test in the sample (number of times of sitting and standing up in 30 seconds) (13.4 repetitions) were similar to the values obtained by Jones et al. (1999), the author of Sit to Stand Test, in its validation study, with a sample with an analogous mean age.

Timed up and Go (TUG) revealed similar baseline mean values (8 seconds) to the 413 community dwelling women aged 65-85 years of the Bischoff et al. (2003) study. In fact these authors proposed a cut-off point of 12 seconds as normal for TUG between these ages. None of the participants in the present study reached the score of 20 seconds considered as functional impairment (Podsiadlo and Richardson 1991).

Functional Reach Forward and Laterally are designed to assess limits of stability in the anterior-posterior and lateral directions. Functional Reach Forward mean values (26.4 cm) in the present study were higher at baseline than the cut off point of 20.3cm defined by Duncan et al. (1992) for older persons and confirmed by Murphy et al. (2003) (mean age 72.3 years, sd 8.6) as a fall risk factor. It is difficult to explain why the participants in this study were able to reach further than those of a similar mean age, reported in previously published studies. One possible reason was the fact that the cut off point was calculated in an American population, different from the population used in this study.

Voluntary Stepping mean time baseline values (0.30 seconds) were slower in this Portuguese Study than analogous studies with a similar mean age. Rogers et al. (2003) found a value 0.20 seconds on voluntary Stepping Forward baseline mean time in response to an electronic auditory beep while trying to investigate the influence of step training on timing characteristics of voluntary stepping. The drawback to Rogers et al. study is that they only had a sample of six participants. The values for the mean time for voluntary stepping laterally and backwards (0.30 seconds) were slower than those reported by Luchies et al. (2002). They found in a sample of 24 older people, with a similar mean age, the same values for all the directions of voluntary stepping (0.18 seconds), with a visual stimulus. The difference in the mean time for voluntary stepping between the present study and the two previously mentioned studies may be due to the devices used to measure the time. Rogers et al. (2003) and Luchies et al. (2002) used forceplates to measure time while in the present study the measurement tool was a photoelectric cells system. Increase verbal commands can influence the speed of voluntary stepping as well the motivation of the participant being important to maintain the same tone of voice in order to avoid any bias. There have been no studies that provide insight into which method of measurement might be the most accurate. In addition it is not possible to know if these Portuguese participants were physically different to those participating in other studies.

Baseline mean values related to the active range of ankle motion and Kyphotic Index were not comparable to any other study because no publications were found using either the same sample group or the same measurement instruments. The research reported here therefore represents an advance in knowledge.

Baseline female Kyphotic Index (KI) mean values (10.4) were lower than the values described by Chow and Harrison (1987) in a study of a small group of somewhat younger participants. For these authors a KI greater than 13 (taken in a relaxed posture) was seen as "a clinically kyphotic". On the other hand Cutler et al. (1993) looking at pre and post menopausal women (1993) proposed using KI thresholds of 10 or 11 (taken in a normal, relaxed posture) to classify an individual as "Kyphotic." Based on Chow and Harrison's criterion, 10% of the older Portuguese women in this study had excessive kyphosis. Using Cutler's criteria, 20% of the women would have been classified as kyphotic. It would be interesting to see whether participants with normal and excessive kyphotic posture performed differently in the functional tasks but because of the measurement method used in this study. It was not possible to divide the participants into feasible categories based on their posture. There are no studies relating kyphotic indexes and different postures. Obviously, additional studies are needed to establish the most specific and sensitive cut-off scores for distinguishing between normal and kyphotic curves in various age and gender groups as it is not established in the literature.

The scores for the Falls Efficacy Scale showed that 40% of the participants scored the maximum (100) revealing a very good self efficacy related to falls. Of concern was the fact that more than a half of the participants showed problems in self efficacy related to falls, which might be explained by the 32% of the participants that stated that they had a fear of falling, 37% reporting loss of balance and the significant relationship between these parameters and Falls Efficacy Scale.

Age was an imperative factor for analysis. As expected older subjects in this study took more time to perform Timed Up and Go (TUG) than the younger because gait speed and stride length decline with age, which agree with reports from Grabiner et al. (2001), Shumway-Cook and Woollacott (2001), Trew 2001a, Buchner et al. (1996), and Lord et al. (1996). Steffen et al. (2002) report an increase of 1 second in TUG performance for each decade of life.

When analysing the baseline data by age Functional Reach Forward performance decreased significantly between the younger group and the older one. This measure reflects the forward stability capacity that involves postural control. This task, as a measure of balance, is clearly affected by the physiological effects of ageing (Shumway-Cook and Woollacott 2000).

Lateral stepping was also associated with age, older participants taking longer time. ($r=-44$ and $p< 0.05$). This was suggested by Lindle et al. (1997) as being due to the decrease of muscle strength and also increase in muscle reaction time (Hultsch et al. 2002, Rudisill and Toole 1992) due to ageing. However when calculating the r^2, age did not explain the slower lateral step (only 19%). Forward and backwards stepping didn't reveal any significant differences between ages and there seems to be no rational explanation for this.

It is important to note that all self reported measures with the exception of Quality of Life presented a ceiling effect in the baseline measurements. The value of these measurements is compromised by their failure to discriminate between small but important differences between individuals and this may have distorted the distribution of the values, because these tests are unable to measure above their ceiling.

Gender was a vital factor of analysis too. Women had previous fallen more than men, consistent with the results of Tinetti et al. (1988) in her community-dwelling population study involving 328 old participants and with Cesari et al.'s (2002) study with 5570 participants. In the study reported here it was a female characteristic "to have a fear of falling" and this agrees with the results of Vellas et al. (1997) and Arfken et al. (1994) and McAuley et al. (1994) who studied similar populations. It has been demonstrated by several authors that the psychological symptom of falls is the fear of falling, which is common among older female adults (Cumming et al. 2000, Lachman et al. 1998, Mendes de Leon et al.1994 and Tinetti et al.1990).

In relation to the physical tests, women presented lower values related to static and dynamic balance (Timed Up and Go, Functional Reach and Stepping) than men. This fact may be related to fear of falling and related to more women stating that they had fallen in the last year. Whilst the Functional Reach Forward values for the whole group were good, when divided by gender results were worse for the women. The men achieved a mean of 29.7 cm and the women only 24.2 cm, which was therefore lower than the Functional Reach Norms by Duncan (1990b) (men-33.4cm) and (women-26.6cm). This may perhaps be due to balance problems as participants in this study were mostly sedentary and this was a contributory factor to decreased balance performance.

Women in the present study were significantly less able in relation to Basic Activities of Daily Life (BADL) and Instrumental Activities of Daily Life (IADL) and had a lower social role performance than men. Similarly more women stated they had fallen and had a fear of falling. According to Tinetti et al. (1994) fear of falling is related to falls, as there is a loss of autonomy, and limitation of movement for fear of further falls, influencing negatively BADL-IADL functioning, interfering too with their social role or social participation. On the other hand as “lower levels of education are related to poorer health literacy” according to Gazmararian et al. (2003) and the women had lower levels than the men, perhaps they had poorer health literacy and this also contributed to them being more disabled than men.

7.2.1. Association between sample characteristics and measurements at baseline

As might be expected the participants who walked regularly revealed better physical test performance related to balance and flexibility. In fact, Functional Reach Lateral (FRL) Test, Active Range of Ankle Movement and Kyphotic Index were better in this group than in the group that did not walk regularly. The better performance observed in FRL can be explained by the fact that walking requires active feedback control for lateral stability by the central nervous system. This causes an adjustment of the lower limb muscles and a medio-lateral foot placement improving lateral stability (Donelan et al. 2004, Krebs et al. 1998).

Those participants who walked regularly presented a better active ankle range of motion than those who did not. Good ankle range of motion is necessary for gait as it needs 10 º of dorsiflexion during swing phase and about 19º of plantar flexion during propulsion after toe off (Vandervoot 2002). This suggests that “walking regularly” considered here as a physical activity, can maintain or improve ankle motion.

Walking regularly seems to have a positive influence on thoracic kyphosis explained perhaps by the action of the erector spinae and the fact that the trunk has an essential role during walking. Together with lower limb and pelvis movements and opposite arm swing, rotational movements of the trunk are also walking characteristics. (Anders et al. 2007, Norkin and Levangie 2000).

The scores from the Instrumental Activities of Daily Living, such as Social activity were better in the “walking regularly” group. Walking improves strength and flexibility reflecting on function and consequently on social activity (Cumming et al. 2000, Howland et al. 1998).

The negative influence that “Living alone” showed on Functional Reach Forward and Lateral, on Stepping Forward, on Basic and Instrumental Activities of Daily Living and on Emotion Function can be related to loneliness. Loneliness here is seen as a "subjective, negative feeling related to the person's own experience of deficient social relations" (Kaasa 1998). Holmèn et al. (1992) showed in a Swedish study with 1725 old participants that one of the main predictors for loneliness was low self-perceived health. This association was also shown by Lindgren et al. (1994) in a Swedish study with sample of 959 participants of 75 years and over. A low self-perceived health reflects intrinsic physical factors and environmental factors that can justify these results. Furthermore an association has been demonstrated between loneliness and a low ADL scores (Holmèn et al. 1992).

The participants in this study who had fallen in the past year and had fear of falling, walked slower during the Time Up and Go test and presented lower functional capacities when performing Activities of Daily Living. Elderly people with a history of past falls have more fear of falling, decreasing self efficacy and have low perceptions of their postural control reducing dynamic balance (Evitt and Quigley 2004, Li et al. 2003, Shummay-Cook et al. 2000, Tinetti et al. 1995). Mendes de Leon (1996) state that high self efficacy is needed to maintain Basic and Instrumental Activities of Daily Living skills in the face of declining physical function. In addition fear of falling might lead to self induced restrictions in activity and a reduction in physical activity participation contributing to a decrease in activities of daily living performance (Lachman et al. 1998).

The group who "feel loss of balance" presented lower scores on Time Up and Go, and Functional Reach Forward and Laterally, Activities of Daily Living and Self Efficacy as ageing affects postural control decreasing balance mechanisms and functional activities (Shumway-Cook and Woollacott 2001).

7.2.2. Correlation among measurements at baseline

Different associations were found between the baseline variables, some of which may be explained and others may be coincidental. In spite of the significant correlations found between some variables described previously the coefficient of determination (r^2) indicating the proportion of the variance of one variable scores that is predictable from the other variable scores the values are not significant.

The relationship observed between height and Functional Reach Forward and Laterally and Stepping Forward and Laterally suggest that height could confound the results of the present study. Taller people may have longer arms and legs leading to the idea that they could reach and step further. Nevertheless, after normalising for height, the results did not change.

Sit to Stand (STS) test used as a lower limb strength measure was associated with Timed up and Go Test (TUG) corroborating Bohannon and Eriksrud's (2001) results that found a relationship with gait performance. If the coefficient of determination (r^2) was used in spite of the significant correlation it could be observed that only 30% of the variation of TUG scores was explained by STS scores. The Sit to Stand Test is associated with the Functional Reach Forward (FRF) and Lateral (FRL) as measures of balance (Brauer et al. 1999, Podsiadlo and Richardson, 1991, Duncan et al. 1990). Lower limb strength would appear to be essential for balance, this statement being supported by several authors who found a relationship between lower limb strength and balance (Lord et. 2002, Guralnik et al. 2000, Shumway-Cook et al. 2000, Buchner et al. 1997, Johansson and Jarnlo 1991, Schenkman et al. 1990). The relationship between STS and ankle active range of motion is related to the biomechanics of standing. In spite of being biomechanically possible to stand up without ankle muscle strength (shifting both feet backwards) in normal individuals ankle dorsiflexor strength is essential when the body weight is shifted from the buttocks to the feet as well as ankle plantar flexor strength after the completion of sit to stand in order to maintain postural stability and balance (Schenkman et al. 1990).

Taking into account that Basic Activities of Daily Living include feeding, toileting, bathing, grooming, walking, and dressing, it is clear the influence of STS in those Basic Activities is explained by the fact that lower limb strength is considered a major contributing factor to the capacity to perform them (McCarthy et al. 2004). The association between muscle strength and self efficacy related to falls was already highlighted by Tinetti et al. (1994).

The Timed Up and Go (TUG) test showed an association with most of the studied variables except the thoracic curve, quality of life, emotional function and quality of social interaction. As TUG involves gait and consequently the mechanisms of balance and postural control it is understandable how it can influence Functional Reach Forward (FRF) and Lateral Reach (FRL) as they are considered dynamic balance activities (Brauer et al. 1999, Duncan et al. 1990). This is so even when only 25% of the variation of FRF scores and 16% of the variation of FRL scores were explained by TUG scores. The TUG test provides a measure of functional mobility in older adults involving those motor skills essential for independent living, explaining its relationship to activities of daily life and consequently social activities (Shumway-Cook et al. 2000, Podsiadlo and Richardson 1991).

In agreement with Hirose et al. (2004) no correlation was observed between TUG and the degree of the Kyphotic Curve. This lack of correlation in the current study and in the work of Hirose are perhaps counter-intuitive.

The strong correlation between FRF and FRL (0.62) can be explained by the fact that both tests are measuring postural stability, being in accord with the studies of DeWaard et al. (2002) (r=0.65) and Newton 2001 (r= 0.61). Even so only 37% of the variation of FRF scores was explained by FRL scores.

Functional Reach Forward was negatively associated with Kyphotic Index being consistent with Chow et al. (2004) who analysed the relationship between the kyphotic index, calculated by means of a flexicurve and Functional

Reach Forward, in a sample of sixteen women aged over 45 years. The variation of FRF scores was explained only by 36% of the flexicurve measurements. Furthermore O'Brien et al. (1997) also found a negative but weaker relationship of these two variables in a sample of 48 women aged over 65 years, with the thoracic curve measured by an inclinometer.

Psychosocial dysfunction caused by impaired functional balance and mobility performance (Means et al. 2003) is a possible explanation for the relationship between Functional Reach Forward and emotional function, as a sub domain of the psychological domain of functioning of the Portuguese Functional Status Questionnaire.

Voluntary stepping was negatively correlated with Self Efficacy related to falls, Basic Activities of Daily Living and Instrumental Activities of Daily Living, Emotion Function, Social Role and Quality of Social Interaction. As voluntary stepping involves a quick contraction of the lower limb muscles, engaging type II fibres, older people who are able to do this quickly may have a greater functional mobility (Brauer and Burns 2002, Shumway-Cook and Woollacott 2001, Luchies et al.1999).

The relationships found between voluntary forward and laterally stepping with strength of lower limbs measured by the Sit to Stand Test (STS), are sustained by Lord et al. (2002) who found this relationship between lower limb strength measured by the STS Test and simple foot reaction time. Furthermore besides the different mechanisms related to voluntary and involuntary stepping the former is related to Time Up and Go (TUG) performance values, as a measure of dynamic balance, and with the limits of stability measured by Functional Reach Forward (FRF) and Laterally (FRL). These findings are supported by Mendell and Alexander (2000), Maki et al. (1999) and Luchies et al. (1999) suggesting that some balance mechanisms are involved in voluntary stepping, such as the capacity for transferring the centre of mass, the step duration and the step length among others.

In this present study active ankle range of motion was related to limits of stability through their positive associations with FRF and FRL. These results are supported by Mecagni et al. (2000) who found correlations between ankle range of motion and the Functional Reach Test in 37 community-dwelling old women ($r=0.63$). Additionally McIlroy and Maki, (1996) stated that sufficient ankle movements are required for the muscular reactions used to maintain the anterior and lateral postural sway on FRF and FRL respectively while Hsu et al. (2005) found a correlation between muscle activity of contra lateral tibialis anterior and soleus and forward ($r = 0.66$, $p < 0.01$) and lateral reaching ($r = 0.68$, $p < 0.01$) in healthy older subjects.

The association observed in the current study between Self Efficacy related to falls and Basic Activities of Daily Living and Instrumental Activities of Daily Living skills had also been found by Howland et al. (1998) and Cumming et al. (2000). Self-efficacy is a psychological factor significant enough to influence the physical performance (Mendes de Leon et al. 1996, Strawbridge et al. 1996, Seemen et al. 1994) and consequently the basic and instrumental activities of daily life (Li et al. 2003).

In conclusion participants in the present study mostly had similar baseline abilities to those observed in other studies on older people. Some of the disparities may have been due to differences in measuring techniques.

7.3. Dropouts at the baseline

It is important to note that 44% of the participants in the intervention group dropped out in the first three months. It seems that adherence rates are usually low, early in the course of new treatments (Schechter and Walker 2002). Jones et al. (1995) and Fiore et al. (1994) found in a study about hypertension treatment and smoking cessation respectively, where dropout rates were higher initially declining afterwards.

Ten of the participants who dropped out in the first three months mentioned lack of time as the major reason of leaving the programme. As referred to on page 83, in Portugal the family is the main support mechanism for older people. It is common for older people to live with their children. As the majority of adults normally work all day, older people normally take care of the grandchildren after school, reducing their availability for any personal projects. On the other hand it is important to be aware that Portuguese people have a huge problem in changing behaviour in relation to their own health that may justify the non appearance of seven participants for the first reassessment (Serra 2005).

Nevertheless the number of dropouts indicates too that motivation during the educational sessions and during the exercise correction sessions each month were not enough. The need to keep attrition rates low influenced the planning of the exercise programme and regular contact with the researcher was built in. Disappointingly this strategy was not as effective as had been thought. It might be valuable in future studies to use an instrument to evaluate the participants' determination to change their behaviour related to exercise. This could enable the physiotherapist to adapt the motivational strategies used.

To answer the question "Why people dropout from this type of programme?" it was decided to undertake focus group discussions with participants from the group who persevered with the exercise and with from the group who dropped out. The purpose was to understand the reasons for giving up; this forms the second part of this thesis.

7.4. Profile Analysis within and between groups of the studied variables

The only home based exercise programme study comparable to the current one was a Canadian one accomplished by Johnson et al. (2003). Their exercise protocol did not include any equipment, it was a four month controlled trial and the objectives were similar to the present one. Exercise progression also had some similarity as they increased the number of repetitions, speed and difficulty. The outcome variables considered by Johnson et al. were Timed Up and Go, Functional Reach Forward, Sit to Stand Test, Falls Efficacy Scale, 6-min-walk Test, and a Short version of Activities-Specific Balance Confidence, the first four using in the present study. Nevertheless in Johnson's work, eight of the ten exercises were performed in standing and only two, getting up from a chair and reaching up and to the front were specific to the outcome variables. The lack of other published work on similar exercise programmes makes it impossible to make a direct comparison, but emphasises that the current exercise programme represents an advance in knowledge.

7.4.1. Improvements at three and nine months

In this study it was observed that the number of times participants were able to sit to stand in 30 seconds increased significantly after three months with the same target heart rate, in the intervention group. This significant increase in the number of repetitions maintaining the target heart rate could be due to several possible physiological adaptations to the exercise. A probable first physiological adaptation was strength gains provoked by the performance of sit to stand exercise daily, seven days a week, that were primarily due to modification of the nervous system that are observed during the first four weeks and later to muscle hypertrophy. A second potential physiological adaptation was an increase in lower limb muscle endurance with higher thresholds of muscle fatigue possible due an increased muscle oxidative capacity. A third plausible physiological adaptation was cardiovascular adaptation with an increase of capillary contacts per myofibre probably required to clear the lactate produced by muscle and a possible increase in VO_2 max (Lambert and Evans 2005, Deschenes and Kraemer 2002).

After nine months of exercise these Portuguese participants showed improvement in most of the physical tests. Sit to Stand Test, Functional Reach Forward, Stepping in all directions and Instrumental Activities of Daily Living improved significantly at three months of intervention and continued improving until the end of the programme when compared with the control group.

The three and nine month improvements in the Sit to Stand (30 seconds) observed in the intervention group were reached using no equipment. The Sit to Stand Test used by Johnson et al. (2003) cannot be used as a comparator because their mode of application was substantially different. The authors used the time in seconds taken to perform five stand ups as quickly as possible. A similar test was used in home based studies by Gill et al. (2004) and Yamauchi et al. (2005) to measure the lower limb strength improvements after using lower limb resistive exercises with therabands. As it was accepted that Sit to Stand Test was used as a lower limb strength measure it can be stated that the results of the current study showed that there is no need to use resistive exercises to increase lower limb strength. The repeated use of the simple sit to stand movement as an exercise, with an increase in speed and decrease in seat height was enough to improve lower limb strength.

After three months of this Portuguese home based exercise programme, the intervention group participants increased the forward limits of stability (Functional Reach Forward) and continued improving until nine months when compared with the control group. In Johnson et al.'s (2003) study, a four month home based exercise intervention with no equipment, produced no improvement on Functional Reach Forward, and in some cases even showed a deterioration, despite the existence of a specific exercise with Functional Reach Forward (FRF) movement in the exercise programme. An explanation may that as the participants in the exercise programme devised by Johnson were doing the exercises on their own most of the time they only had weekly contact with the home-support worker to deliver the weekly reports. FRF movement must be well controlled because any wrong movement, such as unwanted trunk rotation or if the heels rise up when doing the forward movement may reduce the amount of challenge to postural stability. The impact of lower limb strength gain on the performance of the FRF is not yet clear. Sousa and Sampaio (2005) and

Yamauchi et al. (2005) improved FRF with resistive exercises to improve lower limb strength. On the other hand, some home based interventions with a duration between two and a half months, and six months, provided no evidence that lower limb strength training with therabands and ankle cuff weights could positively affect Functional Reach Forward, (Chandler et al. 1998, Campbell et al. 1997, McMurdo and Johnstone 1995). The present study showed that FRF was improved using a home based exercise programme with no equipment, with a specific repeated exercise of the Functional Reach Forward movement. It is argued that this shows the importance of following the principles of specificity.

Voluntary Stepping training in all directions was innovative, in that it was not found as an exercise in either centre based or home based exercise programmes reviewed in the literature. Voluntary Stepping time improved significantly in the exercising group at three months, in all directions, continuing to improve until the end of intervention when compared with the control group. These results are in accordance with a small research programme by Rogers et al. (2003) when they improved completion time of voluntary forward stepping, by training twice a week for three weeks, in a sample of 70 year old participants. However this was not part of a general exercise programme. Furthermore, Hsiao and Robinovitch (2001) after a research programme involving only backward stepping suggested that when training stepping, subjects must undertake steps in all directions using lower extremity strength, flexibility, and endurance. To date this Portuguese study is the only one to undertake step training in all directions.

When the term “Functional abilities” is used it includes a number of activities of daily living and these have usually been split into the two categories; instrumental activities of daily living (IADL) and basic activities of daily living (BADL). IADLs are activities that promote independent living and include telephone use, food preparation, medication administration, driving or travelling, financial management, meal preparation, housekeeping, laundry, and shopping. BADLs are composed of basic, self-care, accustomed behaviours that include feeding, toileting, bathing, grooming, walking, and dressing (Jette 2003). The randomised controlled trial regarded here provides evidence that a home based specific exercise programme can be effective at three and nine months, in increasing function related to Instrumental Activities of Daily Living. The findings are consistent with results from Blair and Connelly (1996) and Miller et al. (2000). These authors stated that physical activity might improve IADL functional capacity and delay the onset of chronic health problems and disease often associated with aging. Most of the instruments employed in determining the effects of exercise programmes for older people do not differentiate between the concept of disability and that of functional limitations (Jette 2003). The evaluation of IADL in this study was associated with functional limitations rather than with the Nagi's disability concept that implies an interaction of the participant's physical or mental limitations with the social and physical factors in the individual's environment.

7.4.2. Improvements shown at nine months

The outcome measures for the exercises related to the Timed Up and Go, Functional Reach Laterally, and Active Range of Motion of ankles took nine months to improve when compared with the control group.

Johnson et al.'s (2003) home based exercise programme, using no equipment, found significant improvements after 4 months of intervention in the Timed Up and Go, while in the present study it took nine months to improve significantly. A probable explanation is that the participants of Johnson's study were older (82 years) with lower baseline mean scores (35 seconds) than the participants of the present study (8 seconds). People higher initial scores have greater possibility to show improvement (Mancuso et al. 2003).

Functional Reach Laterally is an accurate measure of lateral reach ability and consequently of balance (Brauer et al. 1999). It is a complex movement that involves participants' motor skills, and learning time, which might explain the late improvements (only at nine months) observed in this study.

Active range of motion of both ankles was a specific exercise in this home based exercise performed without equipment and it was an exclusive outcome, as it was not used in any other similar study. Although improvement in ankle range of motion are quoted as outcomes of home based exercise programmes and centre based programmes using resistive exercises (Sohng et al. 2003, Yates and Dunnagan 2001). The time taken to achieve significant improvements in ankle range of motion may be related to the fact that these were non weight bearing exercises. In spite of the lack of evidence about the differences in passive versus active stretching perhaps if weight bearing stretching exercises had been used, (using body weight to stretch the muscles) the improvements would have taken place earlier.

7.4.3. No improvements

The nine months of intervention seemed to have no statistically significant effect on reducing the Thoracic Curve, on improving fear of falling (measured by Falls Efficacy Scale), Basic Activities of Daily Living, Emotional Function, Social Activity and Quality of Social Interaction and Quality of Life.

The improvement in the Kyphotic Index profile of the thoracic spine in the intervention group, though statistically not significant, showed marked improvement at nine months. This lack of significance can be related to the differences present in the two groups at baseline. Another possible explanation might be that the flexicurve is not responsive enough to detect small clinically important changes. Another possible explanation is that the exercises to decrease the thoracic curve were not effective. Due to the lack of evidence of the influence of exercise programmes for older people on the thoracic curve it was not possible to compare with other studies.

The Falls Efficacy Scale did not improve in the present study and similarly no improvement was seen in the Johnson et al. (2003) study of four months duration. This scale, as well as Basic Activities of Daily Living, Emotional Function, Social Activity and Quality of Social Interaction, sub domains of the Functional State Questionnaire, showed a ceiling effect, in that a great number of participants were already achieving high scale values when measured at baseline (85% of the intervention group participants showed score higher than 85), giving participants little chance to improve. This is a possible reason for the lack of significant results following the intervention. Another reason that can be associated with the ceiling effect of the self-reported measures is that the capacity of older people to recognize their ageing is sometimes limited. If older people can execute a task, they are not necessarily aware about functional decline because they are not aware of the increased time to complete the task, or of modifications they made to complete it or of the decreased frequency in which they performed the task (Brach et al. 2002). The researcher suggestes that Falls Efficacy Scale and Functional State Questionnaire were not sensitive enough measures for this study.

Quality of Life (QoL) scores decreased during the intervention time in the present study in both groups (0.2 points), but at nine months the intervention participants revealed a better QoL than the control group. Taking into account that the emotional condition of the individual can be seen as a perceived barrier (The Health Belief Model) may have influence on self reported measures, it is important to mention that older people may pass long periods alone, having moments of sadness that could coincide with time of filling the self reported tests. This possibly explains the decrease in the QoL values. It is hoped then that this is not a true reflection of the quality of life of the participants and their enjoyment of life did not deteriorate over a nine month period. This reveals a lack of sensitivity of the questionnaire. Self reported measures always have a subjective bias as the exact phrasing and succession of questions, answer plans, environment of the interview and emotional condition influences responses (Roberts 2005).

The exercise programme was effective in improving Timed up and Go, Sit to Stand, Functional Reach, Voluntary Stepping, active ankle range of motion and Instrumental Activities of Daily Living in the intervention participants.

The control group showed a statistically significant worsening in almost all the measured parameters at the end of the nine months.

7.5. Analysis of trial adherence

Adherence rate to the exercise programme was based on self reports. It was measured using the log books distributed to intervention group participants. They were encouraged to make a daily report of the exercises performed in order to track the exercise programme performed at home. It is acknowledged that there is no consensus in the literature about the accuracy of self-reporting. Arts et al. (1996) a good level of agreement between observation and self-report among home help services whereas Van der Beek et al. (1994) found poor agreement. It was hoped that the act of completing the log sheets might encourage the participants to continue with the exercises as well as giving the researcher an idea of the intensity of the exercises that were being undertaken.

The mean adherence rate was calculated using the ratio between the number of exercises performed by the participants of the intervention group and the number of exercises that they were asked to perform. This method was used by Nelson et al. (2004), Jette et al. (1996) and Tinetti et al. (1994) in home based interventions. The mean adherence rate observed in the present study at 9 months (74%) was higher than the one observed by Tinetti et al. (1994) after 4.5 months intervention (58%) and Jette et al. (1996) at 15 weeks intervention (73%). Only the 6 months study from Nelson et al. (2004) reported a higher rate (82%). Nevertheless it must be considered that the present study was the longest one and it should be noted that long term adherence is difficult, thus longer interventions might be expected to have poorer adherence. The results reported in this study can be considered to indicate good adherence (Schechter and Walker 2002).

The mean adherence for the oldest group was similar to the younger groups but with more variability in the adherence rate.

A correlation between each exercise adherence rate and the outcomes measures of each variable was done in order to ascertain if the number of times each exercise was undertaken had influence on the outcome.

Stepping and sit to stand exercises adherence rates were correlated negatively and positively respectively with the results of the Basic and Instrumental Activities of Daily Living, showing the importance of balance maintenance and lower limb strength in daily activities in older people. The walking exercise adherence rate showed a significant positive association with the Falls Efficacy Scale. It is hypothesised that the improvement in dynamic balance with walking training increases physical activity in older people decreasing fear of falling and consequently increasing self efficacy (Cumming et al. 2000). Even with significant associations between the previous variables, the determination coefficient values indicated a low variation (around 16%) of the Basic and Instrumental Activities of Daily Living scores predicted Stepping and Sit to Stand exercise adherence rate values and Falls efficacy Scale values and walking exercise adherence rate.

The association between the adherence rate of a specific exercise and related measurable tests, such as Sit to Stand exercise and Sit to Stand Test, Stepping exercise and Stepping Test, Functional Reach Forward and Laterally exercise and Functional Reach Forward and Laterally Test, was tested but no correlations were found. This lack of correlation questions the specificity principle of training. There could be several explanations, such as small sample size, lack of precision of self-reports, the exercise not being performed properly and non completion of the specified number of repetitions. Cramer et al. (1990) state that self-reports typically provide misjudgements about adherence as they rely on participants' own understanding or memory of what recommendation was given and how closely it was followed. Participants may be inclined to state higher levels of adherence in order to please health care professionals or avoid shame (Cramer et al. 1990). This could have happened in this study as all the participants had an empathy with the supervisor.

In addition it was noted that adherence increased as the time of the appointment with the health professional drew closer. This could be due to the way Portuguese patients think about their health responsibility. For them it is the health professional who take care of them and is responsible for this situation. There is often a kind of paternalism in treating patients in Portugal and many health professionals use very technician language that makes the situation difficult to understand for an ordinary patient who may present with a low level of literacy. The patient himself feels that the situation is more comfortable when he allows the health professional to take care of him. (Serra 2005).

7.6. Effect on studied variables three months post intervention

Three months after the end of the programme, the intervention group participants were reassessed to examine how long improvements have been maintained. It was observed that 35% did not continue the exercises after the programme ended. This may be explained by the fact that the researcher stopped meeting with the participants once the programme ended and for some people the motivation to continue was dependent on the presence of a health professional, or that they were bored with the exercises as these had been modified at three months but were the same for six months.

Analysing the data of the non-exercising group three months post intervention, the data demonstrated a significant decrease in Sit to Stand Test, Timed Up and Go test, Functional Reach Forward and Laterally tests and in the Kyphotic Index. These findings showed that strength, balance and flexibility gains were the first to be lost, reinforcing the need to maintain this programme in order to improve their functionality. When comparing the three months post intervention values with their baseline values there was still an improvement in the number sitting and standing times in 30 seconds over baseline. These findings were consistent with Toraman and Ayceman (2004), and in spite of the difference of the programme structure (with resistive exercises), it has the same duration (nine months). The authors found significant losses after two, four and six weeks of detraining in all the outcome variables (Timed up and Go, Sit to

Stand Test, Arm Curls, Six Minute Walk test, Chair Sit and Reach and Back Scratch) but never below the baseline values (Toraman and Ayceman 2005, Hakkinen et al. 2000, Ivey et al. 2000).

The continuing exercise group showed an overall decrease in all variables at three months after completion when compared to the values at the end of the programme, although the only significant decrease was in the Timed Up and Go test. When comparing variable values at three months post intervention with baseline values they were better in general, still showing significant improvements in Sit to Stand Test, Timed Up and Go, Functional Reach Laterally, Stepping Forward with right Foot, active range of motion of both ankles, Kyphotic Index, Falls Efficacy Scale and Quality of Life reinforcing the benefits of physical activity.

When comparing both groups, the continuing exercising and the non exercising group after three months post intervention, the latter decreased significantly in the number of times they could step forward and laterally. These cannot be seen as a detraining effect as, when comparing these results with nine months of intervention and baseline values, there was no significant deterioration. The difference is due certainly to an increase in stepping performance in the group that continued exercise.

One common problem to all exercise programmes accomplished by older adults is that the acquired functional gains are lost once the programme ends. Every attempt must be made to implement long-term exercise interventions that promote continued adherence. For this it is urgent to modify the plan and the implementation strategies of exercise interventions to improve adherence over time; example regular meetings with supervisors to improve motivation, modify exercises frequently to avoid participants getting bored or assess participants more often in order to show them objective amelioration.

7.7. Conclusion

Developing a safe and effective home-based specific exercise programme for older people is essential for physical activity promotion in this, the fastest growing population in Portugal.

The first aim of this thesis was to design and implement a home-based, moderate intensity, specific exercise programme for older people focusing on fall risk factors and this was completed. The exercise programme that was designed was based on the principles of specificity, and all the exercises were related to function. Emphasis was placed on targeting specific fall risk factors (strength, flexibility, balance and voluntary stepping time). The design and the delivery of the programme worked well.

The second aim was to assess the effect of a nine month, home based moderate intensity specific exercise programme on the fall risk factors and this was achieved. It provided new evidence that a specific home based exercise programme without equipment for older individuals, could improve ankle flexibility, lower limb strength, balance, time of voluntary stepping, all of which are considered fall risk factors. Nevertheless the present home based exercise programme did not decrease the fear of falling of the participants. It was not within the remit of this research to measure the effect on the number of falls, however the exercises in this programme were chosen because it was hoped to show that they might have a positive effect on fall risk factors. Although the effect on falls was not an outcome it can be speculated that if the factors that are directly related to falls have improved, falls may well be reduced too.

The adherence rate of those participants who stayed with the programme after three months was considered as good, even though their level of literacy suggested it might be otherwise. Nevertheless strategies to improve adherence must be always present in a physiotherapist’s mind, such incorporating more educational sessions or using spouses and friends for peer support.

Three months after the end of the programme, those who continued with the exercises showed statistically significantly better performances in Stepping Forward with both feet and Stepping Laterally with left foot when compared with the participants who stopped exercising.

Most of the physical gains were maintained three months after the end of the programme both in the group that continued to exercise and in the group that didn't.

The programme appears to be an easy and safe alternative to promote physical activity in Portuguese older persons as it can be implemented at home or in any institution. Because it doesn't involve any special equipment; the level of intensity is low to moderate intensity and exercises are easy to do and understand.

PART II

QUALITATIVE STUDY

INTRODUCTION

A quantitative study described earlier in this thesis took place in order to measure the effectiveness of a nine month home based exercise programme which aimed to improve muscle strength and endurance, spine and ankle flexibility, balance and voluntary stepping, all considered as falls risk factors in older people. The fact that of the initial 43 persons in the intervention group, seventeen dropped out within the first three months of home exercise, created a need to explore why some people adhered to the whole programme and others didn't.

In order to further elucidate the reasons for participant's adherence and non adherence it was decided to employ a qualitative approach using phenomenology. This approach permitted the exploration, description and interpretation of the participants' lived experience in this home based exercise programme.

The researcher, in this approach, is a research instrument and when seeking participants' perspectives he/she must be alert, and protect himself/herself against personal discrimination and preconceptions in data gathering and interpretation (Cobb and Forbes 2002).

The qualitative approach, besides exploring subjective perspectives, focused on factors that can contribute to adherence in a specific home based exercise programme. By undertaking the study it was hoped that it would further clarify some results of the quantitative study related to outcome measures (Brannen 1995).

Focus group discussions among people who have lived a common experience are used to generate data because interaction between the participants is wanted. Instead of the facilitator asking each participant to answer a question in turn, they are persuaded to talk to one another asking questions, and making commentaries on each others' experiences and points of view. This method is particularly useful for exploring people's knowledge and experiences and can be used to examine not only what people think but how they think and why they think that way (Kitzinger 1995).

The selection of the sample in this qualitative study was a purposive sample. Participants were deliberately chosen from the intervention group of the controlled randomised sample of the previous quantitative study. One focus group was formed of the participants who had adhered to the home based exercise programme for nine months, called the adherent focus group, and the other by the participants who dropped out within three months, called the non adherent focus group. The purposive sampling was based on a cultural and gender heterogeneity and availability to meet on a selected day and hour.

The facilitator presented open-ended questions to the group. According to Morgan and Krueger (1997) opening questions are questions that are easy-to-answer and help people share and discover common interest. Introductory questions lead to the main theme of the study and transition questions deepen the conversation and move it towards the key questions. Key questions drive the study, directly addressing the goals of the study and ending questions summarize and provide closure of the focus group session Morgan and Krueger (1997).

A literature review about psychological models, theories and constructs related to exercise adherence and their relevance for physiotherapists when designing and implementing an exercise programmes is included in chapter eight.

The methodology used for focus groups sessions and analysing data are included in chapter nine.

Chapter ten illustrates the findings of the focus groups sessions and chapter eleven the discussion and conclusion of this qualitative study and chapter eleven contains the qualitative study discussion and conclusion.

Chapter twelve includes the epilogue linking the quantitative and qualitative studies.

CHAPTER 8

PSYCHOSOCIAL THEORIES AND MODELS RELATED TO EXERCISE PARTICIPATION

This chapter describes the relevant psychological and social theories, models and determinants that explain exercise adherence in older people.

For older people being inactive can be a large problem (Van der Bij et al. 2002, Haskell and Phillips 1995) and participation in regular exercise programmes is recognised as one of the most important health behaviours connected with prevention of fall risk factors and well being among older people.

Terms related to exercise participation such as compliance, adherence or more recently concordance are used in the literature involving exercise programmes for older people.

According to Brawley and Culos-Reed (2000) and Mullen (1997) compliance has a connotation of submission to health professional instructions where the client has an inactive role, following the professional faithfully without questioning.

Whilst according to Brawley and Culos-Reed (2000) adherence implies that people have the freedom to choose to undertake the programme, and have a contributing and collaborative involvement in developing and adjusting what happens.

Exercise adherence also refers to the level of participation achieved in a behavioural regimen after agreeing to participate in an exercise intervention (King et al. 2001). For Milroy and O'Neil (2000) adherence is the ability to be consistent with a task believing that there will be some expected results in continued participation in that activity.

Over the last few years, some sociological critiques about the terms "compliance" and "adherence" argue that these two concepts do not do any justice to the complexity of illness (Bissell et al. 2004). Health care relationships must be seen as a space where the knowledge of both patients and health professionals can be changed in order to agree goals. Using this point of view the members of a working party of the Royal Pharmaceutical Society of Great Britain suggested that the developing of "concordance" between health professionals and their clients, become a negotiation between equals, their aim being a therapeutic alliance (Working Party 1997).

For Weiss and Britten (2003), compliance measures behaviour while concordance measures a process.

Due to the characteristics of the quantitative study described in Part One of this thesis, the term "adherence" was considered the most appropriate for the level of participation of older Portuguese people in this exercise programme.

Adherence to exercise suggests a behavioural change that can be explained by various theoretical approaches. No one theory has all the answers and solutions and there is probably an overlapping of all the theories in real life situations (Epstein 1998)

The theories and models of behavioural changes described below can be very useful for physiotherapists who intend to design exercise programmes. They will enable them to take the necessary measures to overcome possible barriers related to individual beliefs and attitudes.

8.1. The Health Belief Model

The Health Belief Model (HBM) developed by Becker and Maiman (1975) and Rosenstock (1974), is *"a psychological model that tries to give details and predict health behaviours, focusing on persons' attitudes and beliefs"*. This model proposes that a person will take health-related action (i.e., doing regular physical exercises) if that person:

1. Feels that he/she can stay away from a negative health condition (i.e. decreasing mobility)

2. Has a positive hope that, by doing an advised action, he/she will avoid a harmful health condition (i.e., doing physical exercises will be effective in preventing lack of mobility)
3. Considers that he/she can accomplish an advised health action with success (i.e., he/she can do an exercise programme comfortably and with confidence).

The HBM key variables are as follows (Rosenstock et al. 1994) (Figure 8.1.):

1. *Sociodemographic variables* such as gender, education, race and ethnicity.
2. *Expectations*
   a. Perceived benefits represent the individual's belief in the effectiveness of taking a specific health action. The benefits could include improved physical capabilities, social support, or enjoyment from the exercise itself (Coats et al. 1995).
   b. Perceived barriers relate to the potential negative aspects of adopting particular health behaviour, such as the time involved, the physical effort required to exercise or that exercise programmes interfere with the individual's daily life.
3. Perceived self efficacy to perform action or the confidence in their ability to successfully execute an action
4. *Perceived Threat*
   a. perceived susceptibility refers to the personal perception of the threat of dealing with a particular health problem
   b. perceived severity relates to the sensations concerning the importance and consequences of contracting a health problem
5. *Cues to action* could be bodily (physical) symptoms or media publicity or environmental events that motivate people to take action.

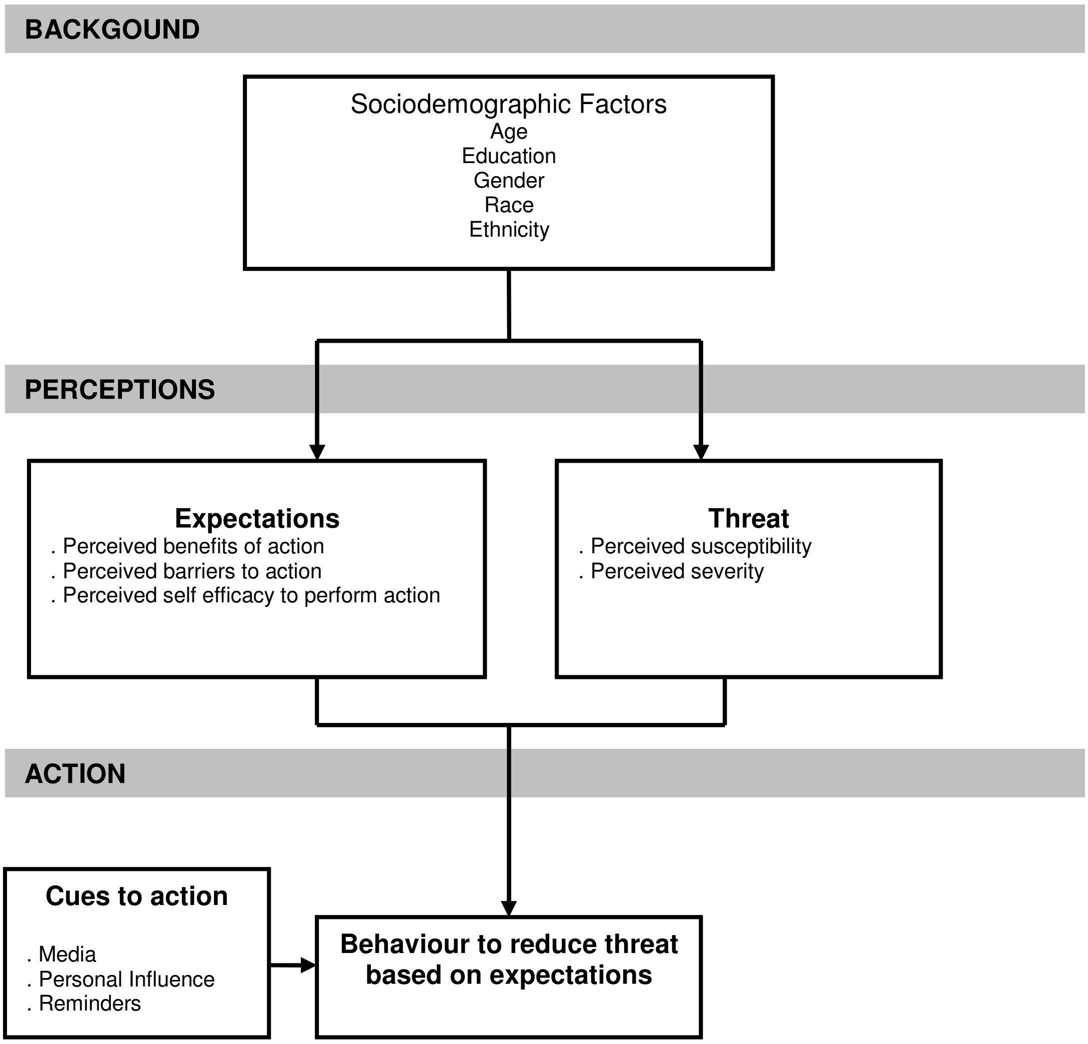


Figure 8.1. The Health Belief Model variables (Adapted from Rosenstock et al.1994)

The Health Belief Model helps individuals' decision making and motivation to participate in exercise programmes on the basis of perceived expectations, threats and information. This model assumes that people fear diseases related to inactivity and that health actions are motivated in relation to the degree of fear (perceived threat), assumptions that on some occasions are not present (Bissel et al. 2004).

8.2. The Transtheoretical Model of Behaviour Change

The Transtheoretical Model of Behaviour Change (TMBC) was developed by Prochaska and DiClemente in 1982, as a method of stopping negative behaviours such as smoking, alcohol and drug abuse, and can be applied to achieve and adhere to positive behaviours such as exercise.

One challenge of home based exercise programmes is determining whether older persons are interested in changing their life styles, and in changing their behaviours. TMBC postulates that the process of behaviour change related to issues such as exercise occurs in the following stages:

1. *Pre-contemplation* where the subject has no intention to change his/her behaviour e.g. perform physical activities
2. *Contemplation* where the person is thinking about changing; for example about participating in an exercise programme
3. *Preparation* where the person makes a concrete plan to change as, for example, buying training shoes or making any appropriate environmental modifications
4. *Action* where the person begins changing in an open way and on a regular basis as a regular participation in an exercise programme
5. *Maintenance* where the behavioural changes (physical activity) are maintained for more than 6 months
6. *Termination* when they maintain their behaviour for more than five years, have no temptation to engage in the undesired behaviour such as sedentarism, and have the necessary self-efficacy to engage in the desired behaviour. (Prochaska & Velicer, 1997).

Prochaska and DiClemente (1982) suggested that behavioural change is a repeated process, persons moving back and forth between the stages, with periods of going back to earlier stages. In successful behaviour change, individuals revert but continue until they arrive at the maintenance stage.

The “Stages of Exercise Change Questionnaire” designed by Reed et al. (1997) is an instrument that assesses the stage where people are before they adhere to a programme. It gives the opportunity of knowing in which stage the participant is and enables the planning of strategies to deal with the participant during the exercise programme. This questionnaire was not used before and during the home based exercise programme described in part one of this thesis as there was no validated Portuguese version.

The transtheoretical model proposes a set of constructs that are thought to influence movement through stages of change. These constructs include the processes of change, decisional balance and self-efficacy. The processes of change are the cognitive and behavioural strategies used for changing behaviour and moving through six identified stages (Burbank et al. 2002).

Prochaska and DiClemente (1982) and Prochaska et al. (1992) identified ten basic processes or strategies people use to change behaviour. Five processes are cognitive in nature while five have a behavioural focus (Table 8.1.).

Table 8.1. The processes people use to change behaviour (adapted from Prochaska and Velicer (1997)

PROCESSES OF CHANGING	
Cognitive Processes	**Description**
Consciousness raising	Seek new information about exercise (e.g. reading about the benefits of exercising in old age)
Dramatic Relief	Experience and express intense feelings about being inactive
Environmental re-evaluation	Assess how being inactive affects physical and social environments (e.g. thinking about how inactivity affects family and friends)
Self re-evaluation	Re-appraise values regarding inactivity (e.g. the more time I will be on the sofa the less lower limb strength I will have)
Social liberation	Develop awareness and acceptance of an active lifestyle
Behavioural Processes	**Description**
Counter-conditioning	Substitute alternative behaviours for sedentary activities instead of remaining inactive (e.g. to go walking to the grocery shop instead of going by car)
Helping relationships	Use support from others to be more active (e.g. finding a family member to provide support for physical exercise)
Reinforcement management	Change contingencies; reward physical activity (e.g. admiration from the Physiotherapist)
Self-liberation	Choose and commit to be more active; believe that change is possible (e.g. use facilities such as community walking paths to help to promote exercising)
Stimulus control	Control situations and cues that support inactivity(e.g. instead of sitting after lunch go for a walk)

The individual characteristics in each stage of change, goals, processes of change, and strategies most relevant for each stage can be found in Table 8.2.

Table 8.2. Goals, Processes, and Strategies for Each Stage of Change (Adapted from Burbank, et al. 2000)

Stage	Individual Characteristics	Goal	Strategies to Support Change
Pre Contemplation	• Not exercising regularly • No intention to exercise • May verbalize an inability to exercise • May be uninformed or under-informed about the consequences of inactivity in terms of functional ability • May have no information about benefits of sustained physical activity initiated at any point in the life cycle • Tend to avoid reading, talking, or thinking about their inactivity • View that the cons outweigh the pros	Increase consciousness of the need to change	*Change processes:* consciousness raising, dramatic relief, environmental re-evaluation • Encourage thinking about change • Discuss feelings and perceptions of exercise/lack of exercise behaviour — what in their life contributes to it, what meaning does activity/inactivity have for the client/family? • Give personalized feedback about the risks of inactivity (decreased functional ability) • Personalize information about the benefits of beginning an exercise programme as an older adult • Dialogue about how inactivity affects role implementation, social activities
Contemplation	• Seriously contemplating exercising change in next 6 months but not within the next month • More conscious of the pros of changing, but the cons still are more important than the pros, resulting in difficulty progressing to next stage • May verbalize an understanding of the need for exercise but does not have the energy or willingness to change the behaviour • May verbalize: "1 know 1 should, but 1 can't now"	Motivate and increase confidence in ability for change	*Change processes:* consciousness raising, self re-evaluation, social liberation, self-liberation • Help client set realistic expectations reinforced by small success • Identify questions about exercising and continue to provide education about personal risks and benefits • Decrease the barriers to exercise •Promote reflection on the ways inactivity affects their life • Indicate people who included regular exercise in their lives • Help to make a explicit commitment to change
Preparation	• Intend to exercise in the near future (within the next 30 days) • Pros become stronger and outweigh cons • Has more confidence that they can successfully exercise	Negotiate a plan for exercise	*Change processes:* self-re-evaluation, helping relationships, self-liberation • Create a new self-image as an exerciser • Make a public commitment to exercise • Identify alternatives for exercise and make a plan • Facilitate involving supportive others • Encourage a component of behavioural change where they can experience success
Action	• The individual has made changes in activity and exercise level within the past 6 months and is meeting recommended exercise levels • Relapses are frequent	Reaffirm commitment to exercise and implement plan	*Change processes:* reinforcement management, helping relationships, counter conditioning, stimulus control • Frequent positive reinforcement with rewards for exercising regularly • Initiate walking clubs • Mobilization of social supports to participate with the process or reinforce the process • Introduce additional exercise alternatives • Keep a record of each time exercise takes place
Maintenance	• Exercising regularly for more than 6 months • Exercise has become an established pattern • Increasingly more confident that he/she can continue to sustain activity	Problem solve to prevent non adherence	*Change processes:* counter-conditioning, helping relationships, reinforcement management • Plan for resisting temptations to skip exercise sessions • Join support groups • Provide a significant recompense for long-term regular exercising

Marcus et al. (1992) studied exercise patterns of middle-aged people and found that the use of specific processes of change varied according to the exercise stage. Precontemplators used significantly less change processes than subjects in other stages. During the contemplation and preparation stages there was no difference in the use of cognitive processes, but three of the behavioural scales (counter-conditioning, reinforcement management, and self-liberation) were significantly higher in the preparation stage. Cognitive processes peaked in the action stage and behavioural processes, as a whole, were used more in the action and maintenance stages than in the earlier stages.

However it is questionable if the processes described previously are operational in the presence psychological stress (Burbank 2002).

It is important for a physiotherapist to assess the older adult's stage of change before starting any programme, using the Transtheoretical Model in order to tailor the exercise programme and strategies to individual patients' stage of change (Lambert et al. 2001). As a physiotherapist for 30 years and being involved in physiotherapy education in Portugal for 26 years it is the researcher opinion that there is a lack of preparation of Portuguese physiotherapists in relation to strategies to support change in participants of treatment programmes. It is also important for Portuguese Physiotherapists to improve their communication skills because it is an essential tool for improving adherence.

The Processes of Change Questionnaire (Nigg et al. 1999) is a 30 item questionnaire, using a Likert scale to assess five cognitive and behavioural processes. Higher scores reveal a greater use of these processes. The lack of a validated Portuguese version meant that it wasn't possible to use it during the home based exercise programme described in the first part of the present thesis.

Another construct that influences movement through stages of change is the Decisional Balance Model, being the evaluation of the pros and cons of engaging in the target behaviour and self-efficacy.

8.3. The Decisional Balance Model

The Decisional Balance Model is another component of the Transtheoretical Model. When making a decision the advantages and disadvantages of the decision will affect the chosen behaviour to perform (Velicer et al. 1985).

It compares the perceived benefits (pros) and costs (cons) of participation in exercise programmes (Marcus et al. 1992). People who see more benefits or value the benefits of activity above costs will probably participate in activity.

The barriers that especially influence older people and can increase the costs are:

1. transportation problems
2. medical concerns and risk of injury
3. lack of a physician advice about physical exercises
4. perceived lack of ability to perform physical activities
5. erroneous beliefs about physical exercising

Prochaska and Velicer (1997) suggested that in order to move forward from pre-contemplation to a contemplation stage of change, the perceived benefits must increase. To change from contemplation to the action stage, the costs of changing must decline considerably in relation to the benefits. In action and maintenance stages both benefits and costs are relatively unimportant as people have already changed their behaviour.

It is important for the physiotherapist, before implementing an exercise programme, to use a decisional balance sheet to help guide the discussions with clients, about the benefits and costs of being active.

Prochaska et al. (1994) proposed that once in the pre-contemplation stage, consciousness raising, dramatic relief and self-re-evaluation precede the tipping of decisional balance.

The “Decisional Balance Questionnaire” designed by Nigg et al. (1998) is composed of ten items related to the costs or perceived benefits of participation in a programme, answered using a Likert scale. The final score is obtained by calculating the difference between the sum of the perceived benefits and costs. It was not used with the participants of the home based exercise programme described in the quantitative part of this thesis because there was no validated Portuguese version.

It is considered that decision making and self efficacy tend to improve as the individual progresses with successive levels of behaviour change. However it must not be forgotten that change progression can regress suddenly in the presence of an important life event (for example some older people choose to take care of a grandchild to the detriment of doing regular physical activity).

8.4. Self Efficacy

The strongest construct of Bandura's Social Cognitive Theory is Self Efficacy appearing to be a determinant of initiation and maintenance of health behaviour changes (Bandura 2001, 1991).

According to the social cognitive theory, exercise adherence is determined, in part, by "*a person's self confidence that he or she can successfully take part in a new behaviour or do a specific task (i.e. self efficacy expectations) and achieve desirable results (i.e. outcome expectations/realization)*".

The expectations (Bandura 1997) are thought to be influenced by:

1. past performance
2. social modelling
3. verbal persuasion
4. physiological responses

Perceived Self Efficacy can be modified by:

1. *modelling or observation* as watching others of the same age performing physical exercises, overcoming barriers, builds confidence to attempt new behaviours (Bandura 1977)
2. *a followed process* providing detailed information about the exercises programmes and comments on objectives and self-monitoring can increase self efficacy (Dzewaltowski 1994)
3. *performance accomplishments* showing the improvement of specific skills acquired by exercising develops confidence and in turn self efficacy (Bandura 1977)
4. *constructive feedback* and positive reinforcements supporting people's efforts to perform the exercises (Bandura 1977)
5. *using adequate and safe equipment* making sure that the fear of injury is overcome

Perception of self-efficacy affects thoughts, emotional arousal and actions. The higher the perceived self-efficacy for a behaviour the higher is its accomplishment (Bandura 1986).

In a study of sedentary middle aged adults over a period of 5 months, self efficacy appeared to be a significant predictor in the initial adoption of exercise over the first 3 months, but less towards the end (McAuley 1994).

McAuley et al. (2003) in a 6 months randomised controlled trial with 18 months follow up, with 153 older participants confirmed the possibility of self efficacy and social support as predictors of long term exercise adherence of older adults.

Brassington et al. (2002) showed in a study involving 103 older people that self efficacy and fitness outcome realizations were associated with 7 to 12 months of adherence.

However both studies referred to data gathered on healthy older participants which is true of a large number of the studies on the effects of physical activity on self efficacy.

For physiotherapists who design and implement exercise programmes for healthy or non healthy older people, building self efficacy might be a good starting point to promote adherence.

When the older person is in the position of deciding whether or not to be physically active, or to continue or not a programme of exercises, he/she will take decisions based on the intention to do the exercises.

Self efficacy was evaluated in the quantitative study of this thesis, using Tinetti's Falls Efficacy Scale. Portuguese older people showed before the implementation of the home based specific exercise programme high values of self efficacy. It might have been more effective to use the Self Efficacy Scale for exercise designed by Sallis et al. (1988) as it is more specific to physical exercise, but there was not a validated Portuguese version available.

8.5. The Theory of Planned Behaviour (TPB) and Theory of Reasoned Action (TRA)

The theories of Planned Behaviour and Reasoned Action explore the relationship between behaviour and beliefs, attitudes, and intentions. Both the TPB and the TRA assume that behavioural intention is one of the most important determinants of behaviour.

According to these models, behavioural intention is influenced by a person's *attitude* toward performing behaviour, and by beliefs about whether individuals, who are important to the person approve or disapprove of the behaviour (*subjective norm*). The TPB and TRA assume all other factors (e.g., culture, the environment) operate through the models constructs. The TPB differs from the TRA in that it includes one additional construct, *perceived behavioural control* or people's beliefs that they feel they have a high degree of control over a particular behaviour (Figure 8.2.).

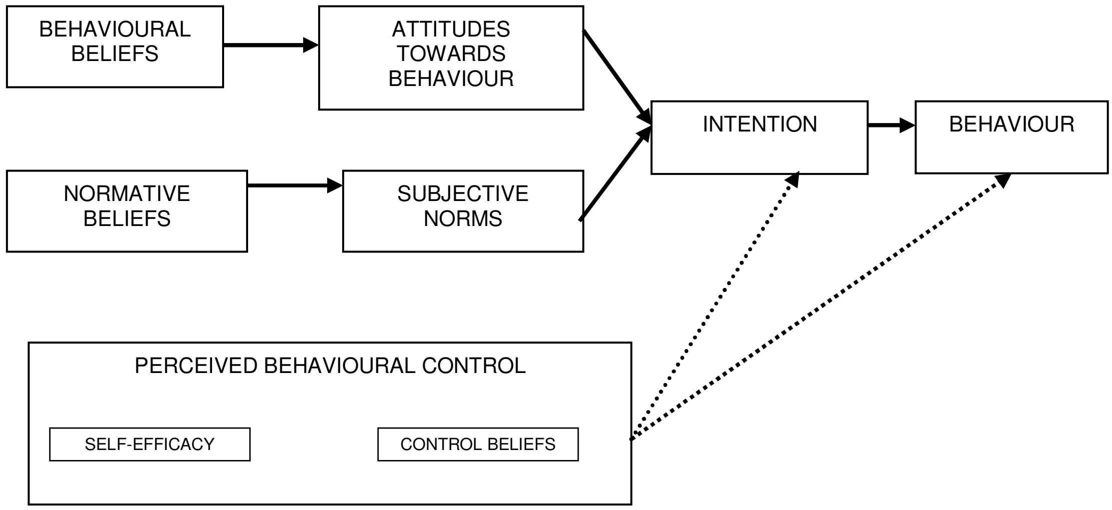


Figure 8.2. The Theory of Reasoned Action (Ajzen and Fishbein 1975) and Planned Behaviour (Ajzen 1988, 1991). The Theory of Planned Behaviour includes the variable "perceived behavioural control"

The Theory of Reasoned Action has different components that play an important role in determining an individual's intention towards a certain behaviour. This theory links with others in the Theory of Planned Behaviour (Conn et al. 2003). The components involved are:

1. *Behavioural beliefs* are the perceived positive and negative consequences of performing the behaviour, in this context the exercise programme. They vary accordingly to populations.
2. *Attitudes towards a behaviour* related to an individual person's positive or negative judgement about if that specific behaviour (doing regular exercise programmes) is accepted or not
3. *Normative beliefs* are used to explore the perception of how appropriate it is to perform certain behaviours (do regular exercise programmes) regarding other people's views. They vary too accordingly to populations.
4. *Subjective norms are* composed of the specific behavioural norms that an individual has chosen; what he must do or not do.

5. *Perceived behavioural control* are perceptions about how easy or difficult it is to perform regular physical exercises, being composed by:
    a. Self Efficacy referring to the an individual's confidence to perform a behaviour satisfactorily to achieve a specific behaviour
    b. Control Beliefs evaluate the chance that the factors, out of the individual's control, have to prevent the successful use of that behaviour to achieve a specific outcome
6. *Intention* being the conscious process of deciding to take part in a specific behaviour

Conn et al. (2003) examined the relationship between some of the constructs of the Theory of Planned Behaviour and exercise behaviour and intention in a sample of 225 women aged 65-90 years old. They found that control beliefs, behavioural beliefs and normative beliefs are significant predictors of exercise intention. Perceived control beliefs such as "exercise is difficult because I am not committed to exercise", "exercise is difficult because I am too tired" and "exercise is difficult because I don't have time" as well as behavioural beliefs such as "exercise is good for my health" are significant predictors of exercise behaviour. The authors recommended trying to increase self-efficacy in older women in order to overcome perceived control beliefs.

The Theory of Planned Behaviour Scale from Courneya and Bobick (2000) has eighteen items that assess attitudes, subjective norms, perceived behavioural control and intentions related to exercise in a seven point Likert scale. Unfortunately there is no validated Portuguese version.

8.6. The Locus of Control

Another construct that has an effect on exercise adherence is the Locus of Control (Rotter 1966). It is a construct within social learning theory, and separates people into internal controllers i.e. those who believe they can control the outcomes in their lives and external controllers those who think that destinies are controlled by chance or by the power of others.

For Dishman (1994) the locus of control is a predictor of health behaviour, suggesting that behaviour such as exercise would be more likely to persist if individuals have a belief that they possess some personal control over their health.

This suggests that the adoption of regular exercise is easiest for those with an internal locus of control (Obrien 1996).

Moreover Waller and Bates (1992) found in the psychological profiles of healthy older people from 66 to 88 years old a high perceived Self Efficacy and Internal Locus Of Control.

Locus of control was not evaluated before the implementation of the home based exercise programme for older people. With hindsight it is clear that evaluation of the locus of control could contribute to the development of strategies to increase adherence rates to the programme.

8.7. Motivation

Motivation is a very important construct to pursue with exercise programmes and must be present and stimulated in the older person. It is defined by Guccione (1993) as *"a complex attitude of wants, beliefs and rewards versus the cost of the behaviour"*. It implies an emotion or a desire that has influence on the person, in order to accomplish the activity (Milroy and O'Neil 2000).

Motivation can be:

1. Intrinsic related to the individual's self satisfaction
2. Extrinsic related to some external reward

Resnik (2002) developed a seven step approach, to assist motivation to exercise in older adults:

1. *The first step* is educating the older adult about the exercise's benefits, referring to the outcomes they can expect if they exercise regularly.
2. *The second step* involves physical screening to provide assurance for the older individual that exercise is safe for them
3. *The third step* involves self-monitoring and goal setting that should be clear, specific, and attainable and must be realistically fit into the individual daily schedule.
4. *The fourth step* attempts to begin with some type of exercise with the older adult, examining carefully the common barriers to exercise and providing reasonable solutions to each barrier, which will help the individual to experience the first exercise session.
5. *The fifth step* exposes the older adult to role models who exercise regularly and can express the many benefits of exercise.
6. *The sixth step* provides verbal encouragement to continue the exercise programme.
7. *The seventh step* includes verbal reinforcement, kindness, or any other rewards for engaging in exercise activities.

It can be said that during the nine month exercise programme for older Portuguese people, already described in chapter three of this thesis, all Resnik's motivation steps were respected. As it was a home based programme, with contact with the researcher only once a month, the fourth, fifth, sixth and seventh steps may not have been implemented strongly enough and this might explain the high rate of people who drpped out of the programme.

8.8. Exercise Determinants

Besides the psychosocial theories and models that have an influence on regular exercise adherence in older adults, there are some other factors that influence adherence.

8.8.1. Personal Characteristics

Personal characteristics that can be related to exercise adherence include demographic and health variables. King (2001) numbered the following factors as having effect on exercise adherence:

1. Gender (with women often found to be less active than men)
2. Age (younger people are most active than older people)
3. Smoking status (smokers less active than non-smokers)
4. Weight (overweight associated with less exercising)
5. Educational attainment and income (lower levels associated with less exercising)
6. Lack of past experience with physically active pursuits may also be associated with lower levels of current exercising, particularly for older women.

Boyette et al. (2003) in their study proposed the creation of a knowledge base of personal characteristics that influence exercise behaviour: these were biomedical status, previous exercise participation, education level, socioeconomic status, smoking, age, occupation, ethnicity and gender. They divided exercise participation into two phases: exercise initiation phase as the first 6 months of starting a new exercise programme and exercise adherence phase as the continuance of the exercise routine after the initial 6 months period. During the exercise initiation phase the most important determinants identified were biomedical status, past exercise participation and education. However during the adherence phase the two first determinants continued to be dominant, only socio-economic status changing. They concluded that older adults who are in a good health and have a past history of being physical active are more likely to participate in long term exercise programmes.

8.8.2. Programme or regimen-based factors

Psychological theories and models focus on the individual without evaluating the influence of structural and environmental problems on the ability to change behaviour. Programme or regimen-based factors also have an effect on exercise adherence (King 2001):

1. *Structure and format of the exercise programme*

According to Annesi (2002) goal setting is the best way to increase exercise adherence in older people as it successfully directs attention and action, prolongs maintenance of effort and motivates people to develop plans of self-regulation for success.

Henry et al. in 1998 studied the effect of the number of home exercises on adherence in 15 older adults over 65 years old, concluding that subjects will perform better and will be more adherent with a smaller number of exercises.

The specific exercise programme for older Portuguese people set the participants goals and took this factor in account giving them only ten exercises to perform.

2. *Complexity and intensity of the exercise programme*

King et al. (1997) when examining predictors of exercise adherence in older adults participating in a higher intensity home based exercise programme, a lower intensity home based exercise programme and a higher intensity supervised programme found the best long term adherence (2 years) was among individuals exercising at home with lower intensity. Additionally Perrin et al. in 2002 demonstrated that a high frequency of exercises increased adherence, whereas higher intensity decreased adherence.

Low intensity and everyday, non-complex exercises were two features of the homebased exercise programme included in the present study.

3. Convenience

Exercise programmes having inconvenient locations or schedules have been associated with decreased participation by older adults (King 2001).

This issue was considered when the decision to design a home based exercise programme, rather than a centre-based programme, was taken in relation to the programme described in the first part of this thesis. The exercises were done at home and meetings with the researcher were scheduled according to participants' availability.

4. Financial as well as psychological costs associated with the activity

Evidence related to this domain remains limited. Available information suggests that programmes that may particularly appeal to older adults are more moderate in intensity, simple and convenient to engage in, relatively inexpensive and non competitive. The present homebased programme was free of charge for the participants and met all the other criteria.

8.8.3. Social and physical environmental factors

Social and physical environmental factors have been found to be significant correlates or predictors of physical exercising in studies that have targeted older individuals. These include support from family members; friends; the staff involved in the exercise programme and peers in the programme (King 2001).

King et al. (1991) suggested that the source, as well as the amount, of social support preferred by the older individual (i.e., from family and friends vs. exercise staff) may differ depending on the stage of behavioural change (e.g., contemplation or maintenance). During the initial 6-month period there was an initial preference for less support from exercise staff, perhaps indicating a greater level of intrinsic motivation, to adopt the exercise regimen. In contrast, in the later 6 months, levels of support were reported as needed from family and friends, as well as increased levels of support received from exercise staff. The amount of support significantly predicted exercise adherence levels during the second 6 months of the programme.

Adherence is said to increase if married couples exercise in the same programme. It is suggested that there is higher monthly attendance and lower dropout away couples who exercise than married men and women who do not exercise with their spouse. The distinction in adherence is more likely to be related to spousal support than to self-motivation. Being divorced may be related to lower levels of family-based support, which could also have a detrimental effect on adherence (Wallace et al. 1995).

Exercising advice from an personal physician appears to be another potentially important, though underused, source of support and motivation for middle- and older-aged adults (King 2001)

An important environmental factor that can influence exercise adherence is the ease of access to appropriate exercise facilities (Jones and Nies 1996). According to Martin (1982) compliance decreases when older people must attend for exercise sessions on the other side of the town.

Time limitations are also one of the frequent barriers to exercise reported by both sedentary and active individuals (King et al. 1990).

8.8.4. Life Events

It is important to refer to the effect of life events on exercise adherence (Comay and King 2000).

Life events are life experiences that have the possibility to significantly impact on an individual's daily routine. The occurrence of a major life event can disrupt a person's life and exercise behaviour regardless of whether it is perceived as a positive or negative stressor (Holmes and Rahe 1967). Examples of such life events are a death in the family, major illness, major change in financial situation, son or daughter leaving home (marriage, studying), major changes in living (home or neighbourhood), gaining a new family member or death of a close friend.

Oman and King (2000) investigated prospectively the influence of reported life events on exercise participation during action (1-6 months) and maintenance (7-24 months) phases of exercise behaviour change in 173 middle aged participants (mean age 57 years old) randomly assigned to 3 different exercise programmes: higher intensity home based exercise; lower intensity home based exercise; higher intensity class based exercise. The exercise programme took place over 2 years, with assessments every 6 months. They demonstrated that life events didn't have a significant impact on exercise adherence during the action stage but had a negative effect during the maintenance stage. The occurrence of life events did not differentially affect exercise adherence as a result of the different exercise formats or intensities. For Oman and King (2000) the occurrence of 3 or 4 life events was sufficient to significantly lower exercise adherence regardless of exercise format or intensity.

Wilcox and King (2004) studied the possible association of life events with participation in home and group-based exercise (n=97 older adults with 64% women), with the exercise participation documented by logs and class-attendance lists. They found that life events, particularly interpersonal loss, appeared to have a negative impact on exercise in women, and this effect appeared greater for class-based, than for home-based exercise.

A physiotherapist must be aware of the influence of life events on exercise adherence and ask participants to contact them if something happens that could compromise adherence to exercise.

Conclusion

Adherence to regular exercise programmes is an important health behaviour associated with prevention of fall risk factors and the development of well being among older people.

Behaviour change related to exercising is explained by various theoretical approaches: the Health Belief Model focusing on persons' attitudes and beliefs; the Transtheoretical Model of Behaviour Change postulating that the process of behaviour change related to exercise occurs in six stages by cognitive and behavioural processes; the Decisional Balance Model involving a comparison of the perceived benefits and costs of participation in exercise programmes; Self Efficacy determined by a person's self confidence that he or she can successfully take part in a new behaviour or do a specific task (i.e. self efficacy expectations) and achieve desirable results (i.e. outcome expectations/realization); the Theory of Reasoned Action stating that to change individuals' behaviour they must have the intention to perform it; the Locus of Control separating those who believe they can control the outcomes in their lives and those who think that destinies are controlled by change or by the power of others.

Motivation must be present and stimulated in the older person who participates in exercise programmes.

Personal characteristic programme or regimen-based, social and physical environmental factors as well as life events can also have an effect on exercise adherence.

All these theories, models and determinants explain and influence the adherence to exercise programmes in older people. It is important to note that self efficacy is a concept present in various theories. The theories, models and determinants help to understand and conceptualise the problem of adherence and can assist in the development of coherent interventions by physiotherapists designing and implementing exercise programmes.

The qualitative study reported in this part of the thesis was designed as a result of a quantitative study, designed to analyse the influence of a home based exercise programme on fall risk factors in older Portuguese people. There was fairly good adherence to the exercises in the programme but a large number of participants left the programme within the first three months. This led to the need to explore possible explanations for the adherence and non adherence of the home based exercise participants.

The aim of this qualitative study was to explore the factors that contributed to adherence in a specific home based exercise programme. The defined objectives were to explore participants' perspectives on the experience of undertaking a home based exercise programme and to gain insight into participants' attitudes and behaviours in relation to physical activity.

CHAPTER 9

METHODS

A phenomenological qualitative approach was taken to explore perceptions of older Portuguese participants in a home based specific exercise programme using focus groups. This chapter describes the methodology used in focus group discussion that was approved by the School Ethics Panel of the School of Health Professions, University of Brighton (Appendix 13).

9.1. Sample

The researcher verbally asked the participants' intervention group about their availability to join a focus group. For those who dropped out before three months the researcher phoned the participants to invite them to enter the focus group discussions. A purposive sample of 11 participants, who were functionally independent, older adults, aged from 65 to 84 years, without cognitive problems. The sample was divided in to two focus groups, one composed of 6 participants who had adhered to the programme for the full 9 months and another group with 5 participants who had given up before the 3 month assessment.

No exclusions were made on the basis of gender, race, and culture. The only exclusion criterion applicable on the present study was inability to attend the focus group session.

The adherent participants' focus group was composed of 4 women and 2 men. The non adherent participants' focus group was composed of four women and one man (one woman was not able to attend because of sudden illness).

9.2. Data collection

The study was approved by the School Ethics Panel of the School of Health Professions, University of Brighton and all standard procedures were taken to protect participants' confidentiality and privacy. All participants signed the consent form (Appendix 14) and permission to use facilities was obtained by the Health Centre Director.

The focus group organisation followed the guidelines suggested by Morgan and Krueger (1997): the first phase was to develop questions and arrange logistics; the second was recruitment of participants; the third phase consisted of training the moderator (as it was the first time the researcher had acted as a moderator); in the fourth phase assistants were choosen and trained; in the fifth phase data was collected and analysed and in the last phase the final report of the findings was written.

Focus group questions comprised opening, introductory, transition, key and ending questions, using similar questions for both groups (Table 9.1.).

Some probes were used in order to maintain and deepen discussion between the participants: "Would you explain further?", "Would you give an example?", “I don't understand."

The participant invitation to attend focus groups was done by telephone by the researcher and a date was arranged to meet in a Health Centre.

A participant information sheet explaining the function of the focus groups was given at the beginning of each focus group session to all participants. The participants signed consent forms covering freedom to withdraw, benefits and risks, measures to maintain anonymity and confidentiality. Participants’ names were not used .

Focus groups interviews were conducted in a quiet room, and refreshments were provided.

Table 9.1. Focus Group Questions

Focus Group Questions	
Opening question	I would like each one of you to tell us your name, age area of living how long have you been doing the home exercise programme
Introductory Question	What were your first thoughts when you were asked to undertake the home exercise programme?
Transition Question	Why did you want to participate in the Home Exercise Programme?
Key Questions	What has been your greatest challenge in doing the home exercise programme?
	What did you think was the least beneficial aspect about the programme?
	In what way could the programme be ameliorated?
	Did you have any help with your exercises?
	Was there anything that interfered with your exercise programme?
	Did your participation in the exercise programme interfere with your daily life?
	What do you think about doing physical activity at your age?
Ending Questions	Imagine that you are on television and you had 1 minute to speak about the home exercise programme. What would you say?
	What recommendations would you make to someone that entered the home programme for the first time?
	Is there anything we should have talked about, but didn't?

The discussion topics of the focus groups were: behaviours related to home exercise programme; factors influencing the adherence and beliefs regarding physical activity.

An introductory script was read to provide the participants with an overview of the study.

The two focus groups sessions were approximately 1 hour long and were led by the researcher as a moderator. Focus groups discussions were audio taped by two recording devices to guard against lost data due to equipment failure and videotaped with the participant's permission.

Two assistants, physiotherapists with more than 20 years of clinical practice with older people, took notes during and immediately following the session (e.g. main ideas or phrases used, body language, etc).

Immediately after each focus group session the moderator and the two assistants had an audio taped discussion, noting group dynamics, common perceptions and unexpected reactions.

9.3. Data Analysis

Participants' discussion were audio taped and videotaped (to have a perspective of seating arrangement and to clarify similar voices). Just after the focus groups sessions an audio taped meeting, with the two assistants present during the sessions, took place in order to discuss the dynamics of the sessions and notes taken.

The content of the audio tape was transcribed verbatim and reviewed for accuracy, and corrected as needed by the researcher (Krueger and Casey, 2000).

The transcripts were prepared for analysis making two copies of each transcript. One was used to cut and past the other one stayed intact for later reference. The adherent focus group was printed in green coloured paper and the non adherent focus group in yellow coloured paper in order to distinguish both groups' answers (Krueger and Casey, 2000).

The transcripts of both focus groups were read several times to memorise/ familiarize where information was located.

Responses to the same question from both focus groups were identified using coloured marking and where quotations were taken, phrases were underlined. Quotes were identified using a code to identify which focus group they came from (Focus Group 1 adherent participants and Focus Group 2 non adherent participants), initials corresponding to the participant's name and the question and the page in order to document the source of the quote.

Unused quotes were put aside for later consideration.

Quotes were translated into English by a bilingual independent person and then translated from English to Portuguese by a different bilingual person. The researcher and the two translators discussed the translations that did not match, and resolved the problems by using the most context related words.

The transcripts of the two focus groups were then analyzed in more depth so that relevant words, statements, and passages were underlined independently by the moderator (researcher) and the two assistants. The underlined statements generally matched between the moderator and the two assistants. When there was not a match the moderator and the two assistants met together to reach an agreement.

After creating the categories and the themes the moderator found that as the she had already reviewed some literature about adherence and psychosocial theories there could be some bias in their creation. She decided to ask to a fourth person from outside the study, with experience in focus groups, to create categories and subsequent themes from the chosen quotes.

Categories were formulated by the external person, as they emerged from the relevant statements. The resulting categories were then organized into clusters of themes. To be considered a theme an idea had to be mentioned several times within a group or across the groups. The themes were validated by referring back to the original transcripts to ensure no data had been ignored or added. At the end a great similarity was seen between those themes and categories created by the external person and those done by the moderator.

In this phenomenological study, credibility was enhanced by using the two assistants to validate the identified themes. The assistants agreed that the themes that had emerged captured the essence of the experiences of the involved participants.

The next chapter describes the findings of the analysis of the focus groups discussion.

CHAPTER 10

FINDINGS

After analysing the transcripts of the focus groups, the translation of the quotes that came out from the transcripts are shown in Appendix 15. The answers were evaluated by an external person who confirmed the formulation of categories and the arrangement of categories into clusters of themes.(Table 10.1.).

Table 10.1. Categories and Themes emerged from the Focus Groups' discussions

<table>
<tr><th>THEMES</th><th colspan="2">CATEGORIES</th></tr>
<tr><td>Perceived Incentives</td><td colspan="2">Health
Instruction and guidance
Home Exercise Programme</td></tr>
<tr><td>Home Based Exercise Programme</td><td colspan="2">Adherence Strategies
Responsibility
Barriers to exercise</td></tr>
<tr><td rowspan="3">Perceived Benefits</td><td colspan="2">Psychological</td></tr>
<tr><td>Physical</td><td>Flexibility
Balance
Posture</td></tr>
<tr><td colspan="2">Quality of Life</td></tr>
<tr><td rowspan="2">Recommendations</td><td>To other participants</td><td>About the programme
About the exercises</td></tr>
<tr><td>To the Programme organiser</td><td>Group Exercise
Increase contact with supervisor
Cognitive Exercises
To spread out the programme to all Health Centres</td></tr>
</table>

Whilst participants were encouraged to give their own personal responses and to speak as individuals, it is interesting to note that on more than one occasion several participants made similar statements. The findings on each category and theme will be presented quantitatively. This consensus of opinion may give some confidence in interpreting the data from the focus groups.

10.1. Perceived incentives to participate in the programme

Participants in both focus groups perceived that there were health incentives to participate in the exercise programme (Table 10.2.):

"I was seeing that it was really good for me, that it was beneficial for me…", subject CC from the adherent group.

"…I thought it was the opportunity to get free of being sedentary, and so to have health benefits" subject AV from the adherent group.

"… because I think it is beneficial, very beneficial for health" subject JM from the non adherent group.

"It was very good to join the programme, it was wonderful for the health, and all the exercises were easy to do ..." .Subject LP from the non adherent group.

Table 10.2. Statements' frequency related to behaviour given by the participants

Perceived Incentives	Adherent Focus Group	Non Adherent Focus Group
Health	8	7
Instruction and Guidance	2	5
Exercise Programme	5	10

There were more statements related to perceived incentives related to instruction and guidance from the researcher, given by the non adherent group showing an overall satisfaction about the programme (Table 10.2.):

*"…I think that the researcher is a kind of magic woman as she guesses what we must do …." s*ubject MJ from the adherent group.

"There is such receptiveness by the researcher that she makes us feel that we have known her all our life" subject CP from the adherent group.

The non adherent group stated:

"Do it all, like it is prescribed, it is good for your health" subject JM from the non adherent group.

"The exercises were great, they were appropriated to our age and gave us much more mobility…" subject LP from the non adherent group.

Curiously it was the non-adherent group that made more statements about perceived incentives associated with the exercise programme (Table 10.2.):

*"… accessible, not too hard…." s*ubject FS from the non adherent group.

"What moved me was the curiosity…" subject F from the non adherent group.

"For our age no, I think that …they are reasonable" subject LP from the non adherent group.

"Firstly this has no expenses…" subject JM from the non adherent group.

"From the moment that they are adjusted to our age, my age, I think that the exercises are not violent..." subject H from the non adherent group.

The adherent group stated:

"…to do these exercises is like taking a pill, it is the best thing we can find" subject MJ from the adherent group.

"After the first time, I saw that the exercises I was doing were very beneficial" subject CC from the adherent group.

*"I had the knowledge that there were exercises….but I could not imagine that it is really wonderful... "*subject RJ from the adherent group.

10.2. Attitudes towards the Home Based Exercise Programme

Both groups made statements about the home based exercise programme in relation to adherence strategies, barriers to exercise and to their responsibility (Table 10.3.).

Table 10.3. Statements' frequency related to home based exercise programme given by the participants

Home Based Exercise Programme	Adherent Focus Group	Non Adherent Focus Group
Adherence Strategies	11	9
Barriers to Exercise	7	14
Responsibility	8	5

The frequency of statements related to adherence strategies was similar in both groups. The adherent group referred to their time constraints and daily routine strategies to maintain adherence as well as the wish to help the researcher:

"*The first thing I did when I woke up was exactly the exercises"* subject RJ from the adherent group.

"I had a predominant rule in my daily life, I had to do the walking and then the other exercises I did them on the morning or in the afternoon, on the bus or on the street..." subject AP from the adherent group.

"…when we can't in that moment, but if we plan we can do everything" subject CC from the adherent group.

"Well, it will be worth to go to, to do, to help the lady in her study…." subject AP from the adherent group.

The non adherent group referred to commitment, innovation, the fact of having no costs and lack of time strategies to try and maintain adherence to the home based exercise programme:

*"I began to do it because I promised the lady that was doing the study…."*subject MJ from the non adherent group.

"...innovative, it was something new, I would never think that the National Health Service would have this kind of service for its clients" subject JM from the non adherent group.

"… it had no charges…" subject JM from the non adherent group.

"… in my home cleaning breaks, I was doing it…." subject LP from the non adherent group.

In relation to the barriers to exercise, the non adherent group made twice the number of statements than the adherent group. Laziness, living alone, lack of time and space, pressure of social life and health problems were their principal barriers (Table 35):

"…and I was lazy to do the exercises alone" subject FS from the non adherent group.

"*It interfered because I have a busy life and so I had to do the exercises …"* subject H from the non adherent group.

"…the house had to have some free space to practice." subject JM from the non adherent

"The fact of going out some days, here and there…. I stopped doing and then the stops were so many ..." subject F from the non adherent group.

"It was my health problem that make me give up the programme" subject F from the non adherent group.

The adherent group referred primarily to barriers related to time availability and health problems:

"For me it is complicated to tie me to schedules." subject AP from the adherent group.

"… it was to accomplish the programme, to get time, it was the timeTable" subject RJ from the adherent group.

"the only thing that interfered sometimes is my respiratory problem" subject AP from the adherent group.

"As I have an increased uric acid….the right foot…sometimes I have the big toe sore and I cannot move" subject AV from the adherent group.

The adherent group made more statements related to responsibility than the non adherent one:

"...and the bigger challenge was "I will never give up" subject AV from the adherent group.

"…taking the responsibility I must do it" subject CC from the adherent group.

"I had to do them, first in the morning, to free myself from that responsibility" subject MJ from the adherent group.

"…. while all people were having fun and dancing, we went to the woods to do the exercises" subject CC from the adherent group.

"… those exercises I had to do were as a promise an obligation, so I really do them …" subject RJ from the adherent group.

"Mine was not to fail, to fulfil the logs and to write what did" subject MJ from the adherent group.

On the other hand the non adherent group referred lack of responsibility and self blame:

"It promotes a self blame related to the non accomplishment of a programme" subject F from the non adherent group.

"I blame myself; in fact it is the lack of persistence and discipline…" subject H from the non adherent group.

10.3. Perceived benefits

Table 10.4. shows the frequency of statements in both focus groups, related to perceived benefits. It can be seen that a higher number of statements were given by the adherent group.

Table 10.4. Statements' frequency related to Perceived benefits given by the participants

Perceived Benefits		Adherent Focus Group	Non Adherent Focus Group
Psychological		4	2
Physical	Flexibility	7	4
	Balance	4	0
	Posture	3	2
Quality of Life		2	0

Psychological benefits were perceived by both groups with more statements from the adherent group showing the influence of exercise on self-esteem and happiness:

"…we feel better inside" subject RJ from the adherent group.

"…a self confirmation that I'm still useful…" subject CP from the adherent group.

"the better the physical part the better the psychological part too, and so to be happy with ourselves, being with a good mobility, we feel happier..." subject RJ from the adherent group.

The non adherent group showed that while doing the exercises they felt happier:

"I went to work more pleased, happier, more tolerant with the others…" subject JM from the non adherent group.

Both groups found improvements in flexibility as a perceived benefit. The adherent group referred to both general and specific improvements.

"…I stayed almost without movement and now I have much more movement" AV adherent participant.

"…the places where I notice more improvements… was the flexibility" RJ adherent participant.

"Me, at the neck level, before doing those exercises, like this, for example I wanted to look to the side, and I had to turn the body. Now I don't need to do it" CC adherent participant.

"I learned that doing these gymnastics I got a lot better of my foot, a lot …." MJ adherent participant.

The non adherent group referred to more general improvements:

"I feel more liberated, I don't have stiff limbs as I used to. Before I had stiff nerves, sometimes with arm aches, backaches and now I'm better" LP non adherent participant.

"… Exercises that made me move better, better move the joints …" LP non adherent participant.

Only the adherent group referred to balance improvements as an outcome of the exercise programme:

"...*the fact was that when I walked, everybody overtook me, upsetting me, but now they don't."* CC adherent participant.

"With the exercises I learned about not to be instable not to fall, and today I can say that I forgot that, I don't remember anymore the instability" AV adherent participant.

"…but that balance on the street, I run, I run to catch the bus with no problems" CP adherent participant.

On the other hand postural improvements were discussed by both groups with reference to posture in general and to the thoracic spine in particular:

"I acquired a better posture, I have my back a bit curved and now I feel, even if they are not completely straight because it is impossible, that I have a better seated and standing up posture". CP adherent participant.

"I know already how to sit correctly" MJ adherent participant.

"…because in reality I was much better in the posture aspect" CP adherent participant.

The non adherent group stated:

"…even the buffalo hump, I don't feel so…" FS non adherent participant.

"The indications for a correct back by themselves are enough, we catch that position" FS non adherent participant.

A relation between the exercise programme and improvement in quality of life was stated by 2 participants of the adherent group:

"… You can have good benefits for your quality of life" AV adherent participants.

"Improve locomotion and, let's say, the quality of life of people of my age" AP adherent participants.

10.4. Recommendations for future participants and programmes

Finally, focus group members made some recommendations for other possible participants and for the programme structure.

Recommendations had the objective of stimulating the adherence of future participants to the exercise programme by referring to health benefits:

"*It was very good for me and I like…If you have the opportunity for such a chance, please accept…"* CC adherent member.

"Go but do it because if you don't do it is no worth …" RJ adherent member.

"Go and do it, you are going to feel as good as I feel" MJ adherent member.

The non adherent group declared:

"There is here a programme to improve mobility, do it, do it right…" F non adherent member.

"…would recommend the programme, it would be good for health …" LP non adherent member.

"Do everything that is written because it will be good for your health" JM non adherent member.

Besides the statements about their perceived health benefits, five participants in each group gave their opinion about the exercises.

The adherent group recommended the exercises and the need to do them correctly:

"I would advise him to do those good exercises…" AP adherent member.

"…don't think that you must do everything quickly, at the same time…." CP adherent member.

"…do it always, I never missed it, observing the rules you are told, everything, do what I did, because sometimes some exercise are hard…" AV adherent member.

The non adherent group recommended different adherence behaviours to their own:

"Don't do like me, don't do the programme casually, because it's no worth" F non adherent participant.

"I advise a regular practice of the programme" JM non adherent participant.

"…to have benefits we must take the programme seriously and do it regularly, if not we will do not have any benefits or results..." H non adherent participant.

In relation to statements about how the programme might be run in the future, there were four main items:

1 - To do group exercise instead of home based exercise

Four statements from the adherent group participants demonstrated their preference for group exercise:

"The place to do the exercises is the Health Centre, we must think that way" RJ adherent subject.

"It is a question of seeing who is available, a free space, to do this once or twice a week" AP adherent subject.

In my opinion once or twice a week in a group, as possible ..." RJ adherent subject.

Similarly, the non adherent group made some statements about their preference for doing the exercise programme in a group as it they thought it would increase their adherence:

"Group exercise it helps and we stimulate each other…" FS non adherent subject.

"Exactly! It helps and we stimulate each other…" F non adherent subject.

"…it was in group, everyone appearing at a certain hour, with some self responsibility, in a space and do it in group" JM non adherent subject.

"…if there was a group probably I would go…" LP non adherent subject.

2 - To increase the number of contact times with the supervisor was an exclusive recommendation of the adherent group:

"Me too, I agree to come more times to the health centre…" CP adherent participant.

"Me too, I agree that it is important to come to the health centre more times" MJ adherent participant.

"If we came, not once a month but every week…" AV adherent participant.

"I don't say daily, but we could come at least every week to the health centre. That would be ideal and then to accomplish the program at home...." RJ adherent participant.

"To come to the health centre every week or every fortnight" CC adherent participant.

3 - To include cognitive exercises together with physical ones was a non adherent group recommendation:

"*…if it was possible to continue, keep the physical and the brain activities running together"* JM non adherent participant.

"Yes, brain exercise would be good" LP non adherent participant.

4 - To promote the exercise programme among the other Health Centres was recommended by a non adherent participant:

"This exercise programme should exist in all health centres" FS non adherent participant.

From these two focus groups, one composed of adherent participants and the other of the participants that dropped out within the first three months, four themes emerged, perceived incentives, home based exercise programme, perceived benefits and recommendations.

Participants in both groups perceived health, instructions and home exercise as incentives to participate in the programme.

Strategies to overcome time constraints in order to preserve adherence to the programme were referred to by the adherent group. Barriers to exercise were different between groups. Laziness and living alone, lack of time were more commonly referred to by the non adherent group while time availability and health problems concerned the adherent group. Responsibility, which was seen as a commitment to the researcher helped to maintain adherence in the adherent group.

Psychological benefits were perceived by both groups while only the adherent group mentioned quality of life improvement.

Flexibility and posture improvement were referred to as physical benefits by both groups whereas only the adherent group focused on improved balance.

Recommendations to other possible participants showed the concern of the adherent group about doing the exercises correctly while the non adherent participants advised future participants not to do what they did.

Both groups mentioned group exercise, and more contact with the supervisor. The need for cognitive exercises as part of an exercise programme structure for older people, as well the need to promote the present exercise programme in other Health Centres were issues for the non adherent group.

CHAPTER 11

DISCUSSION

The aim of this qualitative study was to explore the factors that contributed to adherence in a specific home based exercise programme. The defined objectives were to explore participants' perspectives on the experience of undertaking a home based exercise programme and to gain insight into participants' attitudes and behaviour in relation to physical activity.

It has become more important to enhance our understanding of the exercise behaviour of older people and particularly why they choose, or do not choose, to do exercise. The data discussed in this chapter might help supply important information for health professionals both in Portugal and other countries. The results of this qualitative study show a variation in participants' beliefs, attitudes and health behaviour between the "adherent" and "non adherent" group.

11.1. Methodology

In relation to the qualitative methodology the researcher was the focus group moderator and this can be viewed in a both positive and negative ways. On the positive side she already knew the participants and it was easy to facilitate group interaction. On the negative side it is accepted that because the participants knew the moderator, and because she implemented the home-based exercise programme this may have influenced their responses. The statements made by the participants about the researcher who ran the exercise programme are all highly positive. It is possible that if she had not facilitated the focus group some of the members may not have been quite so positive about the exercise programme. There is always a concern that participants do not want to upset the researcher even when advised to say what they think and so there is always a possibility of bias in the participants' responses. Moreover in spite of the training that the researcher undertook, she was relatively inexperienced. There was always a risk of not promoting discussion effectively and the quality of information gained from a focus group is dependent on the skills of the moderator (Morgan and Krueger 1997) .

The questions were planned by the researcher to focus on the problem “why some adhere the programme and some dropped out?”. They followed a sequence proposed by Krueger and Casey (2000) with general questions related to the topic of interest to begin the discussion. Afterwards in the key questions were more specific moving into participants’ opinions, attitudes and beliefs.

As the researcher was aware of the psychosocial theories and models related to adherence this could have influenced the identification of themes and categories. To overcome this she asked a second person to undertake this task. An English physiotherapist, with experience in facilitating focus groups was used, as no Portuguese expert in focus groups was available at that time. All the transcripts had to be translated into English, and it is possible that this may have influenced the themes and categories as some emotions and feelings transmitted in Portuguese phrases may have been lost when translated to another language.

When analysing the findings and using the Transtheoretical Model of Behaviour Change of Proshaska and DiClemente (1991), the adherent group, those who accomplished the nine months intervention, were considered to be in the maintenance stage while the non adherent group or those who gave up before 3 months never passed beyond the action stage.

Transtheoretical Model of Behaviour Change	
Stages of changing behaviour related to exercise	
Adherent Group	Maintenance stage
Non Adherent Group	Action stage

Both groups had already used cognitive processes following the behavioural processing stage (Prochaska and Velicer 1997) to change their behaviour. It seems however that the non adherence group did not achieve these behavioural processes of change; they couldn't overcome behaviours related to inactivity.

11.2. Perceived incentives to participate in the programme

The Health Belief Model of Rosenstock (1974) proposes some cognitive factors that will predispose a person to health behaviours, in this case participating in an exercise programme. According to this model, both groups referred to perceived incentives showing that they recognized that they were susceptible to a health threat and when considering the exercise programme, they pondered the benefits and barriers when making the decision to participate in the programme.

By deciding to start the programme both participant groups showed a self confidence in their ability to complete the programme.

Curiously, it was the non adherent group that made more statements related to perceived incentives associated with the physiotherapist's personality and the design of the homebased programme:

"There is such receptiveness by the researcher that she makes us feel that we have known her all our life" subject CP from the adherent group.

Normally these incentives are related to motivation, as Resnick (2002) suggests: "*among the steps that help to motivate older people to exercise is kindness and verbal reinforcement from the supervisor and to provide assurance that exercises are safe for them*". Whilst these were mentioned by the non adherent group, they were clearly not strong enough factors to ensure adherence. King et al. (2001) reported that the structure and format of the programme as well as the complexity and intensity of the exercises are factors that influence exercise adherence.

In designing the exercise programme the researcher was aware that her interaction with the participants would be important, for these reasons she arranged to have regular contact with them. Nevertheless the regular contact did not seem to be sufficient to prevent non adherence. It is possible that more educational sessions regarding the effect of ageing on the neuromuscular system and normal and abnormal posture could be seen as incentives to continue the exercise programme. The researcher also recognised the importance of designing a programme that would be simple and moderate rather than high intensity.

The literature indicates that social support is very important in terms of incentivising individuals to participate in exercise activity. In fact participants said that they wished the exercises had been undertaken as a group in the health centre, indicating that they recognised the value of peer support. Nevertheless this is not coherent when many of the participants gave time constraints as a major factor in not doing exercise. In fact if they had gone to the health centre for their exercises it would have taken up more time. Perhaps if the researcher had tried to link participants into small groups by telephone or even by meeting in each other's houses they could talk to each other and support each other.

It seems that perceived incentives had a strong role on the participants' intention to adhere to the home based exercise programme which is consistent with the Theory of Planned Behaviour (Ajzen 1988). Unfortunately perhaps it was not strong enough for some participants to keep them within the programme.

11.3. Attitudes towards the Home Based Exercise Programme

11.3.1. Adherence Strategies

Participants in both groups, adherents and non adherents showed attitudes related to the home based exercise programme adherence strategies. The strategies used by the adherent group were related to overcoming lack of time and daily routine barriers. The fact that they completed the programme revealed the power they had to overcome potentially negative aspects and this relates to the Health Belief Model of Rosenstock (1974).

The non adherent group adherence strategies were more related to commitment, innovation and the fact that they would not incur any costs through doing the programme:

"I began to do it because I promised the lady that was doing the study…." subject MJ from the non adherent group.

"...innovative, it was something new, I would never think that the National Health Service would have this kind of service for its clients" subject JM from the non adherent group.

Commitment is defined as a global psychological construct reflecting a person's pledge or obligation towards continued exercise involvement (Martin and Hausenblaus 1998). It is an important component of the Health Promotion Model (HPM) of Pender et al. (2002). The HPM proposes that commitment to regular exercise is determined by an individual's beliefs regarding their self-efficacy, outcomes or benefits as well as perceived barriers to action. The fact that the non adherent group made statements implying "commitment" as an adherence strategy, but then left the programme, reveals that the feeling about these factors was not strong enough to change their behaviours.

For the non adherent group innovation was an adherence strategy. Innovation is the act of introducing something new and useful and in this case the invitation to participate in the home based exercise programme and the exercise structure itself, was seen by them as a motivating factor. However, it was not enough to complete the nine months of exercise intervention.

Financial costs related to exercise programmes have, according to King et al. (2001), a negative influence in exercise adherence. As the current home based intervention did not have any costs it was considered an adherence strategy based on the non adherent group statements.

The decision to exercise is an individual judgment, a balance of 'pros' and 'cons', and if the benefits are not satisfactorily convincing then the disadvantages of exercise will triumph leading to dropping out. In summary the non adherent focus group perceived incentives were not strong enough to overcome the barriers that appeared with time.

11.3.2. Barriers to exercise

When comparing the two groups, the non adherent group made twice as many statements about the barriers to undertaking the home based exercise programme. Laziness, living alone, lack of time and space, pressure of social life and health problems were considered to be their barriers to exercise. Lees et al. (2005) found, in a sample of 66 individuals aged over 65 years, similar barriers to exercise in their qualitative focus group study which set out to identify the specific barriers to exercise that make it difficult for older people to initiate or maintain exercise adherence.

Similarly the adherent group referred to a lack of time and health problems as barriers to exercise. This is consistent with the study by Cox et al. (2003) which found that the most frequent reason for withdrawing from a programme was illness or injury. The second most frequent reason for participants withdrawing from their programme was “no time”.

Both groups, had two common barriers, lack of time and health problems, but one group of participants kept on participating in the exercise programme and the other gave up. This could be due to the influence of exercise determinants such as time limitation (King et al. 2000) and life events (Comay and King 2000) . Another reason could be related to their different locus of control, as the acceptance of regular exercise is easiest for those with internal locus of control. It is probable that the non adherent group had no internal locus of control but this did not emerge from the focus groups.

It is very important to identify the different individual barriers to undertaking exercise. This helps the physiotherapist to understand the factors that motivate people to be physically active and is a precondition for planning successful physical activity interventions. It may be said that without motivation, effort is not helpful (Chao and Froy 2000).

11.3.3. Responsability

Responsibility was more an adherent group attitude related to the home based exercises statements. It seems that responsibility in this context is more connected to the moral responsibility to perform the programme in order not to disappoint themselves and the researcher and this helps them to overcome exercise barriers. Whether the characteristic of moral responsibility is inherent within a person or whether it can be developed is not known.

11.4. Perceived benefits

As expected the perceived benefits statements by the adherent group were more than double of that in the non adherent group. The adherent participants referred to the psychological, flexibility, balance, posture and quality of life benefits associated with exercise. This is consistent with the Social Cognitive Theory (Bandura 1997) which claims that exercise adherence is determined by the recognition of the benefits of exercise (outcome expectation). The non adherent group perceived psychological, flexibility and posture benefits, but these were not enough to assure a behavioural change to promote exercise adherence.

11.5. Recommendations for future participants and programmes

In relation to the recommendations for future participants, the behaviour of the two groups was completely different. The adherent group recommended adherence to the programme as well as ensuring that the exercises were done correctly, perhaps referring to the problems that they had to solve. The non adherent group recommended a different behaviour compared to the one they exhibited in the past, perhaps indicating a feeling of guilt.

Both groups recommended group exercise instead of an individual home exercise programme to improve participants exercise motivation. However these statements were incompatible with the previously made statements about time commitments. One of the adherence barriers stated by both groups was “lack of time”. To go to a centre would require more time than to do home exercises and would be, in a few days or weeks, a barrier to exercise. King (2001) suggested that exercise interventions in inconvenient locations have been associated with low rates of adherence. The participants liked the idea of doing group exercise but may not have been thinking about the practicalities. It seems that another reason for this recommendation is the fact that the participants, as people already retired with a reduced social life, would see in a group exercise a way to improve social interaction (Cox et al. 2003).

The adherent group recommended an increase in the number of contact times with the supervisor of the programme suggesting that once a month was not enough. There is some support for this in the literature, King et al. (1990) suggested that the use of a weekly supervisor telephone call maintained adherence and improved a better maintenance of the behaviour among long-term participants in a home based exercise programme. They also found that in the maintenance phase of the study, daily self-monitoring was superior to weekly self-monitoring. It must not be forgotten however that increasing the number of contact times would increase the costs when delivering the programme.

Curiously, the non adherent group suggested a need for cognitive exercises together with the physical exercises. One reason for this suggestion could be that they got bored with the exercises and they wanted something new. There are no references to this mixed structure in the literature, but perhaps this is an example of where client groups have better knowledge of their needs than health professionals. Lezak (1995) suggested that older people seem to have a form of intelligence,called crystallised intelligence, that does not decrease with age, and consists primarily of specific acquired knowledge such as the vocabulary and the ability to see similarities between objects and situations. Fluid intelligence that includes such abilities as problem solving, memory, learning, and pattern recognition seems to deteriorate with age, but it is suggested that it can be improved through mental exercises.

Taking into account that most older Portuguese people are inactive, both physically and cognitively as normally they spend a lot of time alone (INE 2002) it seems important to introduce cognitive exercises in programmes for this kind of population.

Finally the non adherent group recommended the provision of the programme in all Health Centres; this seemed to suggest a level of satisfaction in relation to the programme, even though they did not complete it.

The current exercise programme was innovative not just in the Oporto Health Centre, but in Portugal. Whilst it was not an aim of this research to cascade the programme to other Health Centres, it is clear from the success of the programme, and the recommendation of the participants, that once the outcomes of this study have been used to make some positive changes, this exercise programme can, and will be delivered elsewhere.

11.6. Conclusion

The achievement of the first two aims of this thesis was already reported in chapter seven.

The third aim was to explore the factors contributing to adherence to a specific home based exercise programme and this was fulfilled.

Participants' perspectives on the experience of undertaking a home based exercise programme were explored and participants' attitudes and insight was gained into behaviours in relation to physical activity.

The focus groups with adherent and non adherent participants showed differences in perspectives, attitudes and behaviours.

Both groups suggested several factors that contribute to the specific home based exercise programme participants' adherence. These included perceived incentives and attitudes towards the home based exercise programme as factors that facilitated their participation in the programme. Perceived benefits were reported by both groups.

Nevertheless the non adherent focus group results showed more barriers to exercise adherence such as laziness, living alone, home space, pressure of social life, and lack of social interaction. It is likely that these barriers were the most important factor leading to non adherence to this home based exercise programme. When the nature of these barriers is considered physiotherapists' strategies must carefully considered these issues; their professional accountability, communication, collaboration, professional judgment and reasoning competences.

These findings support the importance of health promotion interventions in changing perceptions, attitudes and behaviours about desirable levels of physical activity among older Portuguese people. There needs to be more emphasis on health promotion but realistically, there will always be some people for whom the barriers are too great.

CHAPTER 12

EPILOGUE

12.1. Introduction

This study used a combined quantitative and qualitative approach, treating them as complementary approaches. The main part of this research, reported in Part One, measured the efficacy of a specific home based exercise programme and Part Two included focus group discussions on factors influencing exercise adherence.

12.2. Quantitative Study

The quantitative study evaluated potential changes in physical function by both performance-based and self-reported measures in a specific home based exercise programme. It was observed that important changes were more evident in most performance-based than in self-reported measurements during the nine months of intervention.

The performance-based measures of the Sit to Stand Test, Functional Reach Forward, Voluntary Stepping Time in all directions and Instrumental Activities of Daily Living improved significantly in the intervention group after three months of the exercise programme, continuing their improvement until the end, when compared with the control group. The Timed Up and Go Test, Functional Reach Laterally and Active Range of Motion in both ankles took nine months to show significant improvements in the intervention group when compared with the control group. For the intervention group, in all performance based measures there was improvement between the start and the end of the programme.

The programme showed a very good adherence rate to the exercises with 79% of the required exercises being performed at three months and 74% at nine months.

Three months after the end of the programme the participants sdowed a detraining effect on Sit to Stand, Timed Up and Go, Functional Reach and on Kyphotic Index when compared with the nine month measures.

The results of these measures showed that the home based exercise programme was effective in improving the selected physical parameters.

12.3. Qualitative Study

The qualitative study findings showed that the adherent and the non adherent groups had similar incentives to participate in the programme and similar attitudes towards the programme. They differed in the strength of statements related to barriers to exercise, showing that this was the main cause of leaving the programme.

12.4. A comparison of the outcomes of the Quantitative and Qualitative Study

The quantitative study showed that changes were more evident in the performance-based than in the self-reported measurements during the nine months of intervention. This failure to show improvement in the self reported measurements may be more indicative of weakness in the measurement tools than a lack of actual improvement because statements from the qualitative study showed that the intervention had a positive effect in self-reported measures.

The only physical test that did not show any statistically significant improvement due to the exercise programme was the Kyphotic Index, representing the thoracic curve, when compared with the control group. Data showed that the intervention group had a non significant decrease in the kyphosis curve and the focus groups reported a perception of being straighter. In fact, both the adherent and non adherent groups reported that one of the perceived benefits was the correction of posture and a reduction of the thoracic curve. Using this mixed approach provided a more complete picture of the effectiveness of the programme itself.

Findings from the qualitative research suggested that focus group participants perceived psychological benefits, whereas the parameters measured by the sub domain of the Functional Status Questionnaire, Emotional Function, did not improve significantly in the intervention group, over nine months, when compared with the control group.

The nine month non improvements in Social Activity and Quality of Social Interaction outcomes in the intervention group, within or between groups, matched the focus group participants' recommendations that a group exercise programme instead of a home regimen would be better in terms of socialisation between participants.

Exploring both datasets also showed congruence along the performance based outcome measures and focus group participants' statements. The benefits perceived by the focus groups for flexibility and balance were congruent with the quantitative study flexibility and balance measures outcomes.

Both focus groups referred to some barriers to exercise, for example a lack of time. The influence of time constraints on adherence to exercise is precious information that can be used by the physiotherapist in order to improve adherence to home based exercise programmes. Participants indicated to the researcher that they thought they had to do all the exercises at one time and they found it difficult to identify a period of the day where a complete hour was free for exercising. Once they understood that they could divide the exercise programme into smaller sections they found they could identify times throughout the day for exercise. This illustrates how important it is for physiotherapists to understand barriers to exercise and to induct and educate their clients properly. On the other hand it is important that physiotherapists have good educational, communication and reasoning skills in order to instruct individuals into the programmes appropriately.

After concluding the two studies, it was felt that the qualitative methodology provided rich, detailed information regarding older people's attitudes and behaviours towards exercise and adherence. The quantitative research did not provided all of the data needed to develop effective evidence about the complex mechanisms that influenced health behaviour.

12.5. Study Limitations

The results of the quantitative study should be interpreted in the context of some limitations.

At baseline the two study groups differed significantly in one of the eight sociodemographic characteristics (more participants of the intervention group walked more regularly than the control group). Also two of the twenty four outcome variables, Emotional Function and Social Activity showed higher scores in the intervention group than the Control Group. This may have increased possibility of a type I error.

Another limitation was the fact that visual acuity was not tested in the participants, in particular contrast sensitivity and depth perception. Visual acuity is important for gait (Lord et al. 1991), limits of stability (Lord et al. 1996), stepping (Lord et al. 2001) and the sit to stand test (Lord et al. 2002). Whilst there was no evidence that this caused a problem during data collection it is recommended that in future studies this is measured.

The number of steps that each individual took on turning during the Timed Up and Go Test was not controlled. Turning quality can influence the total time of the test and it is possible that this parameter should have been controlled. During the testing procedure it was noted that there were several different turning strategies.

"Blinding" the researcher during data collection was not possible because it was not feasible to use another person during 2 years of collecting data.

On the whole the quantitative methodology worked well. The only limitation to data collection being the flexicurve which was not able to identify small changes. More studies need to be taken to identify a sensitive method of measuring static thoracic posture and thoracic mobility.

For the qualitative study three issues have been identified: the first was the inexperience of the researcher in facilitating focus group sessions. Whilst the researcher had some training in this technique reflection suggests that richer data could have been obtained if she had been more experienced. Secondly there is concern that the process of translating the quotes from the focus groups may have caused the loss of some emotional content of Portuguese words. The researcher tried to avoid this problem with back translation but the success of this strategy could not be guaranteed. Thirdly the relationship between the researcher and the focus group participants may have influenced the responses but at the time it was not possible to identify an impartial assistant.

12.6. Clinical Implications

The home based exercise programme has been shown to be effective in this group of Portuguese participants in reducing fall risk factors, improving flexibility, strength, balance and voluntary stepping time. The literature showedonly two studies in this area that considered home exercises without equipment (Johnson et al. 2003 and Helbostad et al. 2004), neither of which demonstrated a clear link between the exercises and the methods of measurement. In this Portuguese study the measurement tools were chosen specifically to assess the changes expected from the exercises which showed lead to confidence in accepting the results. Of clinical significance is the fact that in this research the outcomes showed that a moderate intensity exercise programme was effective in producing positive changes. This information is important for physiotherapists because traditionally it is believed that they should use high intensity resistive exercises often requiring equipment. Older people find high intensity exercises daunting and so it is important to know that a moderate intensity exercise programme can be used instead. This research also showed that an exercise programme using no equipment could be effective. This type of exercise programme is cheap and easy to implement anywhere.

Whilst there is no evidence, subjectively it is felt that in Portugal the responsibility for health change is taken by health professionals, not the clients. It is generally accepted that clients are passive. This research indicated by the end of the programme that some of the Portuguese participants appeared to have taken responsibility for their own health. It is thought that because it was a home based exercise programme this transferred some responsibility from the health professionals to the participants. The clinical implications of this are that physiotherapists can be more confident in expecting some clients to take responsibility to do exercises at home. This may reduce the demand in the clinic enabling them to focus on more severe problems. This research has also shown the importance of physiotherapists understanding the processes of health behaviour changes.

12.7. Recommendations for future delivery of this home based exercise programme

It can be said that in general this home based exercise programme was effective. Its value has been recognised in Oporto and it is going to be implemented in other Health Centres and Residential Homes in the north of Portugal and in the Azores. This will be done by incorporating it into the final year project undertaken by physiotherapy students. In Oporto the programme has been accepted by some community leaders who have asked for it to be delivered in two community centres. Because the underpinning philosophy governing the design of this exercise programme was of specificity and of appropriate exercise progression, the programme must not be delivered as an 'off-the-shelf package. In each location the programme must be specifically adapted to the target population. Whilst the exercises will remain the same, the physiotherapist delivering the programme will need to review the number of repetitions, progression and frequency in order that the programme specifically meets the needs of the individuals who are participating.

The negative quantitative results related to thoracic spine flexibility could lead to reflection about the usefulness of specific spine exercises. The data from this research showed an improvement in the Kyphotic Index in the intervention group but the statistical tests did not show significant changes. The focus group statements about posture improvements helped the decision not to change these exercises.

For the future delivery of this programme a few small changes are proposed. The progression of the exercise to increase ankle joint range of movement had some risks as participants were required to sit on the edge of the chair which made them unstable. It is proposed that the exercise will be progressed by stretching the gastrocnemius in standing. Another proposition is to increase the contact time with the physiotherapist during home based exercise programmes to once a week by telephone, and a face-to-face appointment every fortnight. The recommendation from the focus group participants about cognitive exercises was accepted. Whilst this will not have a direct effect on fall risk factors there may be some indirect benefits. Among the cognitive exercises are some tasks related to improving attention. This should be beneficial as gait control requires attention and it is possible that with improved attention during gait there may be less risk of falling.

It is important to include at baseline, psychosocial measures that evaluate the participants' readiness to change behaviour and monitor the processes of changing throughout the programme. It is important to have this knowledge before and during the implementation of any exercise programme as it will help the Physiotherapist to devise strategies to promote exercise adherence.

12.8. New contribution to knowledge

These studies have increased the body of knowledge in the following areas:

- ✓ A specific home based exercise programme was designed. This programme was innovative in that it did not use any equipment and followed the principles of specificity in both choice of exercises and method of assessment. It also included exercises of moderate intensity only. A careful search of the literature revealed that this is probably the only programme of exercises for older people that included spinal exercises.

- ✓ A new device was developed to measure voluntary stepping.
- ✓ The results showed that this programme design could improve strength, flexibility, balance and voluntary stepping time, all considered fall risk factors.
- ✓ The research identified those barriers to undertaking exercise that contributed to non adherence to the exercise programme in a sample of older Portuguese people.

12.9. Future Research

As a consequence of this research it is clear that there are a number of questions still to be answered. The top five research priorities will be to investigate:

- The role of hyperkyphosis in older people's falls.
- The efficacy of voluntary step training on stepping strategy in older people.
- The influence of the present moderate and easy home based exercise programme on the number of falls in older people.
- The efficacy of this programme on older Portuguese people who have different dependency levels.
- How to improve adherence to specific exercise programme for older people

12.10. Conclusion

This research consisted of a quantitative study that analysed the influence of a home based exercise programme in performance-based and self-reported outcome measures and a qualitative study that helped to 'get behind the numbers' and understand participants perspectives, attitudes and behaviours related to the home based programme.

This research showed that a safe home based exercise programme, of moderate intensity and not requiring the use of equipment was effective in improving some fall risk factors in older Portuguese people.

Both the participants who completed the programme and those who dropped out in the early stages identified perceived incentives to enter the programme, benefits of exercising and barriers to exercising. The group who failed to complete the programme listed a greater number of barriers to exercise but did not appear to be able to change their behaviour in order to overcome these barriers.

Prior to these studies little was known about the influence of a home based exercise programme with no equipment on fall risk factors and the factors that contribute to exercise adherence in older Portuguese people. This knowledge is important for physiotherapists planning future exercise programmes for older people in Portugal.

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APPENDICES

APPENDIX 1

The booklet with all the exercises and their progression comprised in this Home Based Programme

THE PORTUGUESE BOOKLET I

THE PORTUGUESE BOOKLET II

ENGLISH VERSION BOOKLET

APPENDIX 2

SOCIODEMOGRAPHIC AND PERSONAL CHARACTERISTICS QUESTIONNAIRE

N.º DO SUJEITO		
IDADE	______ANOS	
SEXO	FEMININO	MASCULINO
PESO (kg)		
ALTURA (m)		
ESTADO CIVIL	CASADO VIÚVO	SOLTEIRO DIVORCIADO
HABILITAÇÕES LITERÁRIAS	<4º ANO 6º ANO 4º ANO 9º ANO MEST. DOUT.	10º ANO 12º ANO 11º ANO LICENC OUTROS
VIVE SÓZINHO	SIM	NÃO
FAZ ACTIVIDADE FÍSICA	SIM	NÃO
SOFREU ALGUMA QUEDA NO ÚLTIMO ANO?	SIM	NÃO
TEM MEDO DE CAIR?	SIM	NÃO
SENTE FALTA DE EQUILÍBRIO?	SIM	NÃO
MEDICAMENTOS QUE TOMA	________________________ ________________________ ________________________	________________________ ________________________ ________________________
DOENÇAS	________________________ ________________________ ________________________	________________________ ________________________ ________________________

APPENDIX 3

MINIMENTAL STATE EXAMINATION (MMSE)

Nº: IDADE: DATA:

1- ORIENTAÇÃO – (1 PONTO POR CADA RESPOSTA CERTA) total 10 pts

1. Qual é o dia da semana? ………………..
2. Qual é o dia do mês? …………………….
3. Qual é o mês? ……………………………
4. Qual é a estação do ano? ………………..
5. Qual é o ano?………………………………
6. Onde estamos agora?……………………..
7. Em que andar estamos? ………………….
8. Em que cidade estamos? …………………
9. Em qual zona do país estamos? …………
10. Em qual País estamos? ………………… Total: …..

2- RETENÇÃO - (1 PONTO POR CADA PALAVRA CORRECTAMENTE REPETIDA) total 3 pts
Examinador pronuncia as palavras na freqüência de uma por segundo (repetir até 5 vezes)
Pêra ………
Gato ………
Bola ……… Total: …..

3- ATENÇÃO E CÁLCULO – (1 ponto por cada resposta correcta. Se der errada mas depois continuar a subtrair bem, consideram-se as seguintes correctas. Parar ao fim de 5 respostas) total 5 Pt
Agora peço-lhe que me diga quantos são 30 menos 3 e depois ao n.º encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar"

27 …. 24 …. 21 …. 18 …. 15 …. Total: …..

4- MEMÓRIA - (1 ponto por cada resposta correcta) total 3 Pt
"Veja se consegue lembrar-se das 3 palavras que lhe pedi há pouco para decorar"
Pêra ………
Gato ………
Bola ……… Total: …..

5- Linguagem - (1 ponto por cada resposta correcta) total 2 pts
a) O que é isto? (Mostre uma caneta) ……………………..

O que é isto? (Mostre um relógio) ………………………...

b) Repita a frase: "O rato roeu a rolha" …………

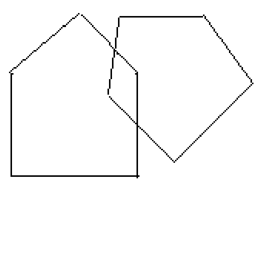
c) "quando lhe der esta folha, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa" (dar a folha com as duas mãos)
pega com a mão direita ……..
dobra ao meio ……………….
Coloca onde deve …………

d) Leia o que está neste cartão e faça o que lá diz . (Mostrar um cartão com a frase FECHE OS OLHOS)
fechou os olhos ………….

e) "Escreva aqui uma frase inteira". Deve ter sujeito e verbo e fazer sentido: os erros não prejudicam a pontuação
…………. Total: …..

6. Habilidade construtiva (1 ponto pela cópia correcta)
Copie este desenho

Total: …..



APPENDIX 4

PORTUGUESE FALLS EFFICACY SCALE (PFES)

ESCALA DE MEDIÇÃO DO MEDO DE CAIR
FES

Nº ------

ABAIXO ESTÃO INDICADAS VÁRIAS TAREFAS.

Á FRENTE DELAS ENCONTRA-SE UMA LINHA QUE MEDE O GRAU DE CONFIANÇA, OU SEJA, O MEDO QUE TEM DE CAIR NA SUA EXECUÇÃO.

MARQUE NA LINHA COM UMA CRUZ O QUE SENTE AO EXECUTAR A TAREFA

	Sem nenhuma Confiança				**Minimamente Confiante**					**Muito Confiante**
1. Vestir e despir-se	**1**	2	3	4	**5**	6	7	8	9	**10**
2. Preparar uma refeição ligeira	**1**	2	3	4	**5**	6	7	8	9	**10**
3. Tomar um banho ou duche	**1**	2	3	4	**5**	6	7	8	9	**10**
4. Sentar / Levantar da cadeira	1	2	3	4	**5**	6	7	8	9	**10**
5. Deitar / Levantar da cama	**1**	2	3	4	**5**	6	7	8	9	**10**
6. Atender a porta ou o telefone	**1**	2	3	4	**5**	6	7	8	9	**10**
7. Andar dentro de casa	**1**	2	3	4	**5**	6	7	8	9	**10**
8. Chegar aos armários	**1**	2	3	4	**5**	6	7	8	9	**10**
9. Trabalho doméstico ligeiro (limpar o pó, fazer a cama, lavar a louça)	**1**	2	3	4	**5**	6	7	8	9	**10**
10. Pequenas compras	**1**	2	3	4	**5**	6	7	8	9	**10**

APPENDIX 5

PORTUGUESE FUNCTIONAL STATUS QUESTIONNAIRE

Nº -------

1.Quais das seguintes afirmações descreve melhor a sua situação no emprego durante a última semana?

Empregado a tempo inteiro ___
Empregado a meio tempo ___
Desempregado por razões de saúde ___
Reformado por razões de saúde ___
Reformado por outra razão ___

2.Quantos dias da semana passada teve de ficar em casa (o dia todo ou parte do dia) por razões de saúde?

___dias (1 a 7 dias)

3.Durante a semana passada quantos dias (o dia todo ou parte do dia) teve de reduzir as suas actividades normais por razões de saúde?

___dias (1 a 7 dias)

4.Como é que se sente em relação à sua saúde?

Muito satisfeito ___
Satisfeito ___
Não tenho a certeza ___
Insatisfeito ___
Muito insatisfeito ___

5.Durante a semana passada com que frequência contactou amigos ou família? (por exemplo, saírem juntos, visitarem-se uns aos outros, falarem ao telefone)

Todos os dias ____
Várias vezes por semana ___
Cerca de uma vez por semana ___
Duas ou três vezes por mês ___
Cerca de uma vez por mês ___
Nunca ___

6. Durante a semana que passou, teve dificuldade

Para cada afirmação, escolha um dos números que identifique a sua resposta:

4	3	2	1	0
fiz sem dificuldade	fiz com alguma	fiz com bastante dificuldade	não fiz por razões de dificuldade	não fiz por outras razões saúde

a) tratar de si próprio, isto é comer, vestir-se ou lavar-se?
4 3 2 1 0
b) entrar e sair da cama ou sentar-se e levantar-se de uma cadeira?
4 3 2 1 0
c) andar dentro de casa?
4 3 2 1 0
d) andar fora de casa?
4 3 2 1 0
e) subir um lance de escadas?
4 3 2 1 0
f) fazer tarefas domésticas como limpar, trabalhar no quintal, manter a casa?
4 3 2 1 0
g) fazer as compras?
4 3 2 1 0
h) entrar e/ou sair de um carro ou utilizar os transportes públicos?
4 3 2 1 0
i) fazer tarefas vigorosas como correr, levantar pesos ou participar em desportos vigorosos?
4 3 2 1 0

7. Durante a passada semana

Escolha um dos números que identifique a sua resposta:

1	2	3	4	5	6
SEMPRE	**QUASE SEMPRE**	**FREQUENTEMENTE**	**POR VEZES**	**RARAMENTE**	**NUNCA**

a)foi uma pessoa nervosa?
1 2 3 4 5
6
b)esteve calma/o e tranquila/o?*
1 2 3 4 5
6
c)sentiu-se infeliz e/ou triste?
1 2 3 4 5
6
d)foi uma pessoa feliz?*
1 2 3 4 5
6

8. Durante a passada semana teve dificuldade em

Para cada afirmação, escolha um dos números que identifique a sua resposta:

4	3	2	1	0
Fiz sem dificuldade	**Fiz com alguma dificuldade**	**Fiz com com bastante dificuldade**	**Não fiz por razões de saúde**	**Não fiz por outras razões**

a)visitar a sua família ou amigos
4 3 2 1 0

b)participar em actividades da sua comunidade por exemplo cerimónias religiosas ou actividades sociais
4 3 2 1 0

c)tomar conta de outras pessoas como por exemplo membros da sua família
4 3 2 1 0

9. Durante a passada semana

Para cada afirmação, escolha um dos números que identifique a sua resposta:

1	2	3	4	5	6
SEMPRE	**QUASE SEMPRE**	**FREQUENTEMENTE**	**POR VEZES**	**RARAMENTE**	**NUNCA**

a)isolou-se daqueles que lhe são próximos?
1 2 3 4 5 6

b)agiu carinhosamente com os outros?*
1 2 3 4 5 6

c)irritou-se com os que lhe são próximos?
1 2 3 4 5 6

d)fez pedidos pouco razoáveis à sua família e amigos?
1 2 3 4 5 6

e)deu-se bem com as outras pessoas (fora do círculo familiar)?*
1 2 3 4 5 6

***Perguntas de cotação invertida**

APPENDIX 6

QUALITY OF LIFE OF PORTUGUESE OLD PERSON QUESTIONNAIRE

Nº ……

QVPIR - Qualidade de Vida da pessoa Idosa

Instruções

O seguinte questionário pretende avaliar a sua qualidade de vida. Entendemos por qualidade de vida o quanto a pessoa está satisfeita com os aspectos da vida que são importantes para si (Raphael et al 1997, Ferrans 1990, Bowling 1995, Farquhar 1995).

Por importante entendemos as coisas que significam mais para si e por satisfação entendemos o seu julgamento quanto a essa característica, quando comparado com valores externos.

Neste questionário são sugeridos um conjunto de 23 itens, que a literatura indica como aspectos importantes na vida das pessoas. É-lhe pedido que classifique cada item, quanto à importância que tem para a sua vida e também quanto à satisfação que sente quanto a esse aspecto neste momento. Ao responder deve sempre referir o número a que corresponde a sua resposta (de 1 a 5). Se houver alguma pergunta que não tenha a ver consigo, deixe-a em branco.

A escala que deve utilizar para a classificação é a seguinte:

CLASSIFICAÇÃO	IMPORTÂNCIA	SATISFAÇÃO
1	Nada Importante	Muito insatisfeito
2	Pouco Importante	Insatisfeito
3	Indiferente	Nem satisfeito, nem insatisfeito
4	Importante	Satisfeito
5	Muito importante	Muito satisfeito

Faça a classificação correspondente à Importância e à Satisfação nas respectivas colunas do lado direito, das folhas abaixo.

Aspectos da Vida	Importância	Satisfação
SAÚDE EM GERAL E FUNCIONALIDADE		
1. A minha saúde em geral		
2. Tratar de mim (lavar-me, vestir-me e comer sozinha/o)		
3. Tratar da casa e do quintal (fazer tarefas domésticas ou arranjar o quintal/pequena horta)		
4. Movimentar-me em casa e no meu bairro		
5. Não ter dores		
BEM ESTAR EMOCIONAL E ESPIRITUAL		
6. Decidir o que eu quero fazer da minha vida		
7. Não ter demasiadas preocupações, arrelias ou tristezas		
8. Lembrar-me das coisas de que preciso		
9. A minha fé/religião		
10. Ter coisas que me interessam no futuro		
11. Sentir-me bem comigo mesmo/a		

Aspectos da vida	Importância	Satisfação
VIDA SOCIAL E FAMILIAR		
12.Poder contar com a família quando é necessário		
13.Não ser um peso para a minha família		
14.Tomar conta dos netos ou outras crianças		
15.Tomar conta da/o esposa/o		
16.Distrair-me, por exemplo ver televisão, fazer tricot, crochet ou bordar, conversar com os amigos na praça, jogar cartas.		
17.Dar um passeio a pé, participar em passeios organizados pela comunidade		
18.Visitar/ser visitado por pessoas da minha família		
19.Visitar/ser visitado por amigos		
A SITUAÇÃO FINANCEIRA E O AMBIENTE		
20.Ter dinheiro suficiente para satisfazer a minhas necessidades		
21.Ter acesso fácil ao médico ou outros serviços de saúde		
22. Viver num local seguro		
23. Viver numa zona limpa e sem barulho		

APPENDIX 7

Brochure available at the Foz Health Centre

SOON YOU WILL HAVE AT YOUR DISPOSAL

IN THIS HEALTH CENTER

A PHYSIOTHERAPIST

TO TEACH YOU

HOME PHYSICAL EXERCISE

FREE OF CHARGES

HOME BASED EXERCISE PROGRAM

[illegible]
UNIVERSITY OF BRIGHTON

CRISTINA MELO – PHYSIOTHERAPIST

CONTACTS:
[illegible]
[illegible]
E-MAIL: [illegible]

EXERCISE YOURSELF
FOR
YOUR HEALTH

HEALTH UNIT OF FOZ

FOZ HEALTH CENTER
[illegible] HEALTH CENTER

AS YOU BECOME OLDER
THE BODY SUFFERS
SOME CHANGES

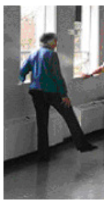
IT DECREASES

- THE BALANCE
- THE STRENGTH
- THE MOVEMENTS

IT INCREASES

THE FALLS

BUT FALL'S TENDENCY
CAN BE
DIMINISHED



WITH MODERATE
PHYSICAL EXERCISE
SUPERVISED BY
A PHYSIOTHERAPIST

AND WITHOUT GET OUT OF HOME

MODERATE PHYSICAL
EXERCISE HELPS TOO
IN CHRONIC DESESASES
AS

HYPERTENSION

DIABETES

ARTHROSES

APPENDIX 8

ETHICAL APPROVAL ACCORDING TO THE HEALTH CENTRE ETHICS COMMITTEE

Administração Regional de Saúde do Norte, I.P.

Centro de Saúde da Carvalhosa e Foz do Douro

Ministério da Saúde

DECLARAÇÃO

Graça Maria Martins Gonçalves de Azevedo, Directora do Centro de Saúde da Carvalhosa e Foz do Douro, declara que o projecto "Influência de um Programa de exercício físico em casa na população idosa portuguesa" efectuado nesta instituição entre Janeiro 2004 e Dezembro 2005, da responsabilidade da Drª. Maria Cristina Damas Argel de Melo, cumpriu com os requesitos éticos exigidos.

Por ser verdade e lhe ter sido pedida passa a presente que data e assim.

Porto, 19 de Novembro de 2007

A Directora do C. S. Carvalhosa / Foz do Douro

Graça Azevedo

Graça Azevedo (Drª.)

APPENDIX 9

Participant consent form

Participant Consent Form

Pilot studies for instrument's reliability

I agree to take part in this research which is to use some instruments and some movements. The researcher has explained to my satisfaction the purpose of the study and the possible risks involved. I have had the principles and the procedure explained to me. I am aware that I will be required more times to repeat the tests. I understand that any confidential information will be seen only by the researchers and no one else. I understand that I am free to withdraw from the study at any time, without giving any reasons.

Name (please print) ....

Signed..

Date...

APPENDIX 10

BASELINE DATA

Nº	IDADE	GENDER	WEIGHT	HEIGHT	MARITAL STATUS	YEARS OF STUDY	LIVING ALONE	WALKING REGULARLY	FALLS PAST YEAR	FEAR OF FALLING	FEELING LOSS OF BALANCE
1	71	FEMALE	59	1,56	MARRIED	8	NO	NO	NO	NO	NO
2	73	MALE	88	1,72	MARRIED	3	NO	YES	NO	NO	NO
3	66	MALE	81	1,82	MARRIED	8	NO	YES	NO	NO	NO
4	69	MALE	89	1,83	MARRIED	7	NO	YES	NO	NO	NO
5	78	MALE	62	1,68	MARRIED	7	NO	YES	NO	NO	YES
6	69	MALE	67	1,64	MARRIED	4	YES	YES	YES	YES	YES
7	67	MALE	64	1,78	MARRIED	3	NO	NO	NO	NO	NO
8	71	MALE	85	1,72	MARRIED	3	NO	YES	NO	NO	NO
9	79	MALE	75	1,75	MARRIED	3	NO	YES	NO	NO	NO
10	70	FEMALE	54	1,64	MARRIED	8	NO	NO	YES	NO	NO
11	70	MALE	55	1,64	MARRIED	6	NO	NO	NO	NO	NO
12	65	FEMALE	57	1,65	WIDOWED	7	YES	YES	NO	YES	YES
13	72	FEMALE	59	1,52	MARRIED	8	NO	NO	YES	YES	YES
14	70	FEMALE	66	1,58	WIDOWED	1	NO	NO	NO	NO	NO
15	69	FEMALE	58	1,61	MARRIED	8	NO	YES	NO	NO	NO
16	80	MALE	67	1,66	MARRIED	8	NO	YES	NO	NO	NO
17	74	MALE	93	1,71	MARRIED	2	NO	NO	YES	NO	NO
18	68	FEMALE	68	1,62	WIDOWED	3	YES	NO	NO	NO	NO
19	71	FEMALE	71	1,57	WIDOWED	7	YES	YES	YES	YES	NO
20	70	FEMALE	50	1,55	WIDOWED	2	NO	YES	YES	NO	NO
21	74	MALE	67	1,65	WIDOWED	4	YES	YES	NO	NO	NO
22	69	MALE	69	1,65	MARRIED	2	NO	YES	NO	NO	YES
Nº	IDADE	GENDER	WEIGHT	HEIGHT	MARITAL STATUS	YEARS OF STUDY	LIVING ALONE	WALKING REGULARLY	FALLS PAST YEAR	FEAR OF FALLING	FEELING LOSS OF BALANCE

23	67	FEMALE	76	1,62	MARRIED	8	NO	YES	NO	NO	NO
24	70	FEMALE	67	1,63	WIDOWED	8	YES	YES	NO	YES	NO
25	68	MALE	60	1,63	MARRIED	3	NO	NO	YES	NO	YES
26	77	FEMALE	50	1,55	WIDOWED	3	YES	YES	YES	YES	YES
27	67	FEMALE	89	1,73	WIDOWED	2	YES	NO	NO	NO	NO
28	74	MALE	61,5	1,77	MARRIED	7	NO	YES	NO	NO	YES
29	74	FEMALE	76	1,56	MARRIED	1	YES	NO	YES	YES	YES
30	66	FEMALE	72	1,65	WIDOWED	1	YES	YES	NO	YES	NO
31	74	FEMALE	72,5	1,57	WIDOWED	1	NO	NO	NO	YES	YES
32	80	FEMALE	79	1,56	WIDOWED	3	YES	NO	YES	YES	YES
33	72	FEMALE	70	1,64	MARRIED	2	NO	NO	YES	NO	NO
34	73	FEMALE	72	1,5	OTHERS	10	YES	NO	NO	YES	NO
35	78	FEMALE	90	1,64	MARRIED	2	NO	NO	NO	YES	NO
36	66	MALE	83	1,81	OTHERS	7	NO	YES	NO	NO	YES
37	65	MALE	77	1,79	MARRIED	9	NO	YES	NO	NO	NO
38	66	MALE	90	1,82	WIDOWED	2	NO	NO	NO	NO	YES
39	79	FEMALE	58	1,49	WIDOWED	5	YES	NO	YES	NO	NO
40	77	FEMALE	51	1,46	WIDOWED	4	NO	YES	YES	NO	YES
41	74	MALE	93	1,71	MARRIED	2	NO	NO	YES	NO	NO
42	78	MALE	110	1,67	WIDOWED	2	YES	NO	NO	NO	NO
43	65	FEMALE	69	1,55	OTHERS	4	YES	YES	NO	NO	NO
44	67	FEMALE	60	1,65	OTHERS	8	YES	YES	NO	NO	NO
45	79	FEMALE	61	1,57	WIDOWED	1	NO	NO	YES	YES	YES
46	79	MALE	75	1,75	MARRIED	3	NO	YES	NO	NO	NO
Nº	IDADE	GENDER	WEIGHT	HEIGHT	MARITAL STATUS	YEARS OF STUDY	LIVING ALONE	WALKING REGULARLY	FALLS PAST YEAR	FEAR OF FALLING	FEELING LOSS OF BALANCE
47	66	MALE	90	1,82	WIDOWED	2	NO	NO	NO	NO	YES
48	65	MALE	77	1,79	MARRIED	9	NO	YES	NO	NO	NO

49	77	MALE	90	1,8	MARRIED	2	NO	NO	YES	YES	YES
50	75	FEMALE	43	1,56	WIDOWED	1	YES	NO	NO	YES	YES
51	65	FEMALE	62	1,64	MARRIED	3	NO	NO	NO	YES	YES
52	65	FEMALE	75	1,64	MARRIED	3	NO	NO	YES	YES	YES
53	72	FEMALE	64	1,48	WIDOWED	3	YES	NO	YES	NO	YES
54	71	MALE	70	1,7	MARRIED	2	NO	YES	NO	NO	NO
55	69	MALE	58	1,66	MARRIED	7	NO	YES	NO	NO	NO
56	75	FEMALE	50	1,5	WIDOWED	2	YES	NO	NO	YES	NO
57	73	FEMALE	72	1,5	OTHERS	10	YES	NO	NO	YES	NO
58	71	FEMALE	60	1,5	WIDOWED	1	YES	NO	NO	YES	YES
59	69	FEMALE	67	1,55	MARRIED	2	NO	NO	NO	NO	NO
60	66	FEMALE	72	1,65	WIDOWED	1	YES	YES	NO	YES	NO
61	77	FEMALE	51	1,52	WIDOWED	7	YES	NO	YES	NO	NO
52	66	MALE	90	1,63	MARRIED	2	NO	YES	NO	NO	NO
63	68	FEMALE	60	1,68	MARRIED	8	NO	NO	NO	NO	NO
64	71	MALE	71	1,66	MARRIED	2	NO	NO	YES	YES	NO
65	66	FEMALE	68	1,59	MARRIED	8	NO	NO	YES	NO	YES
66	66	FEMALE	89	1,72	WIDOWED	2	YES	NO	YES	NO	NO
67	69	MALE	88	1,75	MARRIED	8	NO	NO	NO	NO	NO
68	71	FEMALE	68	1,68	OTHERS	7	NO	YES	YES	NO	NO
69	69	FEMALE	67	1,59	WIDOWED	2	YES	YES	YES	NO	YES
70	72	FEMALE	57	1,59	MARRIED	8	NO	YES	NO	NO	NO
71	71	FEMALE	55	1,65	MARRIED	2	NO	NO	YES	YES	NO
Nº	IDADE	GENDER	WEIGHT	HEIGHT	MARITAL STATUS	YEARS OF STUDY	LIVING ALONE	WALKING REGULARLY	FALLS PAST YEAR	FEAR OF FALLING	FEELING LOSS OF BALANCE
72	74	FEMALE	43	1,55	WIDOWED	9	NO	NO	NO	NO	YES
73	65	FEMALE	81	1,53	MARRIED	4	NO	NO	YES	NO	NO
74	72	MALE	72	1,7	MARRIED	7	NO	YES	NO	NO	NO
75	82	FEMALE	62	1,5	WIDOWED	1	YES	NO	NO	YES	YES

76	71	FEMALE	45	1,51	MARRIED	2	NO	NO	YES	YES	YES
77	76	FEMALE	51,5	1,58	WIDOWED	4	YES	NO	NO	NO	YES
78	68	MALE	79	1,65	MARRIED	4	NO	NO	NO	NO	NO
79	67	FEMALE	53	1,49	MARRIED	2	NO	NO	YES	YES	YES
80	77	FEMALE	59	1,62	WIDOWED	2	YES	YES	NO	NO	NO
81	73	MALE	74	1,69	MARRIED	2	NO	YES	NO	NO	YES
82	67	MALE	64	1,78	MARRIED	8	NO	NO	NO	NO	NO

Nº	GENDER	STS	TUG	FRF	FRL	SFRF	SFLF	SLRF	SLLF	SBRF	SBLF	AROM RF	AROM LF	KI	FES	QoL	FF BADL	FF IADL	EF	FS SA	FS QSI
1	FEMALE	11	5,78	26	13	0,31	0,28	0,35	0,37	0,27	0,21	40	50	9,1	100	6,7	100	100	100	100	100
2	MALE	13	9,08	31	20	0,24	0,22	0,28	0,28	0,15	0,19	18	17	13,1	97	6,3	100	83	100	100	100
3	MALE	12	6,95	36	28	0,32	0,4	0,28	0,29	0,29	0,31	61	64	10,2	100	6,3	100	100	80	100	92
4	MALE	17	8,25	39	21	0,19	0,17	0,16	0,16	0,25	0,27	35	36	9,6	100	6,4	100	100	80	100	40
5	MALE	15	10,69	29	19	0,18	0,19	0,22	0,23	0,24	0,27	19	15	9	97	6,4	100	100	100	100	100
6	MALE	16	8,91	27	24	0,19	0,19	0,25	0,22	0,32	0,31	48	51	10,2	100	6,1	89	87	65	100	92
7	MALE	14	7,71	38	21	0,33	0,31	0,37	0,36	0,39	0,28	32	16	6,9	98	6,3	100	100	40	100	96
8	MALE	15	8,7	20	27	0,18	0,17	0,23	0,18	0,13	0,2	25	32	11,8	100	6,4	100	83	100	100	96
9	MALE	11	7,39	32	22	0,36	0,26	0,29	0,3	0,32	0,34	43	44	6,9	99	6,2	100	100	90	100	88
10	FEMALE	10	11,03	37	14	0,51	0,48	0,46	0,36	0,41	0,43	50	35	6,8	100	6,4	100	100	65	100	72
11	MALE	15	6,93	33	22	0,22	0,23	0,27	0,28	0,36	0,31	28	32	8,9	100	6,3	100	83	80	100	92
12	FEMALE	15	6,04	38	22	0,31	0,27	0,28	0,3	0,29	0,3	51	50	9,4	88	5,9	100	78	50	100	100
13	FEMALE	10	10,21	26	16	0,32	0,22	0,31	0,25	0,33	0,3	24	30	14,6	85	6,5	89	73	30	100	80
14	FEMALE	17	9,05	25	20	0,26	0,32	0,26	0,26	0,28	0,32	31	15	11,1	100	6,2	100	93	80	100	100
15	FEMALE	11	9,04	28	17	0,36	0,36	0,3	0,32	0,42	0,33	61	66	14	96	6,5	100	87	90	100	96
16	MALE	18	8,5	32	21	0,23	0,22	0,33	0,3	0,34	0,3	62	50	10,5	96	6	100	100	90	100	100
17	MALE	16	8,09	24	18	0,34	0,31	0,31	0,3	0,39	0,31	34	42	5,1	98	6,5	100	92	90	0	88
18	FEMALE	18	7,08	23	24	0,2	0,27	0,27	0,25	0,26	0,23	37	46	6,8	100	6,4	78	100	75	100	100
19	FEMALE	13	9,92	22	19	0,31	0,28	0,35	0,31	0,32	0,33	42	42	13,9	91	6,2	100	100	90	100	100
20	FEMALE	13	7,78	24	14	0,4	0,43	0,32	0,26	0,27	0,24	42	45	10,9	100	5,7	100	100	55	100	80
21	MALE	14	7,23	30	20	0,5	0,42	0,31	0,37	0,3	0,32	29	14	7,1	100	5,9	100	100	80	100	84
22	MALE	12	8,2	28	14	0,42	0,37	0,35	0,3	0,3	0,31	42	44	11,4	84	6,4	89	89	50	100	92
23	FEMALE	16	6,46	22	20	0,24	0,28	0,26	0,27	0,27	0,29	48	42	18,5	100	6,4	100	100	90	100	100
24	FEMALE	15	7,36	29	31	0,27	0,25	0,27	0,27	0,22	0,26	29	26	8,2	100	6	100	100	50	100	92
26	FEMALE	18	6,55	21	15	0,21	0,23	0,31	0,28	0,32	0,32	38	38	15,6	98	6,5	100	100	65	100	84

Nº	GENDER	STS	TUG	FRF	FRL	SFRF	SFLF	SLRF	SLLF	SBRF	SBLF	AROM RF	AROM LF	KI	FES	QoL	FF BADL	FF IADL	EF	FS SA	FS QSI
27	FEMALE	10	6,63	25	25	0,3	0,29	0,29	0,29	0,38	0,4	42	43	11,1	100	5,4	78	60	50	67	84
28	MALE	8	14,68	12	9	0,42	0,56	0,42	0,34	0,52	0,51	15	22	14	96	5,6	100	100	100	100	100
29	FEMALE	12	8,17	25	17	0,36	0,38	0,26	0,26	0,3	0,3	9	11	11,7	95	5,9	100	80	100	100	100
30	FEMALE	12	7,43	24	13	0,26	0,25	0,3	0,31	0,36	0,36	38	40	11,6	86	6	89	93	50	100	96
31	FEMALE	9	12,6	23	17	0,24	0,33	0,3	0,33	0,24	0,3	19	15	10,5	93	6	100	100	95	100	100
32	FEMALE	11	9,69	19	11	0,27	0,27	0,35	0,35	0,4	0,4	28	23	12,1	100	6,4	100	100	90	100	100
33	FEMALE	10	10,33	28	16	0,39	0,31	0,38	0,36	0,29	0,3	14	20	13,8	98	6,1	100	93	80	100	96
34	FEMALE	16	10,44	24	11	0,36	0,24	0,35	0,33	0,31	0,35	33	27	7,9	99	6	100	100	100	100	100
35	FEMALE	12	9,14	25	15	0,24	0,21	0,29	0,25	0,28	0,34	17	17	9,5	95	5,8	89	100	75	0	100
36	MALE	13	8,27	27	24	0,27	0,4	0,3	0,25	0,29	0,23	47	55	6,7	97	6,2	100	100	100	100	100
37	MALE	10	7,92	38	25	0,21	0,22	0,26	0,31	0,3	0,3	27	19	5,5	91	6	100	100	100	100	100
38	MALE	12	7,36	29	14	0,2	0,22	0,26	0,26	0,33	0,32	37	32	10,8	94	6,2	100	93	75	100	96
39	FEMALE	12	8,7	19	9	0,29	0,3	0,32	0,33	0,33	0,37	39	36	10,8	93	6,5	100	87	50	100	100
40	FEMALE	15	7,66	26	16	0,23	0,21	0,3	0,26	0,29	0,27	42	37	7,1	98	6,4	100	100	65	100	100
41	MALE	12	8,7	27	20	0,23	0,28	0,32	0,27	0,4	0,24	13	12	6,7	97	6,5	100	80	90	100	88
42	MALE	14	10,29	17	10	0,33	0,24	0,24	0,32	0,27	0,29	22	20	8,3	97	6,3	100	87	65	100	96
43	FEMALE	12	7,52	13	11	0,18	0,21	0,24	0,22	0,18	0,22	34	28	10,9	98	6,5	100	100	10	100	92
44	FEMALE	13	6,64	24	18	0,27	0,28	0,25	0,25	0,22	0,23	39	30	12,3	100	6,1	100	89	100	100	96
45	FEMALE	12	11,98	15	17	0,35	0,35	0,35	0,32	0,39	0,36	37	35	9,6	75	6,3	78	67	75	67	92
46	MALE	9	9,56	26	18	0,23	0,19	0,22	0,23	0,24	0,23	30	25	10,6	89	6,4	100	100	100	100	96
47	MALE	12	7,26	29	14	0,2	0,22	0,26	0,26	0,33	0,32	37	32	10,8	94	6,4	100	93	75	100	96
48	MALE	10	7,77	38	25	0,21	0,22	0,26	0,31	0,3	0,3	30	16	5,5	91	6,3	100	100	100	100	100
49	MALE	12	9,28	40	23	0,16	0,22	0,2	0,22	0,22	0,25	17	14	6,6	92	6,2	100	100	75	100	88
50	FEMALE	11	10,84	21	18	0,27	0,34	0,37	0,39	0,35	0,33	53	47	9,3	79	6,1	89	73	25	78	100
51	FEMALE	8	9,67	21	13	0,36	0,4	0,33	0,32	0,34	0,35	36	25	11,4	95	6,3	100	67	90	83	80
52	FEMALE	7	12,18	19	12	0,34	0,32	0,3	0,29	0,32	0,3	27	18	9,3	90	6,4	89	60	75	100	100
53	FEMALE	16	7,83	22	14	0,3	0,35	0,32	0,27	0,38	0,36	22	18	9,4	92	6,5	89	73	50	100	80
54	MALE	10	7,55	27	16	0,24	0,25	0,26	0,28	0,18	0,16	18	21	13	97	5,6	100	100	50	100	80

Nº	GENDER	STS	TUG	FRF	FRL	SFRF	SFLF	SLRF	SLLF	SBRF	SBLF	AROM RF	AROM LF	KI	FES	QoL	FF BADL	FF IADL	EF	FS SA	FS QSI
55	MALE	21	6,7	34	38	0,33	0,32	0,35	0,29	0,32	0,32	58	49	9,4	99	5,9	89	100	65	100	80
56	FEMALE	18	7,17	22	26	0,41	0,42	0,32	0,3	0,3	0,26	38	44	9	98	6,3	100	100	90	100	96
57	FEMALE	16	10,41	24	11	0,36	0,24	0,35	0,33	0,31	0,35	33	27	7,9	99	6,1	100	100	100	100	100
58	FEMALE	15	9,26	26	15	0,4	0,39	0,29	0,39	0,34	0,24	18	27	6,9	91	6,3	100	73	75	0	80
59	FEMALE	11	9,94	22	18	0,26	0,27	0,31	0,32	0,35	0,34	45	43	10,6	95	6,4	89	87	50	100	92
60	FEMALE	12	7,43	24	13	0,26	0,25	0,3	0,31	0,36	0,36	38	40	11,6	86	6,3	89	93	50	100	96
61	FEMALE	10	10,62	21	10	0,49	0,39	0,51	0,46	0,4	0,53	23	22	6,6	94	6,3	89	87	75	78	100
52	MALE	15	7,68	22	10	0,2	0,24	0,26	0,29	0,36	0,31	14	14	12,6	99	6	100	100	65	100	96
63	FEMALE	19	5,53	39	16	0,24	0,21	0,2	0,21	0,28	0,28	29	39	8,8	100	6,1	100	100	100	100	84
64	MALE	15	8,76	18	13	0,2	0,24	0,22	0,23	0,27	0,32	31	28	9,8	100	6,5	100	100	80	100	96
65	FEMALE	17	8,14	30	25	0,23	0,24	0,31	0,29	0,3	0,3	44	40	6,7	100	6	100	100	75	67	96
66	FEMALE	12	8,86	20	12	0,26	0,25	0,28	0,35	0,33	0,29	49	47	11,7	100	5,7	78	73	50	100	100
67	MALE	18	5,77	39	33	0,21	0,24	0,29	0,31	0,4	0,4	44	37	7,8	100	6,5	100	100	90	100	92
68	FEMALE	13	8,44	33	28	0,24	0,25	0,24	0,26	0,32	0,25	34	35	16,1	98	5,5	100	83	50	100	88
69	FEMALE	12	10,47	25	15	0,45	0,54	0,38	0,35	0,47	0,34	46	45	10,4	100	6,5	89	33	0	0	76
70	FEMALE	16	9,65	37	28	0,28	0,27	0,32	0,32	0,27	0,24	52	56	10,9	100	5,1	100	100	90	0	96
71	FEMALE	14	10,98	33	19	0,28	0,33	0,33	0,32	0,27	0,27	38	41	11,9	82	5,9	78	60	50	67	84
72	FEMALE	16	7,11	28	26	0,3	0,28	0,31	0,33	0,51	0,5	44	46	7,7	100	4,4	100	100	25	100	92
73	FEMALE	9	10,03	26	17	0,36	0,37	0,27	0,3	0,28	0,26	37	32	8,2	98	6,1	100	100	100	100	100
74	MALE	25	5,16	34	38	0,24	0,33	0,27	0,29	0,26	0,25	47	43	9,3	100	6	100	94	65	100	92
75	FEMALE	6	12,78	14	7	0,43	0,44	0,54	0,62	0,23	0,27	23	10	8,6	73	6,1	78	56	45	67	80
76	FEMALE	10	19,8	12	17	0,55	0,62	0,42	0,41	0,35	0,32	20	14	11,9	72	5,7	67	20	0	67	60
77	FEMALE	12	8,87	22	9	0,3	0,33	0,28	0,3	0,21	0,21	28	24	8	100	6,3	100	100	70	100	100
78	MALE	15	7,19	35	20	0,2	0,18	0,24	0,18	0,26	0,32	26	21	13,4	100	6,3	100	100	35	100	100
79	FEMALE	21	7,51	19	15	0,36	0,26	0,24	0,25	0,24	0,28	34	20	7	100	6,4	100	100	45	100	88
80	FEMALE	5	13,8	16	10	0,41	0,51	0,44	0,48	0,4	0,41	36	35	14,3	88	5,6	89	73	10	83	100
81	MALE	20	7,26	29	17	0,23	0,21	0,23	0,25	0,26	0,3	24	15	11,7	100	6,4	100	100	90	100	92
82	MALE	14	7,92	36	31	0,21	0,23	0,24	0,25	0,29	0,29	54	57	10	100	6,2	100	100	65	100	88

APPENDIX 11

DATA AFTER DROPOUTS

GROUP	AGE	GENDER	WEIGHT	HEIGHT	BMI	MARITAL STATUS	Y OF STUDY	LIVING ALONE	WALKING REG	F PAST YEAR	FEAR FALL	FEEL L OSS BALANCE
INTERVENTION	71	FEMALE	59	1,56	24	MARRIED	LICENCE	NO	NO	NO	NO	NO
INTERVENTION	73	MALE	88	1,72	30	MARRIED	6 Y	NO	YES	NO	NO	NO
INTERVENTION	71	FEMALE	59	1,56	24	MARRIED	LICENCE	NO	NO	NO	NO	NO
INTERVENTION	69	MALE	89	1,83	27	MARRIED	12 Y	NO	YES	NO	NO	NO
INTERVENTION	78	MALE	62	1,68	22	MARRIED	12 Y	NO	YES	NO	NO	YES
INTERVENTION	69	MALE	67	1,64	25	MARRIED	9 Y	YES	YES	YES	YES	YES
INTERVENTION	67	MALE	64	1,78	20	MARRIED	6 Y	NO	NO	NO	NO	NO
INTERVENTION	71	MALE	85	1,72	29	MARRIED	6 Y	NO	YES	NO	NO	NO
INTERVENTION	79	MALE	75	1,75	24	MARRIED	6 Y	NO	YES	NO	NO	NO
INTERVENTION	70	FEMALE	54	1,64	20	MARRIED	LICENCE	NO	NO	YES	NO	NO
INTERVENTION	70	MALE	55	1,64	20	MARRIED	11 Y	NO	NO	NO	NO	NO
INTERVENTION	72	FEMALE	59	1,52	26	MARRIED	LICENCE	NO	NO	YES	YES	YES
INTERVENTION	70	FEMALE	66	1,58	26	WIDOWED	LESS THAN 4 Y	NO	NO	NO	NO	NO
INTERVENTION	69	FEMALE	58	1,61	22	MARRIED	LICENCE	NO	YES	NO	NO	NO
INTERVENTION	80	MALE	67	1,66	24	MARRIED	LICENCE	NO	YES	NO	NO	NO
INTERVENTION	74	MALE	93	1,71	32	MARRIED	4 Y	NO	NO	YES	NO	NO
INTERVENTION	68	FEMALE	68	1,62	26	WIDOWED	6 Y	YES	NO	NO	NO	NO
INTERVENTION	71	FEMALE	71	1,57	29	WIDOWED	12 Y	YES	YES	YES	YES	NO
INTERVENTION	70	FEMALE	50	1,55	21	WIDOWED	4 Y	NO	YES	YES	NO	NO
INTERVENTION	74	MALE	67	1,65	25	WIDOWED	9 Y	YES	YES	NO	NO	NO
INTERVENTION	69	MALE	69	1,65	25	MARRIED	4 Y	NO	YES	NO	NO	YES
INTERVENTION	67	FEMALE	76	1,62	29	MARRIED	LICENCE	NO	YES	NO	NO	NO
INTERVENTION	70	FEMALE	67	1,63	25	WIDOWED	LICENCE	YES	YES	NO	YES	NO
INTERVENTION	68	MALE	60	1,63	23	MARRIED	6 Y	NO	NO	YES	NO	YES

GROUP	AGE	GENDER	WEIGHT	HEIGHT	BMI	MARITAL STATUS	Y OF STUDY	LIVING ALONE	WALKING REG	F PAST YEAR	FEAR FALL	FEEL L BALANCE
INTERVENTION	77	FEMALE	50	1,55	21	WIDOWED	6 Y	YES	YES	YES	YES	YES
INTERVENTION	67	FEMALE	89	1,73	30	WIDOWED	4 Y	YES	NO	NO	NO	NO
CONTROL	77	FEMALE	51	1,46	24	WIDOWED	9 Y	NO	YES	YES	NO	YES
CONTROL	74	MALE	93	1,71	32	MARRIED	4 Y	NO	NO	YES	NO	NO
CONTROL	78	MALE	110	1,67	39	WIDOWED	4 Y	YES	NO	NO	NO	NO
CONTROL	65	FEMALE	69	1,55	29	DIVORCED	9 Y	YES	YES	NO	NO	NO
CONTROL	67	FEMALE	60	1,65	22	DIVORCED	LICENCE	YES	YES	NO	NO	NO
CONTROL	79	FEMALE	61	1,57	25	WIDOWED	LESS THAN 4 Y	NO	NO	YES	YES	YES
CONTROL	79	MALE	75	1,75	24	MARRIED	6 Y	NO	YES	NO	NO	NO
CONTROL	66	MALE	90	1,82	27	WIDOWED	4 Y	NO	NO	NO	NO	YES
CONTROL	65	MALE	77	1,79	24	MARRIED	MASTER	NO	YES	NO	NO	NO
CONTROL	77	MALE	90	1,8	28	MARRIED	4 Y	NO	NO	YES	YES	YES
CONTROL	75	FEMALE	43	1,56	18	WIDOWED	LESS THAN 4 Y	YES	NO	NO	YES	YES
CONTROL	65	FEMALE	62	1,64	23	MARRIED	6 Y	NO	NO	NO	YES	YES
CONTROL	65	FEMALE	75	1,64	28	MARRIED	6 Y	NO	NO	YES	YES	YES
CONTROL	72	FEMALE	64	1,48	29	WIDOWED	6 Y	YES	NO	YES	NO	YES
CONTROL	71	MALE	70	1,7	24	MARRIED	4 Y	NO	YES	NO	NO	NO
CONTROL	69	MALE	58	1,66	21	MARRIED	12 Y	NO	YES	NO	NO	NO
CONTROL	75	FEMALE	50	1,5	22	WIDOWED	4 Y	YES	NO	NO	YES	NO
CONTROL	73	FEMALE	72	1,5	32	SINGLE	PhD	YES	NO	NO	YES	NO
CONTROL	71	FEMALE	60	1,5	27	WIDOWED	LESS THAN 4 Y	YES	NO	NO	YES	YES
CONTROL	69	FEMALE	67	1,55	28	MARRIED	4 Y	NO	NO	NO	NO	NO
CONTROL	66	FEMALE	72	1,65	26	WIDOWED	LESS THAN 4 Y	YES	YES	NO	YES	NO
CONTROL	66	MALE	90	1,63	34	MARRIED	4 Y	NO	YES	NO	NO	NO
CONTROL	68	FEMALE	60	1,68	21	MARRIED	LICENCE	NO	NO	NO	NO	NO
CONTROL	71	MALE	71	1,66	26	MARRIED	4 Y	NO	NO	YES	YES	NO
CONTROL	66	FEMALE	68	1,59	27	MARRIED	LICENCE	NO	NO	YES	NO	YES
CONTROL	66	FEMALE	89	1,72	30	WIDOWED	4 Y	YES	NO	YES	NO	NO
CONTROL	69	MALE	88	1,75	29	MARRIED	LICENCE	NO	NO	NO	NO	NO
CONTROL	71	FEMALE	68	1,68	24	DIVORCED	12 Y	NO	YES	YES	NO	NO
CONTROL	69	FEMALE	67	1,59	27	WIDOWED	4 Y	YES	YES	YES	NO	YES

GROUP	AGE	GENDER	WEIGHT	HEIGHT	BMI	MARITAL STATUS	Y OF STUDY	LIVING ALONE	WALKING REG	F PAST YEAR	FEAR FALL	FEEL L BALANCE
CONTROL	72	FEMALE	57	1,59	23	MARRIED	LICENCE	NO	YES	NO	NO	NO
CONTROL	71	FEMALE	55	1,65	20	MARRIED	4 Y	NO	NO	YES	YES	NO
CONTROL	74	FEMALE	43	1,55	18	WIDOWED	MASTER	NO	NO	NO	NO	YES
CONTROL	65	FEMALE	81	1,53	35	MARRIED	9 Y	NO	NO	YES	NO	NO
CONTROL	72	MALE	72	1,7	25	MARRIED	12 Y	NO	YES	NO	NO	NO

GROUP	AGE	GENDER	STS0	STS1	STS2	STS3	TUG0	TUG1	TUG2	TUG3	FRF0	FRF1	FRF2	FRF3	FRL0	FRL1	FRL2	FRL3
INTERVENTION	71	FEMALE	11	18	23	18	5,78	6,53	6,16	7,14	25,7	29,7	28,7	25	13,3	18,7	20,3	18
INTERVENTION	73	MALE	13	21	23	20	9,08	6,75	6,03	7,11	31	41,7	44	41,8	20	28	36	19,7
INTERVENTION	71	FEMALE	11	18	23	18	5,78	6,53	6,16	6,45	25,7	29,7	28,7	38	13,3	18,7	20,3	27,7
INTERVENTION	69	MALE	17	21	23	23	8,25	6	5,49	6,89	39	35	35	31	21,2	16,8	23,5	32,3
INTERVENTION	78	MALE	15	22	22	21	10,69	10,17	7,78	9,05	28,8	26,2	34,3	35	19,2	16,5	28,3	26
INTERVENTION	69	MALE	16	19	26	24	8,91	7,76	7,26	7,83	27,2	30	35,2	30	23,5	24,8	30,7	31,3
INTERVENTION	67	MALE	14	16	18	14	7,71	7,06	7,23	7,5	37,8	35,7	39,3	35,3	20,7	21	26	31,3
INTERVENTION	71	MALE	15	19	22	22	8,7	7,06	7,19	7,92	19,8	37,7	39	44,3	27	21,7	33,3	35,3
INTERVENTION	79	MALE	11	17	18	17	7,39	8,24	7,62	7,57	31,7	44,7	43,7	32	22	32	34,3	26
INTERVENTION	70	FEMALE	10	14	13	13	11,03	9,03	8,42	8,68	36,5	38	30,2	29,2	13,7	20	25,7	20,3
INTERVENTION	70	MALE	15	22	22	22	6,93	6,16	5,86	6,45	33	25,2	33,8	35	22	14,2	29,7	25
INTERVENTION	72	FEMALE	10	10	11	14	10,21	8,05	7,51	7,54	26,2	29,5	32,7	32,7	15,5	13,3	16,3	10
INTERVENTION	70	FEMALE	17	22	23	23	9,05	5,52	5,63	6,43	25,3	27,3	30	31	20,3	18,7	33	33
INTERVENTION	69	FEMALE	11	14	19	18	9,04	8,47	7,56	8,43	28,3	31,8	30	26,8	16,5	21,3	28	23,2
INTERVENTION	80	MALE	18	20	19	12	8,5	8,1	8,86	8,88	31,7	32,3	36	30,3	21,3	25,3	32	28
INTERVENTION	74	MALE	16	18	20	19	8,09	7,7	6,79	7,65	24	31,3	28,7	23	17,7	35	34	26
INTERVENTION	68	FEMALE	18	20	21	20	7,08	7,02	6,69	7,19	23,2	31	31	27	24	30,7	31	23
INTERVENTION	71	FEMALE	13	14	18	15	9,92	8,9	8,66	9,64	22,2	27	28	25	18,5	23	24	20
INTERVENTION	70	FEMALE	13	15	15	17	7,78	6,8	7,55	7,76	24,3	27,7	33	25	13,8	18	22,3	16
INTERVENTION	74	MALE	14	18	18	16	7,23	6,16	6,51	6,73	30,3	34,3	35,3	33,3	20,3	25	25	24
INTERVENTION	69	MALE	12	15	11	11	8,2	6,68	7,18	7,97	28,2	35	31	25	14	26,7	27	24
INTERVENTION	67	FEMALE	16	20	25	21	6,46	5,72	5,97	6,24	22,3	32,2	28,8	22	19,8	28	27	24
INTERVENTION	70	FEMALE	15	21	21	19	7,36	5,83	6,47	6,28	29,3	37	33	25	30,5	40	39,3	30,7

GROUP	AGE	GENDER	STS0	STS1	STS2	STS3	TUG0	TUG1	TUG2	TUG3	FRF0	FRF1	FRF2	FRF3	FRL0	FRL1	FRL2	FRL3
INTERVENTION	68	MALE	15	20	19	17	7,1	8,36	8,61	8,18	25,5	24,7	26,17	26,3	17	24	20	21,3
INTERVENTION	77	FEMALE	18	18	21	22	6,55	6,68	6,24	6,13	20,5	23,7	23,5	25,7	15,2	16,7	19,5	29
INTERVENTION	67	FEMALE	10	18	18	15	6,63	6,33	5,67	7,19	28	36,2	36,3	30,7	25	37	36,7	21
CONTROL	77	FEMALE	15	17	15		7,66	6,49	6,83		25,5	29,5	21,3		15,8	19,8	22	
CONTROL	74	MALE	12	13	16		8,7	9,42	8,09		27,3	26,33	24		20,1	22,33	17,7	
CONTROL	78	MALE	14	13	14		10,29	10,32	9,62		16,7	25	25,7		10,3	20	22,5	
CONTROL	65	FEMALE	12	12	13		7,52	10,17	7,55		12,7	24,67	27		10,7	20,33	20,3	
CONTROL	67	FEMALE	13	16	18		6,64	5,06	5,3		23,5	32,7	42,7		18	21,3	26	
CONTROL	79	FEMALE	12	12	14		11,98	11,64	11,83		15,3	20,7	22		17	22	21,3	
CONTROL	79	MALE	9	12	11		9,56	7,28	7,39		26	24,7	31,3		18	18,83	22	
CONTROL	66	MALE	12	11	11		7,26	6,62	7,18		29,3	34,2	36		14	27,3	31,3	
CONTROL	65	MALE	10	20	14		7,77	5,55	6,25		38,3	36	29,2		25	27,3	30,3	
CONTROL	77	MALE	12	13	13		9,28	7,41	8,35		40,2	32,3	31,3		23,3	20,3	23,3	
CONTROL	75	FEMALE	11	13	12		10,84	10,26	10,48		20,7	18,7	19,8		17,5	15	23	
CONTROL	65	FEMALE	8	8	8		9,67	10,06	8,98		20,8	29	20		12,5	21	19	
CONTROL	65	FEMALE	7	10	10		12,18	9,72	9,47		18,5	29	20		12,2	14	12,7	
CONTROL	72	FEMALE	16	12	11		7,83	8,27	9,69		22	21,3	21		14,2	18,3	12	
CONTROL	71	MALE	10	17	14		7,55	5,45	6,98		27	27,3	28,3		16,3	18,7	20,2	
CONTROL	69	MALE	21	18	20		6,7	7,07	7,4		33,7	37,2	42		38	30,2	31	
CONTROL	75	FEMALE	18	17	18		7,17	7,32	7,54		22,3	29	22,7		25,7	29,3	25,7	
CONTROL	73	FEMALE	16	15	18		10,41	7,22	7,81		24,3	20,2	25,7		10,7	27	22,3	
CONTROL	71	FEMALE	15	14	15		9,26	7,1	8,09		26	25,5	26,3		15,3	26,5	19	
CONTROL	69	FEMALE	11	11	13		9,94	9,21	9,36		21,5	26,7	26,7		17,7	13,7	12,3	
CONTROL	66	FEMALE	12	15	15		7,43	7,12	7,2		23,7	28,7	29,7		12,7	24,5	21,5	
CONTROL	66	MALE	15	17	19		7,68	6,24	6,42		21,8	28,5	28,3		10	23,7	21,3	
CONTROL	68	FEMALE	19	18	18		5,53	6,02	6,1		39,3	29,7	27		16,3	21,7	25	
CONTROL	71	MALE	15	14	12		8,76	8,55	9,44		17,5	18,3	20,3		12,8	12	17	
CONTROL	66	FEMALE	17	14	14		8,14	8,41	8,56		29,5	32	28,5		24,8	23	23,2	
CONTROL	66	FEMALE	12	11	10		8,86	7,65	6,63		20	17,7	24		12	9,3	10	
CONTROL	69	MALE	18	13	13		5,77	7,27	8,08		38,7	42	40		32,7	31,7	30	
CONTROL	71	FEMALE	13	10	8		8,44	8,83	9,02		32,7	37,7	34,67		28,2	26,8	23	
CONTROL	69	FEMALE	12	10	14		10,47	10,35	9,28		24,7	20,67	22		14,7	14	14,3	

GROUP	AGE	GENDER	STS0	STS1	STS2	STS3	TUG0	TUG1	TUG2	TUG3	FRF0	FRF1	FRF2	FRF3	FRL0	FRL1	FRL2	FRL3
CONTROL	72	FEMALE	16	16	15		9,65	8,33	8,59		37	31	29		27,7	24	21,3	
CONTROL	71	FEMALE	14	14	14		10,98	9,45	9,49		32,7	30,3	25		19	19,7	13,7	
CONTROL	74	FEMALE	16	12	11		7,11	7,76	7,91		28,3	26,3	23		26,33	29,3	25,3	
CONTROL	65	FEMALE	9	15	17		10,03	8,17	8,61		26,3	29,7	23,7		16,7	24,3	19,7	
CONTROL	72	MALE	25	22	21		5,16	5,96	7,21		34,3	34,3	32		38	36	34	

GROUP	AGE	GENDER	SFRF0	SFRF1	SFRF2	SFRF3	SFLF0	SFLF1	SFLF2	SFLF3	SLRF0	SLRF1	SLRF2	SLRF3	SLLF0	SLLF1	SLLF2	SLLF3	SBRF0	SBRF1	SBRF2	SBRF3	SBLF0	SBLF1	SBLF2	SBLF3
INT	71	FEMALE	0,31	0,23	0,23	0,28	0,28	0,21	0,23	0,29	0,35	0,27	0,28	0,32	0,37	0,3	0,27	0,33	0,27	0,29	0,3	0,34	0,21	0,3	0,29	0,35
INT	73	MALE	0,24	0,2	0,22	0,2	0,22	0,27	0,22	0,18	0,28	0,3	0,22	0,26	0,28	0,26	0,27	0,27	0,15	0,24	0,15	0,26	0,19	0,25	0,22	0,27
INT	71	FEMALE	0,31	0,23	0,23	0,17	0,28	0,21	0,23	0,16	0,35	0,27	0,28	0,17	0,37	0,3	0,27	0,18	0,27	0,29	0,3	0,24	0,21	0,3	0,29	0,21
INT	69	MALE	0,19	0,2	0,22	0,23	0,17	0,24	0,21	0,2	0,16	0,23	0,22	0,18	0,16	0,26	0,26	0,22	0,25	0,31	0,27	0,25	0,27	0,25	0,3	0,28
INT	78	MALE	0,18	0,25	0,21	0,24	0,19	0,25	0,21	0,23	0,22	0,28	0,2	0,25	0,23	0,29	0,22	0,26	0,24	0,36	0,22	0,35	0,27	0,37	0,2	0,37
INT	69	MALE	0,19	0,22	0,21	0,24	0,19	0,21	0,18	0,26	0,25	0,24	0,24	0,27	0,22	0,27	0,24	0,26	0,32	0,42	0,33	0,36	0,31	0,31	0,3	0,36
INT	67	MALE	0,33	0,3	0,2	0,24	0,31	0,29	0,22	0,27	0,37	0,3	0,22	0,32	0,36	0,3	0,24	0,3	0,39	0,25	0,26	0,29	0,28	0,29	0,23	0,26
INT	71	MALE	0,18	0,22	0,18	0,17	0,17	0,22	0,17	0,18	0,23	0,27	0,2	0,22	0,18	0,25	0,2	0,21	0,13	0,24	0,22	0,27	0,2	0,23	0,21	0,2
INT	79	MALE	0,36	0,23	0,23	0,28	0,26	0,22	0,23	0,28	0,29	0,25	0,29	0,32	0,3	0,25	0,25	0,26	0,32	0,26	0,29	0,24	0,34	0,27	0,28	0,26
INT	70	FEMALE	0,51	0,24	0,26	0,44	0,48	0,24	0,27	0,34	0,46	0,39	0,4	0,33	0,36	0,25	0,34	0,32	0,41	0,31	0,28	0,29	0,43	0,32	0,27	0,28
INT	70	MALE	0,22	0,22	0,18	0,18	0,23	0,24	0,19	0,2	0,27	0,27	0,24	0,22	0,28	0,26	0,27	0,24	0,36	0,34	0,31	0,27	0,31	0,28	0,27	0,22
INT	72	FEMALE	0,32	0,31	0,24	0,24	0,22	0,21	0,21	0,27	0,31	0,27	0,29	0,32	0,25	0,23	0,28	0,3	0,33	0,25	0,28	0,28	0,3	0,25	0,31	0,33
INT	70	FEMALE	0,26	0,23	0,22	0,22	0,32	0,21	0,18	0,24	0,26	0,22	0,23	0,32	0,26	0,24	0,22	0,31	0,28	0,21	0,26	0,29	0,32	0,25	0,27	0,29
INT	69	FEMALE	0,36	0,24	0,26	0,28	0,36	0,24	0,26	0,28	0,3	0,3	0,25	0,28	0,32	0,24	0,27	0,32	0,42	0,3	0,31	0,28	0,33	0,35	0,27	0,32
INT	80	MALE	0,23	0,23	0,17	0,26	0,22	0,21	0,18	0,24	0,33	0,31	0,21	0,3	0,3	0,3	0,25	0,27	0,34	0,33	0,26	0,3	0,3	0,29	0,27	0,35
INT	74	MALE	0,34	0,24	0,23	0,28	0,31	0,28	0,24	0,28	0,31	0,26	0,29	0,21	0,3	0,27	0,3	0,24	0,39	0,24	0,24	0,3	0,31	0,28	0,29	0,3
INT	68	FEMALE	0,2	0,22	0,21	0,23	0,27	0,27	0,24	0,25	0,27	0,22	0,29	0,29	0,25	0,25	0,27	0,32	0,26	0,24	0,24	0,24	0,23	0,26	0,21	0,26
INT	71	FEMALE	0,31	0,27	0,28	0,33	0,28	0,29	0,26	0,33	0,35	0,29	0,27	0,29	0,31	0,29	0,26	0,3	0,32	0,3	0,28	0,34	0,33	0,32	0,32	0,34
INT	70	FEMALE	0,4	0,26	0,25	0,19	0,43	0,29	0,34	0,2	0,32	0,31	0,33	0,27	0,26	0,33	0,3	0,27	0,27	0,23	0,28	0,29	0,24	0,23	0,3	0,28
INT	74	MALE	0,5	0,24	0,25	0,27	0,42	0,23	0,26	0,26	0,31	0,3	0,33	0,31	0,37	0,25	0,3	0,35	0,3	0,28	0,28	0,28	0,32	0,3	0,27	0,3
INT	69	MALE	0,42	0,25	0,24	0,28	0,37	0,22	0,29	0,25	0,35	0,29	0,3	0,3	0,3	0,22	0,28	0,34	0,3	0,24	0,35	0,35	0,31	0,23	0,31	0,28
INT	67	FEMALE	0,24	0,22	0,23	0,14	0,28	0,25	0,26	0,23	0,26	0,27	0,28	0,23	0,27	0,27	0,27	0,2	0,27	0,26	0,31	0,25	0,29	0,23	0,28	0,23
INT	70	FEMALE	0,27	0,19	0,24	0,18	0,25	0,19	0,24	0,19	0,27	0,22	0,27	0,22	0,27	0,21	0,26	0,22	0,22	0,23	0,24	0,2	0,26	0,24	0,24	0,21
INT	68	MALE	0,31	0,25	0,28	0,25	0,27	0,23	0,27	0,27	0,29	0,23	0,25	0,3	0,3	0,25	0,27	0,28	0,35	0,26	0,35	0,33	0,38	0,26	0,32	0,33

GROUP	AGE	GENDER	SFRF0	SFRF1	SFRF2	SFRF3	SFLF0	SFLF1	SFLF2	SFLF3	SLRF0	SLRF1	SLRF2	SLRF3	SLLF0	SLLF1	SLLF2	SLLF3	SBRF0	SBRF1	SBRF2	SBRF3	SBLF0	SBLF1	SBLF2	SBLF3
INT	77	FEMALE	0,21	0,26	0,25	0,2	0,23	0,26	0,24	0,21	0,31	0,31	0,29	0,26	0,28	0,31	0,3	0,22	0,32	0,32	0,33	0,31	0,32	0,31	0,33	0,3
INT	67	FEMALE	0,3	0,23	0,24	0,29	0,29	0,23	0,23	0,27	0,29	0,29	0,25	0,31	0,29	0,31	0,24	0,33	0,38	0,22	0,24	0,31	0,4	0,26	0,23	0,28
CONTROL	77	FEMALE	0,23	0,28	0,32		0,21	0,23	0,4		0,3	0,32	0,34		0,26	0,34	0,42		0,29	0,26	0,33		0,27	0,29	0,3	
CONTROL	74	MALE	0,23	0,27	0,34		0,28	0,28	0,31		0,32	0,31	0,31		0,27	0,4	0,3		0,4	0,37	0,39		0,24	0,34	0,31	
CONTROL	78	MALE	0,33	0,38	0,4		0,24	0,3	0,31		0,24	0,26	0,31		0,32	0,34	0,34		0,27	0,29	0,27		0,29	0,31	0,33	
CONTROL	65	FEMALE	0,18	0,39	0,26		0,21	0,4	0,29		0,24	0,29	0,29		0,22	0,29	0,31		0,18	0,28	0,29		0,22	0,28	0,3	
CONTROL	67	FEMALE	0,27	0,27	0,23		0,28	0,3	0,3		0,25	0,29	0,31		0,25	0,23	0,24		0,22	0,3	0,26		0,23	0,34	0,25	
CONTROL	79	FEMALE	0,35	0,41	0,39		0,35	0,43	0,35		0,35	0,41	0,4		0,32	0,37	0,38		0,39	0,43	0,41		0,36	0,32	0,35	
CONTROL	79	MALE	0,23	0,35	0,36		0,19	0,24	0,25		0,22	0,28	0,29		0,23	0,28	0,3		0,24	0,33	0,32		0,23	0,33	0,34	
CONTROL	66	MALE	0,2	0,23	0,23		0,22	0,24	0,27		0,26	0,29	0,31		0,26	0,24	0,31		0,33	0,42	0,36		0,32	0,34	0,36	
CONTROL	65	MALE	0,21	0,19	0,18		0,22	0,22	0,17		0,26	0,23	0,2		0,31	0,22	0,23		0,3	0,25	0,22		0,3	0,3	0,23	
CONTROL	77	MALE	0,16	0,24	0,31		0,22	0,27	0,3		0,2	0,26	0,27		0,22	0,26	0,25		0,22	0,29	0,31		0,25	0,3	0,32	
CONTROL	75	FEMALE	0,27	0,44	0,31		0,34	0,46	0,36		0,37	0,42	0,42		0,39	0,43	0,38		0,35	0,5	0,38		0,33	0,51	0,39	
CONTROL	65	FEMALE	0,36	0,36	0,31		0,4	0,38	0,33		0,33	0,36	0,36		0,32	0,37	0,35		0,34	0,37	0,37		0,35	0,37	0,37	
CONTROL	65	FEMALE	0,34	0,35	0,34		0,32	0,36	0,35		0,3	0,36	0,33		0,29	0,38	0,32		0,32	0,33	0,33		0,3	0,39	0,36	
CONTROL	72	FEMALE	0,3	0,25	0,28		0,35	0,25	0,35		0,32	0,27	0,32		0,27	0,34	0,32		0,38	0,34	0,34		0,36	0,37	0,36	
CONTROL	71	MALE	0,24	0,22	0,23		0,25	0,28	0,35		0,26	0,25	0,28		0,28	0,27	0,27		0,18	0,21	0,24		0,16	0,19	0,22	
CONTROL	69	MALE	0,33	0,21	0,42		0,32	0,23	0,39		0,35	0,25	0,27		0,29	0,24	0,25		0,32	0,25	0,27		0,32	0,26	0,31	
CONTROL	75	FEMALE	0,41	0,24	0,22		0,42	0,28	0,23		0,32	0,29	0,27		0,3	0,28	0,3		0,3	0,24	0,29		0,26	0,3	0,29	
CONTROL	73	FEMALE	0,36	0,23	0,28		0,24	0,24	0,33		0,35	0,33	0,33		0,33	0,31	0,33		0,31	0,35	0,31		0,35	0,33	0,37	
CONTROL	71	FEMALE	0,4	0,35	0,31		0,39	0,39	0,33		0,29	0,27	0,35		0,39	0,34	0,38		0,34	0,41	0,32		0,24	0,42	0,33	
CONTROL	69	FEMALE	0,26	0,3	0,25		0,27	0,35	0,29		0,31	0,34	0,31		0,32	0,35	0,29		0,35	0,38	0,29		0,34	0,41	0,3	
CONTROL	66	FEMALE	0,26	0,25	0,24		0,25	0,26	0,27		0,3	0,29	0,34		0,31	0,32	0,31		0,36	0,3	0,33		0,36	0,35	0,38	
CONTROL	66	MALE	0,2	0,35	0,23		0,24	0,37	0,24		0,26	0,34	0,29		0,29	0,33	0,28		0,36	0,36	0,36		0,31	0,32	0,32	
CONTROL	68	FEMALE	0,24	0,22	0,26		0,21	0,22	0,26		0,2	0,26	0,28		0,21	0,26	0,3		0,28	0,28	0,29		0,28	0,3	0,34	
CONTROL	71	MALE	0,2	0,24	0,26		0,24	0,3	0,3		0,22	0,25	0,23		0,23	0,25	0,29		0,27	0,3	0,33		0,32	0,33	0,34	
CONTROL	66	FEMALE	0,23	0,3	0,25		0,24	0,3	0,26		0,31	0,31	0,3		0,29	0,33	0,34		0,3	0,32	0,33		0,3	0,32	0,34	
CONTROL	66	FEMALE	0,26	0,31	0,3		0,25	0,29	0,29		0,28	0,31	0,29		0,35	0,34	0,3		0,33	0,34	0,38		0,29	0,32	0,4	
CONTROL	69	MALE	0,21	0,21	0,23		0,24	0,23	0,25		0,29	0,28	0,3		0,31	0,26	0,29		0,4	0,4	0,42		0,4	0,36	0,42	
CONTROL	71	FEMALE	0,24	0,23	0,26		0,25	0,21	0,24		0,24	0,31	0,35		0,26	0,33	0,34		0,32	0,27	0,34		0,25	0,23	0,29	
CONTROL	69	FEMALE	0,45	0,31	0,35		0,54	0,49	0,35		0,38	0,38	0,36		0,35	0,39	0,34		0,47	0,43	0,34		0,34	0,4	0,33	
CONTROL	72	FEMALE	0,28	0,28	0,35		0,27	0,25	0,3		0,32	0,29	0,28		0,32	0,3	0,32		0,27	0,26	0,21		0,24	0,24	0,18	

GROUP	AGE	GENDER	SFRF0	SFRF1	SFRF2	SFRF3	SFLF0	SFLF1	SFLF2	SFLF3	SLRF0	SLRF1	SLRF2	SLRF3	SLLF0	SLLF1	SLLF2	SLLF3	SBRF0	SBRF1	SBRF2	SBRF3	SBLF0	SBLF1	SBLF2	SBLF3
CONTROL	71	FEMALE	0,28	0,24	0,27		0,33	0,3	0,25		0,33	0,32	0,31		0,32	0,33	0,33		0,27	0,28	0,31		0,27	0,3	0,29	
CONTROL	74	FEMALE	0,3	0,28	0,26		0,28	0,3	0,29		0,31	0,32	0,32		0,33	0,32	0,34		0,51	0,47	0,47		0,5	0,41	0,41	
CONTROL	65	FEMALE	0,36	0,39	0,36		0,37	0,32	0,3		0,27	0,33	0,3		0,3	0,37	0,35		0,28	0,26	0,33		0,26	0,26	0,3	
CONTROL	72	MALE	0,24	0,25	0,27		0,33	0,27	0,26		0,27	0,29	0,32		0,29	0,29	0,31		0,26	0,27	0,28		0,25	0,26	0,31	

GROUP	AGE	GENDER	AROMRF0	AROMRF1	AROMRF2	AROMRF3	AROMLF0	AROMLF1	AROMLF2	AROMLF3	KI0	KI1	KI2	KI3	FES0	FES1	FES2	FES3	CONTIN EXERCISE	QoL0	QoL1	QoL2	QoL3
INT	71	FEMALE	40,33	51,33	42	41	50	53	56	52	9,06	7,6	7,6	8,45	100	100	100	100	NO	6,7	6,5	6,4	6,2
INT	73	MALE	18	35	31	36	17	36	41	39	13,13	12,46	11,54	9,68	97	100	100	98	YES	6,3	6,1	6	5,8
INT	71	FEMALE	40,33	51,33	42	68	50	53	56	70	9,06	7,6	7,6	8,44	100	100	100	100	YES	6,7	6,5	6,4	6,2
INT	69	MALE	35	60,67	59	55	36,33	45,67	53	51	9,55	6,55	7,89	4,89	100	100	100	100	YES	6,4	6,3	6,2	6,2
INT	78	MALE	19	37	34	35	14,67	26,67	31	30	9,03	10,36	6,67	7,55	97	100	89	100	YES	6,4	6,3	6,1	6,1
INT	69	MALE	48,33	51	51	46	50,67	49,33	51	44	10,17	9,12	8,91	7,04	100	98	100	100	YES	6,1	6	6,1	5,9
INT	67	MALE	31,67	48,67	55	53	16,33	48,67	53	52	6,86	5,96	7,09	5,19	98	93	100	100	YES	6,3	6,1	6,2	6,2
INT	71	MALE	25	24,33	49	46	31,67	27	52	51	11,75	10,06	9,97	10,84	100	100	99	100	YES	6,4	6,3	6,2	6,2
INT	79	MALE	42,7	46,67	50	43	44	47	49	46	6,9	6,78	8,28	9,31	99	100	100	100	NO	6,2	6,2	6,3	6,4
INT	70	FEMALE	50,33	77,33	71	72	35	76	66	69	6,79	6,5	4,29	6,86	100	100	100	100	NO	6,4	6	5,8	5,7
INT	70	MALE	28,33	38,67	42	41	32	42,67	46	39	8,93	7,27	5,82	7,69	100	98	100	100	YES	6,3	5,8	6,1	5,8
INT	72	FEMALE	24,33	46,33	39	40	29,67	38	40	36	14,55	14,93	10,77	14,62	85	92	97	95	YES	6,5	5,9	5,4	5
INT	70	FEMALE	31	47,67	56	47	15	52,33	46	56	11,11	10,37	5,56	6,67	100	98	100	100	YES	6,2	5,8	6,3	6,2
INT	69	FEMALE	61,33	64	58	57	66,33	71	65	63	14,03	13,7	7,58	10,79	96	99	98	100	NO	6,5	6,3	5,6	5,9
INT	80	MALE	61,67	63	51	55	50	52	52	52	10,49	8	6,9	5,86	96	100	100	100	YES	6	5,7	5,9	6,2
INT	74	MALE	33,7	38	40	34	41,7	40	41	38	5,07	4,81	6,67	6,62	98	100	100	100	YES	6,5	6,4	6,5	6,1
INT	68	FEMALE	37,3	37	42	41	45,7	43,67	46	47	6,78	6,1	5,42	6,73	100	100	100	100	NO	6,4	6,5	6,4	6,4
INT	71	FEMALE	41,7	35,67	40	35	41,7	35	38	35	13,85	9,8	9,6	13,18	91	99	100	100	NO	6,2	6,2	6,2	6
INT	70	FEMALE	42	41	45	45	45	39	41	39	10,87	9,13	13,04	10,82	100	100	100	100	YES	5,7	5,8	5,5	5,5
INT	74	MALE	29	51	53	51	14,33	52	50	50	7,14	5,71	4,29	7,14	100	100	100	100	YES	5,9	5,5	5,9	6,1
INT	69	MALE	42	52,33	56	53	44	56	57	53	11,43	10,36	10,71	10,71	84	100	100	100	NO	6,4	5,9	5,8	6
INT	67	FEMALE	48	49	52	44	42,33	43	48	50	18,52	14,81	11,85	10	100	100	100	100	YES	6,4	6,6	6,3	6,5
INT	70	FEMALE	28,7	42	42	53	26,3	41	46	51	8,21	7,86	7,14	7,64	100	100	100	100	NO	6	6,2	6,1	6

GROUP	AGE	GENDER	AROMRF0	AROMRF1	AROMRF2	AROMRF3	AROMLF0	AROMLF1	AROMLF2	AROMLF3	KI0	KI1	KI2	KI3	FES0	FES1	FES2	FES3	CONTIN EXERCISE	QoL0	QoL1	QoL2	QoL3
INT	68	MALE	43	50,33	50	49	37	41	42	35	14	13,67	10,33	8,47	94	92	94	97	YES	6,2	5,9	5,9	5,6
INT	77	FEMALE	37,7	39,33	36	37	38,3	38	34	42	15,56	16,3	12,59	14,63	98	100	100	100	YES	6,5	6,5	6,5	6,6
INT	67	FEMALE	42	47	56	52	43	47	52	47	11,07	10	7,86	9,43	100	100	100	100	NO	5,4	5,9	6,2	5,8
CONTROL	77	FEMALE	42,33	42,33	35		36,67	46	35		7,14	6,8	6,25		98	100	100			6,4	6	6	
CONTROL	74	MALE	13	35	38		12	35,67	42		6,67	6,43	5,43		97	98	98			6,5	6,3	6,5	
CONTROL	78	MALE	22	43,67	38		20	36,33	39		8,28	6,9	5,43		97	99	96			6,3	5,9	5,4	
CONTROL	65	FEMALE	34,33	60,67	50		28,33	45,67	54		10,85	11,11	10,07		98	100	100			6,5	5,6	5,7	
CONTROL	67	FEMALE	39,33	59	59		29,67	62	62		12,31	12,5	9,53		100	100	100			6,1	5,9	6	
CONTROL	79	FEMALE	36,67	32	34		35,33	35,33	35		9,64	8,33	7,69		75	90	91			6,3	6	6	
CONTROL	79	MALE	30	50,67	49		25	45,33	38		10,63	10,15	7,14		89	100	99			6,4	6,1	6,2	
CONTROL	66	MALE	37,33	31,67	42		32,33	28	43		10,77	11,15	12,7		94	100	100			6,4	6	6,4	
CONTROL	65	MALE	30	43	41		16	41	41		5,48	5,19	6,45		91	98	100			6,3	6,1	5,8	
CONTROL	77	MALE	17,33	33	26		14	25,33	27		6,56	6,45	6,77		92	99	100			6,2	6,3	6,2	
CONTROL	75	FEMALE	52,67	51	50		47	47,67	42		9,26	9,09	9,44		79	85	86			6,1	6	6,2	
CONTROL	65	FEMALE	36	44	47		25	46,67	47		11,38	13,46	14,23		95	91	91			6,3	6,1	5,7	
CONTROL	65	FEMALE	27,33	36	34		18	37,67	30		9,26	8,89	9,26		90	82	84			6,4	6,1	6	
CONTROL	72	FEMALE	22,33	38,67	34		17,67	49,33	41		9,43	9,09	9,81		92	74	87			6,5	6,1	5,7	
CONTROL	71	MALE	17,7	34,67	27		21	36,67	26		12,96	10,07	10,91		97	99	99			5,6	5,7	5,8	
CONTROL	69	MALE	57,7	59,67	60		49,3	59,67	51		9,43	10,19	11,48		99	98	100			5,9	5,7	5,6	
CONTROL	75	FEMALE	38	38,33	40		43,7	33	42		9,02	8,63	9,8		98	100	100			6,3	5,8	6,1	
CONTROL	73	FEMALE	33,33	36	35		27	38	39		7,91	8,93	8,89		99	100	100			6,1	6	6,1	
CONTROL	71	FEMALE	17,67	45,33	44		27	45	45		6,92	7,83	7,92		91	94	95			6,3	6,3	6,1	
CONTROL	69	FEMALE	45,33	46,33	47		42,67	43,67	50		10,57	10,94	11,85		95	98	99			6,4	5,8	5,6	
CONTROL	66	FEMALE	37,67	46	34		40,33	46,63	35		11,64	11,03	11,11		86	99	97			6,3	5,8	5,6	
CONTROL	66	MALE	14	33	35		14	34,67	31		12,58	11,51	11,61		99	100	100			6	6,2	5,8	
CONTROL	68	FEMALE	28,67	70,33	60		39,33	64	59		8,77	7,35	6,62		100	100	100			6,1	5,9	6,1	
CONTROL	71	MALE	31	29,33	31		28,33	28	33		9,82	10,55	11,64		100	100	100			6,5	6,4	6,4	
CONTROL	66	FEMALE	44	44,33	37		40	43	49		6,67	7,17	7,92		100	100	100			6	5,8	5,9	
CONTROL	66	FEMALE	49	45,33	43		47,33	45	42		11,7	11,07	11,07		100	100	100			5,7	5,4	5,4	
CONTROL	69	MALE	44	44,33	42		37,3	41	40		7,84	7,84	9,8		100	100	100			6,5	6,4	6,4	
CONTROL	71	FEMALE	34	28,67	26		35	33	29		16,14	16,43	16,49		98	90	87			5,5	4,7	4,7	

GROUP	AGE	GENDER	AROMRF0	AROMRF1	AROMRF2	AROMRF3	AROMLF0	AROMLF1	AROMLF2	AROMLF3	KI0	KI1	KI2	KI3	FES0	FES1	FES2	FES3	CONTIN EXERCISE	QoL0	QoL1	QoL2	QoL3
CONTROL	69	FEMALE	46,33	42,33	44		44,67	43	42		10,37	10	10,74		100	99	100			6,5	5,3	5,8	
CONTROL	72	FEMALE	51,7	51,7	58		56	56	57		10,85	10,98	9,62		100	100	100			5,1	5,7	5,5	
CONTROL	71	FEMALE	38,3	33,67	36		41	37	37		11,85	10,53	9,62		82	97	81			5,9	6	5,6	
CONTROL	74	FEMALE	44	46	48		46	47	47		7,72	7,41	5,45		100	97	97			4,4	4,9	4,9	
CONTROL	65	FEMALE	36,7	52,33	46		32,3	43,33	36		8,21	8,93	10		98	99	98			6,1	6	5,9	
CONTROL	72	MALE	46,7	51	48		43,2	43	43		9,3	11,3	11,43		100	100	100			6	6,5	6,5	

GROUP	AGE	GENDER	PF-BADL0	PF-IADL0	EF0	SF -SA0	SF-QSI0	PF-BADL1	PF-IADL1	EF1	SF -SA1	SF-QSI1	PF-BADL2	PF-IADL2	EF2	SF -SA2	SF-QSI2	PF-BADL3	PF-IADL3	EF3	SF -SA3	SF-QSI3
INTERVENTION	71	FEMALE	100	100	100	100	100	100	78	65	56	84	100	78	65	56	96	100	78	90	100	100
INTERVENTION	73	MALE	100	83	100	56	100	100	56	75	-33	96	100	56	75	-33	100	100	78	100	11	100
INTERVENTION	71	FEMALE	100	100	100	100	100	100	78	65	56	84	100	78	65	56	96	100	78	90	56	92
INTERVENTION	69	MALE	100	78	80	100	40	100	78	65	100	84	100	89	80	100	96	100	78	80	100	92
INTERVENTION	78	MALE	100	78	100	56	100	89	94	90	56	96	89	78	90	11	100	100	78	90	11	92
INTERVENTION	69	MALE	89	67	65	11	92	100	72	65	11	88	100	72	65	56	80	100	78	30	11	96
INTERVENTION	67	MALE	100	78	40	11	96	100	56	90	100	100	100	78	100	11	100	100	78	100	11	92
INTERVENTION	71	MALE	100	83	100	11	96	100	56	90	11	100	100	78	100	11	100	100	78	90	11	100
INTERVENTION	79	MALE	100	33	90	11	88	100	78	75	56	96	100	78	65	100	92	100	78	50	100	92
INTERVENTION	70	FEMALE	100	78	65	100	72	100	78	80	56	84	100	78	80	100	92	100	78	50	100	80
INTERVENTION	70	MALE	100	83	80	56	92	100	78	100	56	100	100	78	65	56	92	100	78	75	100	92
INTERVENTION	72	FEMALE	89	56	30	11	80	100	56	10	100	84	100	50	50	100	88	100	33	35	56	72
INTERVENTION	70	FEMALE	100	72	80	56	100	100	78	50	100	96	100	78	70	100	96	100	78	65	56	80
INTERVENTION	69	FEMALE	100	67	90	11	96	100	78	50	100	84	100	78	80	56	88	100	78	75	-33	96
INTERVENTION	80	MALE	100	56	90	56	100	100	78	80	56	92	100	78	80	56	100	100	78	100	56	100
INTERVENTION	74	MALE	100	50	90	-33	88	100	78	90	-33	88	100	78	100	11	100	100	78	80	11	92
INTERVENTION	68	FEMALE	78	78	75	100	100	100	78	65	100	100	100	78	65	100	92	100	78	75	100	100

GROUP	AGE	GENDER	PF-BADL0	PF-IADL0	EF0	SF -SA0	SF-QSI0	PF-BADL1	PF-IADL1	EF1	SF -SA1	SF-QSI1	PF-BADL2	PF-IADL2	EF2	SF -SA2	SF-QSI2	PF-BADL3	PF-IADL3	EF3	SF -SA3	SF-QSI3
INTERVENTION	71	FEMALE	100	78	90	100	100	100	78	50	100	92	100	78	50	56	96	100	78	70	100	88
INTERVENTION	70	FEMALE	100	78	55	56	80	100	78	50	11	84	100	78	50	11	88	100	78	35	11	100
INTERVENTION	74	MALE	100	78	80	11	84	100	78	80	11	92	100	78	65	56	64	100	78	65	11	72
INTERVENTION	69	MALE	89	28	50	56	92	100	78	90	11	100	100	78	75	-33	88	100	78	65	11	88
INTERVENTION	67	FEMALE	100	78	90	100	100	100	78	80	100	92	100	78	65	100	96	100	78	90	100	100
INTERVENTION	70	FEMALE	100	78	50	56	92	89	78	25	56	100	100	78	50	100	92	100	78	20	100	80
INTERVENTION	68	MALE	89	67	60	56	96	67	56	65	56	100	78	44	75	11	100	89	61	50	56	92
INTERVENTION	77	FEMALE	100	78	65	11	84	100	78	65	100	100	100	78	65	56	92	100	78	60	100	96
INTERVENTION	67	FEMALE	100	56	80	33	100	100	78	90	56	100	100	78	50	56	100	100	78	100	56	100
CONTROL	77	FEMALE	100	78	65	56	100	100	78	65	11	100	100	78	65	100	100					
CONTROL	74	MALE	100	61	90	56	88	100	78	90	56	96	100	50	90	-33	88					
CONTROL	78	MALE	100	67	65	11	96	89	56	65	11	100	89	56	65	11	100					
CONTROL	65	FEMALE	100	78	10	56	92	100	67	20	-33	96	100	72	50	11	96					
CONTROL	67	FEMALE	100	89	100	56	96	100	-33	80	-11	96	100	78	90	11	96					
CONTROL	79	FEMALE	78	50	75	0	92	78	56	75	100	100	67	61	65	11	100					
CONTROL	79	MALE	100	78	100	100	96	100	67	80	100	80	100	33	90	11	88					
CONTROL	66	MALE	100	72	75	11	96	100	78	90	100	100	100	78	100	100	96					
CONTROL	65	MALE	100	78	100	11	100	100	56	75	11	100	100	78	100	11	100					
CONTROL	77	MALE	100	78	75	100	88	100	72	65	100	84	100	78	50	100	88					
CONTROL	75	FEMALE	89	56	25	78	100	89	56	65	100	100	89	67	50	100	96					
CONTROL	65	FEMALE	100	17	90	44	80	89	33	50	100	84	89	67	45	11	92					
CONTROL	65	FEMALE	89	44	75	56	100	89	44	50	100	92	100	44	65	100	96					
CONTROL	72	FEMALE	89	56	50	56	80	78	56	50	56	100	100	67	75	11	96					
CONTROL	71	MALE	100	78	50	11	80	100	78	65	56	88	100	78	80	100	88					
CONTROL	69	MALE	89	78	65	56	80	100	78	75	56	84	100	78	40	56	84					
CONTROL	75	FEMALE	100	78	90	11	96	100	78	90	11	92	100	78	80	56	96					
CONTROL	73	FEMALE	100	78	100	56	100	100	78	100	56	92	100	78	100	-33	92					
CONTROL	71	FEMALE	100	56	75	-33	80	100	67	100	56	100	100	78	75	56	100					
CONTROL	69	FEMALE	89	67	50	56	92	89	56	65	56	100	100	56	25	11	92					
CONTROL	66	FEMALE	89	72	50	100	96	100	78	50	56	88	100	67	50	11	88					
CONTROL	66	MALE	100	78	65	11	96	100	72	65	0	88	100	78	50	11	88					
CONTROL	68	FEMALE	100	78	100	56	84	100	67	75	56	84	100	78	50	56	88					

GROUP	AGE	GENDER	PF-BADL0	PF-IADL0	EF0	SF -SA0	SF-QSI0	PF-BADL1	PF-IADL1	EF1	SF -SA1	SF-QSI1	PF-BADL2	PF-IADL2	EF2	SF -SA2	SF-QSI2	PF-BADL3	PF-IADL3	EF3	SF -SA3	SF-QSI3
CONTROL	71	MALE	100	78	80	100	96	100	78	75	11	88	100	78	95	56	88					
CONTROL	66	FEMALE	100	78	75	0	96	100	72	75	89	88	100	78	90	-33	100					
CONTROL	66	FEMALE	78	56	50	11	100	67	56	50	33	100	100	56	80	33	100					
CONTROL	69	MALE	100	78	90	11	92	100	78	100	56	100	100	78	90	100	92					
CONTROL	71	FEMALE	100	44	50	11	88	89	44	0	-11	60	89	44	0	56	60					
CONTROL	69	FEMALE	89	11	0	-33	76	67	50	0	-33	68	100	50	65	11	100					
CONTROL	72	FEMALE	100	78	90	-33	96	100	78	50	-33	72	100	78	50	-33	76					
CONTROL	71	FEMALE	78	44	50	0	84	100	56	40	11	88	100	50	65	56	80					
CONTROL	74	FEMALE	100	78	25	11	92	89	61	10	44	92	89	61	10	44	92					
CONTROL	65	FEMALE	100	78	100	100	100	100	89	65	0	88	100	72	90	56	92					
CONTROL	72	MALE	100	94	65	11	92	100	78	80	56	88	100	78	75	11	88					

APPENDIX 12

GLM REPEATED MEASURES RESULTS

VARIABLE	Type III Sum of Squares	df	Mean Square	F	Sig.
SIT TO STAND TEST					
Group (Between-Subjects Effects)	488.670	1	488.670	19.519	0.000
Error	145200.058	58	2500.035		
STS (Within-Subjects Effects)	285.550	2	142.775	36.189	0.000
STS*Group	223.505	2	111.753	28.326	**0.000**
Error (STS)	457.650	116	3.945		
TIME UP AND GO					
Group (Between-Subjects Effects)	30.438	1	30.438	5.994	0.017
Error	294.535	58	50.078		
TUG (Within-Subjects Effects)	2200.004	2	1100.002	18.348	0.000
TUG*Group	300.031	2	1.515	2.527	**0.084**
Error (TUG)	69.557	116	0.600		
FUNCTIONAL REACH FORWARD					
Group (Between-Subjects Effects)	592.828	1	592.828	7.701	0.007
Error	4464.626	58	76.976		
FRF (Within-Subjects Effects)	345.550	2	172.775	12.542	0.000
FRF*Group	122.853	2	61.426	4.459	**0.014**
Error (FRF)	1597.967	116	13.776		
FUNCTIONAL REACH LATERAL					
Group (Between-Subjects Effects)	333.639	1	333.639	3.695	0.060
Error	5237.577	58	90.303		
FRL (Within-Subjects Effects)	927.499	2	463.749	34.251	0.000
FRL*Group	278.869	2	139.434	10.298	**0.000**
Error (FRL)	1570.597	116	13.540		
STEPPING FORWARD RIGHT FOOT					
Group (Between-Subjects Effects)	0.042	1	0.042	6.581	0.013
Error	.372	58	0.006		
SFRF (Within-Subjects Effects)	0.024	2	0.012	4.727	0.011
SFRF*Group	0.056	2	0.028	110.090	**0.000**
Error (SFRF)	0.293	116	0.003		
STEPPING FORWARD LEFT FOOT					
Group (Between-Subjects Effects)	0.087	1	0.087	12.789	0.001
Error	0.395	58	0.007		
SFLF (Within-Subjects Effects)	0.011	2	0.005	2.450	0.091
SFLF*Group	0.032	2	0.016	7.168	**0.001**
Error (SFLF)	0.260	116	0.002		
STEPPING LATERAL RIGHT FOOT					
Group (Between-Subjects Effects)	0.020	1	0.020	4.190	0.045
Error	0.273	58	0.005		
SLRF (Within-Subjects Effects)	0.001	2	0.000	0.494	.612
SLRF*Group	0.023	2	0.011	13.777	**0.000**
Error (SLRF)	0.095	116	0.001		
STEPPING LATERAL LEFT FOOT					
Group (Between-Subjects Effects)	0.054	1	0.054	15.112	0.000
Error	0.206	58	0.004		
SLLF (Within-Subjects Effects)	4.22E-005	2	2.11E-005	0.019	.981
SLLF*Group	0.016	2	0.008	7.324	**0.001**
Error (SLLF)	0.127	116	0.001		

APPENDIX 13

BRIGHTON UNIVERSITY ETHICAL

University of Brighton
School of Health Professions
School Ethics Panel (SEP)

Project Title:	A specific home based exercise programme for Portuguese old people : participants perspectives
Student's Name:	Christina Argel de Melo
Supervisor's Name:	Marion Trew / Raija Kuisma
Course Title:	PhD

The decision of the school ethics panel is :-

i)	that this study is approved by the SEP	✓
ii)	that this study is approved by the SEP subject to the minor amendments listed below	☐
iii)	that this study must be resubmitted to the SEP after the amendments listed below have been carried out	☐
iv)	that this study must be submitted to the University of Brighton Research Ethics Committee	☐
v)	that this study must be submitted to the relevant external Ethics Committee	☐

Amendments

None

Signed on behalf of the Panel........L Redhead........ LR

Date 24/3/06

APPENDIX 14
Participant consent form

University of Brighton
School of Health Professions

Participant Consent Form

A specific home based exercise programme for Portuguese older people: participants' perspectives

I agree to take part in this research which is to explore the factors that contribute to Portuguese older people's adherence to a specific home based exercise programme. The researcher has explained to my satisfaction the purpose of the focus group and the possible risks involved. I have had the principles and the procedure explained to me, I have read the information sheet and I understand it fully. I am aware that I will be required to participate in a group discussion about the home exercise programme I undertook last year. I understand that any confidential information will be seen only by the researchers and no one else. I understand that I am free to withdraw from the investigation at any time, without giving any reasons.

Name (please print) ....

Signed..

Date...

APPENDIX 15

CATEGORIES AND THEMES EMERGED FROM THE FOCUS GROUPS' DISCUSSIONS

THEMES	CATEGORIES	QUOTES	CODES
READINESS FOR CHANGING BEHAVIOUR	**PERCEIVED BENEFITS**	*I will do anything for my health*	F1AVp2
		I'm always ready for anything rregarding gymnastic	F1APp2
		for my own benefit	F1RJp1
		I was going through a health difficult period and I wanted to know if the programme would imrove or not my situation	F2Fp3
		Improve locomotion and, let's say, the quality of life of people of my age	F2Fp3
		" No, this is good for me so I'm going there" until today I have the book as a Bible with me….	F1APp4
		After the first time, I saw that the exercises I was doing were very beneficial.	F1APp4(2)
		I was seeing that it was really good for me, that it was beneficial for me …..	F1CCp4
		…. because I think it is beneficial, very beneficial for health	F1AVp4
		… you can have good benefits for your quality of life.	F2JMp3
		I began to liberate with this opportunity to come here and do the exercises	F1AVp8
		…I thought it was the opportunity to get free of that sdentarism, of that thing, and so to have health benifits	F1AVp8(3)
		… more stimulating relating to health prevention and maintenance	F2Fp3
		that it would be pleasant, something useful for us, that would help us on our daily life and on our health.	F2LPp1
	NORMATIVE BELIEFS	*knowing that I was helping in a PHD study*	F1CCp3
		well, it will be worth to go to, to do, to help the lady….	F1APp2
		pleasant invitation	F1CPp7
		it is such a receptivity by the researcher that it makes us feel that we have known her all our life	F1CPp7
		I thought I was collaborating with someone ifrom my area, because I know how difficult is to have volunteer collaboration in any questionnaire about health.	F2Fp3
		…because I was collaborating with someone.	F1RJp1

READINESS FOR CHANGING BEHAVIOUR	EXERCISE PROGRAMME FACTORS	*...innovative, it was something new, I would never think that the National Health Service would have this kind of service for its clients.*	F2JMp2
		This is innovative, yes sir, something that moves forward……	F2Hp2
		What moved me was the curiosity	F2Fp3
		… it was something new	F2Hp2 (2)
		"Is this true? I was so astonished, so astonished "….	F2FSp2
		We….. National Health Service….. A number…… in a general way nothing is personalized , and to receive a letter, an invitation, has... psychologically, it was positive.	F2Hp3
	NO FINANTIAL TRUSTS	*… it had no charges…*	F2JMp4
		Firstly this has no expenses	F2JMp3
	COMMITMENT(A GLOBAL PSYCHOLOGICAL CONSTRUCT REFLECTING A PERSON PLEDGE OR OBLIGATION TOWARDS EXERCISE INVOLVEMENT)	*I began to do it because I compromised….*	F1MJp4
		I did them (exercises) always correctly, continually, I never split them and I always began on the first one, I did them all.	F1MJp6
		I had to do them,first in the morning, to free myself from that responsibility	F1MJp6(2)
		...and the bigger challenge was "I will never gave up".	F1AVp5
		… what I love most is my health, and so my challenge was this one, I must really undertake this up to the end, I cannot give up	F1AVp5(2)
		Mine was not to fail, to fulfil the logs and to write what did.	F1MJp5
		…taking the responsibility I must do it	F1CCp6
		… there is a very important challenge and that is persistence	F2Fp5
		… those exercises I had to do were as a compromise, an obligation, so I really do them	F1RJp1
		...the exercise book and the logs had always to go in my make up bag to be able to write yes or no	F1RJp5
		… it was to accomplish the programme, to get time, it was the timetable	F1RJp4
		…because I was collaborating with someone.	F1RJp1

READINESS FOR CHANGING BEHAVIOUR	**FAMILY POSITIVE REINFORCEMENT**	*I didn't want to, it was my son that has pushed me.*	F1MJp4
		And I came! To be nice to my son	F1MJP2
BARRIERS TO EXERCISE	**LACK OF TIME DAILY ROUTINE**	*The first thing I did when I woke up was exactly the exercises*	F1RJp5
		…. while all people were having fun and dancing, we went uto the woods to do the exercises …	F1CCp6
		I had a predominant rule n my daily life, I had to do the walking and then the other exercises I did them on the morning or in the afternoon, on the bus or on the street...	F1APp5
		*…the one with the feet was done a lot of times on the bus, the one looking there (*made the rotation movement of the neck)*, sometimes I looked to one side, to the other whispering the counting …*	F1CCp6(2)
		… in my home cleaning brakes , I was doing it….	F2LPp4
		… I did them more sporadically, because I also had my daily life	F2LPp18
		…the house had to have some free space to practice.	F2JMp5 (3)
		I plan things, so my exercise programme is a job, a responsibility, I have a schedule	F1MJp18
		Not to interfere with my timetables, and I have some, it was the first thing I did after waking up…	F1RJp17
		…when we can't in that moment, but if we plan we can do everything	F1CCp18
		I had no interference because I had to do the exercises just after wake up. It was not regular nor systematic nor disciplined…	F2Fp16
		the only thing that I had to do was to exercise early in the morning, I had the habit to do the exercises in the morning	F2JMp16
		It interfered because I have a busy life, and so I had to do the exercises	F2Hp15
		There was always an interference because I had to do lunch on time, breakfast...and I had just a little bit of free time in the afternoon	F2LPp15

BARRIERS TO EXERCISE	LAZINESS	*…and I was lazy to do the exercises alone*	F2FSp2
		walking, the fingers, the hands, we need exercising. Doing them at home no, I'm lazy….	F2FSp17
	PERSONALITY TRAITS	*Sometimes we take part in non obvious things and those essentials things we despise a little, and that is stupid. In fact it is a stupid*	F2Hp6
		I blame myself; in fact it is the lack of persistence and discipline…	F2Hp14
		I don't have that kind of availability nor a stimulus nor that …	F2JMp14
		Mea culpa, lack of persistence that leaves to abandon the programme	F2Fp6
	PRESSURE OF SOCIAL LIFE	*The fact of going out some days, here and there…. I stopped doing and then the stops were so many …..*	F2Fp14
	LIVING ALONE	*… to stay at home by oneself, for whom who don't like to move a lot, in terms of programmed and disciplined exercises, the lack of an exterior control decrease the possibility of being persistent persons.*	F2Fp5
		I really wanted but I couldn't, alone I couldn't	F2FSp4
		...to play role of a clown, I don't do alone, I turned my backs on and I went away	F2FSp4(2)
		I live alone, nobody stimulates me …	F2Fp14
	LACK OF TIME LACK OF SPACE	*…as it was only me I had to go to the dinning room or to the corridor, and meanwhile my daughter was going to the bathroom, all that conditioned my activity*	F2JMp5 (2)
		For me it is complicated to tie me to schedules.	F1APp7
		...is what I said there is no space nor free hours to practice that we some regularity.	F2JMp14
	HEALTH PROBLEMS	*the only thing that interfered sometimes is to my respiratory problem*	F1APp16
		I had an interference because I fell and was badly hurt	F1CCp16
		I had a surgery too, I was in the hospital, and it was the only period were I didn't do the exercises.	F1CCp16(2)
		I had, I didn't do the exercises for a period of time because I had a vertigo problem …	F1RJp16
		I was always 3 months stopped because I had an eye surgery, I only did the walking exercise...	F1CPp10
		As I have the uric acid increased ….the right foot…sometimes I have the big toe sore and I cannot move	F1AVp16

BARRIERS TO EXERCISE	**HEALTH PROBLEMS**	*It was my health problem that makes me give up the programme*	F2LPp14
		I cannot say that it was a health problem, in the negative sense, that interfered with the programme but a health reason on a positive way, because as I resolved my knee problem everything was put in a secondary plan.	F2Fp4
PERCEIVED BENEFITS	**BALANCE IMPROVEMENTS**	*With the exercises I acquired a knowledge about not to be imbalance, not to fall, and today I can say that I forgot that, I don't remember anymore the imbalance.*	F1AVp11
		Now I can say that with all that balance exercises, that I continue to do, I don't have vertigo for a long time.	F1AVpII(2)
		…even in the last times I had a balance that I hadn't before, even young or old, I never was able to do it, that was the part I noticed the ameliorations.	F1RJp10
		…but that balance on the street, I run, I run to catch the bus with no problems	F1CPp13
	POSTURAL IMPROVEMENTS	*…because in reality I was much better in the posture aspect*	F1CPp12
		… except the back that is what I need more…	F1CPp7
		I acquired a better posture, I have my back a bit curved and now I feel, even if they are not completely straight because it is impossible, that I have a better seated and standing up posture	F1CPp13(2)
		I know already how to sit correctly, as I'm here	F1MJp10
		The back rules by themselves are enough, we catch that position.	F2FSp7
		…even the buffalo hump, I don't feel so.…	F2FSp8
	FLEXIBILITY IMPROVEMENTS	*Me, at the neck level, before doing those exercises, like this, for example I wanted to look to the side, I had to turn the body. Now I don't need to do it.*	F1CCp12
		I learned that doing these gymnastics I got a lot better of my foot, a lot ….	F1MJp2
		…the places where I notice more improvements…., was the flexibility	F1RJp10
		Now, since I began to do the gymnastic, I have much more mobility, much more easiness to move	F1AVp2
		I feel more liberated, I don't have stiff limbs as I used to. Before I had stiff nerves, sometimes with armaches, backaches and now I'm better	F2LPp8

PERCEIVED BENEFITS	FLEXIBILITY IMPROVEMENTS	*...but sometimes I had occasions where I couldn't even stand up.*	F2LPp8
		... exercises that made me move better, better move the joints ...	F2LPp2
		I felt better with the exercises I did. I felt lighter	F2FSp9
		... I stayed almost without movement and now I have much more movement	F1AVp8(2)
	GAIT IMPROVEMENTS	*....the fact was that when I walked, everybody went beyond, upseting me, but now they don't.*	F1CCp3
		I walk better and much more, I don't limp anymore from the left foot, I feel good	F1MJp10
		Now I feel better, i walk better...	F2LPp8
	PSYCHOLOGICAL EFFECTS	*For me everything was beneficial as I'm an active person. I had an early retirement, one of the most awful things that happenned to me*	F1RJp9
		...we feel better iinside	F1RJp22
		...a self confirmation that I'm still useful....	F1CPp13
		I went to work more pleased, happier, more tolerant with the others....e	F2JMp9
		It was very good for me and I like.It was a challenge and I liked it. If you have the opportunity for such a chance, please accept...	F1CCp20
		the better the physical part the better the psychological part too, and so to be happy with ourselves, being with a good mobility, we feel happier....	F1RJp2
		...I think that my exterior psycological behaviour was different... better	F2JMp9(2)
	EXERCISES	*... accessible, not too hard....*	F2FSp12
		they are not violent...	F2Hp12
		I think that the researcher is a kind of witch as she guesses what we must do	F1MJp13
		I had the knowledge that there were exercises....but I could not imagine that it is really wonderful...	F1RJp18
		...sometimes we do exercises that are not advisable ...	F1APp18
		From the moment that they are adjusted to our age, my age, I think that the exercises are not violent...	F2Hp18
		...to do these exercises is like taking a pill, it is the best thing we can find	F1MJp20

EVALUATION OF THE POSITIVE HOME BASED OUTCOMES	**EXERCISES**	*For our age no, I think that …they are reasonable*	F2LPp13
		I think it is good….. If I could I would make exercises for elderly as compulsory	F1AVp19
		In my case the ideal is to do home exercises…	F2Hp12
		…and gymnastics, physical exercises must me preventive. To prevent diseases and not to heal….	F1RJp19
		I think it is wonderful because elderly have their mobility decreased, have more difficulties. The joints are deteriorated, the bones don't support the same rhythm anymore…	F2LPp17
		I think that these kind of exercises must be done continuously to have a good result	F2F P10
		The exercise is always important and it not only the exercise: it is the exercise, the kind of food, the weight loss, etc. and all this make us to have a better quality of life	F2Fp19
EVALUATION OF THE NEGATIVE HOME BASED PERSPECTIVES	**TO INCREASE PHYSIOTHERAPIST CONTACT NUMBER OF TIMES**	*The place to do the exercises is the Health Center, we must think that way*	F1RJp10
		to have finished was the less beneficial thing	F1RJp9
		Me too, I agree to come more times to the health centre….	F1CPp14
		Me too, I agree that it is important to come to the health centre more times.	F1MJp14
		To come to the health centre every week or every fortnight	F1CCp14
		If we came, not once a month but every week…	F1AVp14
		I don't say daily, but we could come at least every week to the health centre. That would be ideally and then to accomplish the program at home....	F1RJp14
		I think that to come only once a month Is not enough, to continue, for a protocol…..	F1RJp14 (2)
		It was only once, one hour per week ….	F1CCp14(2)
	COMMITMENT PRESSURE	*The less beneficial was to promote a self blame related to the non accomplishment of a programme that initially I was excited about and I thought it would be able to do.*	F2Fp7
		the less beneficial was the really compromise we had of accomplishing the timetables.	F1APp9
		That compulsoriness of doing that, no, if I could come here and do them I wouldn't miss a day.	F1RJp9

RECOMMENDATIONS TO OTHER POSSIBLE PARTICIPANTS	RELATED TO THE EXERCISE PROGRAMME	*I would advise him to do those good exercises ….*	F1APp20
		Do it all, like it is prescribed, it is good for your health.	F2JMp22
		Go but do it because if you donn't do it it is no worth …	F1RJp21
		..it is to do what you must do, do what the lady tells you to do	F1MJp22
		Don't do like me, don't do the programme casually , because it's no worth	F2Fp23
		There is here a programme to improve mobility, do it, do it right	F2Fp23(2)
		I advise a regular practice of the programme	F2JMp22
		it is a programme, it is not really gymnastics, it is a very specific programme, each exercise is very specific to help here and there…	F2Hp23
		It was very good to enter the programme, it was wonderful for her health, All the exercises were easy to do	F2LPp24
		…don't think that you must do everything quiclky, at the same time….	F1CPp22
		…when you feel tired stop with the exercises, and begun again when you feel relaxed…	F1AVp23
		…do it always, I nver missed it, observing the rules you are told, everything, do what I did, becuase sometimes some exercise are hard…	F1AVp23(2)
		…this programme is not exactly a gymnastics one, it is a very specific programme, each exercise is specific to help a certain area…	F2Hp23
		Pratice them all and don't change the routine, do first the one with the chair and then… do it according to the standards you were given. It was extremely well dimensioned to be practised regularly and safely	F2JMp22
		the exercise were great, they were appropriated to our age and gave us much more mobility	F2LPp22
	PERCEIVED HEALTH CHANGES	*Go and do it, you are going to feel good as I feel.*	F1MJp21
		Go for me it was very beneficial….	F1CCp21
		…to have benefits were must take the programme seriously and do it regularly, if not we will don't have any benefits nor results...	F2Hp23
		It was very good for her to enter the programme, it was very good for her health too	F2LPp22

RECOMMENDATIONS TO OTHER POSSIBLE PARTICIPANTS	PERCEIVED HEALTH CHANGES	*…would recommend the programme, it would be good for health …*	F2LPp24
		I would tell him come with me, to my house to see something,… for your health you must do this…that…	F1AVp20
		Do everything that is written because it will be good for your health.	F2JMp22
		I would say, get old but wisely. You must profit from all the exercises can give you in order to have a better quality of life .	F1RJp20
OTHER SUGGESTIONS	NEED OF COGNITIVE EXERCISES	*…if it was possible to continue, keep the physical and the brain activities running together…*	F2JMp26
		…the brain has to keep up with the body, but sometimes it falls asleep…	F2JMp26(2)
		Yes, brain exercise would be good	F2LPp26
	CENTRE BASED EXERCISE PROGRAMME	*I think that probably it would be better in group*	F2LPp12
		…if it was a group activity…	F2Fp10
		All the people could join and do it twice a week…..	F2FSp12
		… once a week, I'm very lazy at home….. I don't do it alone, don't do…	F2FSp12
		Personally I'm not disciplined,for me it was hard to have that routine.	F2Hp12
		It helps and we stimulate each other ….	F2FSp11
		It is a question of seeing who is available, a free space, to do this once or twice a week	F1APp10
		…it was in group, everyone appearing at a certain hour, with some self responsibility, in a space and do it in group.	F2JMp6
		Exactly! It helps and we stimulate each other ….	F2Fp11
		…if there was a group probably I would go…	F2LPp20
		In my opinion once or twice a week in a group, as possible ...	F1RJp14
		If there was any possibility to do it in group, because we hold responsible for appearing ….	F2JMp12
	CONTINUITY OF HOME BASED PROGRAMME	*This exercise programme should exist in all health centers*	F2FSp2