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THE EFFECTS OF AN 8-WEEK HOME BASED BALANCE EXERCISE PROGRAM AMONG PERSONS WITH MULTIPLE SCLEROSIS: A CASE STUDY

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The effects of an 8-week home based balance exercise program among people with multiple sclerosis: a case study

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The purpose of this study was to find out the effects of an 8-week long exercise program on balance among persons with multiple sclerosis (MS). MS is a major cause of neurological disability among adults. Symptoms caused by the condition vary from one individual to another depending on the location of the lesions. Deficits can involve only one neurological function or be a combination of many. Accumulated impairments due to lost or impaired function can increase fear of falling and fall related injuries. Decreased confidence in balance can reduce individual's physical activity and participation which in turn can lead to social isolation.

This thesis is a practical implementation based on earlier thesis and was conducted in co-operation with the local MS-association. Subjects were volunteers who exercised according to a balance exercise program for eight weeks. Subjects' balance and confidence in balance related activities was assessed with functional measurements and semi-structured interviews.

The results suggest that 8-week long home based exercise program which is based on scientific background of balance, is performed regularly and has progression in exercises can improve the assessed and perceived balance of a person with MS.

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1 INTRODUCTION

Multiple sclerosis (MS) is a major cause of neurological disability in young and early middle-aged adults. The peak incidence is between the ages of 25 to 35 and the disease is twice as common in women as in men. Onset of symptoms is rare in children and in adults older than 50. (Stokes & Stack 2012, 89-90. O'Sullivan, Schmitz & Fulk 2014, 721.) Course of the disease is variable and unpredictable between patients with MS. (O'Sullivan et al. 2014, 722). Individual's symptoms may include impairments in vision, somatosensory or vestibular system. These impairments combined with other disabilities associated with MS can result impaired balance which in turn can lead to increased risk and fear of falling (Matsuda, Shumway-Cook, Ciol, Bombardier & Kartin 2012). More than 50 percent of patients with MS report one or more falls in the past 6 months (Finlayson, Peterson & Cho 2006; Matsuda et al. 2011) and in addition up to two thirds have restricted their everyday activities due to fear of falling (Matsuda, Shumway-Cook, Ciol, Bombardier & Kartin 2012). Increased risk and fear of falling may lead to social isolation, reduced physical activity and fall related injuries. (Carr & Shepherd 2010, 338; O'Sullivan et al. 2014, 726.)

The purpose of this study was to find out the effects of an eight week long regular balance exercise program in individual setting on measured and perceived balance among persons with multiple sclerosis. Based on reference material, persons who are ambulatory with mild to moderate level of disability can benefit from exercise program that includes balance and strengthening exercises. Physical exercise is tolerated well by MS patients and exercise neither increases the subjective symptoms nor speeds up the course of the disease. (Padgett & Kasser 2013; Tallner et all. 2012.)

2 MULTIPLE SCLEROSIS

The symptoms and the clinical signs of multiple sclerosis can vary significantly and unpredictably depending on individual over time. In its lightest form multiple sclerosis can manifest in fully recovering single neurological symptom and deficit. On the other end of very large variety of symptoms is a condition which can result in permanent and almost continual progression leading to severe disability or even death in weeks and months after the first onset of symptoms. (O'Sullivan et al. 2014, 722; Stokes & Stack 2012, 89-90.) In a typical course of MS, symptoms and clinical signs show a variation of progression over time developing neurological symptoms, cognitive and behavioral deficits. Although there are recent advances in understanding MS, the exact etiology and origination of the disease is still unclear. Currently there is no cure for MS, however disease-modifying medications are used to slow down the progression of disease and to reduce the severity of relapses. In general MS affects the quality of life more than the duration. Person with MS survives approximately 6 years less when compared to general population. (Carr & Shepherd 2010, 335, 338; Durstine, Moore, Painter & Roberts 2009, 322; Kingwell et al. 2012.)

2.1 Etiology and pathogenesis

The exact etiology and origination of multiple sclerosis is unclear. One view is that the acquisition of MS it thought to require an interaction between genetic and an environmental factor. Exposure to an environmental factor, possibly viral, during or after childhood by those who are genetically predisposed to MS, results over time development of condition. The acquisition requires prolonged or repeated exposure and is followed by prolonged latent or incubation period which eventually leads to the first onset of symptoms. (Carr & Shepherd 2010, 335-336; Kurzke 2005; Stokes & Stack 2012, 92.)

In a healthy nerve system, nerve axon (nerve cell process) is surrounded by layer of insulating myelin. This insulation preserves energy of a nerve and speeds up the nerve impulse along the nerve fibers. In multiple sclerosis nerve fibers lose the surrounding

myelin layer and depending on the site and severity of the lesion, functionality of an individual can be impaired to varying degree. Myelin is lost by body's own autoimmune response which triggers inflammatory reaction (demyelination) against native myelin. As a result conduction of nerve impulses slows down and nerves fatigue rapidly. The conduction speed remains normal on unaffected sites of nerve system. (Carr & Shepherd 2010, 336-337; O'Sullivan et al. 2014, 722.)

During the early stages of MS, cells that produce myelin survive and can replace the lost myelin in a process called remyelination. However with repeated inflammatory reactions healing process becomes less effective over time and as the disease becomes more chronic, the process stalls altogether. As a result healing is incomplete and further inflammatory reactions leave the individual with increasing level of disability and neurological deficit. Lesions are healed by scar formation which reduces the conductivity even further and causes the neuron to undergo irreversible neurodegeneration. Neurodegeneration is the main cause of progressed neurological disability on individual. On chronic stages of the disease, some patients may have short periods of stability or even slight improvement in function. These improvements are a result of compensatory and adaptive changes in central nervous system. (O'Sullivan et al. 2014, 722; Carr & Shepherd 2010, 336; Stokes & Stack 2012, 92; Sa 2012.)

The inflammatory reaction against myelin can occur anywhere in brain, spinal cord and/or optic nerve. The symptoms and impairments that result from reaction can involve only one neurologic function or can be a combination of many which explains the wide variety of symptoms and clinical signs on people with MS. (Carr & Shepherd 2010, 337; Fox, Bethoux, Goldman & Cohen 2006.)

2.2 Epidemiology, incidence and prevalence

Incidence is by definition a probability that a patient, without disease develops the disease during certain time period (e.g. year) and prevalence is the probability of disease in the whole population at any point in time. (Stokes & Stack 2012, 401-402.)

Epidemiological studies indicate that there is strong link between the latitude and prevalence of multiple sclerosis of global scale. MS affects predominantly white populations and in regions near the equator the disease is rare, prevalence less than 1 per 100 000 people compared to prevalence in colder climate regions in Northern Europe for example where it increases to 120 per 100 000 people. (Carr & Shepherd 2010, 336; Stokes & Stack 2012, 91.)

Finland is generally consider to be one of the high-risk regions of MS (Kurtzke 2005). Although there are several studies conducted in various parts of Finland, there is no official prevalence and incidence rates on population level. The average incidence is estimated to be around 7 per 100 000 population and prevalence 130 per 100 000 population. (website of Käypähoito.) Further support to these figures can be found from several studies. A study conducted in Ostrobothnia region in Finland found the incidence rate 6,3 per 100 000 and prevalence of 103 per 100 000 people (Krökki, Bloigu, Reunanen & Remes 2011). Another study conducted in Central Finland established the incidence rate at 9,2 per 100 000 people and prevalence 105 per 100 000 population (Sarasoja, Wikström, Paltamaa, Hakama & Sumelahti 2004).

2.3 Clinical subtypes of multiple sclerosis

Multiple sclerosis is highly variable and unpredictable between individuals in terms of progression and location of lesions. Despite the seemingly random course of disease, four sub-types of MS can be identified. These sub-types each have specific course of the disease. (Carr & Shepherd 2010, 337; O'Sullivan et al. 2014, 722.)

2.3.1 Relapsing-remitting MS (RRMS)

The most common form of multiple sclerosis is the relapsing-remitting MS which affects around 85% of patients with MS. Typically discrete attacks or relapses occur with acute worsening of neurological functions. These attacks are followed by periods where the progression of disease stalls and sites of attacks undergo partial or complete

healing. Signs and symptoms decrease in strength and severity and function is restored. These episodes of relapses and remissions in general occur both in random frequency and duration and can affect the same or different regions of central nervous system. (Carr & Shepherd 2010, 338; O'Sullivan et al. 2014, 722.)

2.3.2 Secondary-progressive MS (SPMS)

Before the development of disease-modifying medication, majority of patients with relapsing-remitting MS developed secondary-progressive MS as a result from frequent relapses. In this progressive form, a patient would experience a steady and irreversible decline in neurological functions. Typically this decline would occur with or without continued attacks. (Carr & Shepherd 2010, 338; O'Sullivan et al. 2014, 722.)

2.3.3 Primary-progressive MS (PPMS)

With primary-progressive MS patient experiences accumulation of neurological deficits from onset without periods of relapses and remissions. This form of MS is relatively rare and occurs in about 10 % of cases. (Carr & Shepherd 2010, 338; O'Sullivan et al. 2014, 722-723.)

2.3.4 Progressive-relapsing MS (PRMS)

Progressive-relapsing MS is similar to primary-progressive MS but with occasional acute attacks. During relapses the disease progresses more rapidly and periods between attack is characterized with slower but still progressing state of the disease. Around 5% of patients with MS have this form of the disease. (O'Sullivan et al. 2014, 723.)

2.4 Clinical signs and symptoms

At the onset of MS careful review of patient history will in many cases reveal indefinite feelings and temporary periods of ill health in the past months or even years. Visual disturbances or rotational vertigo for example can in many cases suggest an episode of

demyelination in the past. It is common that the first onset of symptoms are forgotten and will not encourage the individual to seek medical assistance. (Stokes & Stack 2012, 93.)

2.4.1 Sensory impairments and balance disturbances

The impairment in vision is the most common single symptom in people with multiple sclerosis. Usually it starts spontaneously and involves only one eye, rarely affects the both and in many cases is associated with pain or discomfort. Deafness is more often seen in patients with chronic stages of the disease. (Stokes & Stack 2012. 93; Carr & Shepherd 2010, 340.)

Altered sensation occurs almost in every individual with MS. These include sensation deficits, numbness or tingling and may be present in one limb or more. In some cases one side of the body is affected. Pain is another common symptom in people with MS. It can be direct result of axonal damage or secondary pain related to another MS symptom. (Carr & Shepherd 2010. 338-339.)

Weakness and spasticity are common and invariable symptoms and clinical signs of MS. Weakness can gradually develop in one or alternatively more limbs, generally increases with use and is often described by a patient with MS as heaviness and clumsiness. This affects patient's ability to walk and in later stages of MS when there are more neurological conditions present, e.g. ataxia (uncoordinated movements of a limb) and spasticity, many patients will rely on walking aids and many will need wheelchair in everyday life. Problems with walking and balance together with visual, vestibular and somatosensory impairments increase the risk of falls and injury. The more there are accumulated impairments, the higher the risk of fall is. These symptoms over time and fear of falling reduce the possibilities of participating in activities of daily living and will result in progressing decrease in physical activity as well as social isolation. (Carr & Shepherd 2010. 338; Matsuda, Shumway-Cook, Ciol, Bombardier & Kartin 2012; O'Sullivan et al. 2014, 726; Stokes & Stack 2012, 94.)

2.4.2 Cognitive symptoms

Cognitive impairments in MS are fairly common and are related to the location of lesion rather than the overall severity or course of the disease. In general short-term memory, attention and concentration are affected which alongside with other MS related symptoms may cause further challenges with learning and mood related problems such as depression. Severe dementia is rare and is mostly present with rapidly progressing form of the disease. (Carr & Shepherd 2010, 339; O'Sullivan et al. 2014, 726.)

2.4.3 Fatigue

Fatigue is one of the most common symptoms of MS and is felt by individual as lack of physical and/or mental energy which interferes with physical and social function. The onset of fatigue is spontaneous and symptoms usually get stronger during the day. Individual with MS might report feelings of overwhelming physical and mental tiredness and exhaustion with difficulty concentrating. Fatigue is reported by many to be one of the most troubling symptoms of MS. Severity of disease is not related to the severity of experienced fatigue and individuals with otherwise minor symptoms and mild disability level might report very high level of disabling fatigue. (Carr & Shepherd 2010, 340; O'Sullivan et al. 2014, 725.)

2.5 Management of symptoms

MS is characterized by episodes of relapses and remissions. Several factors which increase the possibility of relapsing episode to occur have been identified and the avoidance of these factors is important in terms of preservation of patient's function. Infections, both bacterial and viral, such as cold or flu and diseases of major organ systems, e.g. asthma attacks, are closely linked to episodes of relapses. In addition there is an increase in evidence showing that stressful events in individual's life are associated with relapses. (Edwards, Zwartau, Clarke, Irving & Blumhardt 1998; Carr & Shepherd 2010, 335; O'Sullivan et al. 2014, 723.)

Many symptoms worsen with heat and patients with MS frequently report an increase in symptoms when the body is exposed to heat in a form of hot weather or strenuous physical activity. In order to preserve functional capacity of a patient and to avoid discomfort, extreme temperatures and overexertion should be avoided. Physical exercise itself does not increase the symptoms or have any other influence on the course of the disease (Tallner et al. 2012.) In addition patients should be educated about the importance of balancing rest and activity, pacing tasks and taking regular rests between activities in everyday life and exercise. Mindfulness has in many cases been connected to better coping strategies with people with MS and education about lifestyle factors which can be deemed aggravating is advised. For example tobacco smoke can lead to more severe course of the disease and faster disability progression. (Carr & Shepherd 2010, 340-346; Humm et al. 2004; Manouchehrinia et al. 2013; O'Sullivan et al. 2014, 725; Senders, Bourdette, Hanes, Yadav & Shinto 2014; Stokes & Stack 2012, 94;.)

3 BALANCE

The ability to control different body positions in various everyday life activities and to maintain balance is fundamental to physical function and participation. Balance is achieved by postural control which involves the control of body's position in various tasks such as standing, walking and so on. The greatest balance occurs when body's center of mass is above its base of support. Center of mass corresponds to the center of the total body mass and base of support is the area of the body that is on contact with the supporting surface. (Shumway-Cook & Woollacott 2007, 158; Kisner & Colby 2012, 260; Sandström & Ahonen 2011, 51.)

3.1 Sensory systems

Task to maintain balance is complex motor task. It involves detection and integration of information from multiple sensory systems. The message from sensory systems holds information concerning the current position and motion of the body and its parts related to surroundings. Based on this information appropriate responses are executed

from central nervous system to maintain balance while on stationary or moving. Responses are specific to each individual, environment and task. (Kisner & Colby 2012, 260)

3.1.1 Visual system

Alongside with sense of sight, eyes provide the information where and how our body and body parts are in relation to one another in space. Visual system provides information regarding the position of head in relation to environment. It also informs the body about the orientation of head in order to maintain level sight line of eyes as well as speed and direction of head movements. (Trew & Everett 2005, 244; Kisner & Colby 2012, 262.)

3.1.2 Vestibular system

Vestibular system provides information about the head position and movement with respect to gravity and inertial forces. This information is provided by two systems which are located in inner ear; receptors in semicircular canals detect head's angular acceleration and receptors in the otoliths detect linear acceleration as well as head position in relation to gravity. Semicircular canals are sensitive to fast and sudden head movements and the otoliths are more geared to sense slow movements. (Kisner & Colby 2012, 262.)

3.1.3 Somatosensory system

Somatosensory system provides information about the position and motion of the body and body parts relative to one another and the supporting surface. This information is provided by multiple receptors which sense the changes in muscle, joint and skin. Changes in muscle length and tension are detected by muscle proprioceptors including Golgi tendon organ and muscle spindles. Changes in joint angles and movements are detected by joint receptors and skin stretch, vibration and touch are detected by mechanoreceptors of skin. (Kisner & Colby 2012, 262.)

3.2 Balance control

Functional tasks require different types of postural control to maintain balance. Static balance control is required to maintain balance when person is stationary, e.g. sitting or standing and dynamic balance control when either the support surface or body moves on stable surface, e.g. walking or changing position from sitting to standing. In order to do so, in technical terms, body must continuously make adjustments to ensure center of mass is within boundaries of base of support. Movements that provide the mechanism to control and restore balance in different parts of body and in sudden events are called hip, ankle and stepping strategies. These strategies are used alone or in combination depending on what is required. (Kisner & Colby 2012, 263-264.)

Balance is restored and maintained during quiet standing and in case of small balance disturbances by movements of ankle. Hence the name; ankle strategy. Muscle contractions follow a pattern from down to up, distal to proximal. (Kisner & Colby 2012, 264.)

If the disturbances that affect balance are rapid and larger in magnitude and ankle strategy is insufficient, hip strategy is used to restore the balance. Centre of mass is moved within the boundaries of base of support by the movement hip, namely hip extension and flexion. In case of rotational forces, movements from hip act to counteract the rotation by moving the center of mass on opposite direction.
(Kisner & Colby 2012, 265.)

Stepping strategy is used in cases when center of mass is displaced outside the boundaries of base of support by a large force. To restore lost balance, a step or hop is taken based on the direction of displacement. This movement widens the base of support where the newly displaced center of mass would fall in order to restore balance. (Kisner & Colby 2012, 265; Trew & Everett 2005, 247.)

4 AIM AND PURPOSE OF THE STUDY

Purpose of the study was to find out the effects of an eight week long home based balance exercise program among persons with multiple sclerosis. In addition, aim of the study was to give participants a training tool and a setting which promotes and encourages regular exercising.

A study hypothesis predicts a difference in balance measurements of before and after the intervention. Based on the scientific literature and references, balance exercise program can improve the balance of subjects with MS if exercises are performed regularly for 7 to 12 weeks (Nilsagard, van Koch, Nilsson & Forsberg 2014; Padgett & Kasser 2013.) The strongest outcomes are associated with interventions based on theoretical background of balance and interventions using well defined and progressive training programme. (Paltamaa, Sjogren, Peurala & Heinonen 2012.) A change is expected based on literature. A research question is formulated to find the measured and perceived change in balance among subjects;

> "How does 8-week long exercise program in individual setting affect the balance of a person with multiple sclerosis?"

5 METHODOLOGY AND THE COURSE OF THE STUDY

This thesis is practical implementation based on previous study of which purpose was to compile an exercise program to improve balance among people with multiple sclerosis. Research method is case study. Case study is a method to structure qualitative research project where a well-defined unit, patients with MS in this case, is systematically documented before and after of an episode of intervention, 8 week long balance exercise program (Carter, Lubinsky & Domholdt 2011, 158). Both studies were conducted in co-operation with local MS association (Porin Seudun MS-yhdistys ry). Practical implementation of this study was designed to be easily accessible and act as

an entry level introduction to regular exercising aimed at people who might have reduced their participation and activities already due to their medical condition. The exercise program was compiled exclusively for the association and consisted of closed kinetic chain exercises which focused on balance and lower extremity strength and were performed on standing position. As an example different variations of lunges, squats and tandem walking was included in the final program. The final product was a booklet which was given to the association and was not published. Therefore unfortunately the author is not authorized to include it in the appendices. In the booklet each exercise was explained written and with series of pictures to clarify the correct sequence of movements. Written explanation also included instructions of how much and how often one should exercise in order to achieve the desired benefits based on current recommendations. Instructions also informed the reader how to take multiple sclerosis into account while exercising. The program consisted of five basic exercises and each exercise had three modifications allowing progression based on the physical capacity of a person who performs the exercises.

The practical implementation consisted of three phases. On the first phase a person who meets the inclusion criteria was assessed in terms of static and dynamic balance with functional measurements. On the second phase a subject exercised according to the program for eight weeks. On the last phase the subject's balance and confidence in balance related activities in everyday living was assessed again with semi-structured interviews and functional measurements. A conclusion was drawn based on the results. Semi-structured interview is by definition a format which allows searcher to look for information which is somewhat abstract based pre-developed questions (Carter et al. 2011, 173.)

5.1 Subjects

At the beginning of the study local MS association was contacted. With the first email the study was introduced and course of the study was roughly explained. A representative from the association took the task to enquire possible volunteers who would be interested in taking part in the study. Enquiries were made on face-to-face and on

word-of-mouth basis in a time span of 4 weeks in meetings that the association had among its members. Information about the study and instructions how to participate were published on the Facebook-page and on website of the association.

Total number of people who contacted the author and expressed their interest in taking part in the study was 12 at this stage. These people received email where the study, inclusion criteria and confidentiality were thoroughly explained. They were sent the booklet to familiarize themselves with the exercises and in exchange of emails few dates were agreed to meet for the first time. For the convenience of subjects meetings were agreed to take place at the premises of the association, Naseva.

The subjects who would be eligible to participate in the study were expected to meet the following criteria; diagnosed multiple sclerosis, 18 years of age and the ability to stand and walk without assistive aids. Persons who either were in relapse or had contraindicating condition which would have prevented them from performing the exercises regularly were excluded from the study.

Prior to the first meeting four participants cancelled their participation due to lack of time. Total of eight persons agreed to start the project. At the start the aim and methods of the study were individually explained to the subjects. Static and dynamic balance was measured and exercises were showed and instructed. The subjects were given printed copy of the booklet and explained the idea of dosage and modifications in order to achieve the desired benefits. They were also asked to use diary to mark down each time they exercised according to the program and were also asked to record any additional physical activity during the 8 week long study. The author offered to answer by phone or email their questions and concerns in case anything came up during the project. Inquiries were made should there be a need for "a half-way meeting" for a lack of a better term. This meeting would have offered the subjects peer support and further instructions in case someone's process was not going as intended at the start. However the subjects felt that there was no need for such event.

At the end the subjects were invited to final meeting where their balance was measured again. The subjects reported how many times they performed the exercises on each week and on what level. Additional physical activity was noted as well. During semi-

structured interviews subjects were asked to describe subjective views of their balance and overall condition and if they felt any improvements in their physical functionality over the course of the study.

5.2 Balance measurements

Static and dynamic balance was measured by using ‘functional reach’ and ‘timed up and go’ -tests. Both tests are well established to measure basic mobility skills and balance. They are reliable and precise and in addition are widely used in various studies assessing the baseline and changes in balance of people with MS. (Cattaneo, Regola & Meotti 2006; Duncan, Wiener, Chandler & Studenski 1990; Freeman, Fox, Gear & Hough 2012; Frzovic, Morris & Vowels 2000; Learmonth, Paul, McFadyen, Mattison & Miller 2012; Martin et al, 2006; Website of Rehabilitation Measures Database.)

Functional reach was performed standing next to a wall with arm closer to wall flexed 90° from shoulder with closed fist. A subject was instructed to reach as far as possible without taking a step while maintaining balance. The location of 3rd metacarpal was recorded and the distance from starting position is measured. Three trials were done and the average of last two was noted. Result was measured in centimeters. (Website of Rehabilitation Measures Database.)

Timed up and go- test was performed once. A subject was granted a practice trial followed by timed attempt. A subject sat on armchair resting his back against the chair and was instructed to stand up, walk to a cone which was placed three meters away, return and sit back to the chair. Test was timed from standing up to sitting down and the result was recorded in seconds. (Website of Rehabilitation Measures Database.)

6 RESULTS

Initially 12 people expressed their interest in participating in the study. At the end of the project six subjects who had started the study were present at the last meeting. These participants were between the ages of 35 to 65, they have had the diagnosis for 5 to 25 years and had mild or moderate disability level. Two subjects who started the project withdrew themselves from the last meeting. Results are presented in tables 1 and 2.

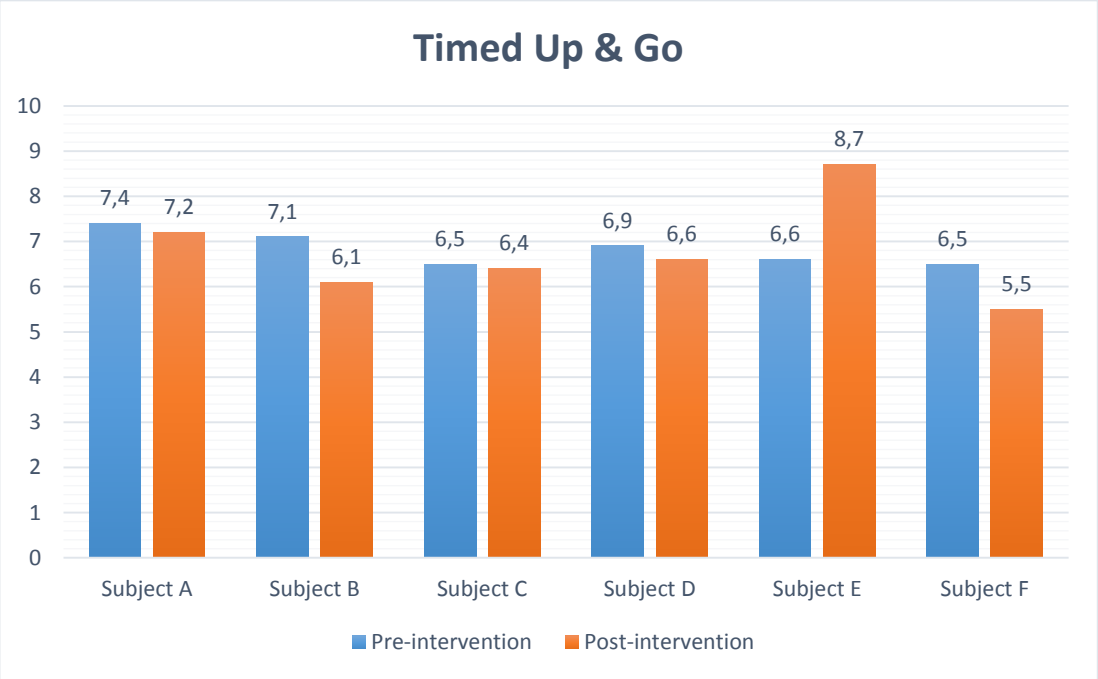

Table 1. Timed up & go pre- and post-intervention results. Results measured in seconds.

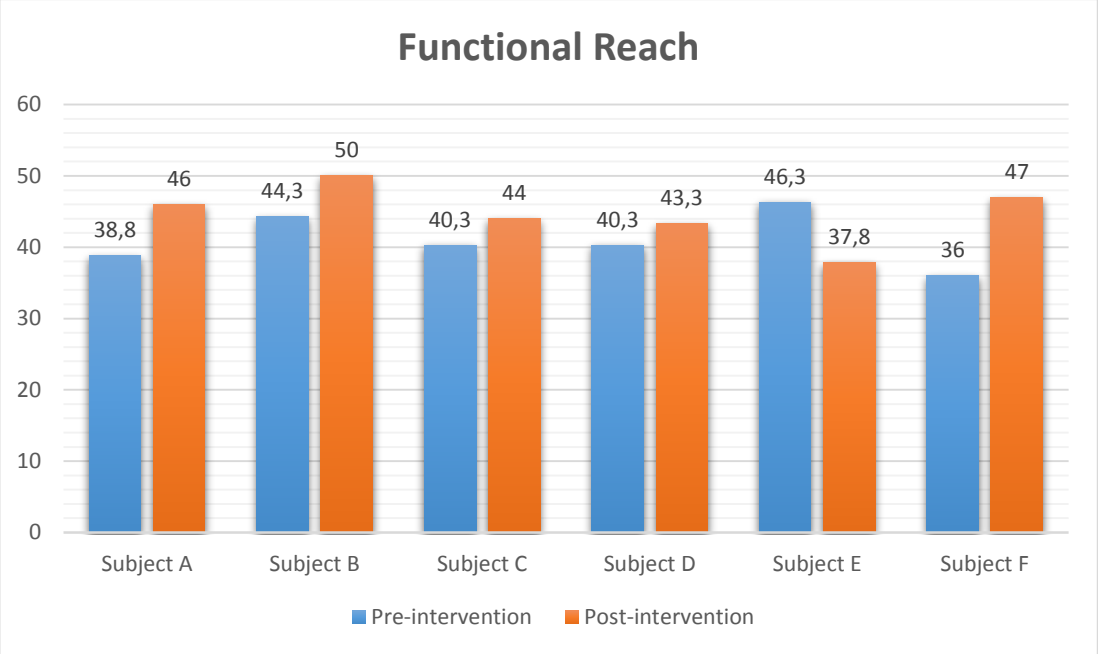

Table 2. Functional reach pre- and post-intervention results. Results measured in centimetres.

At the beginning of the study all subjects started to exercise according to the program. Three subjects exercised two to three times a week for eight weeks. Two subjects exercised for the first six weeks and did not exercise during the last two weeks of the intervention. One subject exercised for the first two to three weeks but had to discontinue due to increase in MS related symptoms. None of the subjects had increased their physical activity with additional exercising during the study.

In general the results show improvement in functional reach- and timed up and go-test scores. The subject's own view and confidence in their functionality in balance related everyday activities in comparison to pre-intervention did improve as well which reflects the measured test results. During semi-structured interviews subjects reported improvement in functions which included walking and standing on one leg. Some of the subjects reported a sense of 'sturdiness' in their legs as a result of the intervention and for example this could be seen when following someone else's footsteps in snow. Subjects who were able to exercise at least six weeks during the intervention report improvement in perceived balance.

7 CONCLUSION

The aim of this study was to evaluate the effects of 8-week long home based balance exercise program on persons with MS. Based on the measurements performed pre- and post-intervention as well as subjects' own accounts of their increased confidence in their functionality, balance exercise program which is based on theoretical background of balance, is performed regularly and has progression in exercises can improve the assessed and perceived balance of a person with MS.

8 DISCUSSION

The purpose of the thesis was to find out the effects of an 8-week long exercise program on balance of persons with multiple sclerosis. The subjects were volunteers associated with local multiple sclerosis association, were ambulatory and had mild or moderate level of disability. Six subjects followed the intervention through of whom two subjects exercised regularly for the first six weeks and had the last two weeks 'off' and one subject was unable to follow the program due upper respiratory tract infection induced increase in symptoms. Of the three subjects who exercised regularly for eight weeks one person completed the intervention despite diagnosed ear infection, albeit on lighter level and one subject reported that symptoms which are related to subject's course of the disease did increase towards the end of the study probably due to flu. Symptoms which are associated with multiple sclerosis can increase in strength and magnitude as a result of a viral infections (Edwards, Zwartau, Clarke, Irving & Blumhardt 1998). This intervention was conducted in November 2014 to January 2015, at the time of flu season and it can be said with some level of certainty that infections that some of the subjects had over the course of the study did affect the test results.

At the start of the study subjects were asked to keep a diary where they would mark each time they exercised according to the program and mark down times they had done some additional physical activity which had not been a part of their routines pre-intervention. The benefit of having the information of additional physical activity was that

the changes in the assessed and experienced balance was easier to attribute to the intervention. Subjects were asked to record their views of how they perceive their functionality in everyday activities during and after the intervention. The reason why subjective views were highlighted on the study was to see how the subjects would see their confidence in balance change as a result. Hypothetically the confidence should grow as their assessed balance improves. With increased confidence a person would be more prone to maintain the current level of physical activity or return to activities the subject had prior to the current level of disability. This in turn would in some cases prevent, reverse or diminish the problems which might have occurred due to reduced physical activity. There are scales and structured interviews available to measure subject's confidence in performing various ambulatory activities without falling or experiencing a sense of unsteadiness (Website of Rehabilitation Measures Database). However with this study the confidence in balance was measured by defining certain moments in everyday life with semi-structured interviews. Subject reported situations where they have felt that their balance had improved or they felt that they were more able in some everyday activities. A scale such as activities-specific balance confidence scale (ABC) would have definitely given more comprehensive and specific score but the answers the subjects gave do reflect their post-intervention confidence in their balance related activities adequately. (Nilsagard, Carling & Forsberg 2012.) From the views of the subjects it is feasible to draw a conclusion which also supports the scores from balance measurement scales.

Sample size was small and with the study conducted at the height of flu season risk was that the results of the study would be compromised due to increased symptoms of the subjects. Although half the sample (3/6) encountered flu or flu-like symptoms fortunately only one subject had to withdraw from the study. Three subjects did follow the intervention through exercising the whole eight week period. The individual results show that persons who exercised the whole eight weeks did have better results at the end of the study than the ones who did less. However with all subjects who took part in the study and exercised at least six weeks the results did improve in comparison to pre-intervention results. Small sample size also presented difficulties in presenting the results in a manner that confidentiality of subjects who participated in the study would remain intact. Based on the results from pre- and post-intervention tests and the views

of subjects concerning their functionality in terms of balance related activities, subjects' balance improved as a result of the intervention.

At the start 12 persons with MS expressed their interest in the study. Half of the persons withdrew and in the end six subjects followed the intervention through. There is a plethora of scientific evidence showing that people with multiple sclerosis can benefit from balance exercise training in both individual and group setting. Improved confidence in balance can help the person to maintain the level of participation in everyday activities as per usual. There is no cure for the medical condition but with rehabilitative physiotherapy which focuses on different aspects of balance the quality of life can be improved and people can learn how to cope with the condition. For future study it would be interesting to see the motivational factors which affect the desire of a person with mild to moderate level of disability to participate in rehabilitative exercising and also see the preferred rehabilitation method, whether group is preferred over individual setting.

The idea of the study was presented to me in May 2014. Literature search started in October, measurements with the subjects were on November and December of 2014. Actual writing process begun on November but the most of the work was done on February 2015. The final measurements were done in January-February 2015 and the thesis was finalized on May.

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