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Impact of Different Training Regimes on Adherence and "Correctness" of Exercises in Elderly

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Declaration

This work is original and has not been previously submitted in support of a Degree, qualification or other course.

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Date …………………………………………….

Impact of Different Training Regimes on Adherence and "Correctness" of Exercises in the Elderly

Introduction: Adherence and accuracy of home exercises contribute largely to the effectiveness of physiotherapy treatment. Poor memory attributed to aging can however impede these two key factors. Although exercise sheets are often provided to help the elderly remember their exercises, little is known about how different modes of training with exercise brochure may impact these factors over time.

Aims: To investigate the impact of various training regimes on adherence and "correctness" of exercise in the elderly and its resultant effect on fall risk factors such as lower limb strength, dynamic standing balance and fear of falling.

Methods: 17 community dwelling elderly (aged 78±6.5 years) from three falls prevention classes in Cheshire were recruited. Participants from the same falls prevention class were clustered as a research group. Five home exercises were taught to all participants individually. Each group randomly received exercise instructions through verbal instructions and live demonstration only (no brochure group), verbal instruction and live demonstration with reference and explanation to pictures in the brochure (brochure (before) group) or verbal instruction and live demonstration with an unexplained brochure provided only after the training session (brochure (after) group). Participants continued to perform the exercises unsupervised at home, for six weeks. Exercise adherence was assessed with an exercise log book and "correctness" of exercise was scored against an exercise assessment scale at the end of six weeks. Measurement of fall risk factors such as lower limb strength (using 30 seconds chair stands), dynamic standing balance (using four square step test) and fear of falling (using the Activities-specific Balance Confidence scale) were also assessed prior to the research and at the end of six weeks.

Results: No statistically significant difference was found in exercise adherence and "correctness" of exercise scores between the no brochure group, the Brochure (after) group and the Brochure (before) group (62± 26.6 %, 70±15.1 %, 77±13.7 %, p=0.448 and 33±8.7 marks, 34±4.6 marks, 38±1.3 marks, p = 0.175, respectively). Fall risk factors such as lower limb strength (r=0.205, p=0.429), dynamic standing balance (r=-0.253, p=0.327) and fear of falling (r=0.255, p=0.322) were also not found to be significantly correlated with "correctness" of exercise scores after six weeks. "Correctness" of exercise scores was found to be significantly correlated with exercise adherence (r=0.506, p=0.038).

Conclusion: There is little evidence that a clearly explained exercise brochure coupled with live demonstation of the exercises improves exercise adherence or "correctness" of exercise in the elderly, compared to no exercise brochure or providing an unexplained exercise brochure. There is also little evidence to suggest that the more accurately exercises are performed, the better the improvement in fall risk factors. There is evidence, however, that accuracy of exercise performed is dependent on how well an exercise regime is adhered to. Hence, it is important that the elderly are encouraged to adhere to exercising regularly, in order to reap the benefits of exercise.

***Key Words*: MEMORY; OLDER ADULTS; BROCHURE; PATIENT EDUCATION**

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LIST OF CONTENTS

Chapter 1

Introduction

1. Introduction

1.1. Overview of the study

The graying population in the United Kingdom (UK) has been increasing rapidly over the years. According to the Office for National Statistics (2010), the number of elderly people, aged over 65 years old, has increased by 1.7 million from 1984 to 2009 (from 8.4 million to 10.1 million). In addition, the old-old population (85 years old and older) has doubled (from 0.63 million to 1.4 million), while the percentage aged under 16 fell from 21% to 19%, over the same period (Office for National Statistics, 2010). Although advances in the medical field enables more humans to live till a riper age, it also increases the number of people living with chronic diseases and disabilities (Jagger et al., 2007; Khaw, 1999).

Common deteriorations accompanying ageing include: sarcopenia (Jones, Rikli & Beam, 1999), impairments in balance (Langley & Mackintosh, 2007), increasing levels of disability and reduced function (Jones & Rikli, 2002). Such deteriorations increases the risk of falls, resulting in factures and other injuries (Cumming & Klineberg, 1994). In addition, the confidence to mobilise safely (Langley & Mackintosh, 2007) and remain independent (Berg, Alessio, Mills, & Tong, 1997) will also decrease, resulting in increase activity avoidance (Myers et al., 1996). A vicious cycle of increase in physical decline and further falls is thus formed (Blennerhassett & Jayalath, 2008). Nevertheless, physiotherapy treatments are commonly recommended, to help retard or reverse and restore disability from injury or illness (Sherrington et al., 2008).

Exercise is an essential part of physiotherapy treatment (Smith et.al., 2005). For physiotherapy treatment to be effective, it is essential that individuals are able to adhere and accurately execute home exercises regimes as prescribed by their physiotherapist (Friedrich et.al.,1996). Adherence to exercise is, however often poor, with forgetting stated as one of the top five reasons for patients' non-adherence (Sluijs et.al., 1993). This is especially prominent in elderly as a result of the ageing process (Phair & Good, 1995). There are, however, surprisingly few physiotherapy studies, examining how accurately elderly subjects remember exercises over a period of time.

Although various memory aids have been created over the years (Weeks et al., 2002), brochure remains the primary choice as memory aids for physiotherapy exercises because it is convenient, inexpensive and portable. Brochure can visually remind elderly that they have a task to accomplish, hence, reducing the cognitive burdens of remembering information (Park et.al.,1994).

However, previous physiotherapy studies that investigated the relationship between the use of brochure and "correctness" of exercise remembered by participants, showed no significant difference between having brochure as a memory aid and without (Friedrich, Cermak, & Maderbacher, 1996; Smith, Lewis, & Prichard, 2005). Yet, brochures continue to be widely used in hopitals globally. Face-to-face verbal instructions and demonstration of exercises accompanying brochures, have been found to be as effective as videotapes, as a form of memory aid, in enhancing comprehension, "correctness" of exercise performance and home exercise adherence in older people (Schoo et.al.,2004). Referencing verbal instructions to pictographs has also been shown to further enhance comprehension and recall of large amount of medical information in elderly and low literacy subjects (Houts et.al.,2001). These evidences suggest that effectiveness of an exercise brochure may be affected by the mode of education delivery. Other factors that may affect the effectiveness of an exercise brochure include the readability, layout and design of the brochure.

To the author's knowledge, no previous physiotherapy research, has investigated the effectiveness of a well designed exercise brochure when accompanied with face-to-face verbal instructions and explanation, accompanied by correct demonstration of the exercises. Hence, this research aims to examine if the act of referring to pictures in the brochure during exercise training session, is superior in enhancing memory and accuracy of exercises performed by the elderly, compared to if exercise brochure is given at end of session or no exercise brochure is given at all.

Falls are commonly reported in the elderly population. About 30% of community-dwelling elderly fall each year, with more than half of these people falling more than once (Gregg, Pereira & Caspersen, 2000). Falls prevention is hence, of upmost importance in the elderly population. Falls risk is found to decrease with exercise, if done consistantly and correctly (Sherrington, et al., 2008). Yet, fundings for community falls prevention classes have in recent years, been withdrawn from some parts of UK. With fewer falls prevention classes running in the community, the elderly will have to continue performing falls prevention exercises at home independently. Ability to recall, adhere and accurately excecute the prescribed home exercise is of even greater importance now, because these factors determines the effectiveness of exercise, as an intervention, in reducing the risk of falls. The effectiveness of exercise brochure will be tested on three groups of falls prevention elderly participants over a six week period. To evaluate if "correctness" of exercise and consistant exercise has improve falls risk, changes in fall risk factors such as dynamic standing balance, lower limb strength and fear of falling will be assessed.

1.2. Brief review of the dissertation structure

In chapter 2, a review of current literature with regards to ageing, benefits of exercise for elderly, adherence and "correctness" of exercise with various memory aids and training methods will be discussed.

In chapter 3, aims and hypotheses with its rationale for this research will be listed. In addition, key variables will be identified and operational definations will also be explained .

In chapter 4, a detailed explanation of the procedure and statistical analysis of this research will be discussed. This chapter will provide details of the various training regimes in this research, how exercises brochures and exercise log books were designed and the rationale for the selection of each measurement tool.

In chapter 5, a summary of the findings from this research, in the form of tables and charts, will be presented.

Lastly, further discussion, comparison and contrast of the findings from this research with previous studies, will be done in chapter 6. In addition, limitations of this research and recommendations for further research will also be discussed.

Chapter 2

Literature Review

2. Literature Review

2.1. The healthcare reality

With the graying population growing rapidly in the UK (Office for National Statistics, 2010), medical resources become increasing scarce as health demands rises with age (Department of Health, 2001b; Jagger, et al., 2007; Khaw, 1999). Cost containment to allow more people medical access in the shortest possible time is hence essential. In 2001, the UK government introduced a number of new approaches to cope with this growing demand. One of which, is to engage healthcare providers in encouraging patients to take more ownership for their health. Patients should look to health professionals as a facilitator and mentor, instead of being entirely dependent on health professionals for the maintenance of their good health (Department of Health, 2001a). This can be achieved through empowering patients with the knowledge of their own condition and what they can do independently to assist in their recovery, so that they are actively engaged in improving their own health outside consultation sessions (Department of Health, 2001a). Although patient education on prevention techniques and self-care through exercise prescriptions is the usual practice in physiotherapy sessions, which is in conjunction with the new government policy, assisting patients in learning exercises can be time consuming and problematic (Miller, Litva, & Gabbay, 2009). Patients may forget their exercises or fail to perform them between consultations (Sluijs, Kok, & Van der Zee, 1993; Smith, et al., 2005). In addition, prescribed exercises may also be incorrectly performed by patients (Rastall et al., 1999). These factors make it difficult for an accurate evaluation of the effectiveness of prescribed exercise regime, which is necessary for the planning and progression of treatment (Miller, et al., 2009). Without solving these fundamental issues would render current research for effective treatments useless and furthermore result in longer treatment course and increased healthcare cost incurred.

The following sections shall further discuss the importance of adherence and "correctness" of exercise for effective physiotherapy treatment and how this may be compromise by ageing process. The possibility of varying training methods and providing brochures to help with adherence and "correctness" of exercise hence allowing more accurate evaluation of the effectiveness of prescribed exercise regime will also be discussed.

2.2. Adherence and "correctness" affects effectiveness of Physiotherapy treatment

2.2.1. Exercise adherence

According to Schoo and Morris (2003), adherence is defined as how strictly a patient has followed the prescribed exercise regime. Patient adherence is essential in physiotherapy and can affect the effectiveness of physiotherapy treatment to a large extent. A prospective study conducted by Friedrich et al.(1996) on 87 neck and lower back pain patients (48 $\pm$ 12.7 years old), showed that after eight physiotherapy sessions, the group with a higher exercise adherence median (7 days/week, 95% CI, 3.5-7), had significantly ($p<0.01$) lesser muscle impairment (1.0, 95% CI, 1-2) and better pain relief (50, 95% CI, 25-71.25) compared to the less compliant group (4.5 days/week, 95% CI, 3-6.25; 2.0, 95% CI, 2-3 and 25, 95% CI, 10-40, respectively),. This study is of high validity as patients were randomized into groups, assessors were blinded and there were no drop outs.

When the relationship between compliance and effectiveness of treatment were studied in the elderly population, similar findings were also observed. In 1997, Shumway-Cook, Gmber, Baldwin and Liao did a study on eighty-four elderly subjects (>65 years old), who participated in a multidimensional exercise program and were categorized into either partially adherent or fully adherent group, based on their adherence to the exercise regime. Patients had to attend outpatient physiotherapy session twice weekly and to perform home exercises 5-7 days per week, over a period of 12 weeks. Patients were classified as partially adherent if they attended less than 75% of the physiotherapy sessions and exercised less than four days per week at home. It was found that both groups had significant ($p<0.05$) decrease risk of falls (-33%), when compared to twenty-one age match controls (+8%), as shown in figure 2.1. In addition, it was found that the group that was fully adherent to their exercise had a higher average percentage change in falls risk (-33%) compared to the partially adherent group (-11%).

Figure 2.1: Percentage change in predicted probability of falling for all three groups (Shumway-Cook, Gmber, Baldwin, & Liao, 1997)

However, methodological flaws such as high drop out rate (17%) with no blinding of the assessors in this study, casts doubts over the study's conclusion. Nevertheless, these findings were further supported by another study done by Penninx (2001), on 250 elderly osteoarthritis participants, where investigation was made to determine the probability of living without activities of daily living (ADL) disability after eighteen months of either aerobic, strengthening or no exercise. It was found that the relative risk (RR) of losing the ability to perform at least one ADL after eighteen months, was significantly higher in the age matched control group (RR: 1.0) compared to both the aerobic and strengthening exercise groups (RR: 0.57, 95% CI, 0.38-0.85, $p<0.05$), as shown in figure 2.2. It was also found that higher adherence in either aerobic or strengthening exercise program resulted in significantly ($p<0.05$) lower RR (0.38, 95% CI, 0.17-0.82 and 0.43, 95% CI, 0.19-0.97 respectively) compared to lower exercise adherence (0.77, 95% CI, 0.41-1.46 and 0.57, 95% CI, 0.29-1.49

respectively). This is a high validity study as drop out rate was low (4%), participants were randomized and assessors were blinded.

Figure 2.2: Probability of surviving without ADL disability over 18 months in each group (Penninx, et al., 2001)

It is evident from these results that adherence to participate in exercise is definitely better than not doing any exercise but full benefits of exercise can only be achieved provided participants are adherent with performing these exercises as recommended by their physiotherapist. Despite the importance of adherence in physiotherapy, little research has been done to find the most effective method of increasing exercise adherence. Non-adherence to exercise regimes has been found to be as great as non-adherence to other medical regime (Sluijs, et al., 1993). In order to find the most effective method of increasing exercise adherence, it is essential to first understand the factors for non-adherence. Sluijs et al. (1993) investigated the factors for non-adherence to physiotherapy in 1,931 patients, through interview and questionnaire. Some of the listed factors for non-adherence include: complex exercise regimens, exercise regimens that causes inconvenience, no supervision or feedback about exercise performance, unclear instructions and no explanation of the rationale of performing certain exercises as well as no direct results seen from performing the prescribed exercises. Deteriorating memory in elderly, which will be further elaborated in section 2.3.1, may also result in involuntary non-adherence of exercises, as elderly may forget to perform their exercises. Addressing these factors when prescribing home exercises, has been found to improve patient's adherence to exercise regimes (Friedrich, et al., 1996; Henry, Rosemond, & Eckert, 1999; Reo & Mercer, 2004).

2.2.2. "Correctness" of exercise

Exercise adherence has also been found to affect the "correctness" of exercise performed (Henry, et al., 1999). "Correctness" of exercise is defined by Schoo and Morris (2003) as the physiotherapist's judgment of how accurately patients performed the exercises taught to them. It was found that exercise adherence, as measured by an exercise log, moderately ($r=0.54$) correlated with "correctness" of exercise scores (Henry, et al., 1999). "Correctness" of exercise plays an equally important role in determining the effectiveness of physiotherapy treatment. In the study done by Friedrich et al. (1996), as detailed in section 2.2.1., significant ($p<0.01$) positive correlation was also found for "correctness" of exercise scores with both muscle impairment status ($r=-0.38$) and pain relief ($r=-0.47$). In addition, it was noted that the group with higher exercise adherence obtained better "correctness" of exercise scores on the three point scale (1.0, 95% CI, 1-1.3, $p<0.01$) and hence better improvement in muscle impairment status and pain relief compared to the lower exercise adherence group (1.6, 95% CI, 1.4-1.9, $p<0.01$).

Putting exercise adherence aside, “correctness” of exercise itself, is still essential for an effective treatment. Physiotherapists usually prescribe exercises to achieve specific muscle or muscle group performance while minimizing injury. Being adherent with the prescribed exercise regime but consistently performing the exercises incorrectly, not only defeats the purpose resulting in no improvement, in some cases, may also cause injury to the muscle or surrounding tissue (Reo & Mercer, 2004).

For exercise to be done correctly, it has to first be learnt. Learning is defined as the “acquisition of knowledge or skills achieved by study, instruction, practice and experience”(Guccione, 1993, p. 340). Learning is a concept that is closely related to memory where learning is often assessed by memory tasks (Bottomley & Lewis, 2003). A person is said to have learnt when improvements in task performance is noted (Bottomley & Lewis, 2003). Learning and memory comes in three stages: firstly, the task must be registered into the brain through various senses (encoding), then it is processed and store aside for later use (storage) and finally recalling the information when it is needed (retrieval) (Cowan, 2008). When applied to the current context, exercises taught by physiotherapist must first be encoded before it can be remembered and recalled later through assessment of the correctness of exercise performed.

“Correctness” of exercise can be assessed and quantified using an exercise assessment scale. Various exercise assessment scales have been developed over the years as, to date, no gold standard tool is available for the accurate evaluation of "correctness" of exercise performed by patients. The first exercise assessment scale created was a three point scale (Table 2.1) (Friedrich, et al., 1996), which did not have any subsections to guide assessors on what to look out for when judging the "correctness" of an exercise.

Table 2.1: Three point exercise assessment scale (Friedrich, Cermak and Maderbacher, 1996)

Exercise done so well that the goal of treatment was reached	1
Exercise was not carried out correctly and the goal was not reached	2
Exercise was performed incorrectly and the goal was not reached and that there was reason to believe that the exercise might have had harmful effects	3

In 1999, Rastall et.al, invented a 10 point scale (Table 2.2), that graded the "correctness" of exercise based on four main criteria. In the same year, Henry et.al. (1999) also designed a 12 point Henry-Eckert Performance Assessment Tool (Table 2.3), with three sub-category to consider when judging the "correctness" of each exercise.

Table 2.2: Ten point exercise assessment scale (Rastall, et al., 1999)

Correct starting position for exercise,	2
Exercising body component moving in the correct plane	3
No compensations or cheat movements	3
Movement performed within the correct range	2

Table 2.3: Henry-Eckert Performance Assessment Tool (Henry, et al., 1999)

I. Cueing

Relied on Exercise Sheet, or Maximum Verbal and/or Manual Cueing	1
Moderate Verbal and/or Manual Cueing	2
Minimum Verbal and/or Manual Cueing	3
No Cueing	4

II. Alignment

Alignment Never Established	1
Correct Alignment Maintained less than 50% of Exercise	2
Correct Alignment Maintained more than 50% of Exercise	3
Alignment Maintained Throughout Exercise	4

III. Exercise Quality

Lacks Control, Coordination, and/or Rhythm During Exercise	1
Controlled, Coordinated, and Continuous ,50% of Exercise	2
Controlled, Coordinated, and Continuous .50% of Exercise	3
Controlled, Coordinated, and Continuous Throughout Exercise	4

However, these scales were flawed as they only tested the procedural memory in participants and not the declarative memory. Procedural memory is the subconscious memory of skills and action, while declarative memory is the conscious memory of facts, ideas and images (Squire & Kandel, 1999). Hence, another more comprehensive exercise assessment scale adapted and expanded from Rastall et al.(1999), testing both procedural and declarative memory, was developed by Smith et al. (2005) (appendix 12).

2.3 Effects of ageing and exercise

2.3.1. Ageing and memory

Memory and many other systems in the human body alike, deteriorates with age. Age related neurological changes include: thickening of blood vessels and meninges as well as build up of cholesterol. These changes reduce blood flow and hence nutrients to the brain causing the brain to shrink resulting in memory loss (Bottomley & Lewis, 2003). Loss of myelin sheath and large myelinated fibers together with decrease in the number of neurotransmitters with age, may to a certain extent, account for the presence of slower reaction time and ability to learn in elderly (Langan et al., 2010).

Although research investigating memory for exercises in the physiotherapy area is limited, numerous studies have been done to examine patients' ability to recall general medical and prescription information. A systematic review of studies by Ley (1979) reported that 37%-54% of medical information provided by healthcare professionals was immediately forgotten, and elderly people were more prone to forgetting than the young people. In addition, it was also found that the amount of medical information forgotten by patients was a linear function of the amount presented. This is in agreement to the study conducted by Rastall et al.(1999). Thirty elderly (68.3 $\pm$ 6.6 years) and thirty young (23.7 $\pm$ 3.9 years) adults participated in this study and were randomly assigned to learn and remember either a short-list of five exercises or a long list of ten exercises. Participants were asked to perform these exercises 30 minutes after learning and were marked for how accurately they could recall and perform these exercises. As shown in figure 2.3, the probability of remembering exercises accurately decreases with age and with the amount of exercise taught. Young participants forgot or incorrectly performed an average of 7% of the taught exercises from the short list of five exercises and 15% from the long list of ten exercises, compared to 11% and 15% respectively for the elderly participants. Memory of exercises did not differ significantly ($p = 0.39$) between elderly and young participants for the short list of five exercises but significantly ($p<0.001$) differ for the long list of ten exercises.

Figure 2.3: The Probability of remembering exercises in the young and elderly participants for a list of five and ten exercises (Rastall, et al., 1999)

With memory of exercises decaying overtime, increasing interval between the training and recalling phase (McGuire, 1996) and increasing age, may result in adherence and "correctness" of exercise being compromised.

2.3.2. Ageing and strength

Other common age related decline such as strength (also known as sarcopenia) and balance, have also been known to be directly related to functional limitations regardless of disease status (Jones & Rikli, 2002). Sarcopenia potentially increases by 12%-15% per decade, starting from the fourth and fifth decade until the eighth decade in life (Hinrichs et al., 2009). In 1997, Lindle et al found from 654 participants (20-34 years old: n= 85; 35-49 years old: n= 206; 50-64 years old: n= 191; 65-93 years old: n= 172) that both concentric and eccentric strength declined significantly ($p<0.001$) with age when expressed as a percentage of the mean of the youngest group, as shown in figure 2.4. Strength was tested using the Kin-Com dynamometer, which was found to have high test re-test reliability (ICC=0.99). All test settings were set to accommodate participants of all ages and was kept similar for all participants allowing a fairer comparison and hence a highly valid study. Age was found to explain about 30% of the concentric strength changes and 19% of the eccentric strength changes between groups.

Figure 2.4: Age-related percentage changes in concentric and eccentric strength for men (A) and women (B) (Lindle et al., 1997)

In addition, lower limb strength was also noted to decline at a faster rate compared to upper limb strength and that men experience greater decline in strength compared to age-matched women. This was a prospective study done by Hughes et al. (2001) on 120 community dwelling healthy participants, who had their baseline strength measured and a follow up strength measurement 9.7±1.1 years later. Significant ($p<0.01$) decline in muscle strength for all muscle groups was found at follow up. Absolute change in muscle strength for knee flexor, knee extensor, elbow flexor and elbow extensor was (-11±15 Nm, -9±8 Nm, -2±8 Nm, -0.3±7 Nm respectively) for women and (-24±25 Nm, -14±19 Nm, -6±9 Nm, -5±8 Nm respectively) for men.

Age-related sarcopenia occurs due to physiological and lifestyle changes as adults age, which includes decrease physical activity levels (Stephens & Caspersen, 1994), loss of motor units in muscles (Roubenoff, 2001), decrease protein synthesis (Vandervoort & Symons, 2001), reduced hormone production (Waters, Baumgartner, & Garry, 2000) as well as a possible reduction in diet protein consumption with increase age (Evans, 1995). Sarcopenia have been associated with decrease in ability to perform ADL independently such as getting out of the bed or chair (Alexander, Fry-Welch, Marshall, Chung, & Kowalski, 1995; Alexander, Schultz, & Warwick, 1991) and decreased mobility (Laukkanen, Heikkinen, & Kauppinen, 1995), all of which are related to decrease balance and increase risk of falls (Brown, Sinacore, & Host, 1995; Wolfson, Judge, Whipple, & King, 1995).

2.3.3. Ageing and balance

Besides sarcopenia, age-related decline in sensory function and neural processing as well as common age-related diseases, results in decline balance abilities and places elderly at increase risk of falls (Maki & McIlroy, 2006). Maintaining balance is essential when performing any ADL (Blennerhassett & Jayalath, 2008). Balance is maintained when the body's centre of mass (COM) is over the base of support (BOS) (Maki & McIlroy, 2006). This results from the co-ordination of body's musculoskeletal, sensory and neural systems (Maki & McIlroy, 2006). The key determination of whether a fall will occur with balance perturbation, depends on one's ability or inability to recover balance (Maki & McIlroy, 2006). As shown in figure 2.5, balance can be recovered with either fixed support strategies or change in support strategies. Fixed support strategies include ankle strategy (A), usually to stabilize anteroposterior perturbations and hip strategy (B), usually to stabilize mediolateral perturbations and aid anteroposterior perturbation stabilization. When the COM moves through a larger range, increasing BOS through initiating a step (C) or reaching forward (D) is necessary.

Figure 2.5: Balance-recovery reactions (Maki & McIlroy, 2006)

Elderly were found to initiate stepping at lower levels of instability than young adults when evoked by perturbations but often experienced difficulty in effectively executing stepping reaction (Jensen, Brown, & Woollacott, 2001; Mille et al., 2003). In a study done by Luchies et al. (2002) on 40 healthy, community dwelling, young (20 $\pm$ 0.9 years old) , young-old (67 $\pm$ 3.7 years old) and old adults (78 $\pm$ 2.3 years old), reaction time to balance perturbations were significantly ($p<0.001$) slower in the old adults (33%) and young-old adults (23%) when compared with the young adults, as illustrated in figure 2.6. Time taken to take a step in any direction, in order to increase base of support, also increase significantly ($p<0.001$) with age. Old adults were 44% and 26% respectively slower in liftoff and landing times compared to the young adults. Young-old adults on the other hand, were only slower by 24% and 19% respectively. Such slow reaction time may result in elderly suffering more falls from slips and trips (Legters, 2002).

Figure 2.6: Reaction time, liftoff time and landing time for the young, young-old and old adults (Luchies, et al., 2002)

2.3.4. Ageing and fear of falling (FOF)

Fear of falling (FOF) is common in elderly and is found to increase with age (Legters, 2002). FOF is defined as "low perceived self-efficacy (or self-confidence) at avoiding falls during essential, non-hazardous ADL" (Tinetti, Richman, & Powell, 1990). FOF is a serious concern as it occurs in both fallers and non-fallers and is known to hinder mobility and independence. Prevalence of FOF was reported to be present in 12% to 65% of independent community-dwelling elderly, with no falls history (Legters, 2002). This number was however, noted to double (29% to 92%) in elderly with history of falls (Legters, 2002), most likely due to psychological trauma suffered post fall (Powell & Myers, 1995). Such FOF causes elderly to be trapped in a vicious cycle, where activity is restricted as a protective response to avoid falls, resulting in decrease mobility and independence, leading to further falls, increased FOF and dependence for ADL. A prospective study done by Cumming, Salkeld, Thomas & Szonyi (2000) on 528 elderly subjects found that increase FOF significantly ($p<0.05$) increases risk of falling in fallers (hazard ratio (HR): 2.09, 95%CI, 1.31-3.33) and non-fallers (HR: 2.37, 95%CI, 1.25-4.51) and admission into nursing homes (RR: 4.95, 95%CI, 1.14-21.58) over a year. In addition, increase FOF also resulted in decreased mobility and functional independence in performing ADL, as well as a decrease in the quality of life (QOL) as scored on the SF36 questionnaire. 16% of fallers have reported limiting their usual activity and one third of the fallers had reduced their participation in social activities due to FOF (Nevitt, Cummings, & Hudes, 1991).

Self-efficacy has been suggested to play a significant part in elderly perception of FOF. Defined as the individual's perceptions of his or her balancing capabilities within a particular domain of activities, Bandora's theory of self-efficacy, suggested that one's cognitive appraisals, whether accurate or not, will either facilitate or hinder an individual's decision to engage in a particular activity (Legters, 2002). Hence, improvement of self-efficacy is important to reduce falls and maintain mobility and independence in elderly.

2.3.5. Ageing and exercise

As discussed above, it is evident that the normal process of aging, places elderly at an increased risk of falls and increases their FOF. It has been reported that the frequency of falling in elderly (>65 years old) increases significantly ($p<0.05$) to about 35% compared to only 18% in young adults (20-45 years old) and 21% in middle-aged adults (45-65 years old) (Talbot, Musiol, Witham, & Metter, 2005). Trips were also found to account for 40%-60% of falls in elderly and slips accounted for another 10%-15% of the falls (Berg, et al., 1997; Cumming & Klineberg, 1994; Hill, Schwarz, Flicker, & Carroll, 1999). As seen in figure 2.7, not only do elderly experience more falls compared to the younger population, falls in elderly also results in more detrimental consequences (Talbot, et al., 2005). About 15% of falls results in serious injuries such as fractures, head trauma, soft-tissue injuries or lacerations (Moreland et al., 2003). In addition, post fall trauma and FOF in non-fallers, may also result in a downward spiral of physical functioning, independence and QOL, as discussed in section 2.3.4. (Legters, 2002), adding economical burden on the society. This risk of falling can however be reduced by participating in regular exercise.

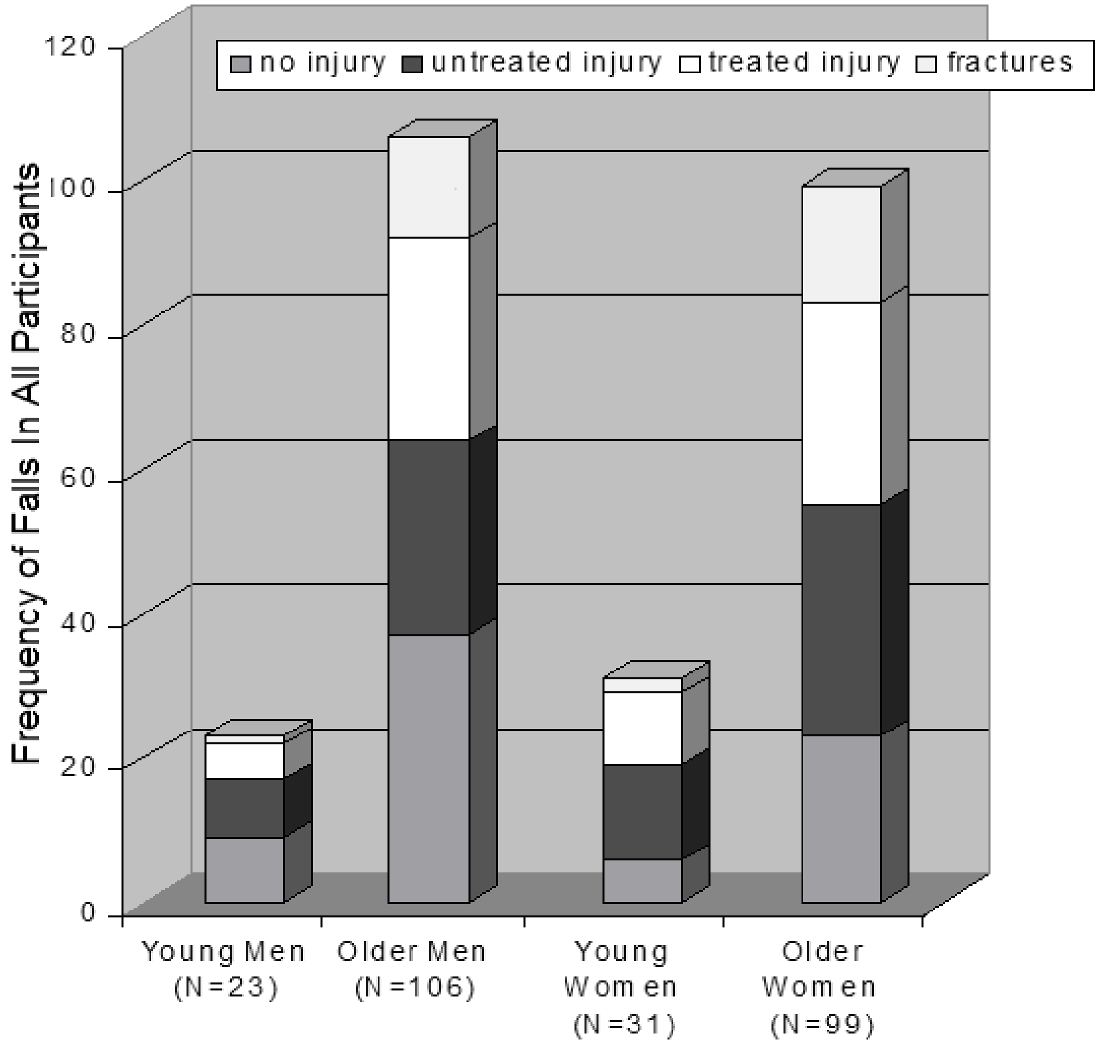


Figure 2.7: The frequency of falls and types of injuries sustained in the young and old populations (Adapted from Talbot et al., 2005)

Elderly who participated in balance exercises, showed improvements in functional balance test (+23%, 95%CI, 14%-31% and +26%, 95% CI, 20%-31%) compared to controls who do not exercise (-5%, 95%CI, -10%-1%) (Shumway-Cook, et al., 1997). These improvements were also found to correlate directly with decrease falls risk in the exercise groups compared to the control group as detailed in section

2.2.1. This was further supported by a high validity systematic review and meta-analysis done by Sherrington et al. (2008), where a thorough search has been done on MEDLINE, EMBASE, CINAHL, PubMed, Pedro and Cochrane review. Only randomized controlled trials conducted in elderly with exercise as the primary intervention for falls prevention were included for review. Clear inclusion and exclusion criteria for the articles taken into review were stated and each article was appraised individually for quality by two independent reviewers. Any disputes were resolved with a third independent reviewer. It was found from forty-seven of the included trials that the RR of falls with balance exercise was 0.75, 95%CI, 0.60-0.94, $p<0.01$.

Participation in strength training exercises, as found in 100 community dwelling elderly (77.6 ± 7.6 years old) who participated in three times per week strengthening exercise for ten weeks, also resulted in significantly ($p<0.05$) greater mean muscle strength improvement in knee extensor (+4.9±1.4 Nm), knee flexor (+4.6±7.1 Nm), dorsiflexion (+0.81±3.1 Nm) and plantarflexion (+3.1±6.4 Nm) compared to the control group (-0.7±8.2 Nm, +0.3±4.8 Nm, -0.3±2.1Nm, +0.25±5.7 Nm, respectively) (Chandler, Duncan, Kochersberger, & Studenski, 1998). In addition, the strength gain from exercise was also found to significantly ($p<0.05$) improve mobility scales, chair stands and FOF in these elderly. This is in agreement with another study done by Liu-Ambrose (2004) who found that elderly who participated in either strengthening or agility exercises over thirteen weeks, significantly ($p<0.05$) improve their FOF from baseline compared to age matched controls.

As causes of falls are multi-factorial, falls prevention exercises are often recommended to be done regularly and to include a variety of exercises that target balance, strength and flexibility, which should be specifically tailored and progressed for each elderly (Campbell & Robertson, 2003; Moreland, et al., 2003; Sherrington, et al., 2008). However, comparisons of the effectiveness of specific types of strength and balance exercises will not be the focus of this review.

It is of paramount importance to maintain and even enhance physical and cognitive function of elderly for a successful ageing. Vitality, not longevity should be the focus. Engaging in exercise is the key to maintain a successful ageing journey (McArdle, Katch, & Katch, 2007, pp. 884-885). Elderly are usually recommended to seek professional advice from physiotherapist regarding the type of exercise suitable for them (Department of Health, 2005). However, the demand for physiotherapy services have also been noted to increase rapidly over the years, as seen in figure 2.8.

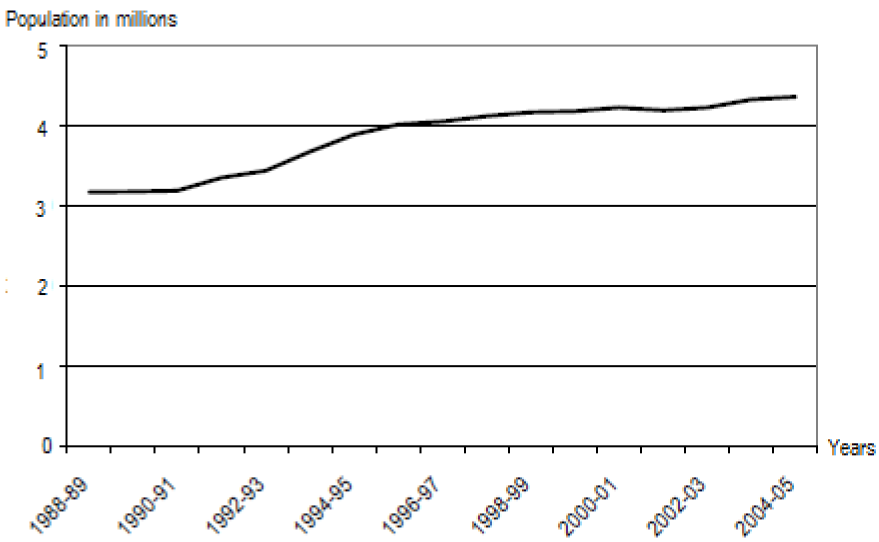


Figure 2.8: Demand for physiotherapy services from 1988-2005 (Department of Health, 2005)

This demand for physiotherapy services is disproportionately higher in people age 85 years and above (more than 400 per thousand population) compared to toddlers, age <5 years old (21 per thousand population) and children, age 5-15 years old (22 per thousand population) (Department of Health, 2005). With a rapidly increasing elderly population (Office for National Statistics, 2010), the demand for physiotherapy services is likely to rise faster than the supply for it. To meet this increasing demand, physiotherapists will be pressured to deliver quality services in shorter and lesser consultation sessions and to rely on patients to continue these exercises at home independently for treatment to be effective (Miller, et al., 2009; Reo & Mercer, 2004). Sherrington et al. (2008) has recommended that elderly should engage in a minimum of 50 hours of exercise over time, to effectively prevent falls. Such effects can be quickly achieved by combining weekly supervised group exercise with follow-up home exercise regimes (Sherrington, et al., 2008). Yet, it is ironic that the elderly population, who require most of physiotherapy services compared to other age groups (Department of Health, 2005), is also the population with the poorest memory compared to other age groups (Rastall, et al., 1999). As discussed in section 2.2.1 to 2.2.3, memory affects compliance and "correctness" of exercise which in return affects the effectiveness of prescribed exercise regime. If elderly do not remember the exercises correctly and the society do not have sufficient resources to supervise all elderly with their exercises, these elderly may injure themselves or even forget to do their exercises resulting in rapid physical decline and higher risk of falls.

This will result in a need for more treatment sessions as well as additional health and financial burden on the society. It is hence, important to investigate ways of helping elderly improve memory of exercise, bringing about adherence and "correctness" of exercise, therefore allowing elderly to reap the benefit of exercise.

2.4. The effect of memory aids and training methods on adherence and "correctness" of exercise

As shown in Ley's (1988) model in figure 2.9, adherence with medication is affected by understanding and memory of the information presented. Remembering and performing exercise correctly, like remembering to take medication, requires initial comprehension of the instructions and sufficient working memory capacity and prospective memory to plan the task (Park, Willis, Morrow, Diehl, & Gaines, 1994). Hence, any method that can improve understanding of the need to do exercise and how to perform them and/or any device that can improve memory of exercises will improve adherence as well as "correctness" of exercise (as discussed in section 2.2.2).

Figure 2.9: Overview of Ley's model on the relationship between understanding and memory (recall) of information affects compliance (adherence) (Ley, 1988)

2.4.1. Types of memory aids

Memory aids are devices commonly used to help patients recall exercises and medical information (Schoo & Morris, 2003). Memory aids for exercise can come in the form of an illustrated brochure, audiotape or videotape/DVD (Schoo & Morris, 2003). Although videotapes and audiotapes are effective in communicating information to even low literacy individuals, listeners must remember the messages, if they are to be used (Houts, Witmer, Egeth, Loscalzo, & Zabora, 2001). This limits their usefulness to simple, important ideas (Houts, et al., 2001). Exercise that involves complex movement may not be correctly remembered and interpreted from audiotapes. In addition, elderly may also lack the skills or access to use of videotape players or even lack of space or privacy to perform exercises because of the need to use videotape, hence hindering adherence to exercise regime (Miller, et al., 2009; Schoo, Morris & Bui, 2005). A brochure, on the other hand, is one of the most cost-effective, portable and widely used memory aid in the medical field. Its role in helping exercise adherence and "correctness" and factors affecting its effectiveness, shall be further discussed in this section.

2.4.2. Layout and readability of Brochure affects adherence and "correctness"

The effectiveness of a brochure as a memory aid for medical information and medications have been well documented (Houts et al., 1998; Houts, et al., 2001; Katz, Kripalani, & Welss, 2006). However, studies focusing on the effectiveness of a brochure as a memory aid for physiotherapy exercises are limited, and most of which have not found brochure as a useful memory aid when compared to either videotape (Reo & Mercer, 2004; Weeks, et al., 2002), or therapist supervision (Friedrich, et al., 1996) or no memory aids (Smith, et al., 2005). Nevertheless, the quality of brochures used in these studies were not checked for readability, proper layout and design. These factors are essential, for a brochure to effectively serve its purpose as a memory aid (Petterson, 1994).

Readability is defined as how easily one can fully comprehend the contents in the brochure (Schoo & Morris, 2003). Readability are usually rated using the Flesch Reading Ease and Flesch-Kincaid Grade Level scales, which will be further elaborated in section 4.6.1. Small prints, complicated words and sentence construction have been found to compromise the effectiveness of written instructions. A study done by Cardinal and Seidler (1995) found that when the readability of an exercise brochure was written at a level equivalent to that of a scientific journal article (Flesch reading-ease score = 18.4), the brochure becomes significantly ($p<0.05$) incomprehensible for more than half of the participants (69.6%, n=39). Two-third (n=37) of the fifty-six participants in this study, were in fact, college graduates and higher. To ensure full comprehension of the contents in the brochure, by even low education people, text in the brochure should be written simply, with no jargon (Petterson, 1994). Words should also be large enough for elderly to read (Petterson, 1994).

As recommended by Petterson (1994) and Katz, Kripalani and Welss (2006), pictures should also be added, to illustrate how each exercise should be done with some supporting text to explain the picture. Pictures have been found to improve learning through the mental model theory (Kools, van de Wiel, Ruiter, & Kok, 2006). Psychology research have found that cognitively, human tend to prefer picture-based, rather than text-based, information, also known as the "picture superiority effect" (Katz, et al., 2006). This is because more cognitive resources is needed to comprehend text compared to pictures (Kools, et al., 2006). Nevertheless, it is still important that supporting text is present in conjunction with pictures to prevent misinterpretation of picture-only instructions (Katz, et al., 2006). Furthermore, mental model theory states that through different processing routes, text and pictures enable construction of both verbally ('propositional') and visually-based mental models (Kools, et al., 2006). These are integrated by the reader in their working memory to foster comprehension (Kools, et al., 2006). Connections between these two representations are best built when both corresponding text and picture are in working memory at the same time (Kools, et al., 2006). However, working memory is limited in its processing capacity and can only retain information for a limited period of time. Hence, presenting connecting text and illustrations simultaneously, is most likely to bring about this concurrent activation, illustrating a "spatial-contiguity effect" (Kools, et al., 2006).

In a study done by Schoo et al.(2005), a brochure was found to be as effective as videotapes and audiotapes as a memory aid, when quality control for readability, layout and design was done. The illustrated brochure had most of its words in font size 14 and was categorized as “easy to read” on the readability scale. 115 osteoarthritis elderly (mean age: 70.5 years) took part in this study, and were instructed to perform home exercises and attend three “in-clinic” sessions, once at baseline, four weeks later for assessment and progression of exercise and at the end of eight weeks. Participants were randomly allocated to receive either a brochure only, a brochure plus videotape or a brochure plus audiotape as memory aid for the nine home exercises. As seen in figure 2.10, although videotapes and audiotapes may have a slight advantage over brochure in performing the exercises correctly, both adherence and “correctness” of exercise were not found to differ significantly ($p>0.05$) between all three groups over the eight weeks duration. Drop out rate in this study was low (<15%), hence making it a high validity study.

Figure 2.10: Percentage of exercises correctly performed in the videotape, audiotape and brochure groups over 3 assessment periods (Schoo, et al., 2005)

2.4.3. Training regimes while using Brochure affects adherence and "correctness" of exercise

In addition to quality control, training regimes also play a major role in determining the effectiveness of brochure as a memory aid. As shown by Morrell, Park and Poon (1990), the lack of verbal explanation even with pictures and text in a brochure, did not help elderly participants comprehend medical information better. Sixty-four subjects participated in this study and were randomized to receive either text or text plus picture instructions from a brochure, for a simulated drug regimen. When asked to recall the drug information, recall was found to be significantly better ($p<0.05$) by providing mixed instructions for adults age 18-22 years. However, this same effect was not seen among participants age 59-85 years. Reo and Mercer (2004) also found that verbal instructions combined with life modeling was as effective as videotaped instructions in aiding accurate performance of exercise. Obtaining instruction from brochure alone without verbal instructions, resulted in significantly ($p<0.05$) lower accuracy in exercise performance (345 errors made in total) compared to live modeling (113 errors made in total) or videotape instructions (150 and 182 errors made in total), as shown in figure 2.11.

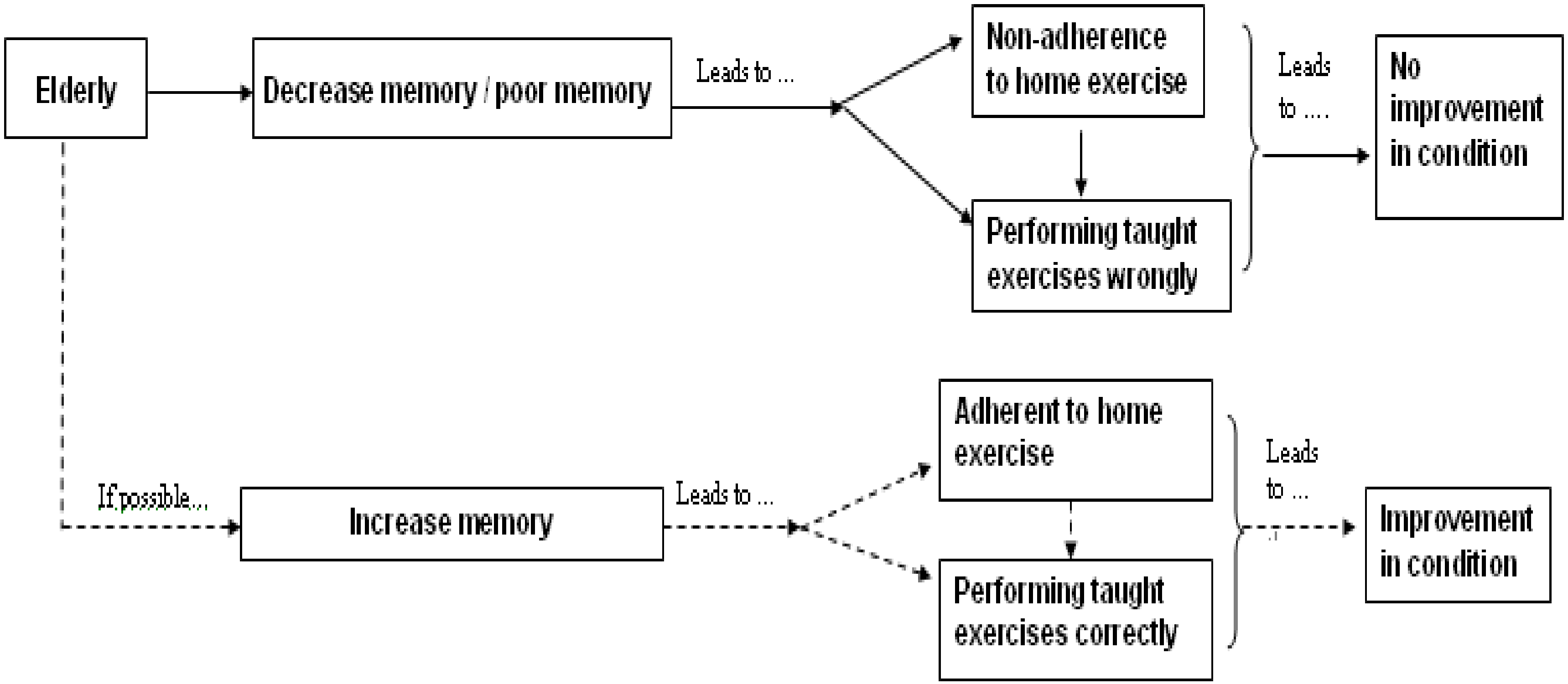
Figure 2.11: Exercise performance accuracy for the four groups (Reo & Mercer, 2004)

In the study done by Schoo et al.(2005), it was found that audiotapes and videotapes do not necessarily improve outcome of home exercise programs in elderly when effective verbal instructions, live modeling and brochures were simultaneously provided (Schoo, et al., 2005). This suggest that the addition of live modeling accompanied with verbal instructions while training with a brochure, may also contribute to the effectiveness of brochure as a memory aid. While audiotapes and videotapes have fixed content, live modeling from a physiotherapist allows delivery of verbal instructions and demonstrations to be individually tailored, to satisfy each patient's particular auditory, visual and cognitive needs, hence improving comprehension and memory of exercises, essential for improving adherence and "correctness" of exercise.

As explained by Houts (1998), pictographs are pictures used to represent ideas and assist in the recall of these ideas. The meaning of these pictographs may not necessarily be obvious to all readers at outset. Hence, referring to the pictures and explaining the meaning of these pictures is essential during verbal instruction sessions. Once these pictographs have been properly explained, it acquire a specific meaning and when reviewed later, remind individuals of what was said and its associated idea. With this explanation placed into practical use, it was found that 85% of medical instructions were accurately recalled, when pictographs were accompanied by verbal explanation of the meaning of each picture compared to only 14% of medical instructions accurately recalled in the verbal instruction group. Similar results were also found in another study with 21 low literacy adults (<fifth grade reading skills) who had to remember 236 medical instruction (Houts, et al., 2001). A mean of 85% of the pictographs meanings were accurately recalled immediately after the training session and 71% accurately recalled 1 month after the training session. Results from these studies, suggest that referencing verbal instructions to pictures in the brochure may also increase the effectiveness of brochure as a memory aid.

Despite reports of low or ineffectiveness of brochure as memory aid for physiotherapy exercises, brochure is still widely used because of its low cost, ease of production and use. The ineffectiveness of brochure may be attributed to the lack of quality control in brochure readability, design and layout as well as training regimes. Although research in this area is limited, controlling these factors seems to yield promising results. Based on the literature reviewed as above, the following aims and hypothesis have been framed and listed in chapter 3. A summary of the rationale of this research is also available at the end of this chapter.

Summary


Elderly
Decrease memory / poor memory
Leads to ...
Non-adherence to home exercise
Performing taught exercises wrongly
Leads to ....
No improvement in condition
If possible...
Increase memory
Leads to ...
Adherent to home exercise
Performing taught exercises correctly
Leads to ...
Improvement in condition

Chapter 3

Aim & Hypotheses

3. Aim and Hypotheses

3.1 Aim of Research

- ***Primary Aim:*** The aim of this research is to investigate the adherence and "correctness" of exercise in elderly through different training regimes over 1 week and 6 weeks
- ***Secondary Aim:*** To investigate if the adherence and "correctness" of exercise scores has an impact on fall risk factors (namely dynamic standing balance, lower limb strength and fear of falling), after 6 weeks of home exercise.

3.2 Hypotheses and Rationale

Rationale 1

With deteriorating memory, memory aids will serve as a reminder for elderly, of the exercises and the need to perform them (Schoo & Morris, 2003). Understanding of information can be improved by refering to the pictures in the brochure during verbal instructions (Houts, et al., 1998) and providing live demostations (Reo & Mercer, 2004). This is known to positively influence adherence rate (Ley, Bradshaw, Eaves, & Walker, 1973).

Hypothesis 1

"The group with verbal instruction, live therapist demosntration, along with reference to the brochure during the training session (Brochure(before)), will adhere better to prescribed exercise regime compared to the group without reference to an exercise

brochure during the training session (Brochure (after)) or to the group with no exercise brochure provided (No Brochure).".

Rationale 2

Exercises can be accurately performed by elderly when verbal instructions, live physiotherapist demonstration and a pictograph brochure is provided during the training session (Schoo, et al., 2005). Referring to and thoroughly explanating the meaning of the pictures in the brochure, is necessary for accurate interpretation, comprehension and recall of its associated meaning (Houts, et al., 1998).

Hypothesis 2

The group with both verbal instruction and live therapist demosntration, with reference to the brochure during the training session (Brochure (after)), will perform better on the exercise assessment scale as compared to the group without reference to an exercise brochure during the training session (Brochure (before)) or to the group with no exercise brochure provided (No Brochure).

Rationale 3

Exercise adherence positively affects "correctness" of exercise and the two factors were found to be moderately correlated (Henry, et al., 1999).

Hypothesis 3

Better adherence on practicing taught exercise according to the perscribed frequency correlates with higher scores on the exercise assessment scale.

Rationale 4

Improved chair stand scores have been attributed to strength gain in lower limbs from regular participation in lower limbs strengthening exercises, performed under physiotherapist supervision (Chandler, et al., 1998). It is assumed that physiotherapist will ensure that the exercises are accurately performed.

Hypothesis 4

Scores on the exercise assessment scale is positively correlated with improvements in 30 seconds chair stand scores after 6 weeks

Rationale 5

Supervised exercises improve functional balance in elderly (Shumway-Cook, et al., 1997). Strengthening and balance supervised exercises were also found to improve stepping reactions which improves dynamic standing balance in the elderly (Maki & McIlroy, 2006). Improvements in dynamic standing balance can be concluded when lesser time is taken to complete the four square step test.

Hypothesis 5

Scores on the exercise assessment scale is negatively correlated with improvements in timing for the four square step test after 6 weeks

Rationale 6

Balance confidence improves with strengthening or agility training under supervision (Liu-Ambrose, et al., 2004).

Hypothesis 6

Scores on the exercise assessment scale is positively correlated with improvements in self perceived Activities-specific Balance Confidence Scale ratings after 6 weeks

3.3 Identification of Key Variables

- **The Independent Variable is:**

  The training regime that the participant will be assigned to, which is either:

1. Without an exercise brochure (no brochure)
2. Exercise brochure given before the training session (brochure (before))
3. Exercise brochure given after the training session (brochure (after))

- **The Primary Dependant Variables are:**

  adherence to taught exercises and "correctness" scores of taught exercises

- **The Secondary Dependant Variables are:**

  Changes in fall outcome measures, namely;

  1. Lower limb strength
  2. Dynamic standing balance
  3. Confidence in performing various activities of daily living.

3.4 Operational Definitions

- **Adherence:** Is performing the exercises in the daily and weekly frequency as instructed by the physiotherapist.
- **“Correctness” of exercise:** Is the accurate performance of the exercise in terms of the right starting position, plane of movement, range of movement, speed of movement, repetitions and frequency per day as taught by the physiotherapist.

Chapter 4

Methods

4. Methods

4.1. Research Participants

Seventeen (n=17) community-dwelling, elderly male and female (mean age 78 ± 6.5 years, ranged from 68-89 years old, height 1.59 ± 0.04 m and body mass 67.6 ± 3.83 kg) gave informed consent to participate in this research. They were participants from three falls prevention classes around Cheshire area, organized and co-ordinated by "Age-Concern, Cheshire". Community dwelling is defined as living independently without extra care, at home rather than residing in a nursing home or hospital (Buchner et al., 1997). Written permission for use of facilities and recruiting of participants in falls prevention classes were given by Age-Concern (appendix 3).

Participants were eligible and included in this research if they fit all of the following **inclusion criteria**:

- elderly (age≥65years),
- male or female volunteers,
- able to understand verbal explanations and written information given in English adequately,
- able to travel to exercise center for initial teaching session, testing session one week and six weeks later.

Participants were **excluded** if:

- they had a score of less than 8 out of 10 on the Abbreviated Mental Test (AMT) (appendix 6), suggesting possible presence of confusion or dementia

(Jitapunkul, Pillay, & Ebrahim, 1991).

- There were no other health related exclusion criteria for this research, as participants had been screened for clearance by their GP, to participate in the falls prevention class.

Eligible participants were given a participant information sheet (appendix 4) to take home, read and consider, before giving written, informed consent (appendix 5) one week later.

No formal sample size calculation was conducted due to the lack of literature providing the necessary data for sample size calculations. This research is hence, considered as exploratory. As such, 12 participants were recruited for each group, which fits with the group size run by “Age Concern, Cheshire”. However, 12 participants did not occur in each group during recruitment. This was due to low attendance rate and hence low recruitment in each exercise class over summer.

All participants in the same falls prevention class were clustered as a group and allocation to each research group was based on randomisation of each falls prevention class via the draw lots method. The nature of each research group can be found in section 4.4.

To maintain participant confidentiality, an identification numbering system was used in this research. Each participant was allocated a number that was used to identify them throughout the research instead of referring to them by names.

Ethical approval for this research was granted by Faculty of Applied and Health Sciences Research Ethics Committee of the University of Chester on 12 May 2010 (appendix 2).

4.2. Research Procedure

This research was designed to investigate the adherence and "correctness" of exercise in elderly through different training regimes over 6 weeks, as well as to see if these compliance and "correctness" of exercise scores had an impact on falls outcomes (namely dynamic standing balance, lower limb strength and fear of falling), after 6 weeks of home exercise.

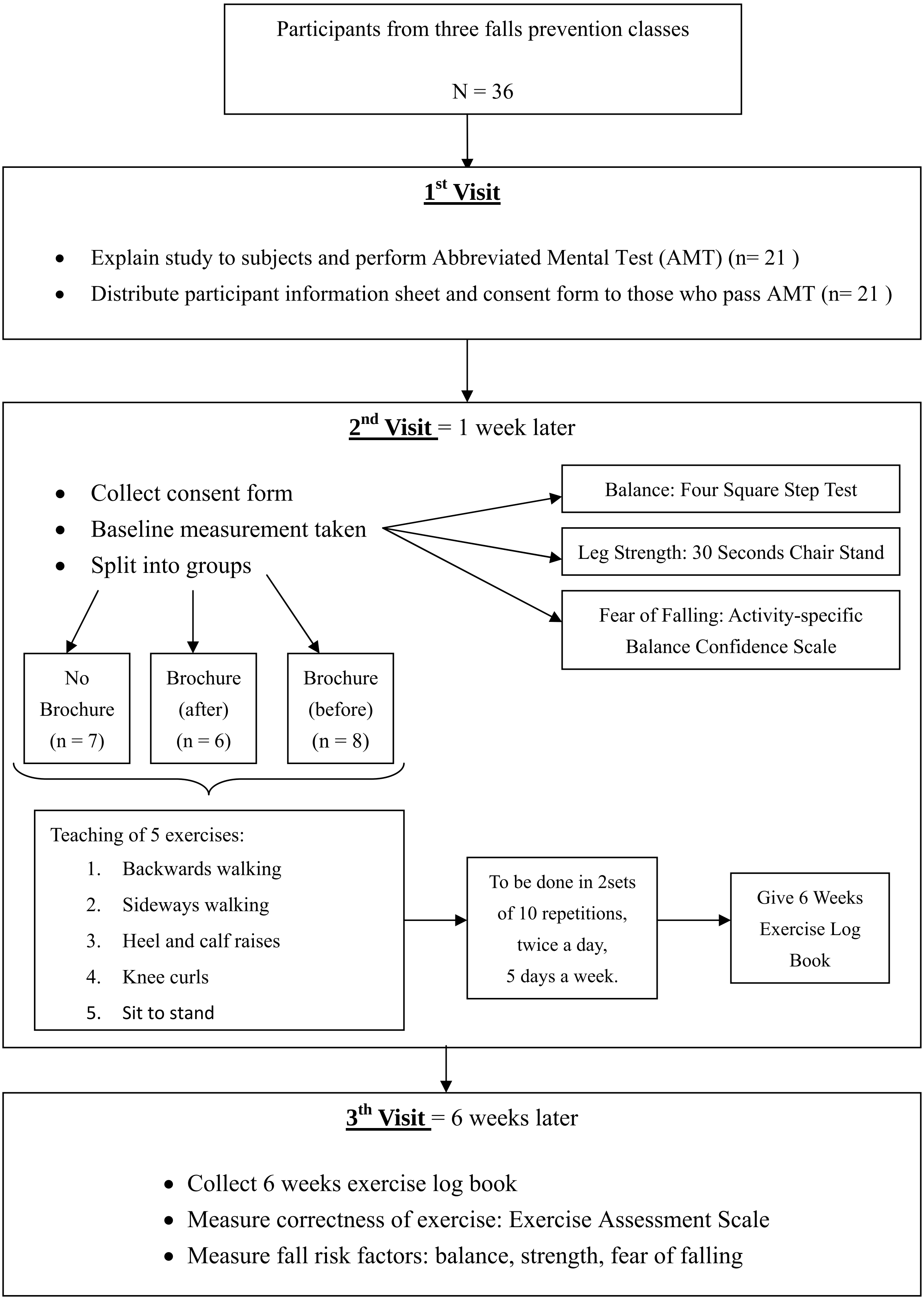
Baseline measurements of the participants were taken on the 2^{nd} visit (1^{st} visit was to introduce research), after consent was obtained. Basic information obtained included age, height, weight and highest education level. Baseline measurements for fall risk factors included firstly, the number of completed chair stands in thirty seconds (30SCS) for assessment of bilateral lower limb strength (Jones & Rikli, 2002). Secondly, the time taken to complete the four step square test (4SST) for assessment of dynamic standing balance (Dite & Temple, 2002). Lastly, ratings from The Activities-Specific Balance Confidence Scale (ABC) for assessment of self-perceived fear of falling (Parry, Steen, Galloway, Kenny, & Bond, 2001). Details of these outcome measures, will be further discussed in section 4.7. These scores were recorded on a score sheet (appendix 13).

On the same day, participants were also taught five simple and safe exercises (5TE), which they had to continue doing at home unsupervised. The 5TE consist of balance and lower limb strengthening exercises as detailed in the exercise brochure (EB) (appendix 10). Further information about the 5TE and EB can be found in section 4.5 and 4.6.1. respectively. Exercise training regimes varies with each research group, which are further elaborated in section 4.4. To ensure consistancy in verbal instructions and modelling of the 5TE across all research groups, the 5TE were taught only by the researcher, who refered to a paper with cues of the critical components when demonstrating each exercise. Participants were also given a six weeks exercise log book (ELB) to record the frequency and repetitions, they have been performing the 5TE over the six week duration (appendix 11). Details of the ELB is further elaborated in section 4.6.2.

On the 3rd visit (6 weeks later), participants were asked to return the ELB and then performed the 5TE, as a way of testing their memory of the exercises. This session was video recorded and the “correctness” of exercises were then graded by the reseacher based on the criteria in the exercise assessment scale (appendix 12) (Smith, et al., 2005). Details of this scale is further discussed in section 4.7.5. Participants were allowed to perform the exercises in any order desired but had to say the name of the exercise prior to performing the exercise. No cue or feedback were provided during the video recording. Pausing for thought was allowed. There was no time limit for the test. The FSST, 30SCS and ABC were also assessed again.

A detailed flow chart of this research procedure is provided in section 4.3.

4.3. Research Procedure Flowchart



4.4. Research Groups

4.4.1. *No Brochure*

The 5TE were taught to the participants with face-to-face verbal instructions and live demonstration from the researcher. The rationale for doing each exercise was explained to the participants, so that they understood how these exercises could help their condition, hence associating the exercise as meaningful and tailored to their situation. Participants were then expected to return demonstration for each of the 5TE. Any wrong movements demonstrated by the participant, were corrected by the researcher, until the participant could reproduce the 5TE correctly, without prompting. This would have equated to obtaining full marks on the exercise assessment scale, should they have been graded on the spot for the return demonstration.

4.4.2. *Brochure (After)*

Participants in this group, were given an EB (appendix 10) to take home, at the end of the training session, in addition to performing the research procedure as detailed in section 4.4.1. Information in the brochure was not discussed between the researcher and participant.

4.4.3. *Brochure (Before)*

In this group, an EB (appendix 10) was given to the participant just prior to the training session. In addition to the research procedure as detailed in section 4.4.1, the researcher would make reference to each of the exercises taught by pointing to the exercise in the EB prior to demonstrating the exercise. Participants were encouraged to refer to EB when performing the return demonstration and to ask the researcher about any doubts they had regarding the information in EB. They were also told to continue to refer to the brochure when performing the exercises at home, to ensure exercises were correctly performed.

4.5. The Five Taught Exercises

To ensure that exercise prescribed tailored to the falls prevention elderly recruited for this study, the 5TE were exercises selected from the Otago exercise programme (Campbell & Robertson, 2003). The Otago Programme is, a set of lower limb strengthening and balance retraining home exercises, specifically designed to prevent falls in elderly (Campbell & Robertson, 2003). It has been shown in four separate randomized controlled trails as a safe and feasible programme for elderly to perform unsupervised at home (Campbell et al., 1999; Campbell, Robertson, Ganlner, Norton, Buchner, 1999; Robertson, Devlin, Gardner, & Campbell, 2001; Robertson, Gardner, Devlin, McGee, & Campbell, 2001). In addition, a total of 35% reduction in falls and falls-related injury was reported in a total of 1016 participants from the four trials (Sherrington, et al., 2008). These results suggest that, if prescribed exercises in this research were closely adhered to, it can potentially help reduce falls in elderly, through improvement in lower limb strength, dynamic standing balance and decrease fear of falling with ADLs (Campbell et al., 1999).

However, only five exercises were chosen, as research has shown that adding more exercises beyond this, decreases memory of exercise significantly (Henry, et al., 1999; Rastall, et al., 1999). Compliance with exercises were not affected with the number of exercises prescribed (Henry, et al., 1999).

4.6. Research Handouts

4.6.1. Exercise Brochure (EB)

The illustrated EB was specially designed by the researcher, with words in the brochure set at font size 14, Ariel font and was checked to have a Flesch Reading Ease of 91.3 as well as a Flesch-Kincaid Grade Level of 3.1. This exercise brochure is hence, classified as easy to read and understand. The Flesch Reading Ease Score and the Flesch-Kincaid Grade Level Score were generated using Microsoft Office Word 2003. Each readability score bases its rating on the average number of syllables per word and words per sentence (Wikipedia, 2010). The Flesch Reading Ease Score rates text on a 100-point scale; the higher the score, the easier it is to understand the documents (DuBay, 2004, p. 21). Flesch Reading Ease Score then simplified over the years and was converted to grade level, now known as the Flesch-Kincaid Grade Level Score, which rates documents on a U.S. school grade level (DuBay, 2004, p. 50). In this case, a score of 3.1 will mean that a third grader can understand this brochure. This will ensure that all the participants, regardless of their highest level of education, would have no issues in understanding the brochure.

4.6.2. Exercise Log Books (ELB)

To knowledge, there is still no measurement tool to reliably assess participants' adherence with prescribed exercise outside therapy sessions (Sluijs, et al., 1993). Assessment of exercise adherence in most exercise studies, relies heavily on participant self-reporting through the use of questionnaire, an ELB or an interview, due to convenience and feasibility of the experiments, even though such methods have been shown to overestimate exercise adherence compared to other methods such as learning contracts and checklists (Henry, et al., 1999). An ELB was used in this research as it was the most cost-effective, feasible and commonly used prospective device to assess participants' exercise adherence in an exercise regime, on a daily basis, without having them to recall these information only towards the end of the research, which may introduce recall bias

The ELB was designed such that participants had to record the number of repetitions they had done for each of the 5TE, each exercise session. They were told to record their reasons on the previous page should they not complete the number of frequency and/or repetition as instructed. A list of reasons for not completing all of the 5TE, were provided as well as a 'other' option box present for free-form response. Possible reasons cited in this ELB, were the top reasons listed by a study done by Sluijs et.al.(1993), as detailed in section 2.2.1. In addition, an instruction sheet and an example page of how to fill in the ELB was provided at the front of the log book (appendix 11).

4.7. Measurement Procedure

4.7.1. Height and Weight

All participants had their height and weight measured prior to performing baseline measurements and learning of the 5TE. These measurements were taken with participants wearing light clothing and no shoes.

Each participant's weight was measured using a set of standard weighing scales (Seca 761R, SECA, Hamburg, Germany), in kilograms (kg). The weighing scales was placed on a flat floor, where participant stood straight on the scales and looked ahead. Weight was recorded to the nearest 0.1 kg, once the indicator stopped moving on the scales.

Each participant's height was measured using a portable stadiometer (Leicester Height Measurer, SECA, Hamburg, Germany), in metres (m). Participants were instructed to stand with their heels, scapulae and buttocks pressed against the stadiometer and look straight ahead, such that the lower edge of the eye socket is inline with the centre of the ear (American College of Sports Medicine, 2006, p. 197). Participants then take and hold a deep inhalation while standing straight, and the moveable headboard will show the maximum height. This reading was recorded to the nearest 0.01m.

4.7.2. Dynamic Standing Balance

The FSST was used to assess participants' dynamic standing balance. This test is designed to test the ability of elderly, in maintaining their balance while stepping over small objects rapidly in different directions within a small area (Dite & Temple, 2002). The reliability of this test was reported to have excellent inter- (ICC=0.99) and intra-(ICC=0.98) rater reliability as established in 20 community dwelling elderly (Dite & Temple, 2002). The FSST has been shown to be a valid tool for testing dynamic balance in community dwelling elderly (Dite & Temple, 2002) with a good correlation with Time Up and Go test (r=0.88), designed to assess dynamic standing balance while walking and turning (Podsiadlo & Richardson, 1991); and step test (r=-0.83), used to assess single limb dynamic standing balance while taking rapid steps (Medell & Alexander, 2000); and fair correlation with Functional Reach Test (r=-0.47), developed to assess dynamic standing balance when participants are taxed out of their centre of balance (Duncan, Studenski, Chandler, & Prescott, 1992). It was also 89% sensitive in identifying fallers and 85% specific in discriminating non-fallers from fallers, with a positive predictive value of 86% for detecting a history of falls among community-living adults.

The test area was set up as described by Dite and Temple (2002) with detailed instructions available in appendix 8. In brief, four canes, each 90cm in length, were laid on the ground at 90^{o} angles to each other (like a "plus" sign). Participants were asked to stand in square 1, facing towards square 2, with their shoes on. They then had to move in a clockwise direction and reversed their path in a counterclockwise direction, back to square 1, completing a trail sequence. Both feet must be placed within each square. Participants were allowed to complete the test using their walking aids if they require. Participants were encouraged to face forwards during the entire stepping sequence, however, turning to face each cane before stepping over them was permitted. The time taken to complete the sequence was timed, using a digital stopwatch (Fastime 4R, AST, Ashby-de-la-Zouch, UK). Dite & Temple (2002) suggested that each participant had three attempts at the test. The first attempt was a practice trial, to ensure participants were familiar with the FSST sequence, followed by two test trials were carried out. The better of the two trial scores, was taken for analysis (Dite & Temple, 2002). If the participant touched the cane, lost his/her balance, or did not place both feet in the square, he/she was asked to repeat the trial. Safety precaution was taken by having an assistant researcher and the researcher, giving the participant close supervision as he/she performed the test (Dite & Temple, 2002). The shorter the time taken to complete the a test sequence without losing balance, the better the dynamic standing balance (Dite & Temple, 2002).

4.7.3. Lower Limb Strength

Changes in lower limb strength over time, were monitored using the 30SCS in this research. The 30SCS is a chair stand test modified from the repeated five chair stand test (Jones, et al., 1999). In the 30SCS trial, number of proper stands completed in 30s are recorded instead of recording the time taken to complete 5 stands (Jones, et al., 1999). Floor effects have however been found in a study, where 22% of the 5,000 community residents were not able to complete the required five chair stands, hence, resulting in inability to analyze 22% of the data (Guralnik et al., 1994). Floor effects can affect results, thus should be avoided. Employing the 30SCS test in this research, ensures no floor effects, as scores can go as low as zero (for those who cannot perform even one proper sit to stand), and also caters to a wider population where morbidities may coexist in elderly, such as osteoarthritis (McCarthy, Horvat, Holtsberg, & Wisenbaker, 2008) and stroke (Yukiyasu, Yusuke, & Kazuo, 2004), resulting in varying ability levels, similar to the participants in this research.

A field test was chosen over a standard laboratory leg press for measuring strength, because of its ease of use, low cost and does not require participants to travel down to the laboratory. Leg press has been considered a very accurate measure of lower limb strength in elderly as it involves multiple-joint movement which mimics movement of a number of ADLs such as rising form a chair, getting out of a tub and picking up an object from the floor (Judge, 1993).

Nevertheless, the 30SCS is highly correlated with maximum weight-adjusted leg press performance for both men(r= 0.78, 95% CI, 0.63-0.88) and women (r=0.71, 95%CI, 0.53-0.84) (Jones, et al., 1999). Test-retest reliability of the 30SCS was also found to be good for both men (ICC=0.84, 95% CI, 0.77-0.90) and women (ICC= 0.92, 95% CI, 0.87-0.95) community-dwelling elderly. In addition, it is also able to discriminate lower limb strength significantly ($p<0.01$) across age groups in decades-from the 60s (14.0 $\pm$ 2.4), 70s (12.9 $\pm$ 3.0), 80s (11.9 $\pm$ 3.6) as well as for low-active (10.8 $\pm$ 3.6) participants compared to high-active (13.3 $\pm$ 2.8) participants

($p<0.0001$) (Jones, et al., 1999). Over the years, the 30SCS has also been widely used as part of a battery of physical functioning test in assessing and identifying elderly at high risk of falls (Jones & Rikli, 2002). These results, hence, suggest that the 30SCS is a valid tool for measurement of lower limb strength.

The only tools required for the test were, a 17 inch standard straight –back chair and a stopwatch (Jones, et al., 1999). The chair used for the test was placed against the wall so that it does not move during the test, thus, becoming a hazard for falls (Jones & Rikli, 2002; Jones, et al., 1999). This same chair was used to test all participants in the same research group and used again six weeks later. The test was carried out based on that described by Jones et al.(1999) and is detailed in appendix 7. In brief, the researcher explains the test and demonstrates it once. The participant then cross their arms across their chest and after hearing the word "go", will stand up and sit down as many times as possible in 30 seconds. The participant was instructed to be fully seated between each stand. The number of rising to a full stand from a fully seated position done by the participant was counted and recorded. Incorrect stands were not counted. If the participant was more than half way up at the end of 30 seconds, it was counted as a full stand. Rest during the test was also possible, though the time will continue to run (Jones, et al., 1999).30 seconds was timed using a digital stopwatch (Fastime 4R, AST, Ashby-de-la-Zouch, UK). Participants were allowed a practice trial of one repetition to ensure they were doing the sit to stand properly before commencing with the actual 30 seconds test trial (Powell & Myers, 1995).

Higher number of completed sit to stand, indicated better lower limb strength (Jones, et al., 2002).

4.7.4. Fear of Falling

FOF was measured using a self-efficacy scale known as activities-specific balance confidence scale (ABC). The ABC is a questionnaire that assesses perceived balance confidence in higher functioning elderly when performing balanced challenging ADLs, both indoor and outdoor (Powell & Myers, 1995). This questionnaire is a modification of the falls-efficacy scale (FES), developed by Tinetti, Richman & Powell (1990), to access the FOF in elderly. ABC was chosen over the FES in this research, ABC will provide a more valid result with higher functioning participants like those recruited in this research. The ABC was found to be more sensitive and specific, compared to FES, in discriminating low mobility from high mobility participants ($|t_{ABC}| = 9.34$; $|t_{FES}| = 5.7$) (Powell & Myers, 1995) and from participants who had more FOF compared to those with less FOF ($t_{ABC}| = 3.91$; $|t_{FES}| = 2.88$) (Myers, et al., 1996) in community dwelling elderly. Participants classified in the low mobility group, were older (mean age = 77.7 vs 71.4, $p<0.001$), had more health problems (mean = 4.4 vs 3.0, $p<0.01$), were more likely ($p<0.06$) to have fallen in the past year with significant ($p<0.001$) increase in avoidance of activities (Powell & Myers, 1995). In addition, FES assesses FOF only for performing simple indoor ADLs, which tends to be over rated by both high ($mean_{FES} = 93.4$ vs $mean_{ABC} = 80.9$) and low mobility ($mean_{FES} = 68.4$ vs $mean_{ABC} = 38.3$) participants (Powell & Myers,

1995) and does not give any information about participants perceived balance confidence outdoors. Perceived balance confidence outdoors is an essential component for testing since the participants in this research are community dwelling. Moderate convergent validity was found between ABC and Physical Self-Efficacy Scale ($r = 0.49$, $p<0.001$) especially between the physical abilities subscale score and ABC ($r = 0.63$, $p<0.001$), as well as a high correlation ($r = 0.84$, $p = 0.001$)) found between total ABC and falls efficacy scale scores (Powell & Myers, 1995), all suggesting that ABC is a valid tool for perceived self-efficacy measurement..

To ensure that the questions asked fitted into the British context, the ABC-UK was used in this research. ABC-UK has been modified from the original ABC and validated for use in the UK (Parry, et al., 2001). An example of ABC-UK and its instruction sheet can be found in appendix 9. ABC-UK was found to have an excellent internal reliability (ICC = 0.98) and test-retest reliability (ICC=0.89) (Parry, et al., 2001). It was also found to be more sensitive than falls efficacy scale (FES)-UK, at distinguishing between older and younger participants ($|t_{ABC}| = 4.4$; $|t_{FES}| = 2.3$) and fallers and non-fallers ($|t_{ABC}| = 8.7$; $|t_{FES}| = 5.0$), among 193 British ambulant elderly participants.

ABC-UK was administered as described by Powell and Myers (1995). Participants were instructed to rate their perceived confidence in balancing when performing each of these sixteen activities, on an eleven point visual analog scale

(0%-100%). 0% indicates no confidence and 100% indicates being completely confident in performing task without losing balance or becoming unsteady. A 100% score for each task was possible. The confidence rating for these sixteen items were then added up and divided by sixteen, to get an average percentage of participants perceived balance confidence while performing ADL. The higher the average percentage, the more confident the participant in keeping balance when performing balanced challenged ADLs, hence possesses lesser FOF (Myers, et al., 1996).

4.7.5. Exercise Assessment Scale

The correctness of exercise was determined by performing the exercise in both correct quantity and quality. Correct quantity was defined as performing the 5TE with the correct number of repetitions, sets and frequency as prescribed (Smith, et al., 2005). Correct quality was defined as performing the exercise with the correct techniquee as taught. Correct technique takes into account the starting position, the plane of movement, the range of movement (ROM, any compensatory movements and the speed of movement, as listed in exercise assessment scale (see appendix 12). A perfect score of 8 was possible for each exercise. The inter-rater reliability was excellent (ICC = 0.99, 95% CI, 0.98-0.99), where all five assessors were blinded to the results of other assessors (Smith, et al., 2005). Validity of this scale was however not mentioned.

On the 3rd visit, participants were asked to demonstrate the 5TE (procedural memory recall) and to verbally inform the researcher how frequently they were supposed to be doing the prescribed exercises (declarative memory recall). The assessor did not provide any verbal prompting to assist the participants. This process will be video recorded. Participants were be given a score for each exercise based on the exercise assessment scale (see appendix 12) either through reviewing of the video recordings or on the spot (for participants who did not consent to video recording). Scores of the 5TE were added up. The higher the total score, the better the "correctness" of exercise performed.

4.8. Statistical Analysis

All data collected were explored initially using descriptive statistics, to identify any trends in the data. These trends were then shown with the use of appropriate graphs or tables (in chapter 5).

Inferential statistics were conducted next, to investigate if the different training regimes affected adherence and "correctness" of exercise in elderly. All sets of data involved, were first checked if they met two statistical assumptions, namely normal distribution and homogeneity of variance. Shapiro-Wilk statistic was consulted, for analysis of normal distribution of data, as the research sample size was less than 100 (Coakes & Steed, 2007). Normality and homogeneity of variance of data was assumed if $p>0.05$ (Coakes & Steed, 2007).

Parametric (simple) one-way independent groups ANOVA test was conducted if the data from all three groups met both assumptions. This was presented using the letter 'F'. Should any set of data fail any of the above assumptions, the non-parametric Kruskal-Wallis test was conducted instead. This was then presented using 'Chi^2'. Any significant difference found between groups in the above test, were further analysed with either a post hoc multiple comparisons using tukey if a parametric ANOVA test was conducted or multiple Mann Whitney U tests if a non-parametric Kruskal-Wallis test was conducted, to determine where the significant difference lies within the groups.

All of the above results were reported with mean $\pm$ standard deviation.

All other correlations in this research, were conducted with the parametric pearsons product moment correlation coefficient if the statistical assumption of normal distribution was met and Spearman's rank correlation coefficient if statistical assumption was not met. All correlations were presented with the letter 'r', with '+'indicating a direct relationship between two variables and '-'indicating an inverse relationship between two variables. Interpretation of coefficients were done based on the guidelines offered by Cohen & Holliday (1996), as seen in table 4.1.

Table 4.1: Guidelines to determine the strength of correlation based on the rho value (Cohen & Holliday, 1996)

'rho (r)' value	Meaning
0.00 to 0.19	A very low correlation
0.20 to 0.39	A low correlation
0.40 to 0.69	A modest correlation
0.70 to 0.89	A high correlation
0.90 to 1.00	A very high correlation

These interpretation guidelines applies to all correlations regardless of positive or negative correlation values (Pallant, 2007). Coefficient of determination (r^2 x 100%) was also used to determine what percentage of the total variance of one variable was attributed to another variable (Pallant, 2007).

SPSS statistical package, version 17.0 for Windows, was used to analyse all statistical data in this research, where alpha values were set at 0.05 level. All results were considered statistically significant only if $p<0.05$ (Thomas & Nelson, 2001).

Chapter 5

Results

5. Results

21 participants were recruited for this research. One participant from the No Brochure group and three participants from the Brochure (before) group were not available for re-testing at the end of six weeks either due to illness (n=2) or travelling (n=2) and were hence, excluded from the final analysis. Therefore, a total of 17 elderly participants, six participants each from the No Brochure and Brochure (after) group and five participants from the Brochure (before) group, completed this six weeks research. Participant flow has been illustrated in figure 5.1.

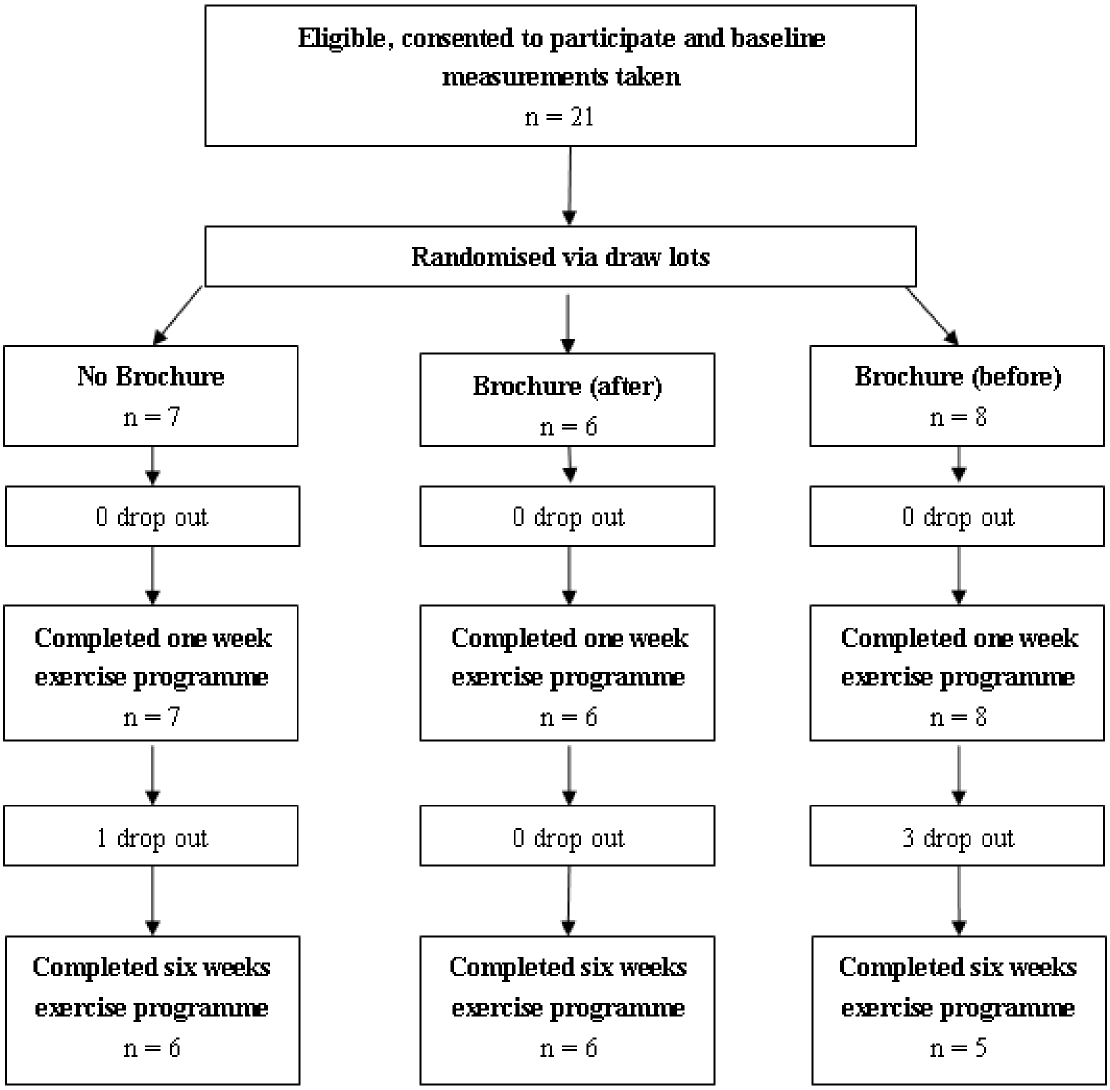


Figure 5.1: Participant Flow Chart

5.1. Demographic Data

Demographic data of participants from all three groups were analyzed to check for homogeneity between groups. No significant difference (p>0.05) was found for age, height, weight, cognitive score (AMT) and highest education level between groups. These demographic data are summarized in table 5.1.

Table 5.1: Demographic data of participants from each of the three groups

Group	No Brochure	Brochure (after)	Brochure (before)	'p' value
Age (years)	80 $\pm$ 5.8	79 $\pm$ 7.3	73 $\pm$ 3.8	0.112
Height (meters)	1.61 $\pm$ 0.06	1.58 $\pm$ 0.03	1.59 $\pm$ 0.03	0.593
Weight (kilograms)	67.2 $\pm$ 4.5	69.7 $\pm$ 1.6	65.4 $\pm$ 4.1	0.166
Cognitive Score (out of possible 10 marks)	9.3 $\pm$ 1.21	8.8 $\pm$ 1.16	9.8 $\pm$ 0.44	0.260
Highest Education	Primary: 0 Secondary: 1 College: 3 University: 2	Primary: 1 Secondary: 1 College: 3 University: 1	Primary: 0 Secondary: 2 College: 2 University: 1	0.794

5.2. Summary of results

Displayed in table 5.2 - 5.3 are summarized results of all five measured variables from the three groups. Comparison of the adherence to prescribed exercise regime and the "correctness" of exercise performance after six weeks between groups along with its resultant alpha value (p value) are summarized in table 5.2. The rho value (r value) for the relationships between the variables and the resultant p value are summarized in table 5.3. Statistically significant results ($p<0.05$) are highlighted. Raw data of the five measured variables from the three groups can be found in appendix 14.

Table 5.2: Summary data for adherence and "correctness" of exercise

	No Brochure	**Brochure (after)**	**Brochure (before)**	**p value**
Adherence (%)	62 ± 26.6	70 ± 15.1	77 ± 13.7	0.448
"Correctness" after 6 weeks (out of possible 40 marks)	33 ± 8.7	34 ± 4.6	38 ± 1.3	0.175

Table 5.3: Summary of correlation between dependent variables

Variables	**r value**	**p value**
"Correctness" and Adherence	+ 0.506	0.038
"Correctness" and Lower Limb Strength	+ 0.205	0.429
"Correctness" and Dynamic Standing Balance	- 0.253	0.327
"Correctness" and FOF	+ 0.255	0.322

5.3. Individual Measured Variables

5.3.1. Exercise adherence

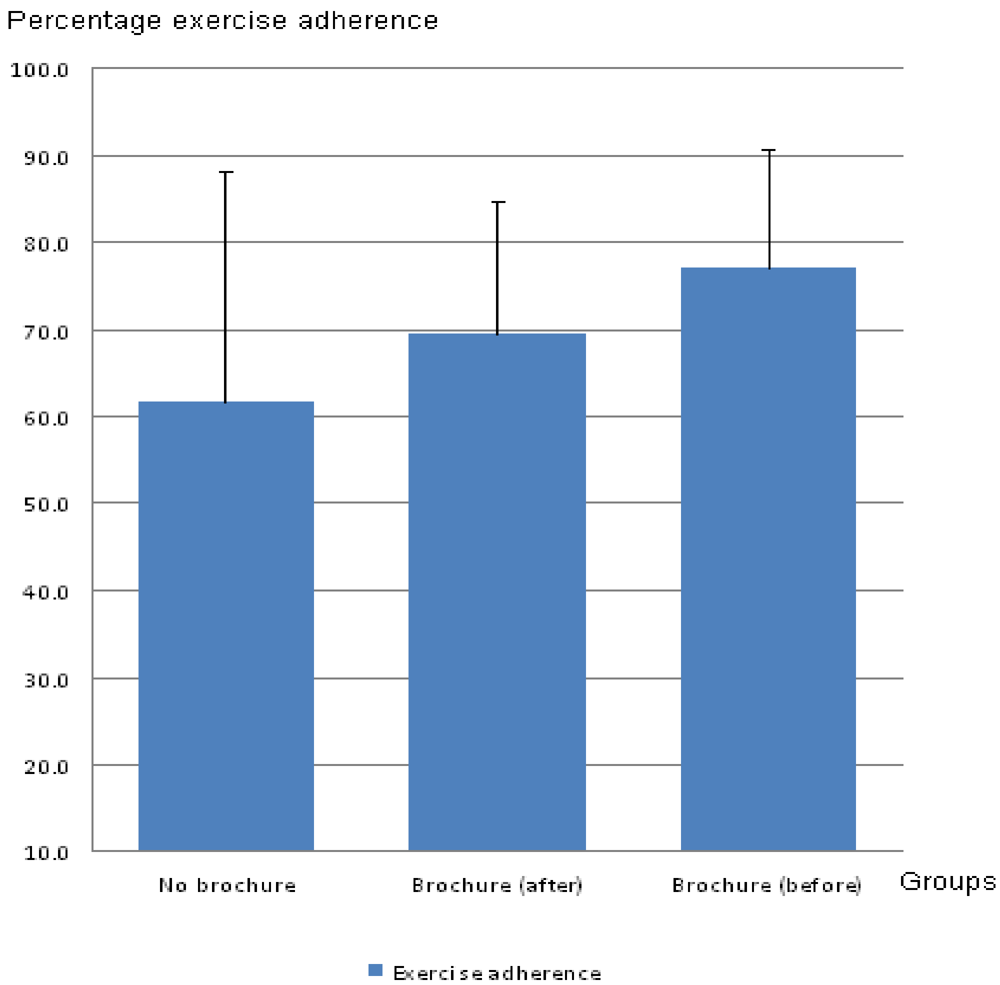


Figure 5.2.: Percentage exercise adherence in all three groups after six weeks

As seen in figure 5.2, adherence to the six weeks exercise regime, which was assessed using an exercise log book, was greatest in the Brochure (before) group (77 $\pm$ 13.7 %), followed by the Brochure (after) group (70 $\pm$ 15.1 %). The no brochure group showed least adherence (62 $\pm$ 26.6 %) compared to the other two groups. The difference in exercise adherence between the three groups was however, not statistically significant (F = 0.85, p = 0.448) as investigated using the one-way ANOVA test.

5.3.2. "Correctness" of exercise

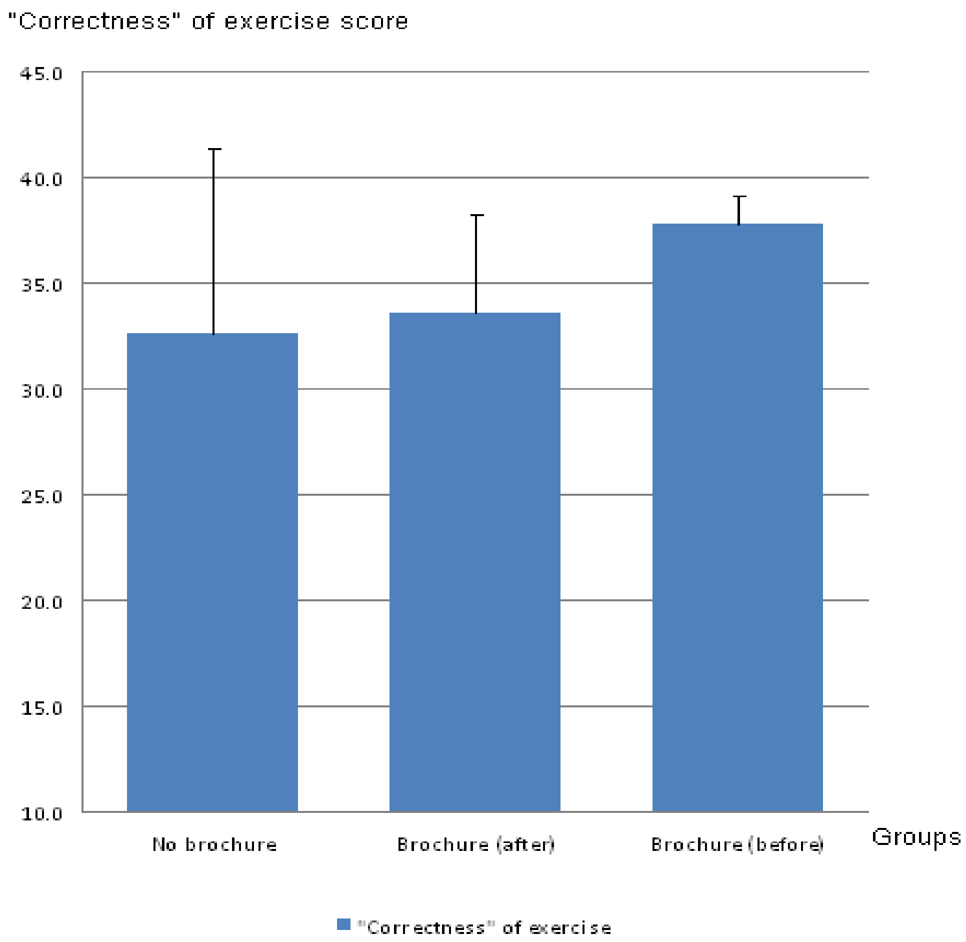


Figure 5.3.: "Correctness" of exercise scores for all three groups after six weeks

As seen in figure 5.3, "correctness" of exercise performance after six weeks, which was determined by the scores on the exercise assessment scale, was highest in the Brochure (before) group (38 $\pm$ 1.3 marks), followed by the Brochure (after) group (34 $\pm$ 4.6 marks). The no brochure group scored the least (33 $\pm$ 8.7 marks) compared to the other two groups. However, the difference in "correctness" of exercise scores between the three groups were not found to be statistically significant (Chi-Square = 3.48, p = 0.175), as investigated with the Kruskal-Wallis test.

5.3.3. Correlation between exercise adherence and "correctness" of exercise

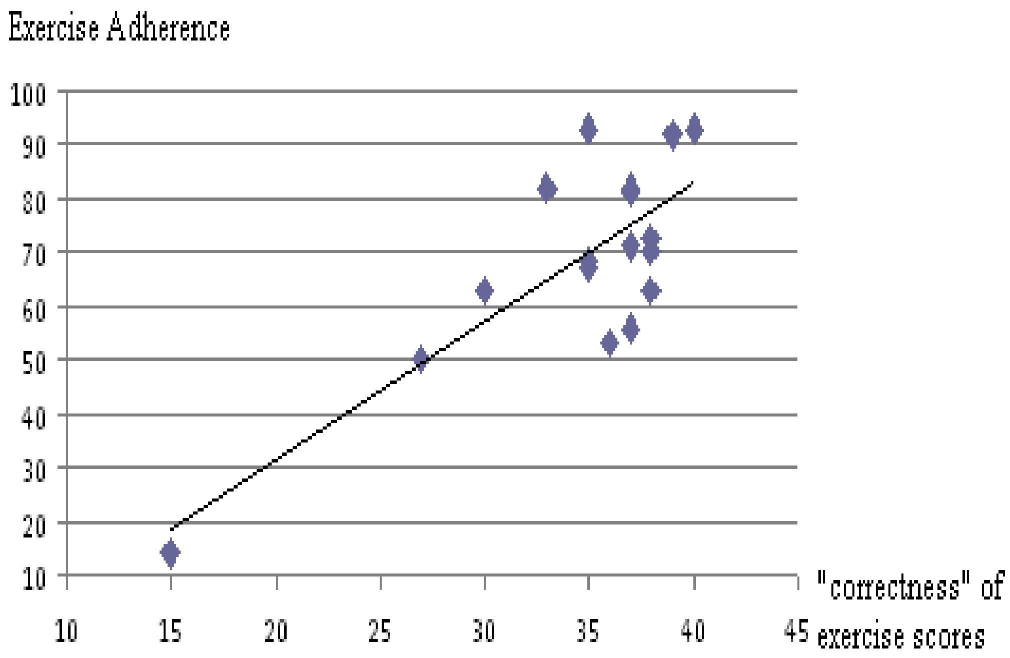


Figure 5.4.: Scatter plot for the correlation between exercise adherence and "correctness" of exercise

The bi-variate relationship between exercise adherence and "correctness" of exercise after six weeks, was investigated using spearman's rank correlation coefficient. A significantly (p = 0.038) modest, positive correlation (r = +0.506) as shown in figure 5.4., was noted between exercise adherence and "correctness" of exercise. In addition, coefficient of determination also indicated that 25.6% of the total variance of "correctness" of exercise was attributed to exercise adherence.

5.3.4. Correlation between "correctness" of exercise and lower limb strength

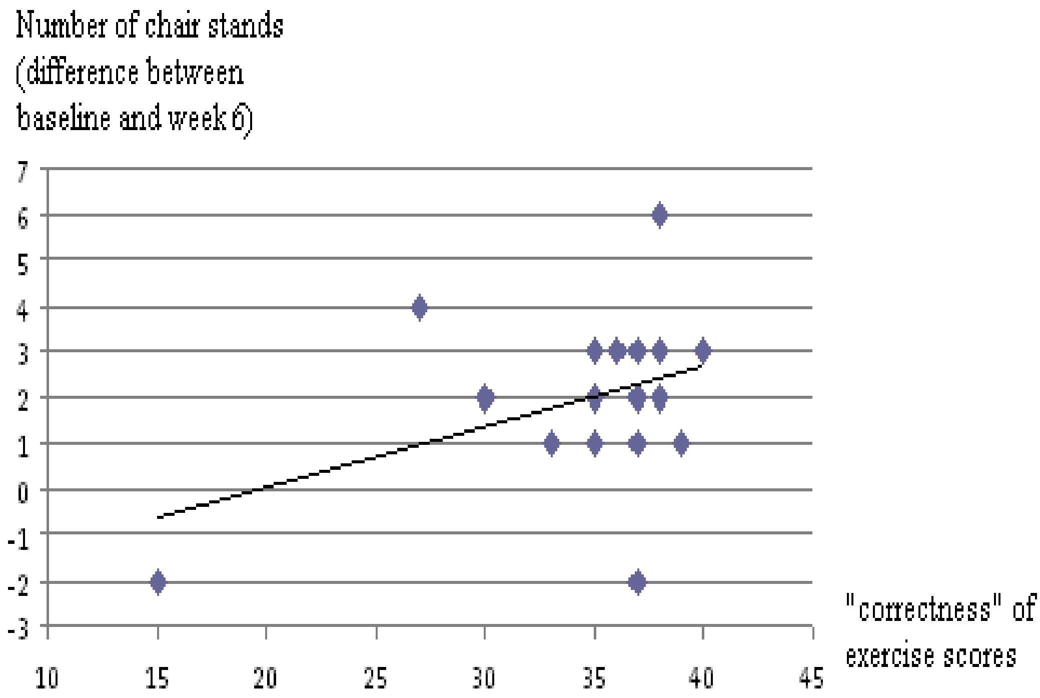


Figure 5.5.: Scatter plot for the correlation between "correctness" of exercise scores and the difference in number of chair stands performed by participants at baseline and 6 weeks later.

As shown in figure 5.5., 15 of the 17 participants showed improvements in lower limb strength after six weeks as measured with the 30 SCS test. This improvement was found to be positively correlated with "correctness" of exercise scores, as investigated using spearman's rank correlation coefficient. However, this relationship was weak ($r = +0.205$) and not found to be statistically significant ($p = 0.429$).

5.3.5. Correlation between "correctness" of exercise and dynamic standing balance

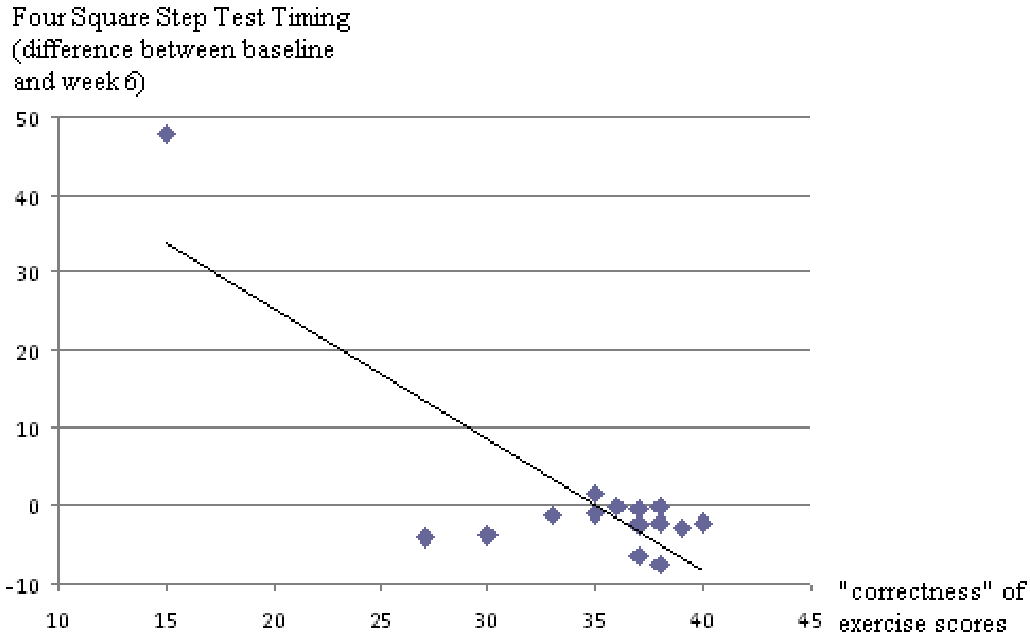


Figure 5.6.: Scatter plot for the correlation between "correctness" of exercise scores and difference in timing for completing the FSST at baseline and six weeks later

As shown in figure 5.6., 15 of the 17 participants also showed improvements in dynamic standing balance after six weeks as measured with the FSST. A negative relationship was found between the FSST timings and "correctness" of exercise scores, indicating that high scores in "correctness" of exercise was associated with lesser time required to complete the FSST. Decrease in FSST timing is indicative of improvement in dynamic standing balance (Dite & Temple, 2002). This relationship was, however, weak (r = - 0.253) and not found to be statistically significant (p = 0.327), as investigated using spearman's rank correlation coefficient.

5.3.6. Correlation between "correctness" of exercise and fear of falling (FOF)

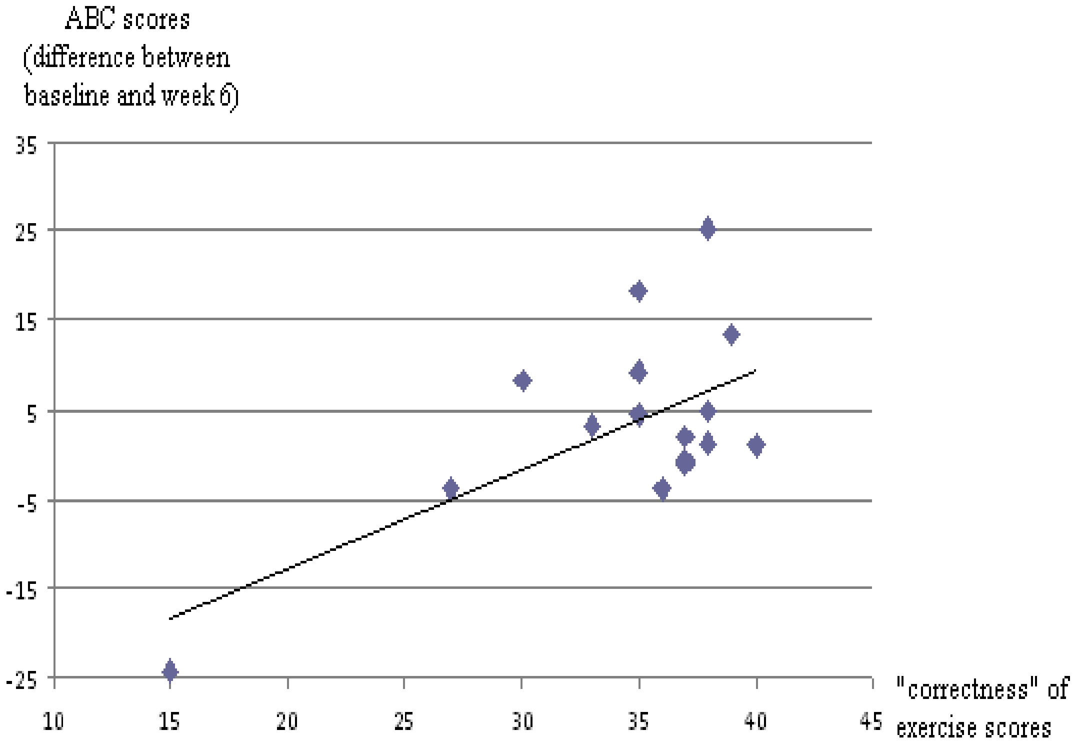


Figure 5.7.: Scatter plot for the correlation between "correctness" of exercise scores and ABC score difference between baseline and six weeks later

As shown in figure 5.7., 11 of the 17 participants showed improvement in FOF as measured with the ABC scale. Improvement in ABC scores was found to be weak but positively correlated with "correctness" of exercise (r = +0.255), as investigated using spearman's rank correlation coefficient. However, this relationship was also not found to be statistically significant (p = 0.322).

Chapter 6

Discussion

6. Discussion

6.1. Overview of the study

17 community dwelling elderly, from three different falls prevention exercise classes around Cheshire, were recruited to investigate the impact different training regimes would have on adherence and “correctness” of home exercise over six weeks. Risk factors for experiencing a fall such as lower limb muscle strength, dynamic standing balance and FOF were also assessed. Participants learnt five home-based exercise through either one of the three following randomly assigned mode of training:

1. verbal instruction and live demonstration, without an exercise brochure (no brochure)
2. verbal instruction and live demonstration with an exercise brochure to take home, given only at the end of the training session (brochure (after)).
3. verbal instruction and live demonstration with reference to the pictures in the take home exercise brochure and a clear explaination of the meaning of each picture in the brochure during the training session (brochure (before))

Each participant was asked to perform these exercises at home as instructed and to record the frequency of performing each exercise, in the ELB provided. There were no significant difference in age, height, weight, cognitive score and highest education level between groups prior to the research.

Exercise adherence throughout six weeks was assessed using a six weeks ELB. "Correctness" of exercise was assessed six weeks after the training session, by grading each exercise performance against the exercise assessment scale. Fall risk factors were assessed prior to the research (baseline) and at the end of six weeks (post). Lower limb strength was assessed using the 30SCS test. Dynamic standing balance was assessed using the FSST. FOF was assessed using the ABC scale.

6.2. Exercise Adherence

No statistically significant difference in exercise adherence ($p = 0.448$) was found between the no brochure group (62 $\pm$ 26.6 %), the brochure (after) group (70 $\pm$ 15.1 %) and the brochure (before) before group (77 $\pm$ 13.2 %). Hence, hypothesis 1 cannot be accepted, which states that:

"The group with verbal instruction, live therapist demosntration, along with reference to the brochure during the training session (Brochure(before)), will adhere better to prescribed exercise regime compared to the group without reference to an exercise brochure during the training session (Brochure (after)) or to the group with no exercise brochure provided (No Brochure)."

Although no similar previous study is available for comparision of this finding, it is perhaps slightly surprising to find no statistically significant difference in compliance between groups despite varing the training regime. One possible reason for the insignificant result may have been that the no brochure group have participated in research studies before and therefore understood the importance of adhering to the exercise regime as instructed. Participants 11, 12, 13,14, continued to perform these exercises even while they were on holiday trips. None of the participants in the other two groups have ever participated in such reseach. Though not significant, participants in the Brochure (before) group were also slightly younger compared to participants in the other two groups, and appeared to have more high pirority personal commitments to attend to, therefore less time to perform these at home. It is also possible that this result may have been affected by the small sample size in this research, which will be futher discussed in section 6.9.1.

6.3. "Correctness" of exercise

No statistically significant difference ($p = 0.175$) in "correctness" of exercise was found between the no brochure group (33 $\pm$ 8.7 marks), the brochure (after) group (34 $\pm$ 4.6 marks) and the brochure (before) group (38 $\pm$ 1.3 marks) after six weeks. Hence, hypothesis 2 cannot be accepted, which states that:

"*The group with both verbal instruction and live therapist demosntration, with reference to the brochure during the training session (Brochure (before)), will perform better on the exercise assessment scale as compared to the group without reference to an exercise brochure during the training session (Brochure (after)) or to the group with no exercise brochure provided (No Brochure)."*

It is slightly surprising that despite controlling for the readability, layout and design of the exercise brochure where pictures and written instructions were clearly explained only to the brochure (before) group, no significant difference in “correctness” of exercise was found between the three groups. This is in contrast to previous medical research (Houts et al., 1998; Houts et al., 2001), where easily readable brochures with clearly explained pictures and written instructions were found to significantly ($p<0.05$) improve memory (from 14% to 85%) of 50 medical information. This significance ($p<0.05$) was still well retained even after four weeks (71%) .

Nevertheless, the findings in this research is consistant with Smith et al. (2005), where no mention of controlling readability, layout, design or explaination of the exercise brochure was done. Although no significant difference ($p>0.05$) was found between the brochure group and the no brochure group, “correctness” of exercise was observed to be slightly better in the brochure group (17.19 $\pm$ 5.91 marks) compared to the no brochure group (16.24 $\pm$ 6.01 marks). It could have been that in both the current study and the study done by Smith et al. (2005), participants were only required to remember a small number of exercise (five and three, respectively). Perhaps greater significance may have been seen if participants had to remember more exercises. “Correctness” of exercise was found to be significantly ($p<0.05$) affected when subjects were made to remember eight exercises exercises (10.25 out of 12 marks) compared to only two (11.5 out of 12 marks). It is also probable that a statistically significant difference may have been observed, had the sample size been larger, which will be further discussed in section 6.9.1.

6.4. Relationship of "correctness" of exercise with exercise adherence

"Correctness" of exercise and exercise adherence were found to be positively and moderately correlated ($r = 0.506$, $p = 0.038$). Hence, hypothesis 3 is supported, which states that:

"Better compliance on practicing taught exercise according to the perscribed frequency correlates with higher scores on the exercise assessment scale."

The modest positive correlation between exercise adherence and "correctness" of exercise scores found in this research is consistant with Henry et al. (1999). However, considering the small sample size in this research, it is possible that such significant finding between the two variables may have happened by chance. Such occurance will be further discussed in section 6.8.

6.5. Lower Limb Strength

The relationship between "correctness" of exercise and improvements in lower limb strength were not found to be significally correlated ($r = 0.205$, $p = 0.429$).

Hence, hypothesis 4 cannot be accepted, which states that:

"Scores on the exercise assessment scale is positively correlated with improvements in 30 seconds chair stand scores after 6 weeks."

All correlation between "correctness" of exercise and fall risk factors were analysed without taking into account the grouping of each participant, as it was possible for a participants from one group to perform the exercises as accurately as a participant from another group. For example, participant 11 from the no brochure group, participant 21 from the Brochure (after) group and participant 32 from the Brochure (before) group all scored 38 marks out of 40 marks for overall "correctness" of exercise performed.

As no pervious study to date have investigated the relationship of "correctness" of exercise and fall risk factors, it is difficult to make an accurate comparision of the result from this research with previous studies. The only possible way for comparision is by assuming that the physiotherapist in the exercise class ensures all participants in the exercise class perform the exercises accurately, these participants will be similar to those who have performed the 5TE accurately in this research; and the control group will be similar to those who do not perform the 5TE accurately in this research.

Though not statistically significant, the positive correlation observed in this research is consistant with Chandler et al. (1998), where 12 weeks of strengthening exercises in elderly, significantly ($p<0.05$) increased the number of chair stands performed when compared to the control group. Perhaps, a better relationship between “correctness” of exercise and lower limb strength may have been observed, with a larger sample size, frail elderly or with a longer research duration. These factors will be further discussed in section 6.9.

6.6. Dynamic standing balance

The relationship between “correctness” of exercise and improvements in dynamic standing balance were not found to be significally correlated ($r = -0.253$, $p = 0.327$). Hence, hypothesis 5 cannot be accepted which states that:

“Scores on the exercise assessment scale is negatively correlated with improvements in timing for the four square step test after 6 weeks.”

Participating in balance exercise was found to significantly ($p<0.05$) increase dynamic standing balance (Sherrington et al., 2008) and stepping reactions (Maki & McIlroy, 2006) in community dwelling elderly. This is consistant with the findings in this research, though not statistically significant. Perhaps, the 5TE prescribed were not individually tailored and challenging enough for most participants as the weeks passed, contributing to the weak correlationship. Again, a better relationship between “correctness” of exercise and dynamic standing balance may have been observed, had the sample size been larger, or in frail elderly or with a longer research duration, which will be further discussed in section 6.9.

6.7. Fear of falling (FOF)

The relationship between "correctness" of exercise and improvements in FOF were not found to be significally correlated (r = 0.255, p = 0.322). Hence, hypothesis 6 cannot be accepted which states that:

"Scores on the exercise assessment scale is positively correlated with improvements in self perceived Activities-specific Balance Confidence Scale ratings after 6 weeks."

Although not statistically significant, the positive correlation between "correctness" of exercise and FOF in this research, is consistant with previous study that showed FOF improved significantly ($p<0.05$) in elderly who exercised regularly (Liu-Ambrose et al., 2004). This is again assuming that "correctness" of exercise was ensured by the physiotherapist at every exercise session. A huge increase in FOF was noted in participant 14 after 6 weeks. This was because her left knee, that had undergone total knee replacement ten years ago, has suddenly flair up and gave occasional pain, making her slightly wobbly and fearful when moving around. Clearly, in a research with such small number of participants per group, one outliases has the capacity to severely affect the results for the whole group. In addition, a better relationship between "correctness" of exercise and FOF may also have been observed, had the sample size been larger, or in frail elderly or with a longer research duration. This will be further discussed in section 6.9.

6.8. Multiple Testing Correction: The Bonferroni Adjustment

Although multiple statistical tests have been conducted to analyse the data in this research, conventional $p<0.05$ was used for statistical significance instead of applying the Bonferroni adjustment. The reasons for doing so and its possible consequences are discussed here.

Bonferroni adjustment is one method of adjustment for multiple tests, based on the following logic; If a null hypothesis is true, a significant difference ($p<0.05$) may still be observed by chance in one out of every twenty tests conducted (Feise, 2002). Such incorrect rejection of the null hypothesis by chance because of random error in sampling is known as type I error. However, when more than 1 test is conducted (e.g. 10 statistically independent tests are performed), and the null hypothesis holds true for all 10 tests, the chance of at least one test being significant is no longer 0.05, but 0.40. Chances of an error rate across multiple outcome measures research is $1-(1-\alpha)^n$, where n is the number of tests performed (Bland & Altman, 1995). Nevertheless, type I error can be accomodated, by adjusting the p-value for each individual test, using the following formula (Perneger, 1998):

$$\frac{0.05}{\text{Number of tests}} = \frac{0.05}{10} = 0.005$$

The new significance level for the above example will now be p<0.005. If this formula was applied in this research, the equation will be as follows:

$$\frac{0.05}{6} = 0.008$$

Hence, the new significance level that should be applied to all analysed data in this research will be p <0.008. This would mean that the correlation between "correctness" of exercise and exercise adherence, the only significant result (p = 0.038) in this research, will be deem statistically insignificant.

Although controlling for type I error is important, to prevent waste of time and money by accepting erroneous studies, reduction in type I error also increases the chance of type II errors, where effective outcomes are deemed non-significant (Feise, 2002). As this is an exploratory study, where the number of tests are large, applying the Bonferroni procedure would imply the possibility of type II error as well.

Currently, there is still a literature debate regarding the use of Bonferroni adjustments for research with multiple comparisons. Until a conclusion can be reached in literatures, on how best to deal with results from multiple comparisons, the best strategy suggested at present (Bender & Lange, 1999; Feise, 2002; Perneger, 1998) is for authors to inform readers what tests of significance were done, the reason for doing it and the potential consequences of type I and II errors and allow the readers to decide.

6.9. Limitations

There are several limitations in this research that should be critically analyzed prior to making any conclusive evaluation of the results obtained here and providing recommandations for future research. The only statistically significant result in this research, was the positive correlationship between exercise aderence and “correctness” of exercise. This lack of significance could be attributed to four major reasons namely, small sample size (section 6.9.1.), limited duration to carry out the research (section 6.9.2.), providing an ELB (section 6.9.3) as well as the attitudes of the participants (section 6.9.4.). These limitations shall be further discussed in this section.

6.9.1. Small sample size

The results in this research were based on only 17 participants. This small sample size in all three groups was due to low attendance in exercise classes during the recruitment stage, as many were on vacation. In addition, several participants were also not available for re-testing at the end of six weeks due to illness or vacation. These factors have greatly limited the scope of the study. As stated by Pallant (2007), r value is strongly influence by the size of the sample. A small sample size will not be sufficient to represent the full range of possible score. A larger sample size on the other hand, allows a better observation of the true relationship between variables. This may have provided the investigation with greater statistical power and probable significant differences.

6.9.2. Research Duration

Due to time constrain, the exercise regime in this research was conducted for only a short period of six weeks and had a definite ending date. It could have been that six weeks, was too short a duration to elicit any statistically significant improvements in the three fall risk variables. In addition, the 5TE may also not have been challenging enough for some participants as exercises were not progressed over the six weeks. As suggested by Sherrington et al. (2008), improvement in falls risk were better observed in participants who perform progressive and challenging exercises for a total dose of more than 50 hours throughout the exercise programme.

6.9.3. Providing an exercise log book (ELB)

Participants from all three groups were given an ELB for the assessment of their compliance to the prescribed home exercises. However, providing the ELB to all participants may have helped with memory of exercise and optimise compliance rate, resulting in no difference in compliance between the three groups. Daily recording may have reminded individuals of the 5TE, resulting in higher compliance rates (Schoo et al., 2005) . Completeing the ELB may have assisted some people to establish an exercise routine, which may prositively influence exercise compliance at home (Schoo et al., 2005).

6.9.4. Participants attitude

All participants were also aware that they were in a research and were enthusiatic about helping. In addition, the overall level of fitness and attitude towards exercise of these participants may also have been more favorable than average elderly adults. Sluijs et al., (1993), found that participants with a better level of fitness and a positive attitude towards exercise, were more compliant to their prescribed exercise regime. Hence, these factors may also have led to no significant difference in compliance between the three groups and bias in results. Patients in reality maybe novice to exercising and may not be as enthusiatic. In addition, only the no brochure group has experience from participating in other research studies, which may have influenced their attitude towards performing the 5TE independently at home, as discussed in section 6.2.

6.10. Future Research

Despite the limitations as discussed above, this study still serve as a valid introduction in investigating the impact different training regimes may have on compliance and "correctness" of exercise and its resultant effect on fall risk factors.

Recommandations for future research should first address the limitations as discussed in section 6.9. Perhaps the addition of measuring frequency of falls may provide a greater insight of the relationship between "correctness" of exercise and falls risk. It may also have been useful to investigate the relationship of how frequently these brochures were used as memory aids of the taught exercises during the participants' exercise sessions at home, with "correctness" of exercise scores.

As this research was done on elderly with high risk of falls, these findings may not be generalised to elderly with other conditions. In addition, these findings were done using brochure as a memory aid. It may be beneficial if future research were done on elderly with other conditions (such as stroke or orthopeadic conditions) or on different memory aids (such as videotapes or audiotapes) for a better understanding of how different training regimes using other memory aids may affect “correctness” of exercise and compliance on elderly with other conditions.

6.11. Conclusion

There is little evidence to suggest that an exercise training session with live demonstation of the exercises and providing an exercise brochure which is clearly explained, results in improved exercise adherence or “correctness” of exercise in elderly compared to not having an exercise brochure or providing an unexplained exercise brochure. There is also little evidence to suggest that improvements in fall risk factors are highly dependent on the accuracy of exercises performed. A modest correlation was found between exercise adherence and “correctness” of exercise after six weeks. However, taking into account the presence of numerous limitations, it is hence, difficult to draw accurate conclusions to the findings in this research. Most importantly, the little difference between the three groups suggest that verbal instructions coupled with exercise demonstrations can help promote exercise adherence and hence “correctness” of exercise, to a certain extend. Exercising regularly, in turn offers some protection against age-related decline in fall risk factors.

Therefore, it is essential that the elderly are encouraged to adhere to exercising regularly, in order to reap the physical benefits of exercise. Whether various modes of training together with an exercise brochure can help improve exercise adherence, “correctness” of exercise and reducing risk of falls in the elderly, warrents more similar studies with bigger sample size and longer research duration, to either refute or confirm the findings in this research.

Chapter 7

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Chapter 8

Appendices

Appendix 1: Abbreviation

ABC	Activity-specific Balance Confidence Scale
ADL	Activities of Daily Living
AMT	Abbreviated Mental Test
BOS	Base of Support
CI	Confidence Interval
COM	Centre of Mass
EB	Exercise Brochure
ELB	Exercise Log Book
FOF	Fear of Falling
FSST	Four Square Step Test
ICC	Inter-class coefficient
kg	Kilograms
m	Meters
OR	Odds Ratio (the chance of something occurring)
QOL	Quality of Life
RR	Relative Risk
secs	Seconds
UK	United Kingdom
5TE	The Five Taught Exercises
30SCS	30 Seconds Chair Stands
△	Change

University of Chester

Faculty of Applied and Health Sciences
Research Ethics Committee
Chester Campus
Tel 01244 51174[illegible]
Fax 01244 51130[illegible]
j.hitchcock@chester.ac.uk

12 May 2010

Dear Serene

Study title: **Impact of different training regimes on compliance and 'correctness' of exercise in the elderly**
FREC reference: **410/10/SL/CENS**
Version number: **2**

Thank you for sending the above-named application to the Faculty of Applied and Health Sciences Research Ethics Committee for review.

The application has been considered on behalf of the Committee by Mohammed Saeed as Lead Reviewer and reported to the Faculty Research Ethics Committee.

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form and supporting documentation.

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Application Form	1	April 2010
Reference list	1	April 2010
Summary CV of lead researcher	-	April 2010
Participant information sheet	1	April 2010
Consent form	1	April 2010
Letters of permission from Age Concern	-	March 2010
Activities-specific balance confidence questionnaire	1	April 2010
Summary CVs of research assistants	-	April 2010
Procedure flowchart	1	April 2010
Health status screening form	1	April 2010
Abbreviated mental test	1	April 2010
Exercise assessment scale	1	April 2010
Exercise protocols and booklet	1	April 2010

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Exercise logs	2	May 2010
Response to FREC request for clarifications	1	May 2010

With the Committee's best wishes for the success of this project.

Yours sincerely,

Cynthia V Burek

Prof. Cynthia Burek
Chair, Faculty Research Ethics Committee

Enclosures *Standard conditions of approval.*

c.c. Supervisor
FREC Representative

FREC/B
Approval letter - 2009/10

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9th March 2010

Serene Lim Peiying
University of Chester

Dear Serene

Thank you for your request to undertake research with some of our clients as part of your studies at the University of Chester. We would welcome you and give you permission to test the participants in our falls prevention sessions. The people attending them would be fully informed as to what you are undertaking during these sessions and attend them on a weekly basis. You would be free to use our buildings to carry out your research and have access to our clients.

The aim of the falls prevention classes is to promote good balance and postural stability to those people who have fallen or are at risk of falling. Referrals come from a variety of sources, GP's, PCT, district nurses, physiotherapists and people can self refer.

As an organisation we work with many of the universities with regard to student placements and we hope that you will find your research with us beneficial.

Yours sincerely

Alexandra Major
Lifelong Learning Manager.

Prepared on: 1st March 2010

Participant Information Sheet

Impact of different training regimes on compliance and "correctness" of exercise in the elderly

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Feel free to ask me questions if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

What is the purpose of the study?

The purpose of the study is to find out if different ways of teaching exercise with or without an exercise brochure will affect correctness of physiotherapy exercises remembered and performed in elderly.

Why have I been chosen?

You have been chosen because you are aged 60 years old and above and able to travel to the exercise centre for exercise class. You have also passed the abbreviated mental test.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive at Age Concern in any way.

What will happen to me if I take part?

If you decide to take part, you will be asked a few simple questions as screening for eligibility into the research. If you pass the screening, you will be asked to fill in your personal particulars and baseline measurements of your standing balance, leg strength and self-perceived fear of falling will be taken. You will then be taught 5 simple exercises. You may or may not receive an exercise brochure to aid your memory. An exercise log book will be provided for you to record the number of repetitions you have done for each prescribed exercise. This should be returned to the researcher at the end of 6 weeks. You will be asked to demonstrate the 5 taught exercises to the researcher at the end of 6 weeks. This demonstration session will be video-recorded so as to allow the researcher an accurate assessment of how correctly you have done your exercises. Measurements of your balance, leg strength and self perceived fear of falling will also be measured again to check for improvements.

What are the possible disadvantages and risks of taking part?
There is a risk that you may experience some muscle soreness after doing the prescribed exercises. However, this muscle soreness should go off with rest. Apart from this there are no foreseeable disadvantages or risks in taking part in the study.

What are the possible benefits of taking part?
You may improve your strength and balance, but no assurance can be given about these possible benefits.

What if something goes wrong?
If you wish to complain or have any concerns about any aspect of the way you have been approached or treated during the course of this study, please contact Professor Sarah Andrew, Dean of the School of Applied and Health Sciences, University of Chester, Parkgate Road, Chester, CH1 4BJ, England. Telephone: 01244 513055.

Will my taking part in the study be kept confidential?
All information, which is collected, about you during the course of the research will be kept strictly confidential so that only the researcher carrying out the research and her supervisor will have access to such information.
Stored material that contains identifiable information will be kept securely, and data will be coded to anonymise it.

What will happen to the results of the research study?
The results will be written up into a dissertation as part of the requirements for an MSc. in Exercise and Nutrition Science, and may be published. Individuals who participate will not be identified in any subsequent report or publication.

Who is organising and funding the research?
The research is not funded. A researcher at The Centre for Exercise and Nutrition Science at the University of Chester will be involved in organising and carrying out the study.

Who may I contact for further information?
If you would like more information about the research before you decide whether or not you would be willing to take part, please contact:

Lim Peiying, Serene
Handphone number:; E-mail :
Thank you for your interest in this research

University of Chester

Prepared on: 1st March 2010

Informed Consent for the Research Study

Title of Project: Impact of different training regimes on compliance and "correctness" of exercise in the elderly

Name of Researcher: Lim Peiying, Serene

Please initial box

1. I confirm that I have read and understand the information sheet dated 1st March 2010 for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my care or legal rights being affected. ☐

3. I agree to allow video recording of my exercise demonstration 6 weeks after the exercises have been taught to me. ☐

4. I agree to take part in the above study. ☐

Name of Participant	Date	Signature

Researcher	Date	Signature

1 for participant; 1 for researcher

Participant's Number: _____________

Highest Education level: _____________________________

The Abbreviated Mental Test

Question	**Score**
What is your age? (1 point)	
What is the time to the nearest hour? (1 point)	
Give the participant an address, and ask him or her to repeat it at the end of the test. (1 point) e.g. 42 West Street	
What is the year? (1 point)	
What is the name of the place where the participant is currently doing the fall prevention exercise class? (1 point)	
Can the patient recognize two persons (the exercise instructor & the lead researcher)? (1 point)	
What is your date of birth? (day and month sufficient) (1 point)	
In what year did World War 2 begin? (1 point)	
Name the present monarch. (1 point)	
Count backwards from 20 down to 1. (1 point)	
Total Score:	

Reference : Hodkinson, H.M.(1972).Evaluation of a mental test score for assessment of mental impairment in the elderly, Age and Ageing, 1, 233 – 238. Retrieved from http://ageing.oxfordjournals.org/cgi/reprint/1/4/233

30 Seconds Chair Stand

Reference: Jones, C.J. & Rikli, R.E.(2002). Measuring functional fitness of older adults, *The Journal on Active Aging,* 1(2), 24-30. Retrieved from: http://www.tobaccofreearkansas.com/healthy_aging/pdf/measuring_functional_fitness.pdf

Four Square Step Test

Reference : Dite, W. & Temple, V.A. (2002). A Clinical test of Steeping and Changing Direction to Identify Multiple Falling Older Adults. Archives of Physical Medicine Rehabilitation, 83, 1566-1571. doi: 10.1053/spmr.20023546

Participant's Number:_____________

The Activities-specific Balance Confidence Scale

Instructions to Participants:

For each of the following, please indicate your level of confidence in doing the activity without losing your balance or becoming unsteady by choosing one of the percentage points on the scale from 0% to 100%. If you do not currently do the activity in question, try and imagine how confident you would be if you had to do the activity. If you normally use a walking aid to do the activity or hold onto someone, rate your confidence as if you were using these supports. If you have questions about answering any of these items, please ask for assistance.

The Activities-specific Balance Confidence Scale

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

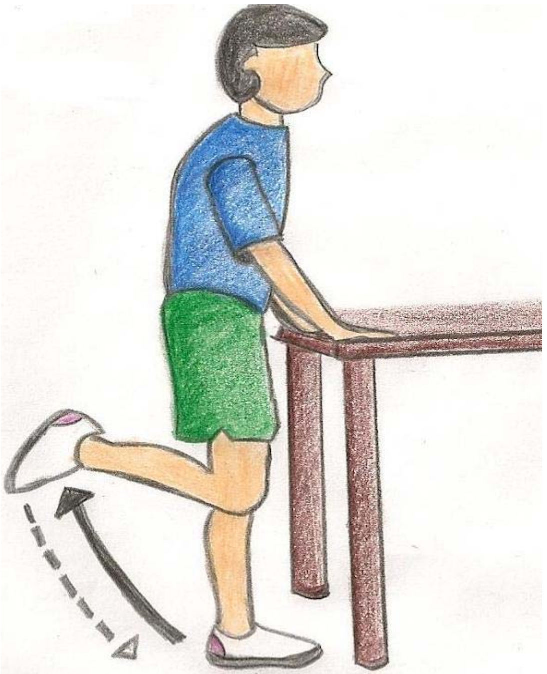
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Not confident Completely confident

How confident are you that you will not lose your balance or become unsteady when you ….	Score
1. … walk around the house?	%
2. … walk up or down stairs?	%
3. … bend over and pick up a slipper from the floor at the front of a cupboard?	%
4. … reach for a small tin of food from a shelf at eye level?	%
5. … stand on your tip toes and reach for something above your head?	%
6. … stand on a chair and reach for something?	%
7. … sweep the floor?	%
8. … walk outside the house to a parked car?	%
9. … get into or out of a car?	%
10. … walk across a car park to the shops?	%
11. … walk up or down a ramp?	%
12. … walk in a crowded shopping centre where people walk past you quickly?	%
13. … are bumped into by people as you walk through the shopping centre?	%
14. … step onto or off an escalator while you are holding onto the handrail?	%
15. … step onto or off an escalator while holding onto parcels such that you cannot hold onto the handrail?	%
16. … walk outside on slippery pavements?	%
Total ratings:	
ABC Score = Total ratings / 16:	

Reference : Parry, S. W., N. Steen, et al. (2001) Falls and confidence related quality of life outcome measures in an older British cohort. Postgrad Med J 103-108 DOI: 10.1136/pmj.77.904.103

4. Knee Curls

- Bend your knee, bringing the foot towards your bottom.
- Keep both thighs level.
- Slowly bring leg back to starting position.
- Repeat.



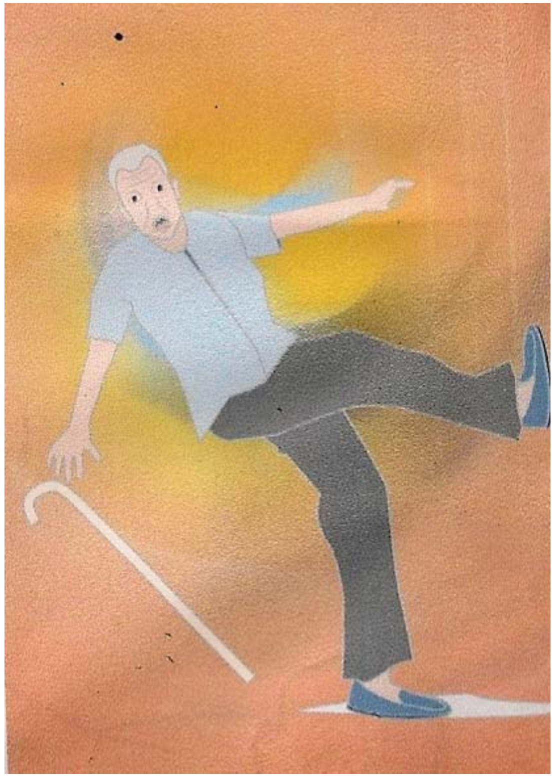
5. Sit to Stand Practice

- Sit on the edge of a firm chair.
- Place your feet behind the knees.
- Lean forwards over the knees.
- Try standing up from the chair without using your hands. If unable, then push off with hands.
- Repeat.

Perform **2 sets** of **10 times for each exercise.** Repeat this **twice a day** for **both legs, 5 days a week.**

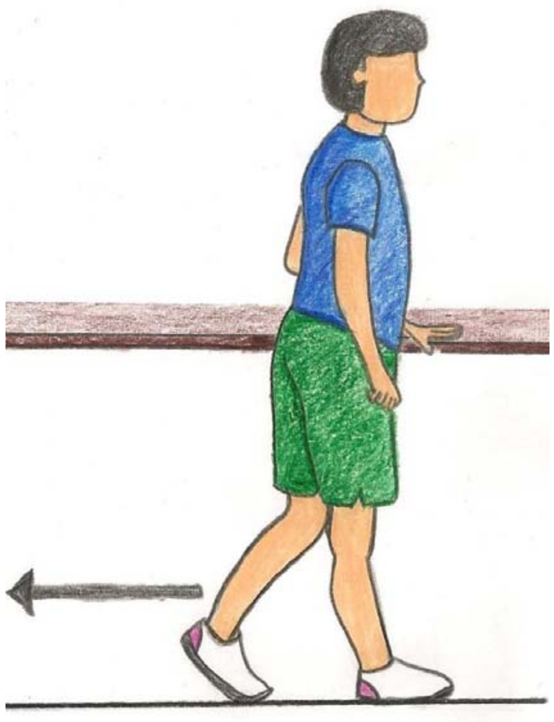
University of Chester

Exercising to Prevent Falls in Elderly



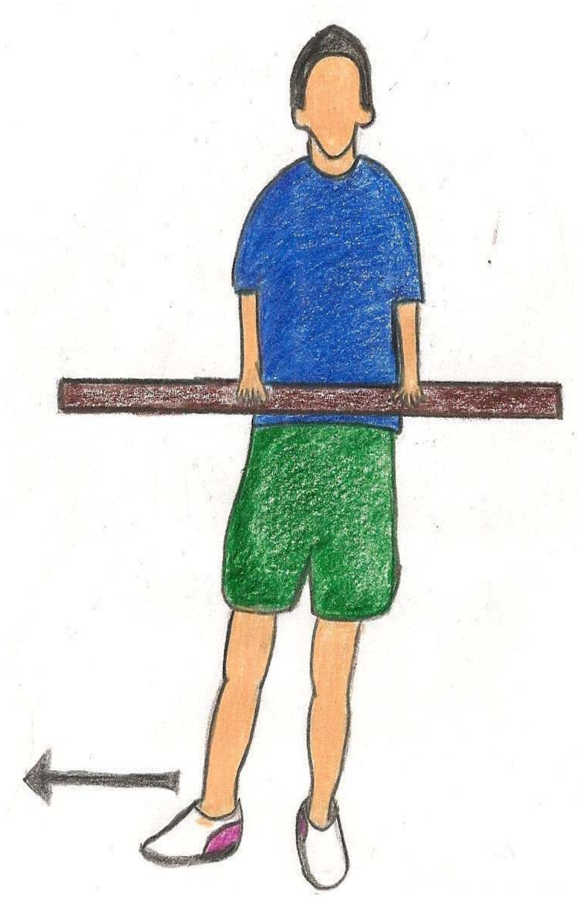
1. Backwards Walking

- Walk backwards 10 steps.
- Turn around
- Walk backwards 10 steps (to the starting point).
- Repeat.



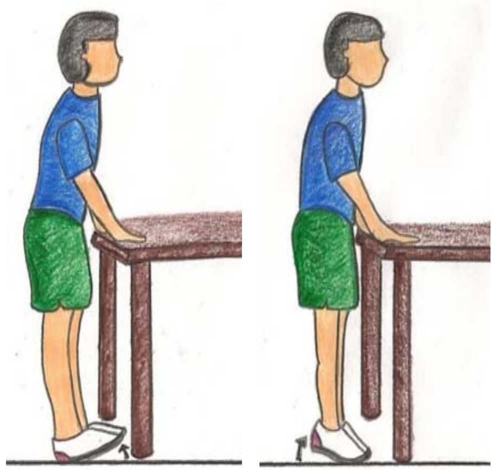
2. Sideways Walking

- Take 10 steps to the Right.
- Take 10 steps to the Left.
- Repeat.



3. Heel and Calf Raises

- Stand tall with feet shoulder-width apart and look ahead.
- Come back onto the heels, raising the front foot off the floor.
- Lower the feet to the ground.
- Come up onto your toes.
- Lower your heels to the ground.
- Repeat.



Perform **2 sets** of **10 times for each exercise.** Repeat this **twice a day** for **both legs, 5 days a week.**

Why is daily exercise important?

Exercise promotes balance and strengthens muscles. Doing them daily improve balance, keeps muscles strong, joints supple and improves blood circulation around the body. It will also help you deal with day-to-day stress, and give you a sense of achievement and control over your condition.

For more information about your condition, please check with your local doctor or your falls prevention exercise trainer.

Tips for exercises

❖ When exercising in standing, stand tall and hold on to table for support (if necessary for stability).

❖ Carry out the exercises when you are well. Do not exercise if you are feeling giddy, or in discomfort or pain.

Perform only the exercises taught by the researcher. Should you have any doubts, please clarify with the researcher.

Instructions to Participants: 6 Weeks Exercise Log Book

This is a 6 weeks exercise log book. Please do the following for the next 6 weeks:

1. Record the number of repetitions you have done for each exercise in the numbered "Days" column, corresponding to the name of the exercise. Top triangle for exercises done in the morning **(am)** and bottom box for exercises done in the afternoon **(pm)**. The exercise log for each week is stated at the top of each page.
2. If you did not manage to complete the recommended number of repetitions, please state the reason on the left side of the page, corresponding to the day of your exercise. You will find at the bottom of the page a list of numbered reasons for not completing the exercises as prescribed. You could label the number, corresponding to the option that best describes your reason for not completing the exercises, in the box provided. If none of the description fits, please state your reason in the box instead. Please be as truthful as possible. You will not be penalised in anyway for not doing your exercises.
3. This completed booklet must be returned back to the researcher on your next exercise class, at the end of 6 weeks.

Week 1

	Day 1	Day 2	Day 3	Day 4	Day 5
Backwards Walking	am 20 / pm 20	am 0 / pm 0	am 20 / pm 20	am 20 / pm 20	am 20 / pm 10
Sideways Walking	am 20 / pm 20	am 0 / pm 0	am 20 / pm 20	am 20 / pm 20	am 20 / pm 10
Heel & Calf Raises	am 20 / pm 20	am 0 / pm 0	am 18 / pm 20	am 20 / pm 20	am 20 / pm 10
Knee Curls	am 20 / pm 20	am 0 / pm 0	am 15 / pm 20	am 20 / pm 20	am 20 / pm 10
Sit to Stand	am 20 / pm 20	am 0 / pm 0	am 10 / pm 20	am 20 / pm 20	am 20 / pm 10

EXAMPLE

Reasons for not completing the exercise(s)

Day	Reasons
Day 1	Morning:
	Afternoon:
Day 2	Morning: } Went to London for a 1 day guided tour
	Afternoon: }
Day 3	Morning: 1 : sit to stand , 2 : knee curls & heel & calf raises
	Afternoon:
Day 4	Morning:
	Afternoon:
Day 5	Morning:
	Afternoon: 6: Muscles were very sore.

Reasons (put the appropriate number in box above):

1. Lack if time to exercise
2. Exercising causes pain / discomfort
3. Forget to exercise
4. Lack of motivation to exercise
5. Unwell (state illness in box)
6. In pain / discomfort

Name:____

6 Weeks Exercise Logbook Record

Week 1

	Day 1	Day 2	Day 3	Day 4	Day 5
Backwards Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Sideways Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Heel & Calf Raises	am / pm	am / pm	am / pm	am / pm	am / pm
Knee Curls	am / pm	am / pm	am / pm	am / pm	am / pm
Sit to Stand	am / pm	am / pm	am / pm	am / pm	am / pm

Reasons for not completing the exercise(s)

Day	**Reasons**
Day 1	Morning:
	Afternoon:
Day 2	Morning:
	Afternoon:
Day 3	Morning:
	Afternoon:
Day 4	Morning:
	Afternoon:
Day 5	Morning:
	Afternoon:

Week 2

	Day 1	Day 2	Day 3	Day 4	Day 5
Backwards Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Sideways Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Heel & Calf Raises	am / pm	am / pm	am / pm	am / pm	am / pm
Knee Curls	am / pm	am / pm	am / pm	am / pm	am / pm
Sit to Stand	am / pm	am / pm	am / pm	am / pm	am / pm

Reasons for not completing the exercise(s)

Day	Reasons
Day 1	Morning:
	Afternoon:
Day 2	Morning:
	Afternoon:
Day 3	Morning:
	Afternoon:
Day 4	Morning:
	Afternoon:
Day 5	Morning:
	Afternoon:

Reasons (put the appropriate number in box above):

1. Lack if time to exercise
2. Exercising causes pain / discomfort
3. Forget to exercise
4. Lack of motivation to exercise
5. Unwell (state illness in box)
6. In pain / discomfort

Week 3

	Day 1	Day 2	Day 3	Day 4	Day 5
Backwards Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Sideways Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Heel & Calf Raises	am / pm	am / pm	am / pm	am / pm	am / pm
Knee Curls	am / pm	am / pm	am / pm	am / pm	am / pm
Sit to Stand	am / pm	am / pm	am / pm	am / pm	am / pm

Reasons for not completing the exercise(s)

Day	**Reasons**
Day 1	Morning:
	Afternoon:
Day 2	Morning:
	Afternoon:
Day 3	Morning:
	Afternoon:
Day 4	Morning:
	Afternoon:
Day 5	Morning:
	Afternoon:

Reasons (put the appropriate number in box above):

1. Lack if time to exercise
2. Exercising causes pain / discomfort
3. Forget to exercise
4. Lack of motivation to exercise
5. Unwell (state illness in box)
6. In pain / discomfort

Week 4

	Day 1	Day 2	Day 3	Day 4	Day 5
Backwards Walking	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**
Sideways Walking	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**
Heel & Calf Raises	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**
Knee Curls	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**
Sit to Stand	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**	**am** / **pm**

Reasons for not completing the exercise(s)

Day	**Reasons**
Day 1	Morning:
	Afternoon:
Day 2	Morning:
	Afternoon:
Day 3	Morning:
	Afternoon:
Day 4	Morning:
	Afternoon:
Day 5	Morning:
	Afternoon:

Reasons (put the appropriate number in box above):

1. Lack if time to exercise
2. Exercising causes pain / discomfort
3. Forget to exercise
4. Lack of motivation to exercise
5. Unwell (state illness in box)
6. In pain / discomfort

Week 5

	Day 1	Day 2	Day 3	Day 4	Day 5
Backwards Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Sideways Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Heel & Calf Raises	am / pm	am / pm	am / pm	am / pm	am / pm
Knee Curls	am / pm	am / pm	am / pm	am / pm	am / pm
Sit to Stand	am / pm	am / pm	am / pm	am / pm	am / pm

Reasons for not completing the exercise(s)

Day	**Reasons**
Day 1	Morning:
	Afternoon:
Day 2	Morning:
	Afternoon:
Day 3	Morning:
	Afternoon:
Day 4	Morning:
	Afternoon:
Day 5	Morning:
	Afternoon:

Reasons (put the appropriate number in box above):

1. Lack if time to exercise
2. Exercising causes pain / discomfort
3. Forget to exercise
4. Lack of motivation to exercise
5. Unwell (state illness in box)
6. In pain / discomfort

Week 6

	Day 1	Day 2	Day 3	Day 4	Day 5
Backwards Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Sideways Walking	am / pm	am / pm	am / pm	am / pm	am / pm
Heel & Calf Raises	am / pm	am / pm	am / pm	am / pm	am / pm
Knee Curls	am / pm	am / pm	am / pm	am / pm	am / pm
Sit to Stand	am / pm	am / pm	am / pm	am / pm	am / pm

Reasons for not completing the exercise(s)

Day	**Reasons**
Day 1	Morning:
	Afternoon:
Day 2	Morning:
	Afternoon:
Day 3	Morning:
	Afternoon:
Day 4	Morning:
	Afternoon:
Day 5	Morning:
	Afternoon:

Reasons (put the appropriate number in box above):

1. Lack if time to exercise
2. Exercising causes pain / discomfort
3. Forget to exercise
4. Lack of motivation to exercise
5. Unwell (state illness in box)
6. In pain / discomfort

Participant's Number: _______________

Exercise Name: _____________________________

Exercise Assessment Scale

Starting position

Correct starting position	1
Incorrect starting position	0

Plane of movement

Correct body part moving in correct plane	1
Body part moving in incorrect plane	0

ROM

Exercise performed using correct ROM for that patient	2
Exercise performed using partially correct ROM	1
Incorrect ROM	0

Compensation

No compensatory movements	1
Use of compensatory movements	0

Duration=speed of movement

Total time taken for exercise correct	1
Time taken for exercise incorrect	0

Reps

Correct number of repetitions	1
Incorrect number of repetitions	0

Frequency

Correct number of times per day	1
Incorrect number of times per day	0

Total Score:________

Reference: Smith, J., Lewis, J. & Prichard, D. (2005). Physiotherapy exercise programmes: Are instructional exercise sheets effective? Physiotherapy Theory and Practice, 21 (2), 93-102. doi: 10.1080/09593980590922316

Researcher's Combined Score Sheet for Group (1 / 2 / 3)

Participant's Number:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
AMT Scores									
(pre) ABC Scores									
(pre) 30 Seconds Chair Stand Timing									
(pre) 4 Square Step Test Timing									
(week1) Exercise Assessment Scores									
(post) ABC Scores									
(post) 30 Seconds Chair Stand Timing									
(post) 4 Square Step Test Timing									
(post) Exercise Assessment Scores									

Table 15.1: No Brochure baseline and post 6 weeks data

	Basic Information			Adherence	"Correctness" of exercise	30SCS			FSST			ABC		
Number	Age (years)	AMT scores	Education	Total 6 weeks adherence	After 6weeks (out of possible 40 marks)	Pre	Post	△	Pre (secs)	Post (secs)	△ (secs)	Pre	Post	△
11	80	10	College	70 %	38	10	16	6	12.23	10.03	- 2.20	53.13	78.44	25.31
12	83	9	College	53 %	36	10	13	3	16.61	16.40	- 0.21	97.50	93.75	- 3.75
13	82	10	University	71 %	37	12	10	-2	12.06	09.31	- 2.75	95.00	93.75	- 1.25
14	88	7	Secondary	14 %	15	11	9	-2	29.23	77.09	47.86	71.13	46.88	-24.25
15	77	10	University	93 %	35	11	12	1	14.41	15.93	1.52	93.75	98.13	4.38
16	71	10	College	68 %	35	13	15	2	07.31	06.21	- 1.10	86.88	96.25	9.37

Table 15.2: Brochure (after) baseline and post 6 weeks data

	Basic Information			Adherence	"Correctness" of exercise	30SCS			FSST			ABC		
Number	**Age (years)**	**AMT scores**	**Education**	**Total 6 weeks adherence**	**After 6weeks (out of possible 40 marks)**	**Pre**	**Post**	△	**Pre (secs)**	**Post (secs)**	△	**Pre**	**Post**	△
21	81	10	College	63 %	38	7	10	3	23.22	15.54	- 7.68	87.50	92.38	4.88
22	76	7	College	82 %	33	13	14	1	17.28	16.00	- 1.28	96.25	99.45	3.20
23	89	9	Primary	50 %	27	6	10	4	16.43	12.35	- 4.08	100.00	96.25	- 3.75
24	75	8	Secondary	92 %	39	13	14	1	11.65	08.59	- 3.06	77.50	80.00	2.50
25	85	9	College	63 %	30	4	6	2	25.00	21.00	- 4.00	70.25	78.64	8.39
26	69	10	University	67 %	35	10	13	3	18.00	16.90	- 1.10	22.50	40.76	18.26

Table 15.3: Brochure (before) baseline and post 6 weeks data

	Basic Information			Adherence	"Correctness" of exercise	30SCS			FSST			ABC		
Number	**Age (years)**	**AMT scores**	**Education**	**Total 6 weeks adherence**	**After 6weeks (out of possible 40 marks)**	**Pre**	**Post**	**△**	**Pre (secs)**	**Post (secs)**	**△**	**Pre**	**Post**	**△**
31	76	10	College	93 %	40	12	15	3	10.00	07.68	- 2.32	96.25	97.19	0.94
32	71	9	Secondary	73 %	38	8	10	2	10.46	10.23	- 0.23	98.13	99.38	1.25
33	71	10	University	56 %	37	10	12	2	10.27	09.93	- 0.34	98.13	97.19	- 0.94
34	68	10	College	81 %	37	9	12	3	16.19	09.71	- 6.48	97.50	99.38	1.88
35	77	10	Secondary	82 %	37	11	12	1	12.82	10.34	- 2.48	98.13	97.50	- 0.63