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THE EFFECTS OF MULTIFACTORIAL FALL PREVENTION ON THE PSYCHOLOGICAL RISK FACTORS OF FALLING

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To my dearest husband, Jukka

Abstract

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THE EFFECTS OF MULTIFACTORIAL FALL PREVENTION ON THE PSYCHOLOGICAL RISK FACTORS OF FALLING

Medical Faculty, the Institute of Clinical Medicine, Department of Family Medicine, University of Turku, Finland. Annales Universitatis Turkuensis, Medica – Odontologica Series D. Painosalama Oy, Turku, 2007.

Psychological factors, such as depression or depressive symptoms and fear of falling are linked to falls among the aged. According to previous studies, they may increase the risk of falls and injurious falls. In addition, depression or a high amount of depressive symptoms and fear of falling may hinder participation in preventive activities. Despite the severe consequences of both conditions and their high prevalence among the aged, they have rarely been studied in the context of fall prevention.

The study aimed to assess the effects of multifactorial fall prevention on the psychological risk factors of falling (depressive symptoms and fear of falling) among the community-dwelling aged at increased risk of falling. In addition, it aimed to determine factors predicting high adherence to preventive activities.

Volunteers aged 65 or over, who had fallen during the year previous to randomisation were recruited. Participants (n=591) were randomised into an intervention or a control group. The intervention group received a multifactorial fall prevention programme including geriatric assessment, individual guidance on fall and fracture prevention, group- and home-based physical exercise, psychosocial group activities, lectures and home hazards assessment. The control group had a one-time counselling on fall and fracture prevention. The data on psychological risk factors of falling were collected by self-rated questionnaires.

Multifactorial fall prevention was not effective in reducing depressive symptoms or fear of falling compared to one-time counselling in the total sample. However, in subgroup analyses, depressive symptoms reduced statistically significantly more among the men and older participants of the intervention group compared to the control group. Female gender, high physical and cognitive abilities and low self-perceived probability of falling were independent predictors of higher adherence in organised activities.

In conclusion, few psychological benefits were gained during this multifactorial fall prevention trial. More attention should be focused on adherence, especially among the aged with functional disabilities.

Keywords: depressive symptoms, fear of falling, aged, fall prevention, adherence

Tiivistelmä

Noora Sjösten

LAAJA-ALAISEN KAATUMISENEHKÄISYN VAIKUTUKSET KAATUMISTEN PSYYKKISIIN VAARATEKIJÖIHIN

Lääketieteellinen tiedekunta, kliininen laitos, yleislääketiede, Turun yliopisto. Medica - Odontologica Series D. Painosalama Oy, Turku, 2007.

Psyykkiset tekijät, kuten masennus tai masennusoireet ja kaatumisen pelko ovat yhteydessä kaatumisiin ikääntyneillä. Aikaisemmissa tutkimuksissa molempien on todettu lisäävän kaatumisten vaaraa. Lisäksi sekä masennus tai masennusoireet ja kaatumisen pelko voivat rajoittaa yksilön osallistumista kaatumisenehkäisyohjelmiin. Psyykkisiä tekijöitä on harvoin tutkittu kaatumisten ehkäisyn yhteydessä, huolimatta niiden vakavista seurauksista ja yleisyydestä ikääntyneiden keskuudessa.

Tutkimuksen tavoitteena oli selvittää laaja-alaisen kaatumisenehkäisyohjelman vaikutuksia kaatumisten psyykkisiin vaaratekijöihin: masennusoireisiin ja kaatumisen pelkoon. Ohjelman vaikutuksia tarkasteltiin kotona tai palveluasunnossa asuviin ikääntyneisiin, joilla oli kohonnut kaatumisen riski. Lisäksi tarkoituksena oli selvittää, mitkä tekijät ennustavat korkeaa osallistumisaktiivisuutta kaatumisenehkäisyinterventioon.

Tutkimukseen osallistui vapaaehtoisia, jotka olivat kaatuneet vähintään kerran tutkimusta edeltävän vuoden aikana. Tutkittavat (n=591) satunnaistettiin interventio- tai kontrolliryhmään. Interventioryhmäläiset osallistuivat laaja-alaiseen kaatumisenehkäisyohjelmaan, johon sisältyi geriatrin arviointi, yksilöllistä neuvontaa kaatumisten ja murtumien ehkäisystä, ryhmäliikuntaa, kotivoimistelua, psykososiaalista ryhmätoimintaa, luentoja sekä kodin vaaratekijöiden kartoitus. Aineisto kerättiin itse täytettävin lomakkein.

Kun tarkasteltiin koko aineistoa, laaja-alaisella kaatumisenehkäisyohjelmalla ei ollut kertaneuvontaa suurempaa vaikutusta masennusoireisiin tai kaatumisen pelkoon. Alaryhmäanalyyseissa selvisi kuitenkin, että masennusoireet vähenivät tilastollisesti merkitsevästi enemmän interventioryhmän miehillä sekä yli 75-vuotiailla kuin kontrolliryhmän vastaavissa alaryhmissä. Kaatumisenehkäisyohjelmaan osallistumista puolestaan lisäsivät naissukupuoli, korkea kognitiivinen ja fyysinen toimintakyky ja vähäiseksi koettu kaatumisen todennäköisyys.

Laaja-alaisen kaatumisenehkäisyohjelman vaikutukset kaatumisten psyykkisiin vaaratekijöihin jäivät vähäisiksi. Erityisesti huonokuntoisten iäkkäiden osallistumisaktiivisuutta tulisi edistää.

Avainsanat: masennusoireet, kaatumisen pelko, ikääntyneet, kaatumisenehkäisy, osallistumisaktiivisuus

Contents

Abbreviations

ABC	Activities-specific Balance Scale
ADL	Activities of daily living
BADL	Basic activities of daily living
CG	Control group
CI	Confidence interval
DSM	Diagnostic and Statistical Manual of Mental Disorders
FES	Falls Efficacy Scale
GDS	Geriatric Depression Scale
GDS-15	15-item version of the Geriatric Depression Scale
HBM	Health Behaviour Model
IADL	Instrumental activities of daily living
ICD-10	International Classification of Diseases
IG	Intervention group
MAOI	Monoamino oxidase inhibitors
MMSE	Mini Mental State Examination
ProFaNE	Prevention of Falls Network Europe
PY	Person year
SSRI	Serotonin selective reuptake inhibitor
TCA	Tricyclic antidepressant

List of original publications

I. Sjösten N, Kivelä S-L. The effects of physical exercise on depressive symptoms among the aged: a systematic review. Int J Geriatr Psychiatry 2006;21:410-8.

II. Sjösten N, Vaapio S, Kivelä S-L. The effects of fall prevention trials on depressive symptoms and fear of falling among the aged: a systematic review. Accepted to be published in Aging and Mental Health, 2007.

III. Sjösten N, Salonoja M, Piirtola M, Vahlberg T, Isoaho R, Hyttinen H, Aarnio P, Kivelä S-L. A multifactorial fall prevention programme in home-dwelling elderly people: a randomized controlled trial. Public Health 2007;121:308-18.

IV. Sjösten N, Salonoja M, Piirtola M, Vahlberg T, Isoaho R, Hyttinen H, Aarnio P, Kivelä S-L. A multifactorial fall prevention programme in the community-dwelling aged: predictors of adherence. Eur J Public Health. Published online (5 Jan, 2007), doi: 10.1093/eurpub/ckl272, http://eurpub.oxfordjournals.org/cgi/content/full/ckl272.

V. Sjösten N, Vahlberg T, Kivelä S-L. The effects of multifactorial fall prevention on depressive symptoms among the aged at increased risk of falling. Accepted to be published in International Journal of Geriatric Psychiatry, 2007.

These articles are referred to in the text by Roman numerals I-V. In addition, some unpublished data and data of the manuscript by Vaapio and co-workers (In press, 2007) are presented.

1. Introduction

Falls are a common public health problem among the aged populations. Approximately 30% to 40% of healthy community-dwelling older people aged 65 or older fall each year (Tinetti et al. 1988; Stalenhoef et al. 2002; Skelton & Todd 2004) and half of them fall subsequently (Tinetti et al. 1988). Even though only a minority of falls lead to severe injuries, they have serious consequences at both an individual and societal level.

In 2000, the estimated costs of acute treatment of fall-related injuries among 65-year-old or older Finns were as high as 39 million euros, mainly due to the treatment of hip fractures requiring hospitalisation (Piirtola et al. 2002). In addition, falls are the leading cause of injury deaths among people aged 65 and older and according to the latest prognosis the incidence of fall-induced severe head injuries and fall-induced deaths is rapidly increasing in Finland (Kannus et al. 2005; National Public Health Institute. Death-induced injuries in 2005; Kannus et al. 2007).

The risk factors of falls have been extensively studied and several factors have been identified (e.g. muscle weakness, history of falls, gait and balance deficits and high age) (Rubenstein & Josephson 2002). In addition, psychological factors, such as depression or depressive symptoms and fear of falling increase the risk of falls. According to prospective studies, conducted among the community-dwelling aged, persons with depression or a high amount of depressive symptoms have a 1.5–3.0-fold risk of fractures, falls or recurrent falls (Whooley et al. 1999; Stalenhoef et al. 2002; Reyes-Ortiz et al. 2004; Andresen et al. 2006). Persons suffering from fear of falling have a 1.5–2.5-fold risk of future fractures, falls or recurrent falls (Luukinen et al. 1997; Cumming et al. 2000; Friedman et al. 2002).

Fall prevention has been targeted at reducing risk factors of falls and by reducing the risks to reduce the incidence of falls and injurious falls. Basically two strategic approaches have been used; a single and a multifactorial approach which may be targeted at either whole populations or selected risk groups. A multifactorial approach has been effective in reducing the proportion of fallers in unselected and selected populations, especially when activities have been individually tailored and targeted to identified risk factors, such as poor balance (Tinetti 2003; Skelton & Todd 2005). The majority of fall prevention trials have focused on reducing physical and medical risk factors, while psychological factors, such as fear of falling and depression have gained less attention, despite their high prevalence in the aged population.

Effective treatment for clinical depression, such as antidepressants, is currently available. However, the use of some antidepressants (at least tricyclic

antidepressant, TCAs, and selective serotonin reuptake inhibitors, SSRIs) increases the risk of falls and especially frail, older people are vulnerable to side effects (Leipzig et al. 1999a; Arfken et al. 2001; Richards et al. 2007). Low dose antidepressant treatment could be suitable for the aged, but its efficacy has not yet been clearly demonstrated (Wilson et al. 2001). Other methods may thus be useful in treating depression in old age and in fall prevention. A low amount of physical exercise has been associated with a high amount of depressive symptoms in previous studies (Ruuskanen & Ruoppila 1995) and intervention programmes including aerobic or non-aerobic physical exercise have been effective in reducing depressive symptoms and clinically diagnosed depression at least in adolescent and adult populations (North et al. 1990; Martinsen 1994; Ernst et al. 2006; Larun et al. 2006). Physical exercise might, therefore, be especially suitable method for reducing depressive symptoms in fall prevention either alone, or combined with other preventive activities.

Fear of falling has been studied to a greater extent in the context of fall prevention than depression and it may be reduced at least by Tai Chi, use of hip protectors or participating in cognitive behavioural classes with an exercise component (Lundin-Olsson et al. 2002). It is not known, however, which method is the most effective in reducing fear.

Persons with a high amount of depressive symptoms or suffering from clinical depression or fear of falling may be especially difficult to recruit and maintain in fall prevention programmes. In addition, adherence to the suggested activities might be compromised due to debilitating symptoms. Adherence to the suggested activities is, however, a key issue in any successful prevention programme and should always be promoted (Yardley et al. 2006a). According to data from six European countries, adherence to preventive activities is actually maintained by several perceived benefits (e.g. improved mood and enjoyment), other than simple fall reduction (Yardley et al. 2006b). Very little is, however, known about factors independently predicting adherence to fall prevention.

The effects of fall prevention on depression or depressive symptoms and fear of falling are important to determine, since both conditions are common among the aged (Lebowitz et al. 1997; Cumming et al. 2000) and may lead to severe consequences in regard to falls by decreasing functional abilities and social contacts, and thus by increasing the risk of falls. It is also important to evaluate factors predicting adherence to be able to target its promotion at persons with the highest risk of missing out on the preventive measures due to non-participation.

2. Review of the literature

2.1. Falls among the aged

2.1.1 Definition

A fall was originally defined as "unintentionally coming to the ground or some lower level and other than as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis as in stroke or epileptic seizure" by the Kellogg International Working Group on the prevention of falls in the 1980s (A report of the Kellogg International Work Group on the Prevention of Falls by the Elderly 1987).

The above definition has been used in many fall prevention studies (Hornbrook et al. 1994; Close et al. 1999; Lord et al. 2003; Davison et al. 2005; Lord et al. 2005). Yet a shorter version of the original definition has also been used by many researchers (Campbell et al. 1997; Hogan et al. 2001; Stalenhoef et al. 2002; Barnett et al. 2003), one of the shortest being "unintentional movements to the floor or ground" suggested by Tinetti and co-workers (Tinetti et al. 1997).

In most definitions, a fall is an inadvertent or unintentional hazard caused by a loss of balance and resulting in a person coming to rest on the ground, floor or other lower level or on an object (e.g. Close et al. 1999; Lord et al. 2003; Wolf et al. 2003a; Davison et al. 2005). A cause of a fall hazard has not usually been defined but major intrinsic factors, such as a sudden onset of paralysis, epileptic seizure, excess alcohol intake, and major extrinsic factors, such as a violent blow, have often been excluded as causes for falls (Close et al. 1999; Lord et al. 2003, 2005). The definition of the Kellogg Working Group excluded also loss of consciousness from its definition while many researchers have subsequently added this aspect to their definitions (Luukinen et al. 1995; Close et al. 1999; Davison et al. 2005).

Falls have been classified according to their occurrence and consequent injuries.

A recurrent fall has been defined as two or more falls occurring within one year or other defined follow-up period (Luukinen 1995; Stalenhoef et al. 2002).

An injurious fall has been defined as a fall resulting in fractures, bruises, strains, sprains, cuts or abrasions, pain or any other physical consequence. In one study, falls causing persistent pain, lasting more than 7 days were also defined as injurious falls (Hornbrook et al. 1994). Luukinen and co-workers (1995) defined an injurious fall according to the International Classification of

Diseases (ICD-10) (World Health Organization 1992) excluding falls from bicycles or caused by motor vehicles.

In some instances a specific fall-induced injury has been in focus. For example, in a study by Kannus and co-workers (2000) a fall-induced fracture-associated spinal cord injury was defined as "an injury that occurred in a person aged 50 years or older as a consequence of a fall from a 1-metre or less standing height that resulted in hospitalization of the victim".

In some studies slips and trips have been defined separately from other falls; slips referring to the occurrence where foot/feet slides from underneath the person and trips referring to a stumble caused by an object on the pathway. These definitions are close to the definition of near falls, used by some researchers, while in both above mentioned cases balance is regained and the person does not actually hit the ground (Steinberg et al. 2000).

2.1.2 Incidence of falls and fall injuries

Approximately 30% to 40% of healthy community-dwelling older person aged 65 or over fall each year (Tinetti et al. 1988; Lord et al. 1993; O' Loughlin et al. 1993; Luukinen et al. 1994; Tromp et al. 2001; Stalenhoef et al. 2002; Skelton & Todd 2004), and half of them fall subsequently (Tinetti et al. 1988). Incidence of falling tends to increase with age, being highest among persons aged 80 years or older (Luukinen et al. 1994; Tinetti et al. 1995; Rubenstein & Josephson 2002; Skelton & Todd 2004) and higher among women than among men (Chu et al. 2005).

Between 24%–45% of fallers suffer from injuries caused by falls; mostly from minor injuries, such as lacerations, bruises and wounds (Tinetti et al. 1988; Stalenhoef et al. 2002). Approximately 10% of falls lead to severe injuries half of which are fractures and half of which other severe injuries, such as head injuries (Tinetti et al. 1988; Luukinen et al. 1995; Skelton & Todd 2004). Only 0.2%–1.5% of fallers suffer from hip fractures (Lord et al. 2001), which, however, lead to the highest healthcare costs (Piirtola et al. 2002). Among home-dwelling Finns aged 70 years or older, the incidence of minor injuries (bruises, superficial lacerations and wounds not needing suturing) caused by falls has been 136 per 1000 person years (PY), of major injuries (dislocations, soft tissue injuries needing suturing) 57 per 1000 PY and of fractures 25 per 1000 PY (Luukinen et al. 1995). In 1997, the age-adjusted incidence of hip fractures was 437 per 100 000 persons in women and 233 per 100 000 persons in men among Finns aged 50 or older; the rates being clearly higher than in 1970 (Kannus et al. 1999). However, during recent years (1997–2004), this threatening tendency has fortunately decreased, and the age-adjusted

incidences of hip fractures have declined among both men and women (Kannus et al. 2006).

2.1.3 Consequences of falls and fall injuries

Mortality

In 2005, 1538 people aged 65 or older died in unintentional injuries in Finland and 922 (60%) of these were caused by falls. Unintentional injuries are the sixth leading cause of death among Finns aged 85 and older and falls are a leading cause of injury-based deaths among people aged 65 and older in Finland (National Public Health Institute. Death-induced injuries in 2005). According to Kannus and co-workers (2005) the nationwide trend in fall-induced deaths has clearly increased during the past three decades, especially among men.

Costs

The costs of fall-related injuries are high. In 2000, the estimated costs of acute treatment (including outpatients and hospital treatment) of fall-related injuries among 65-year-olds and older in Finland were as high as 39 million euros. The costs are mainly due to the treatment of fractures (especially hip fractures) requiring hospitalisation (Piirtola et al. 2002). Even though, the alarming trend of rising incidence of hip fractures, noticed between 1970 and 1997 in Finland, has slowed down in recent years (Kannus et al. 1999, 2006), hip fractures will clearly burden our health care system in the future.

Functional abilities and nursing home admission

Non-injurious and injurious falls are significantly associated with a decline in the basic and instrumental activities of daily living (BADL and IADL), and in physical and social activities during three years after a falling event among the aged community-dwellers (Tinetti & Williams 1998). When resulting in injury, falls may severely reduce mobility and independence, and hasten premature nursing home admission. According to Tinetti and co-workers (1997) persons with one fall leading to a serious injury had a 10-fold risk of nursing home admission during the following year.

Psychological consequences

Psychological distress, such as depression and fear of falling, is a common outcome of a falling event (Scaf-Klomp et al. 2003; de Jonge et al. 2006), in fact far more common than fractures. A considerable number of fallers restrict their daily activities due to the fear of falling (Tinetti et al. 1994b), which may lead to deterioration of functional abilities, reduction in social contacts and worsened quality of life. A high amount of depressive symptoms 8 weeks after a fall-related injury has also been associated with disability 5 and even 12 months

after a falling injury and has independently predicted a decline in social and physical activities after a falling event (Kempen et al. 2003; Stel et al. 2004).

2.2. Risk factors of falls

Several risk factors for falls have been identified. They may be classified into internal, external and environmental risk factors and can be modifiable (e.g. depression) or non-modifiable (e.g. blindness). High age, gender, ethnicity, poor balance and muscle strength, weakened eye sight, side effects of some medicines, impaired cognition, depression, poor cognitive abilities and fear of falling belong to internal risk factors. Polypharmacy is an example of external risk factors, while inadequate lightning, slippery roads and loose carpets are environmental risk factors of falling (American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention 2001; Skelton & Todd 2004). The prevalence of internal risk factors of falls increases notably after the age of 70 (Tinetti 2003; Skelton & Todd 2004).

Most falls have a multifactorial etiology, and are thus rarely caused by one single factor. They usually result from interactions between long-term or short-term predisposing factors and short-term precipitating factors in a person's environment and should thus always be evaluated in a multivariate manner (Tinetti 2003; Skelton & Todd 2004). In previous studies, risk of falling has notably increased when the number of risk factors has increased (Tinetti et al. 1988; Nevitt et al. 1989; Biderman et al. 2002). For example, in a study of Stalenhoef and co-workers (2002) a person with a high amount of depressive symptoms had a 19% probability of recurrent falls, while in a person with both a high amount of depressive symptoms and a previous fall the predicted risk increased to 42% in men and to 33% in women. The interaction and probable synergism between risk factors may thus be as important as identifying a single risk factor (American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention 2001).

An additional factor to be considered when assessing an individual's risk of falls is exposure to risk. A U-shape association between exposure and risk of falling has been suggested in some studies, the most active and the most inactive being at greatest risk (Skelton & Todd 2004).

2.2.1 Most common risk factors of falls

The most common risk factors of falls are muscle weakness, history of falls, gait and balance deficits, use of assistive device, visual deficits, arthritis, difficulties or dependence in activities of daily living (ADL), depression, cognitive impairment and age ≥80 (Rubenstein & Josephson 2002). The

strongest evidence of being a risk factor of falls has been shown to be advanced age, history of falls and injurious falls, difficulties or dependence in ADL, impaired mobility and transferring skills, poor visual contrast sensitivity, muscle weakness and poor reaction time. Of medical factors, impaired cognition, stroke and Parkinson's disease have the strongest evidence of being risk factors of falls (Lord et al. 2001). In addition, persons using psychotropic or antiarrythmic medication, digoxin and diuretics are at increased risk of falling (Leipzig et al. 1999a, 1999b).

2.3. Psychological risk factors of falls among the community-dwelling aged

Depression or a high amount of depressive symptoms and fear of falling belong to the psychological (internal) risk factors of falling. Both conditions are common among the aged. Even though only 1%–2% of the community-dwelling aged suffer from major depression, approximately 13% to 27% have clinically significant depressive symptoms not meeting the criteria of major depression or dysthymia (=subsyndromal depressive symptoms) (Pahkala et al. 1995; Lebowitz et al. 1997). Fear of falling is one of the most common fears among the community-dwelling aged, with estimates of its prevalence ranging from 32% to 58% among previous fallers (Vellas et al. 1997; Cumming et al. 2000; Cesari et al. 2002) and from 21% to 55% among the community-dwelling aged without a history of falls (Cwikel et al. 1989; Arfken et al. 1994; Tinetti et al. 1994b; Howland et al. 1998; Bruce et al. 2002; Friedman et al. 2002; Murphy et al. 2002). The prevalence of depression or depressive symptoms and that of fear of falling increases with age and is higher among women than among men (Arfken et al. 1994; Pahkala et al. 1995; Vellas et al. 1997; Takkinen et al. 2004; Zijlstra et al. 2007).

Fear of falling has been defined as a lasting worry or concern (trait) about falling, which leads to a person to restrict or avoid activities that he/she is still capable of performing (Tinetti & Powell 1993). In its most severe form it has been described as an expression of anxiety.

Another definition relates to perceived falls efficacy, which refers to a person's self-perceived confidence (i.e. lack of fear) to manage daily activities without falling (Tinetti & Powell 1993; Jørstad et al. 2005). This latter definition is derived from Bandura´s Social Cognitive Theory (from the term "self-efficacy") (Bandura 1986) and refers to a person´s own perception of the degree of his/her abilities. Even though these terms have often been used as parallel terms in previous studies (See e.g. Pluijm et al. 2006), they may refer to different underlying constructs. Fear of falling may be an indication of more generalized fearfulness and anxiety, while falls efficacy is thought to be activity or domain specific, which can not be generalised to other functions.

Fear of falling has been associated with impaired balance (Arfken et al. 1994; Burker et al. 1995), slow walking speed and gait abnormalities (Vellas et al. 1997; Kressig et al. 2001). In addition, persons with fear have shown declined abilities to perform ADL functions (Burker et al. 1995; Cumming et al. 2000) and lower levels of perceived abilities to manage falls (Lawrence et al. 1998). Excessive fear may lead to activity restriction (Howland et al. 1998), worsened quality of life and increased risk for institutionalization even among persons without previous falls (Cumming et al. 2000). Sometimes fear of falling may be even more disabling than a fall itself (Cumming et al. 2000; Oude Voshaar et al. 2006) and should thus be considered as a health problem in its own right.

Fear of falling and depression or depressive symptoms seem to be interrelated. A statistically significant association between depressive symptoms and fear of falling has been found in previous studies (Howland et al. 1993; Arfken et al. 1994; Kressig et al. 2001; Chou et al. 2005). For example, Kressig et al. (2001) reported the depressed aged to be more than twice as likely to be fearful than the non-depressed, measured by both Falls Efficacy Scale (FES) and Activities-specific Balance Scale (ABC). Arfken et al. (1994) found that even moderately fearful persons had an elevated risk for depressed mood. The sum score of the Geriatric Depression Scale (GDS) also differed significantly according to the amount of fear, being highest among the very fearful persons.

It has been suggested that falls efficacy and participation in physical activity may both mediate and moderate the linkage between fear of falling and depression (Chou et al. 2005). Those having more fear might restrict their physical activities which may lead to increased amount of depressive symptoms (mediator). On the other hand, participation in physical activity and improved falls efficacy may moderate the detrimental effects of fear of falling on depressive symptoms and thus act as a moderator.

2.3.1 Depression or depressive symptoms as a risk factor of falls

Depression or depressive symptoms have been associated with falls, injurious falls, fractures and recurrent falls in previous population-based studies or studies conducted among selected samples using cross-sectional or longitudinal designs (Whooley et al. 1999; Cesari et al. 2002; Stalenhoef et al. 2002; Lawlor et al. 2003; Reyes-Ortiz et al. 2004; Sheeran et al. 2004; Andresen et al. 2006; Korpelainen et al. 2006). Studies showing independent associations between depressive symptoms, depression or fear of falling and falls, recurrent falls or injurious falls among the community-dwelling aged are shown in Table 1.

Table 1. Associations between psychological factors (depression/depressive symptoms and fear of falling/falls efficacy) and falls, recurrent falls or injurious falls among the community-dwelling aged

Author Year Country	n	Population Lower age limit/ Range (yrs)	Design	Fall measurement	Risk factor measurement	Adjusted risk ratio (95% CI)
All falls						
Whooley et al. 1999 USA	7,414	White women from population-based listings. ≥65	Prospective cohort study (4 yrs)	Self-reported falls, interview	Depressive symptoms, GDS-15[1]	OR 1.4 (1.1–1.8)
Cumming et al. 2000 Australia	528	Community-dwelling aged, recruited from 2 hospitals. Selected population. ≥65	Prospective cohort study (12 mths)	Self-reported falls, monthly fall calendars and phone calls	Falls efficacy, FES[2]	**All subject:** HR 2.1 (1.3–3.3) **Subjects without falls:** HR 2.4 (1.3–4.5)
Cesari et al. 2002 Italy	5,570	Patients admitted to home care programmes. Population-based. Mean age: 77.2	Cross-sectional	Self-reported falls (within 90 days of the assessment), MDS-HC[3]	Depressive symptoms, MDS-HC[3]	OR 1.5 (1.4–1.7)
Friedman et al. 2002 USA	2,212	Community-dwelling aged. Population-based. ≥65	Prospective cohort study (20 mths)	Self-reported falls, questions about falls in past 12 months	Fear of falling at baseline, questionnaire	OR 1.8 (1.4–2.2)
Lawlor et al. 2003 UK	4,050	Community-dwelling women. Population-based. ≥60	Cross-sectional	Self-reported falls during previous 12 months, questionnaire	Depression, medical records, interviews by a nurse, questionnaire	OR 1.8 (1.4–2.2)
Reyes-Ortiz et al. 2004 USA	1,391	Mexican-American men and women. Population-based. ≥72	Prospective cohort study (2 yrs)	Self-reported falls in the previous 12 months, questionnaire	Depressive symptoms, CES-D[4]	OR 1.6 (1.2–2.2)
Sheeran et al. 2004 USA	440	Patients enrolled in home care treatment and subsequently falling (cases) and patients enrolled simultaneously but not falling during one year (controls). Selected population. ≥63	Prospective matched case-control study (1 yr)	Falls, medical charts	Depressive symptoms, presence of depressed mood or anhedonia	OR 3.0 (1.2–7.2)
Andresen et al. 2006 USA	998	Home-dwelling African-American from poor inner-city area. ≥59	Prospective cohort study (2 yrs)	Self-reported falls during one year, telephone interview	Depressive symptoms, 11-item CES-D[4]	OR 1.5*
Korpelainen et al. 2006 Finland	407	Women in lowest BMI[5] tertile (BMI≤25.1) from population-based sample. Selected population. 70-73	Cross-sectional	Self-reported falls in past 3 months, questionnaire	Depressive symptoms, GDS[6]	OR 2.3 (1.2–4.4)
Recurrent falls						
Luukinen et al. 1996	1,016	Home-dwelling older people living in Northern Finland. Population-based.	Prospective cohort study (1 yr)	Recurrent falls (≥2 within 365 days), diary, regular phone	Frequency of fear of falling, questionnaire	OR 2.2 (1.3–3.7)

Finland		≥70		calls, medical records		
Stalenhoef et al. 2002 The Netherlands	311	Community-dwelling aged. Population-based. ≥70	Prospective cohort study (36 wks)	Self-reported falls (≥2 during 36 weeks), regular phone calls	Depressive symptoms, subscale of SCL90[7]	OR 2.2 (1.1–4.5)
Lawlor et al. 2003 UK	4,050	Community-dwelling women. Population-based. >60	Cross-sectional	Self-reported falls (≥2 during past 12 months), questionnaire	Depression, medical records, interviews by a nurse, questionnaire	OR 2.1 (1.5–2.9)
Pluijm et al. 2006 The Netherlands	1,365	Community-dwelling aged. Population-based. ≥65	Prospective cohort study (3 yrs)	Self-reported falls (≥2 falls/6 months), weekly calendars	Falls efficacy, FES[2]	OR 1.4 (1.0–1.9)
Injurious falls						
Ryynänen et al. 1992 Finland	380	Community-dwelling fallers seeking treatment for a fall. Selected population. ≥65	Case-control	Recurrent falls requiring medical treatment, clinical examination	Depressive symptoms, modified ZSDS[8] Frequency of fear of falling, questionnaire	**Men:** OR 7.8 ** **Women:** OR 1.8**
Arfken et al. 1994 USA	1,358	Community-dwellers. Population-based age-stratified random sample. ≥65	Prospective cohort study (1yr), cross-sectional association between fear of falling and falls	Self-reported falls resulting in fracture, monthly postcards, phone calls, telephone interviews	Fear of falling, home-based interview at one year	OR 6.7 (2.0–22.0)
Luukinen et al. 1997 Finland	164	Home-dwelling aged living in northern Finland born 1920 or earlier. Population-based. >70	Nested case-control study (4 yrs)	Fractures caused by falls, medical records	Frequency of fear of falling, questionnaire	OR 2.5 (1.1–5.7)
Whooley et al. 1999 USA	7,414	White women from population-based listings. ≥65	Prospective cohort study (4-6 yrs)	Non-vertebral and vertebral fractures, postcards, telephone calls, radiographic reports	Depressive symptoms, GDS-15[1]	**Non-vertebral fractures:** HR 1.3 (1.1–1.6) **Vertebral fractures:** OR 2.1 (1.4–3.2)
Murphy et al. 2002 USA	1,064	Community-dwelling aged. Population-based. ≥72	Cross-sectional	Self-reported falls and injurious falls in the past year, home-based interview	Fear of falling, home-based interview	RR 1.4 (1.1–1.7)
Lawlor et al. 2003 UK	4,050	Community-dwelling women. Population-based. ≥60	Cross-sectional	Self-reported falls requiring medical treatment in previous 12 months, questionnaire	Depression, medical records, interviews by a nurse, questionnaire	OR 2.2 (1.6–3.0)

CI = Confidence Interval, OR = Odds Ratio, HR = Hazards Ratio, RR = Risk Ratio; RR/OR/HR >1 indicates increased risk for falls at the presence of risk factor (if not stated otherwise); 1 GDS-15 = 15-item Geriatric Depression Scale; 2 FES = Falls Efficacy Scale; 3 MDS-HC = Minimum Data Set-Home Care instrument; 4 CES-D = Center for Epidemiologic Studies Depression Scale; 5 BMI = Body Mass Index; 6 GDS = Geriatric Depression Scale; 7 SCL90 = Symptom Checklist; 8 ZSDS = Zung Self-Rating Depression Scale; *CI not reported, $p<0.05$; **Lower amount of depressive symptoms was significantly associated with recurrent falls requiring medical treatment among men, and non-occurrence of fear of falling was significantly associated with recurrent falls requiring medical treatment among women.

2.3.1.1 All falls

Fallers have had a higher prevalence of depressive symptoms than non-fallers in many cross-sectional studies (Campbell et al. 1981; Cwikel et al. 1989; Cesari et al. 2002; Lawlor et al. 2003). Especially persons with falls caused by internal factors ("pattern falls") have had more depressive symptoms compared to persons with occasional falls (caused by external factors) (Campbell et al. 1981). Lawlor and co-workers (2003) found that almost one third of the persons, who had fallen during the past 12 months suffered from a high amount of depressive symptoms, compared to only 16% of persons without previous falls reporting depressive symptoms.

While sometimes not present, when adjusting for other risk factors, the association between falls and depressive symptoms remained significant in two large population-based studies (Cesari et al. 2002; Lawlor et al. 2003) and in one study in a selected population (Korpelainen et al. 2006) showing that persons with a high amount of depressive symptoms had an approximately 1.5–2-fold risk for a fall compared to persons without depressive symptoms.

Statistically significant bivariate associations between baseline depressive symptoms and future falls have also been found in several prospective studies (Tinetti et al. 1988; Graafmans et al. 1996; Tromp et al. 2001; Chu et al. 2005). These associations have, however, often disappeared when the impact of other risk factors has been taken into account, suggesting that it may be related to other risk factors (Tinetti et al. 1988; Tromp et al. 2001; Chu et al. 2005). However, in three prospective studies conducted in different populations, depressive symptoms independently predicted falls; persons with a high amount of depressive symptoms having an approximately 1.5-fold risk of future falls during 2–4-year follow-ups (Whooley et al. 1999; Reyes-Ortiz et al. 2004; Andresen et al. 2006).

2.3.1.2 Recurrent falls

Less evidence is available in support of an independent association between depression or depressive symptoms and recurrent falls. An independent association between the diagnosis of depression and recurrent falls (≥2 falls during the previous 12 months) was found among community-dwelling women in only one cross-sectional study (Lawlor et al. 2003).

A high amount of depressive symptoms has also been associated with future recurrent falls, during follow-ups of different lengths (Nevitt et al. 1989; Graafmans et al. 1996; Luukinen et al. 1996; Tromp et al. 2001; Biderman et al. 2002; Stalenhoef et al. 2002; Chu et al. 2005; Pluijm et al. 2006). However, when adjusted for other risk factors of falling, depressive symptoms remained a

significant predictor of future recurrent falls in only one study (Stalenhoef et al. 2002) showing that persons with a high amount of depressive symptoms have an approximately 2–fold risk for recurrent falls during the 36-week follow-up, when compared to persons with no falls.

2.3.1.3 Injurious falls

Depression or a high amount of depressive symptoms may also increase the risk of injurious falls. In cross-sectional studies men with one fall requiring medical treatment had more depressive symptoms than men without falls (Ryynänen et al. 1993) and women with recurrent falls requiring medical treatment had more depressive symptoms compared to women with only one single fall (Ryynänen et al. 1992).

In a large population-based study (N=4,050) among women randomly selected from general practice lists in 23 towns in United Kingdom (British Women's Heart and Health Study), self-reported falls requiring medical treatment in the previous 12 months were independently associated with depression diagnosis, often determined already before the falling event (Lawlor et al. 2003).

However, some negative (Ryynänen et al. 1993) and opposite (Ryynänen et al. 1992) results have also been reported. In a case-control study among community-dwelling fallers, men with recurrent falls requiring medical treatment had actually fewer depressive symptoms than men with only a single fall and the association remained, when adjusting for other risk factors of falling (Ryynänen et al. 1992).

Few studies have assessed the association between depression or depressive symptoms and injurious falls longitudinally. In two large prospective cohort studies among the community-dwelling aged, depressive symptoms at baseline were associated with future severe fall injuries (Tinetti et al. 1995) and were independent predictors of non-vertebral and vertebral fractures after adjusting for various confounders (Whooley et al. 1999). Notably, feelings of hopelessness, worthlessness and dissatisfaction in the GDS were strongly associated with fractures (Whooley et al. 1999).

However, in a nested case-control study among the home-dwelling older people aged 70 or older living in Northern Finland, depressive symptoms (Zung Self-Rating Depression Scale, ZSDS) were not associated with fractures caused by falls during a 4-year follow-up (Luukinen et al. 1997).

Conclusion

According to prospective evidence, the community-dwelling aged with a high amount of depressive symptoms or suffering from diagnosed depression have an approximately 1.5–3.0-fold risk of falls, 2-fold risk of recurrent falls and 1.5–

2–fold risk of non-vertebral and vertebral fractures compared to persons without depression or a high amount of depressive symptoms. However, in many previous studies bivariate associations tended to diminish after adjustment for other risk factors of falling suggesting that the association is mediated by other factors. In addition, only a limited number of studies assessing the association between depression or depressive symptoms and recurrent or injurious falls have been conducted and the results have been somewhat inconsistent.

2.3.2 Fear of falling as a risk factor of falls

2.3.2.1 All falls

Both fear of falling and falls efficacy have been associated with previous falls, determined as any fall (Cwikel et al. 1989; Arfken et al. 1994; Mendes de Leon et al. 1996; Cesari et al. 2002). In population-based studies 58% of previous fallers have had fear of falling compared to 43% of non-fallers (Cesari et al. 2002). In addition, low falls efficacy has been more prevalent among fallers than among non fallers (Mendes de Leon et al. 1996). However, independent cross-sectional associations between falls and fear of falling or falls efficacy have not been found.

In contrast, in longitudinal studies with 12 to 20-month follow-ups independent associations between falls and fear of falling or falls efficacy have been found (Cumming et al. 2000; Friedman et al. 2002). In a study of Cumming and co-workers (2000), persons with low falls efficacy (sum score in FES ≤75) had a higher risk of falls during a 1-year follow-up, regardless of previous falling status. In a larger population-based study (N=2,212), fear of falling, measured by one question at baseline, independently predicted future falls during 20-month follow-up (Friedman et al. 2002). It was also found that falls at baseline were an independent predictor for the development of fear of falling during the follow-up, suggesting that either one of these conditions (fear or a fall) may lead to the other.

2.3.2.2 Recurrent falls

In cross-sectional studies, bivariate associations between both moderate and high amount of fear of falling and recurrent falls have been found (Arfken et al. 1994; Lawrence et al. 1998). These associations have, however, disappeared when adjusted for other factors.

In prospective studies, fear of falling has been more prevalent among recurrent fallers than among non-fallers or persons with a single fall (Chu et al. 2005), and low falls efficacy (FES) has been independently associated with future recurrent falls during a 3-year follow-up (Pluijm et al. 2006).

2.3.2.3 Injurious falls

Fear of falling has been associated with previous injurious falls, recurrent falls requiring medical treatment and falls resulting in fractures (Ryynänen et al. 1992; Arfken et al. 1994; Murphy et al. 2002). In population-based studies among the community-dwelling aged, persons with fear of falling had significantly higher risk for self-reported injurious falls and falls resulting in a fracture (Arfken et al. 1994; Murphy et al. 2002). Of persons who were very fearful 9% had had a fracture in the past year compared with less than 0.5% of persons without fear. Fear of falling also remained an independent risk factor of falls resulting in a fracture in multivariate analyses (Arfken et al. 1994).

Contrary results have also been reported (Ryynänen et al. 1992). In a case-control study among the community-dwelling aged seeking medical treatment for falls, women without fear of falling had actually higher risk for recurrent falls requiring medical treatment. In the discussion of the article, the association was explained by behavioural characteristics, since those without fear of falling may be less anxious about falling and thus walk and act incautiously, which puts them at increased risk for falls and injuries.

Few studies have assessed the association between fear of falling and injurious falls longitudinally (Luukinen et al. 1997). In a nested case-control study among home-dwelling aged Finns, fear of falling was independently associated with fractures during a 4-year follow-up. Persons reporting frequent fear of falling had a 2.5-fold risk for fractures compared to controls with a falling induced soft-tissue injury.

Conclusion

The association between fear of falling (or falls efficacy) and falls is still unclear, since very few studies assessing a terminal relationship between these variables have been conducted. It seems, however, that both directions are possible, so that those with fear are at increased risk of falling and those with previous falls are at increased risk for creating fear of falling. According to longitudinal evidence persons with fear of falling or low falls efficacy have an approximately 2-fold risk for falls, 1.5–2-fold risk for recurrent falls and 2.5-fold risk for future fractures.

2.4. Fall prevention among the community-dwelling aged

There are basically two strategic approaches in fall prevention, a non-selective and a selective approach. A non-selective approach means that the effects of the intervention are investigated in the whole population (population-based, community-based programmes) and the programme is implemented in whole communities (Skelton & Todd 2005), including or not including institutional residences (McClure et al. 2005). In a selective approach prevention is targeted

at individuals with the highest risk of falling (e.g. women, frail aged, those at higher age, previous fallers).

In addition, intervention programmes may be generic (same programme for a group of people) or individually tailored, the latter usually being the case among selected populations. In addition, prevention may be based on a single-factor intervention (e.g. physical exercise) or on a multifactorial strategy targeted to reduce various risk factors of falling simultaneously (American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention 2001; Tinetti 2003).

2.4.1 Multifactorial interventions

Due to the multifactorial etiology of most falls, a multifactorial approach targeted at several risk factors simultaneously could be a rational strategy to prevent falls. In fact, multifactorial interventions implemented in selected and unselected populations seem beneficial, reducing the relative proportions of fallers by 14% to 27%, respectively (Gillespie et al. 2003). Benefits have been gained, especially when activities have been individually tailored and targeted at identified risk factors, while multifactorial assessments, not followed by targeted interventions have been ineffective in preventing falls (Tinetti 2003). Population-based multifactorial interventions have also been effective in reducing indicators of fall-related injuries (hospitalisation due to injuries, fractures, injury-rates) by 6% to 33% (McClure et al. 2005).

According to American and European guidelines for fall prevention (American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention 2001; Skelton et al. 2004), a multifactorial intervention programme ideally consists of gait training and advice on the use of assistive devices, review and modification of medication, exercise programmes with balance training, treatment of postural hypotension, modification of the environment and treatment of cardiovascular disorders.

2.4.2 Single factor interventions

Of single factor interventions physical exercise has probably been studied the most. It seems that individually tailored exercise programmes including muscle strengthening combined with balance training are effective in reducing the number of people sustaining a fall or a fall injury (Campbell et al. 1997, 1999; Robertson et al. 2001), while the effectiveness of non-targeted physical exercise programmes has not been demonstrated (Gillespie et al. 2003). In addition, Tai Chi (an ancient form of Chinese martial art, T'ai Chi Ch'uan, consisting of self-defence, calisthenics and meditation) (Cheng & Smith 1993), withdrawal of psychotropic medication, and home hazards assessment with

modification by a health care professional are effective in reducing the risk of falls among community-dwellers (Gillespie et al. 2003).

2.5 Reducing psychological risk factors of falls

The positive effects of antidepressant medications (TCAs, SSRIs and monoamino oxidase inhibitors, MAOIs) compared to placebo treatment have been proven among the aged suffering from clinical depression (Wilson et al. 2001). However, antidepressant users are at increased risk for falls and fractures (Leipzig et al. 1999a; Richards et al. 2007) and especially frail, older people are vulnerable to side effects. In addition, low response to medication has been described among the "old-old" (Watson et al. 2004), and the efficacy of low dose treatment, probably causing less side effects, has not been demonstrated among the aged (Wilson et al. 2001). Other alternatives to reduce depression or depressive symptoms could thus be useful among the aged at increased risk of falling.

2.5.1 Effects of physical exercise on depressive symptoms

Cross-sectional studies have shown an association between a high amount of physical activity and a low amount of depressive symptoms in adolescent, middle-aged (Stephens 1988; Weyerer 1992; Hassmén et al. 2000) and aged populations (Kivelä & Pahkala 1991; Ruuskanen & Ruoppila 1995). Physical exercise might be especially effective in reducing depressive symptoms among patients with mild to moderate depression (Martinsen 1994). It has been suggested that a total energy expenditure of 17.5 kcal/kg/week, consistent with public health recommendations, could be a sufficient dose for treating major depression (Dunn et al. 2005). In studies, assessing the effects of physical exercise on depressive symptoms, benefits have been gained at least among young children, adolescents and middle-aged (Ernst et al. 2006; Larun et al. 2006).

Only few randomized controlled trials on the effects of physical exercise on depressive symptoms or clinical depression have been conducted among the community-dwelling aged. The results of these studies mostly support a hypothesis relating to the positive effects of aerobic and anaerobic exercise on depressive symptoms among the aged. Especially persons with an initially high level of depressive symptoms or suffering from clinical depression seem to benefit (McNeil et al. 1991; Singh et al. 1997; Blumenthal et al. 1999; Mather et al. 2002; Chou et al. 2004). The following synthesis is based on a review about the effects of physical exercise on depressive symptoms among the aged (*Study I*).

Depressed aged

According to Singh and co-workers (1997) an anaerobic exercise programme significantly reduced both self- and therapist-rated depressive symptoms among clinically depressed volunteers. In addition, a total of 59% of the exercise group achieved a response, determined as a 50% reduction in the sum score of the Hamilton Rating Scale for Depression (HRSD), compared to 26% of controls ($p=0.067$). Even those with a disorder non-responsive to antidepressant medication benefited from an anaerobic exercise programme (Mather et al. 2002) (Table 2).

Aerobic exercise has also been effective in reducing somatic symptoms of depression among the moderately depressed aged (McNeil et al. 1991) and comparable with medication in reducing depressive symptoms and clinical depression among older patients with a major depressive disorder (Blumenthal et al. 1999). In addition, preliminary results of the positive effects of Tai Chi have been found among the community-dwelling depressed or dysthymic outpatients (Chou et al. 2004).

Mixed samples

Physical exercise has also been beneficial in samples consisting of both depressed and non-depressed subjects (Netz et al. 1994; Penninx et al. 2002; Timonen et al. 2002) (Table 3).

Penninx and co-workers (2002) compared the effects of aerobic and anaerobic exercise to the control condition and analysed the results by dichotomizing the subjects to those with a low or a high amount of depressive symptoms. Positive effects of aerobic exercise were found for both persons with initially high or low amount of depressive symptoms, but no such effects were observed for anaerobic exercise.

In contrast, Timonen and co-workers (2002) also found supervised anaerobic exercise to be effective in reducing depressive symptoms among frail aged patients discharged from hospital, of which 26% were earlier diagnosed depressed or met the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (American Psychiatric Association 1994) criteria when discharged from hospital.

One study was conducted in clinical settings among geriatric and psychogeriatric patients, who were diagnosed as demented, depressed or psychotic. Physical exercise was effective in reducing depressive symptoms only among psychogeriatric patients. However, psychogeriatric patients had initially more depressive symptoms than geriatric patients (Netz et al. 1994), so the result may be due to regression to the mean.

Non-depressed aged

In contrast, studies conducted on populations not suffering from depression or from a high amount of depressive symptoms at baseline have mostly produced negative results (Blumenthal et al. 1989; Emery & Gatz 1990; McMurdo & Burnett 1992; King et al. 1993; Chin A Paw et al. 2004). Only aerobic exercise has been efficient in reducing depressive symptoms among men after a 16 week aerobic exercise programme (Blumenthal et al. 1989; Emery & Gatz 1990; King et al. 1993). In addition, subjects' own perceptions of their psychological well-being, such as depression, anxiety and stress, have improved after an aerobic exercise programme (Blumenthal et al. 1989; King et al. 1993) (Table 4).

With regard to anaerobic exercise, it has not been effective in reducing depressive symptoms compared to controls among non-depressed volunteers (McMurdo & Burnett 1992; Chin A Paw et al. 2004). The negative results of these studies may be due to the low initial level of depressive symptoms. When already performing at optimal level, it is unlikely that any positive change could be detected.

Table 2. Effects of physical exercise on depressive symptoms or depression among the depressed aged

Authors Year Country	Participants		Intervention			Results
	n	Type and exercise status or fitness level Mean age (yrs), Range	Intervention and control activities	Duration (wks)	Setting of exercise	
McNeil et al. 1991 Canada	30	Moderately depressed (BDI[1]=12-24) community-dwelling volunteers. Baseline fitness level was determined by the Cooper's 112-min walk test. 73 Range not reported.	1. Aerobic exercise: walking 3 times a week. 2. Social control: student home visits two times a week. 3. Wait-list control.	6	Supervised group exercise. Classes held by students.	Positive. Total amount of depressive symptoms and psychological symptoms significantly reduced in both groups. Somatic symptoms reduced significantly ($p< 0.05$) only among exercisers (BDI[1]).
Singh et al. 1997 USA	32	Depressed (BDI[1] > 12) volunteers, not participating in any resistance or aerobic exercise more than twice a week in the previous months. 71 60-84	1. Anaerobic exercise: progressive resistance training 3 times a week. 2. Attention control: interactive health education programme twice a week.	10	Supervised group exercise.	Positive. Both self- and therapist-rated depressive symptoms (BDI[1], HRSD[2]) significantly improved in exercisers compared to controls ($p=0.002$, $p=0.008$).
Blumenthal et al. 1999 USA	156	Older persons diagnosed as having a major depressive disorder (DSM-IV[3]), not participating in any regular exercise. 57 50-77	1. Aerobic exercise: walking /jogging 3 times a week. 2. Medication: sertraline 50-200 mg until therapeutic dosage was received. 3. Combined exercise and medication: same exercise and medication regimens as in groups 1 and 2.	16	Supervised group exercise.	No effect. All groups exhibited a significant ($p<0.001$) decline in depressive symptoms (HRSD[2]), BDI[1]) with no differences between the groups.
Mather et al. 2002 UK	86	Clinically depressed non-responsive to antidepressant therapy, not participating in regular exercise. 63 (IG) 65 (CG) 53-78	1. Anaerobic exercise: weight bearing twice a week. 2. Social control: health education talks twice a week.	10	Supervised group exercise organised by the University of Dundee.	Positive. Significantly more exercisers achieved response (HRSD[2]) compared to controls (55% vs.33%), ($p=0.05$).
Chou et al. 2004 China	14	Clinically depressed or dysthymic community-dwelling outpatients, not participating in regular exercise. 73 ≥60	1. Tai Chi training 3 times a week. 2. Wait-list control group.	12	Supervised group exercise, led by an experienced Tai Chi practitioner.	Positive. Significant reduction in depressive symptoms (CES-D[4]) among exercisers compared to controls ($p<0.01$).

IG = Intervention group; CG = Control group

1 BDI = Beck Depression Inventory; 2 HRDS = Hamilton Rating Scale of Depression; 3 DSM-IV Diagnostic and Statistical Manual of Mental Disorders; 4 CES-D = Center for Epidemiologic Studies Depression Scale

Table 3. Effects of physical exercise on depressive symptoms or depression in mixed aged populations

Authors Year Country	Participants		Intervention			Results
	n	Type and exercise status or fitness level Mean age (yrs), Range	Intervention and control activities	Duration (wks)	Setting of exercise	
Netz et al. 1994 Israel	31	Hospitalized psychogeriatric (PP) and geriatric patients (GP). 64 (PP) 78 (GP) Range not reported.	1. Mixed exercise: calisthenics 3 times a week. 2. Social control: intellectual activity 3 times a week.	8	Group exercise supervised by a physical activity counsellor.	Positive. Depressive symptoms (GDS[1]) of psychogeriatric exercisers improved significantly (p=0.046) more compared to controls.
Penninx et al. 2002 USA	438	Community-based older adults with knee osteoarthritis, not participating in regular exercise. 69 ≥60	1. Aerobic exercise: 3-month facility-based walking 3 times a week, 15 months home-based walking-programme. 2. Resistance training: 3-month facility-based programme 3 times a week, 15-month home-based programme. 3. Health education monthly or bimonthly.	18 mths	Facility-based exercise in groups, supervised by an exercise leader. Individual home exercise, supported by personal and phone contacts.	Positive. Aerobic training, but not resistance training significantly (p<0.001) reduced depressive symptoms (CES-D[2]).
Timonen et al. 2002 Finland	68	Discharged female geriatric patients without walking disabilities. 83 ≥75	1. Anaerobic exercise: resistance training and functional exercises twice week. 2. Control: home-based exercise programme 2-3 times a week.	10	Supervised group-based exercise. Unsupervised home-based exercise individually.	Positive. Depressive symptoms (ZSDS[3]) reduced significantly (p=0.048) in supervised exercise group compared to controls.

1 GDS = Geriatric Depression Scale
2 CES-D = Center for Epidemiological Studies-Depression Scale
3 ZSDS = Zung Self-Rating Depression Scale

Table 4. Effects of physical exercise on depressive symptoms or depression among non-depressed aged populations

Authors Year Country	**Participants**		**Intervention**			**Results**
	n	Type and exercise status or fitness level, Mean age (yrs), Range	Intervention and control activities	Duration (wks)	Setting of exercise	
Blumenthal et al. 1989 USA	101	Healthy volunteers. Aerobic fitness determined by bicycle ergometry testing. 67 60-83	1. Aerobic exercise: cycling/ brisk walking/jogging 3 times a week. 2. Yoga and flexibility control: supervised yoga-classes 2 times a week. 3. Waiting list control group.	16	Supervised group exercise.	Positive. Men in aerobic group achieved a significant reduction ($p<0.01$) in depressive symptoms (CES-D[1]).
Emery & Gatz 1990 USA	48	Ethnically diverse healthy urban dwellers, not participating in any regular exercise. 72 61-86	1. Aerobic exercise: e.g. rapid walking 3 times a week. 2. Social control: different non-physical activities 3 times a week. 3. Waiting list control group.	12	Supervised group exercise, organized in community setting.	Negative. Aerobic exercisers had non-significant reductions in depressive symptoms (CES-D[1]).
McMurdo & Burnett 1992 UK	87	Healthy volunteers. 66 (IG) 65 (CG) 60-81	1. Anaerobic: muscle strengthening and suppleness. 2. Social control: health education classes 6 times/ 8 months.	32	Supervised group exercise organized by the University of Dundee.	No effect. Both groups reported a reduced amount of depressive symptoms at the end (GDS[2]).
King et al. 1993 USA	357	Random sample of the community. Baseline fitness level was determined by treadmill-exercise test. 56 (men) 57 (women) 50-65	1. Group-based endurance training. 2. High intensity home-based exercise. 3. Lower intensity home-based exercise.	1 yr	Supervised group exercise organized at local community college.	Negative. No significant reduction in depressive symptoms (BDI[3]) was found.
Chin A Paw et al. 2004 The Netherlands	173	Non-depressed volunteers living in nursing home or residential care facility, able to walk at least six metres. 82 64-94	1. Anaerobic: strength training twice a week. 2. All-round functional training twice a week. 3. Combination: strength training once a week and functional training once a week. 4. Social control: health education twice a week.	24	Supervised group exercise.	Negative. No reduction in depressive symptoms (GDS[2]).

IG = Intervention group; CG = Control group

1 CES-D = Center for Epidemiologic Studies Depression Scale; 2 GDS = Geriatric Depression Scale; 3 BDI = Beck Depression Inventory

2.5.2 Effects of fall prevention on depressive symptoms

Most fall prevention programmes have been targeted at reducing the physical risk factors of falling, such as poor balance, impaired muscle strength or the harmful side effects of medication and by reducing physical risk factors to lower the incidence of injurious and other falls. Fall-related psychological factors, such as depression and fear of falling, have gained less attention. Depressive symptoms have often been used as a baseline, not an outcome measure in fall prevention studies (Tinetti et al. 1994a; Close et al. 1999; Rubenstein et al. 2000; Nikolaus & Bach 2003; Shaw et al. 2003; Davison et al. 2005; Lord et al. 2005). The following synthesis is based on a review about the effects of fall prevention on depressive symptoms and fear of falling (*Study II*).

Eight studies with depressive symptoms as an outcome measure conducted among community-dwellers were found (Table 5) (Wolf et al. 1996/2003b; Coleman et al. 1999; Hauer et al. 2001; Newbury et al. 2001; Wolf et al. 2001; Yates & Dunnagan 2001; Hauer et al. 2002; Sohng et al. 2003). Five studies were classified as single exercise-focused (Wolf et al. 1996/2003b; Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002; Sohng et al. 2003), two as multifactorial (Coleman et al. 1999; Yates & Dunnagan 2001) and one as a multifactorial assessment focused trial (Newbury et al. 2001). Two studies were conducted among community-dwelling female geriatric patients discharged from acute or rehabilitation care (Hauer et al. 2001, 2002).

Only one study produced positive results in regard to depressive symptoms (Sohng et al. 2003). A statistically significant reduction in depressive symptoms (GDS-15) was found after an 8-week fall prevention exercise programme (FPEP) conducted among ambulatory community-dwelling Koreans, compared to control condition with no activities. This intensive (4-day-per-week) programme consisted of seated strength, endurance, balance, coordination and breathing exercises and health education focusing on self-care skills.

Other single exercise focused trials (Wolf et al. 1996/2003b; Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002) and all three multifactorial trials (Coleman et al. 1999; Newbury et al. 2001; Yates & Dunnagan 2001) did not produce statistically significant changes in depressive symptoms.

Conclusion

Very little evidence was found about the capability of fall prevention to reduce depressive symptoms. However, due to the paucity of studies no definite conclusions can be made. A single exercise-focused fall prevention intervention of high intensity and short duration seems most promising with regard to reducing depressive symptoms.

Table 5. Effects of fall prevention on depressive symptoms among community-dwellers

Authors Year Country	**Participants**			**Intervention**			**Measures**	**Results**
	n	Main characteristics	Mean age (yrs), Range	Type	Intervention and control activities	Duration		
Wolf et al. 1996/2003b USA	200	Ambulatory residents of independent living facilities. 81% females.	77 (TC) 76 (BT) 75 (ED) ≥70	SE	1. Tai Chi (TC) twice a week in groups at increasing difficulty and unsupervised home-exercises advised to be performed at least 15 minutes a day. 2. Computerised balance training (BT) individually once a week at increasing difficulty. 3. Education (ED) in groups once a week for 1 hour.	15 wks	CES-D[1]	Negative. No significant changes were observed between groups in depressive symptoms.
Hauer et al. 2001 Germany	57	Community-dwelling geriatric patients with a history of injurious falls. 100% females.	82 75-90	SE	1.High intensity progressive strength training (1.5 hrs) and functional-balance training (45 min) 3 times a week in small groups and physiotherapy twice a week (25 min). 2. Placebo group activities, such as ball games, memory tasks and calisthenics, 3 times a week for 1 hour and physiotherapy twice a week (25 min).	12 wks	GDS-15[2] PGMS[3]	Negative. No significant changes in depressive symptoms between groups right after intervention (GDS p=0.766; PGMS p=0.850) or 3 months after intervention (GDS p=0.404; PGMS p=0.628).
Wolf et al. 2001 The Netherlands	77	Persons with functional balance problems living independently or in residential care facilities. 73% females.	85 (IG) 84 (CG) 75-97	SE	1. Individual balance training 2-3 times a week at home or at physiotherapy department with a physiotherapist. 2. Individualised extra attention programme with different non-physical activities, such as handicraft, music, board games and discussions in groups.	4-6 wks	HADS-d[4]	Negative. A significant reduction of depressive symptoms in CG in MANOVA, but no significant changes in HADS-d in post hoc tests.
Hauer et al. 2002 Germany	28	Aged subjects with an acute fall-related hip fracture or elective hip replacement admitted to acute care or inpatient rehabilitation.	82 (IG) 81 (CG) >75	SE	1.High intensity progressive strength training (1.5 hrs) and functional-balance training (45 min) 3 times a week in small groups and physiotherapy twice a week (25 min). 2. Placebo group activities, such as	12 wks	GDS[5] PGMS[3]	Negative. No significant changes in depressive symptoms straight after intervention (PGMS p= 0.253) or at 3 months follow-up (GDS p=0.254; PGMS

		100% females.			ball games, memory tasks and calisthenics, 3 times a week for 1 hour and physiotherapy twice a week (25 min).			p=0.302). Almost significant improvement in depressive symptoms at 12 weeks in exercise group (GDS p=0.052).
Sohng et al. 2003 Korea	45	Ambulatory community-dwellers. 96% females.	75.0 (IG) 76.4 (CG) 65-83	SE	1. Fall prevention exercise programme (FPEP) 4 times a week (2 with direct instructions, 2 with videotaped instructions) in small groups for 40 minutes. 2. No activities.	8 wks	GDS-15 [2] (Korean version)	Positive. Mean depression score reduced in IG while it increased in CG (p=0.016).
Coleman et al. 1999 USA	169	Frail older adults at high risk of functional decline and hospitalisation. 49% females (IG), 48% (CG).	77.4 (IG) 77.3 (CG) ≥65	M	1. Quarterly half-day visits at Chronic Care Clinics including development of treatment plan with a nurse and a physician, guidance on medication by a pharmacist, self-management group sessions led by a nurse or a social worker and provision of a health status assessment. 2. Usual care.	24 mths	CES-D[1]	Negative. No significant improvements in depressive symptoms at 12 or 24 months follow-up.
Yates & Dunnagan 2001 USA	37	Rural community-dwellers. 70% females.	76* (IG) 78* (CG) 67-90	M	1. Home-based 4-part fall risk reduction programme including fall risk education, home-based exercise 3 times a week for 15 minutes, nutrition counselling and environmental hazards education. 2. Delayed intervention.	10 wks	Derogatis Depression Scale	Negative. No significant changes in depressive symptoms in IG compared to CG (p=0.082).
Newbury et al. 2001 Australia	100	Urban community-dwellers. 66% females (IG) 60% females (CG).	79* (IG) 75-88 80* (CG) 75-91	MA	1. Health assessment (75+ HA) including assessment of hearing, vision, cognition, physical condition, medication, ADL, nutrition and social and housing conditions following a report to the persons own physician. 2. Usual care.	12 mths	GDS-15[2]	Negative. A significant reduction of depressive symptoms in IG (mean change –0.5 points; p=0.05), but no differences between groups (p=0.10) at 1 yr.

SE = Single Exercise focused; M = Multifactorial; MA = Multifactorial Assessment focused; IG = intervention group; CG = Control group; * = Median age

1 CES-D = Center for Epidemiologic Studies Depression Scale

2 GDS-15 = 15-item Geriatric Depression Scale

3 PGMS = Philadelphia Geriatric Morale Scale

4 HADS-d = Hospital Anxiety and Depression Scale-depression

5 GDS = Geriatric Depression Scale

2.5.3 Effects of fall prevention on fear of falling

Falls and fear of falling are assumed to have a multifactorial etiology and they actually share many risk factors (e.g. gait and balance problems, depressive symptoms, poor cognition). It is thus understandable that a multifactorial fall prevention targeting the reduction of several of these risks simultaneously may be beneficial in reducing not only falls but also fear of falling. Indeed, trials aimed at reducing fear of falling are somewhat more common than those trying to affect depressive symptoms. The following synthesis is based on a review about the effects of fall prevention on depressive symptoms and fear of falling (*Study II*).

Eighteen studies with fear of falling as an outcome measure conducted among the community-dwelling aged were found. Eleven studies were classified as single-factor exercise-focused interventions (Wolf et al. 1996/2003b; Campbell et al. 1997; Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002; Barnett et al. 2003; Brouwer et al. 2003; Nitz & Choy 2004; Devereux et al. 2005; Li et al. 2005; Sattin et al. 2005) and seven as multifactorial interventions (Tinetti et al. 1994a; Gallagher & Brunt 1996; Tennstedt et al. 1998; Yates & Dunnagan 2001; Clemson et al. 2004; Huang & Acton 2004; Davison et al. 2005) (Table 6). Eleven of these trials (six multifactorial and five single trials) produced positive results (defined as statistically significant difference between intervention and control groups) (Tinetti et al. 1994a; Wolf et al. 1996/2003b; Campbell et al. 1997; Tennstedt et al. 1998; Yates & Dunnagan 2001; Brouwer et al. 2003; Clemson et al. 2004; Huang & Acton 2004; Davison et al. 2005; Li et al. 2005; Sattin et al. 2005) in at least one measure of fear of falling/falls efficacy.

Single exercise-focused interventions

According to single exercise-focused trials Tai Chi seems to be the most effective strategy in preventing fear of falling. All studies using land-based Tai Chi as an intervention method produced positive results (Wolf et al. 1996/2003b; Li et al. 2005; Sattin et al. 2005). First, Wolf and co-workers (1996/2003b) demonstrated a significant reduction in fear of falling ($p=0.046$) among the community-dwelling aged after a 15-week Tai Chi training course compared to group education. The amount of subjects without any fear increased by 10% among Tai Chi practitioners, while it reduced in the education group by 9% from baseline until post intervention (at 15 weeks). Recently, these results were replicated in two studies (Li et al. 2005; Sattin et al. 2005) with longer intervention periods (6 mths, 8 mths and 12 mths) and larger sample sizes. Beneficial changes also tended to be maintained during the 6-month follow-up period (post intervention) (Li et al. 2005).

The interventions consisted of other forms of exercise in eight studies (Campbell et al. 1997; Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002; Barnett et al. 2003; Brouwer et al. 2003; Nitz & Choy 2004; Devereux et al.

2005), and two of these produced positive results (Campbell et al. 1997; Brouwer et al. 2003).

Both an education programme and a low-resistance training programme along with home-training reduced fear of falling significantly (p=0.005), but no differences between the groups were found. However, reduction in fear of falling was associated with improvements in balance performance among the persons in the activity group, who also tended to adopt activities they had stopped doing previously more often than persons in the education group (p=0.055) (Brouwer et al. 2003).

The study by Campbell and co-workers (1997) comparing the effects of home-based exercise with regular motivation (first by home visits and then by phone-calls lasting one year) to social home visits, showed an increase of fear of falling in both groups, but considerably more in the control group.

The rest of the single exercise-focused interventions, using different balance and strength exercise formats with or without some educational content (intensive functional balance and strength programme; water-based exercises with self-management; balance training in workstation format with educational booklet; group- and home-based exercises with some practical information on fall prevention and individualised balance training programme), did not produce significant changes in fear of falling compared to control conditions (Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002; Barnett et al. 2003; Nitz & Choy 2004; Devereux et al. 2005).

Multifactorial interventions

Six out of seven multifactorial intervention programmes produced significant improvement in fear of falling (Tinetti et al. 1994a; Tennstedt et al. 1998; Yates & Dunnagan 2001; Clemson et al. 2004; Huang & Acton 2004; Davison et al. 2005) compared with usual care, social control groups or no activities. The trial conducted by Tinetti and co-workers (1994a) among community-dwellers with at least one risk factor of falling was focused on reducing multiple risk factors simultaneously after an individual risk factor assessment and targeted interventions (e.g. medication assessment and education, training in transfer skills, behavioural training, exercise programmes and environmental changes). After a 1-year follow-up the mean scores of FES were significantly better (p=0.02) in the intervention group.

The shortest intervention (four weeks) leading to positive results was based on cognitive restructuring aiming at changing maladaptive attitudes regarding fear of falling and related activity restriction to adaptive conceptions, by using various group techniques. Significant improvements in falls efficacy and falls management (i.e. person's perceived ability to find ways to reduce falls and protect oneself when falling) were found in the intervention group straight after the intervention and at 12 months follow-up, but only among compliant participants (those attending more than 5 out of 8 sessions) (Tennstedt et al.

1998). In a similar trial, using a small group learning environment to improve falls efficacy and to encourage behavioural change (e.g. taking control, using safety strategies, proving different coping behaviours), a significant improvement in confidence in avoiding falls (Mobility Efficacy Scale, MES) was found after a 7-week intervention (Clemson et al. 2004).

Home-based interventions consisting of individually tailored counselling and education on various risk factors of falling (e.g. home hazards, nutrition, physical exercise, medication) were also efficient in improving falls efficacy (FES) among the urban and rural community-dwelling aged (Yates & Dunnagan 2001; Huang & Acton 2004; Davison et al. 2005).

Only one multifactorial intervention did not produce significant changes in fear of falling. In the study of Gallagher and Brunt (1996) a health promotion programme consisting of two comprehensive risk assessment interviews, followed by individual counselling and feedback about identified risk factors and a provision of motivational booklet and video, did not affect fear of falling (FES) nor incidence of falls. According to the authors, the negative result might be due to the poor compliance with the recommendations given during the interviews.

Conclusion

Both single and multifactorial fall prevention seem effective in reducing fear of falling, especially when measured by standardised falls efficacy scales. Among community-dwellers, the most effective strategy seems to be a multifactorial approach, while the majority of the multifactorial trials produced significant improvement in fear of falling. Some single methods, such as Tai Chi also seem effective.

Table 6. Effects of fall prevention on fear of falling among community-dwellers

Authors Year Country	Participants			Intervention			Measures	Results
	n	Main characteristics	Mean age (yrs),Range	Type	Intervention and control activities	Duration		
Wolf et al. 1996/2003b USA	200	Ambulatory residents of independent living facilities. 81% females.	76.9 (TC) 76.3 (BT) 75.4 (ED) ≥70	SE	1. Tai Chi (TC) twice a week in groups at increasing difficulty and unsupervised home-exercises at least 15 minutes a day. 2. Computerised balance training (BT) individually once a week at increasing difficulty. 3. Education (ED) in groups once a week.	15 wks	FES[1]	Positive. Fear of falling reduced significantly in the TC group compared to ED group (p=0.046).
Campbell et al. 1997 New Zealand	233	Community-dwelling women. 100% females.	84.1 ≥80	SE	1. Four physiotherapist home visits to implement the exercise programme (strengthening exercises and walking). Encouraged to do 3 times a week. Regular phone calls to maintain the motivation during the 1- year follow-up. 2. Four home visits during the first 2 months and regular phone calls during the follow-up.	1 yr	FES[1]	Positive. At 1 yr, fear of falling increased more in control group; mean change in FES was −6.1 (CG) vs. −2.5 (IG); mean difference 3.6 points, range 0.4−6.8.
Hauer et al. 2001 Germany	57	Community-dwelling geriatric patients with a history of injurious falls. 100% females.	82.2 (IG) 82.1 (CG) 75-90	SE	1. High intensity progressive strength training (1.5 h) and functional-balance training (45 min) 3 times a week in small groups and physiotherapy twice a week (25 min). 2. Placebo group activities, such as ball games, memory tasks and calisthenics, 3 times a week for 1 hour and physiotherapy twice a week (25 min).	12 wks	Subjective rating of fear.	Negative. Fear of falling reduced significantly in the intervention group, but no significant changes between groups straight after the intervention (p=0.100) or at 3 months (p=0.125).
Wolf et al. 2001 The Netherlands	77	Persons with functional balance problems living independently or in residential care facilities. 73% females.	84.5 (IG) 83.6 (CG) ≥75	SE	1. Individualised balance training 2-3 times a week at home or at physiotherapy department. 2. Individualised extra attention programme with different non-physical activities.	4-6 wks	VAS[2]	Negative. No significant changes in VAS.
Hauer et al. 2002 Germany	28	Aged subjects with an acute fall-related hip fracture or elective hip replacement admitted to acute care or inpatient rehabilitation. 100% females.	81.7 (IG) 80.8 (CG) >75	SE	1. High intensity progressive strength training (1.5 hrs) and functional-balance training (45 min) 3 times a week in small groups and physiotherapy twice a week (25 min). 2. Placebo group activities, such as ball games, memory tasks and calisthenics, 3 times a week for 1 hour and physiotherapy twice a week (25 min).	12 wks	Subjective rating of fear.	Negative. No significant changes within the groups or between the groups at 12 weeks (p=0.179) or at 3 months follow-up (p=0.351).

Barnett et al. 2003 Australia	163	Community-dwellers with impaired balance, reaction time or lower limb weakness. 70% females (IG), 64% (CG).	74.4 (IG) 75.4 (CG) ≥65	SE	1. Progressive group exercises to improve balance, coordination, aerobic capacity and muscle strength including functional exercises and modified Tai Chi once a week for 1 hour. Home-based programme based on class content and information on practical strategies for avoiding falls. 2. No activities.	1 yr	Questionnaire; percentage of those having fear of falling.	Negative. No significant changes between groups. The percentage of those having fear of falling decreased in both groups.
Brouwer et al. 2003 Canada	38	Community-dwelling seniors reporting fear of falling and activity restriction. 76% females (E), 71% (A).	77.1 (E) 78.0 (A) 67-87	SE	1. Education (E) focused on identifying and reducing risk factors for falls (e.g. nutrition, activity, footwear) once a week for 1 hour. 2. Activity (A) programme with low-resistance exercises once a week for 1 hour and home-exercises twice a week for 40 minutes.	8 wks	ABC[3]	Positive[†]. Fear of falling decreased significantly in both groups (p=0.005), but no differences between groups were found.
Nitz & Choy 2004 Australia	73	Community-dwellers. 92% females.	75.9 (IG) 75.7 (CG)	SE	1. Progressive balance exercises in workstation format with different exercises once a week for 1-hour and educational booklet on fall prevention. 2. Education booklet and "typical" balance exercise programme different from that of participants in intervention group.	10 wks	FES[1]	Negative. No changes in CG; a trend for improvement in IG (p=0.09) at 10 weeks. No significant differences at 3 months.
Devereux et al. 2005 Australia	50	Community-dwelling women with a diagnosis of osteopenia or osteoporosis. 100% females	73.3 66-82	SE	1. Water-based exercise (Tai Chi, strength, posture, gait and balance) and self-management programme (self-assessments, group-storming, checklists, goal setting, diaries) twice a week for 1 hour. 2. No activities.	10 wks	Modified FES[1]	Negative. No significant changes in fear of falling between groups (p=0.38).
Li Fet et al. 2005 USA	256	Physically inactive, community-dwelling adults. 70% females.	77.48 70-92 ≥70	SE	1. Tai Chi group 3 times a week for 1 hour. 2. Mostly seated stretching exercises.	6 mths	SAFFE[4]	Positive. Tai Chi practitioners reported less fear of falling than those in the stretching groups (p<0.001) and gains were maintained at 6 month follow-up.

Sattin et al. 2005 USA	311	Persons with previous falls, transitioning to frailty. 94% females.	80.9 (TC) 80.8 (WE) 70-97	SE	1. Tai Chi twice a week increasing progressively from 60 to 90 minutes (TC). 2. Wellness education including instructions of fall prevention once a week for 1 hour (WE).	48 wks	ABC[3] FES[1]	Positive. ABC improved in the TC group at 8 and 12 months ($p<0.001$); mean score increased 13.4% in TC group and decreased 4% education group from baseline until 12 months. FES became better in TC group at 8 mths ($p=0.01$) and at 12 mths ($p<0.001$).
Tinetti et al. 1994 USA	301	Community-dwelling men and women. 69% females.	78.3 (IG) 77.5 (CG) ≥70	M	1. An individual programme targeting to found risk factors including medication adjustment, behavioural training, exercise programme and environmental change. 2. Home-visit from social-work students.	3-6 mths	FES[1]	Positive. Mean change differed significantly between IG and CG ($p=0.05$).
Gallgher &Brunt 1996 Canada	100	Previously fallen community-dwellers. 80% females.	73.8 (IG) 75.4 (CG) ≥60	M	1. Baseline and 6-months interviews and 2 comprehensive risk assessments (2 x 45 min), individualised feedback about identified risk factors of falls (60 min), motivational video and booklet. 2. Baseline and 6-month interviews.	6 mths	FES[1]	Negative. No significant changes in fear of falling.
Tennstedt et al. 1998 USA	434	Persons with fear of falling and associated activity restriction. 90% females.	77.8 ≥60	M	1. Community-based group intervention "Matter of balance" including various techniques (lectures, discussions, problem solving, exercise training and cognitive restructuring) twice a week for 2 hours. 2. Single 2-hour session of fall prevention.	4 wks	Modified FES[1] 4-item scale of perceived control 5-item scale on fall management	Positive. Falls efficacy and falls management improved significantly among compliant subjects straight after intervention ($p<0.05$; $p<0.01$) and at 12-month follow-up ($p<0.05$). No changes in perceived control.

Yates & Dunnagan 2001 USA	37	Rural community-dwellers. 70% females.	76* (IG) 78* (CG) 67-90	M	1. Home-based 4-part fall risk reduction programme including fall risk education, home-based exercise 3 times a week for 15 minutes, nutrition counselling and environmental hazards education. 2. Delayed intervention.	10 wks	FES[1]	Positive. A significant change was observed in FES (p=0.023).
Clemson et al. 2004 Australia	310	Community-dwelling men and women, fallen in the previous 12 months. 74% females.	78.3 (IG) 78.5 (CG) ≥70	M	1. Stepping-on multifactorial programme using small-group learning environment, including balance and strength exercises, visual screening, medication management, assessment of environmental, community and home safety. A total of 7 weekly 2-hour sessions. 2. Social visits.	7 wks	Modified FES[1], MES[5]	MES: Positive. A significant difference between groups. IG maintained confidence while it decreased in CG. modified FES: Negative. No differences between groups.
Huang & Acton 2004 Taiwan	120	Cognitively intact community-dwellers. 46% females.	72.4 (IG) 71.6 (CG) ≥65	M	1. A standardised brochure containing general information about falls. Individualised brochure on medication and environmental safety and verbal teaching given during home visits (3) concerning individual risk factors. 2. A standardised brochure on fall prevention.	4 mths	FES[1]	Positive. Confidence increased in both groups during the intervention (p=0.011) and was significantly higher in IG at the end of the intervention (p=0.042).
Davison et al. 2005 USA	313	Persons presenting to Accident and Emergency department with a fall or fall-related injury and at least one additional fall in the preceding year. 72% females (IG), 73% (CG).	77 >65	M	1. Hospital-based physiotherapy and occupational therapy assessment followed by individualised interventions for fall risk factors. 2. Conventional care without medical or therapy assessment.	12 mths	ABC[3]	Positive. Falls efficacy was significantly better in IG at 1 yr. ABC at 1 yr: 61% in IG and 53% in CG; mean difference 7.5 (CI=0.72-14.2).

SE = Single Exercise focused; M = Multifactorial; MA = Multifactorial Assessment focused; IG = Intervention group; CG = Control group; * = Median age

1 FES = Falls Efficacy Scale

2 VAS = Visual analogue scale

3 ABC = Activities-specific Balance Scale

4 SAFFE = Survey of Activities and Fear of Falling in the Elderly

5 MES = Mobility Efficacy Scale

† Author's note: this study was comparing two different fall prevention programmes without a formal no activities control group. Thus the results were classified as positives even though no significant between-group changes were detected.

2.6. Adherence to fall prevention programmes

2.6.1 Definition

Adherence or compliance means the extent to which patients follow medical advice (Fletcher & Fletcher 2005). Adherence is a crucial issue in preventive interventions, especially when they are conducted outside hospitals or other institutions, where a patient's behaviour is more susceptible to different internal or external influences than in more regimented institutional settings. Recognising factors affecting adherence and uptake is a prerequisite for successful implementation of a prevention programme, given that subject compliance is the most commonly reported barrier to successful intervention in fall prevention (Fortinsky et al. 2004).

2.6.2 Adherence rates

Overall adherence rates in different activities of single and multifactorial fall prevention programmes, such as exercise or educational classes, home-exercises or recommendations for preventive actions, have been reported in previous studies among the aged at high risk of falling (Rubenstein et al. 2000; Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002; Barnett et al. 2003; Brouwer et al. 2003; Helbostad et al. 2004; Liu-Ambrose et al. 2004) as well as in population-based studies (Hornbrook et al. 1994; Day et al. 2002), with some exceptions (Sohng et al. 2003; Nitz & Choy 2004; Devereux et al. 2005). Adherence to home-exercises or to home modifications has usually been measured by self-reports (e.g. calendars, log sheets) (Hornbrook et al. 1994; Tinetti et al. 1994a; Campbell et al. 1997; Yates & Dunnagan 2001; Helbostad et al. 2004; Campbell et al. 2005; Lord et al. 2005) or by interviewing the subjects (Tinetti et al. 1994a; Hogan et al. 2001; Shaw et al. 2003). In group-based activities adherence rates have been collected by instructors (Hauer et al. 2001, 2002; Liu-Ambrose et al. 2004).

Considerably high attendance rates to group exercise sessions have been reported in previous single exercise-focused trials (Rubenstein et al. 2000; Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002; Brouwer et al. 2003; Liu-Ambrose 2004; Morgan et al. 2004) even to intensive programmes among patients at high risk of falling (Rubenstein et al. 2000; Hauer et al. 2001; Wolf et al. 2001). Individualised programmes of short duration seem to attain the highest attendance rates (85%–100%) (Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002), while in longer interventions using generic programmes adherence tends to decline (Barnett et al. 2003; Lord et al. 2003).

In multifactorial trials, adherence is somewhat more difficult to determine, mostly due to the great variety in format (group vs. home-based), target

population and the intensity of activities included in different prevention programmes. The definition and reporting of adherence have also varied greatly between studies. Moderate to high adherence rates to group exercises (Day et al. 2002) and to other group-based activities (Tennstedt et al. 1998; Clemson et al. 2004) have been described. For example, in the study of Clemson and co-workers (2004) 90% of the subjects attended at least 70% of the offered group sessions, while Tennstedt and co-workers (1998) reported 63% of the subjects attending from 63% to 100% of the offered group sessions. Moderate adherence rates have also been reported to home-exercises (Tinetti et al. 1994a; Yates & Dunnagan 2001; Shaw et al. 2003).

Compliance to different treatment or home modification recommendations have varied from low to high (33%–86%) depending on suggested actions (Nikolaus & Bach 2003; Shaw et al. 2003; Clemson et al. 2004; Campbell et al. 2005; Lord et al. 2005).

2.6.3 Factors influencing adherence

Different fall prevention strategies are effective in reducing falls and injurious falls among the aged (Gillespie et al. 2003; McClure et al. 2005). Their acceptability among the aged is, however, less known and it seems to be highly dependent on psychosocial factors (McInnes & Askie 2004).

The major problem in fall prevention trials is that older people consider fall prevention useful, but not personally relevant or appropriate, despite the presence of risk factors. Given advice is often seen as patronizing and threatening to their identity and autonomy (Yardley et al. 2006a). In a review assessing the views, preferences, and experiences of fall prevention among the aged, it was found that adherence to multifactorial interventions depend on personal needs and willingness to modify ones behaviour and environment to reduce the risk of falls (McInnes & Askie 2004). In another recent study assessing perceived factors promoting and inhibiting adherence to fall prevention in six European countries by semi-structured interviews, it was shown that motivation for preventive activities was often maintained by various perceived benefits, (interest and enjoyment, improved health, mood and independence) other than simple reduction of falls (Yardley et al. 2006b). The social values of the intervention programmes have often been emphasized by the aged and attendance to group activities is influenced by expected positive or negative contacts with leaders and other group members (McInnes & Askie 2004; Yardley et al. 2006b). Negative social aspects (e.g. not getting along with other group members) have been found to be barriers of adherence as well as practical factors, such as transport, financial cost and timing (Yardley et al. 2006b).

In addition, the opinions of others (e.g. family members, friends, carers and health professionals) may have a major impact on older peoples' decision to participate or continue in preventive programmes. It has been shown that other people, close to an aged person, actually tend to emphasize avoidance of risky activities (e.g. physical exercise) rather than encourage engagement to these activities due to known benefits (e.g. physical exercise improves balance) (Yardley et al. 2006a, 2006b).

Quantitative studies assessing the predictors of adherence in fall prevention trials have rarely been conducted, and only few predictors have been identified (Hornbrook et al. 1994; Cumming et al. 2001). A person's own beliefs about the possibilities to prevent falls by the activities of the programme, predicts adherence with recommendations for home modifications (Cumming et al. 2001). Persons at high risk of falling attend most due to the highest intrinsic motivation to prevent falling accidents (Hornbrook et al. 1994). These findings support the Health Belief Model (HBM), stating that a perceived susceptibility to a health problem and its severity (=*perceived threat*), and person's own beliefs in the efficacy of the advised activities to reduce risk predict changes in health behaviour. In order to take part in preventive actions, subjects must also feel themselves competent (*self-efficacious*) to overcome perceived barriers (e.g. negative side effects, costs, time-consumption, inconvenience, transportation) (Janz et al. 2002).

3. Aims of the study

The aim of the present study was to describe the implementation and adherence of a multifactorial fall prevention programme conducted among the community-dwelling aged at increased risk of falling and to analyze the effects of prevention on depressive symptoms and fear of falling determined as risk factors of falls.

In detail, the aims were:

1. To describe the implementation of a multifactorial fall prevention programme among the aged and to analyse the success of randomisation.
2. To describe the adherence rates of a multifactorial fall prevention programme and to analyse predictors of adherence.
3. To analyse the effects of a multifactorial fall prevention programme on depressive symptoms in all participants, and when classified according to age, gender, baseline level of depressive symptoms and adherence.
4. To analyse the effects of a multifactorial fall prevention programme on fear of falling in all participants, and when classified according to age, gender and adherence.

4. Materials and methods

The author of this doctoral thesis was not involved in planning the whole project or in collecting the data.

4.1 Setting

The study is a part of a multifactorial fall prevention trial with a randomised design, which was implemented in the city of Pori, in western coastal Finland among the community-dwelling aged at increased risk of falling.

4.2 Population

The sample size was estimated according to main outcome measure of the whole study (a fall) and based on the results of previous fall prevention studies showing that every third fall or injurious fall may be prevented (e.g. Tinetti et al. 1994a). According to power calculation, a 30% difference (power 0.80, significance level 0.05) may be detected with a minimum of 183 persons in both groups and 366 persons in the whole study. With an estimated attrition rate of 20%, the whole study sample should thus be at least 458 persons, representing about 10% of 65-year-olds or older who had fallen during the previous year in the city of Pori (total population of over 65-year-old persons was 13 547 at the beginning of the intervention). With regard to depressive symptoms, power calculations were conducted after the data collection. According to these a mean -1 (SD 3.8) point difference (power 0.80, significance level 0.05) may have been detected with a minimum of 228 persons in both groups and 456 persons in the whole study.

Inclusion criteria for recruitment were 65 years of age or older, having fallen at least once during the past 12 months, intact or lowered cognitive abilities (sum score in the Mini Mental State Examination, MMSE ≥ 17) (Folstein et al. 1975), moderate or high physical abilities (able to walk 10 metres independently with or without walking aids) and living at home or sheltered housing. A fall was defined as an unexpected event where a person falls to the ground from an upper level or the same level (Koski et al. 1996).

The following samples were used in the original studies:

1. All subjects who participated in the baseline assessments (n=591). (Study III)
2. All subjects who were randomised into the intervention group (n=293). (Study IV)
3. All subjects with full data of depressive symptoms at baseline and 1-year follow-up (n=464). (Study V)

4. All subjects with fear of falling data available at baseline and 1-year follow-up (n=512). (Unpublished data/Vaapio et al. 2007, in press)

4.3 Recruitment and progression of the study

Information about the study was widely spread by announcements in local newspapers, pharmacies, Pori Health Centre, Satakunta Central Hospital and private clinics and by written invitations delivered by physicians, home aids and nurses (a total of 3300 invitations and announcements, during the 2-year recruitment). In addition, informative meetings were held in four sheltered housing facilities (total population about 400) to recruit persons living in these facilities. Persons willing to participate were first interviewed by a nurse (usually by phone) and if fulfilling the preliminary inclusion criteria, interviewed by the geriatrician who verified the suitability of the person. Persons living in sheltered housing were primarily interviewed by the geriatrician after each informative meeting. Of 612 persons interviewed by the geriatrician, 591 (97%) were accepted into the study of whom 34 (6%) were living in sheltered housing. Recruitment started in February 2003 and continued until January 2005.

Baseline assessments were conducted for all participants during four visits in the study clinic. In addition, all subjects got a referral to the laboratory tests and subjects in the intervention group were also referred for bone density measurements.

After the baseline assessments subjects were randomly assigned into an intensive prevention programme (intervention group, IG) or into a counselling group (control group, CG) separately in two age groups (65–74 years and ≥75 years). Randomization was carried out by the geriatrician using consecutively numbered sealed "envelopes".

Follow-up assessments (n=530) were carried out after a one-year intervention between April 2004 and March 2006, by three assessors (geriatrician, physiotherapist and public health nurse) not blinded to the group allocation. The progression of the study is presented in Figure 1.

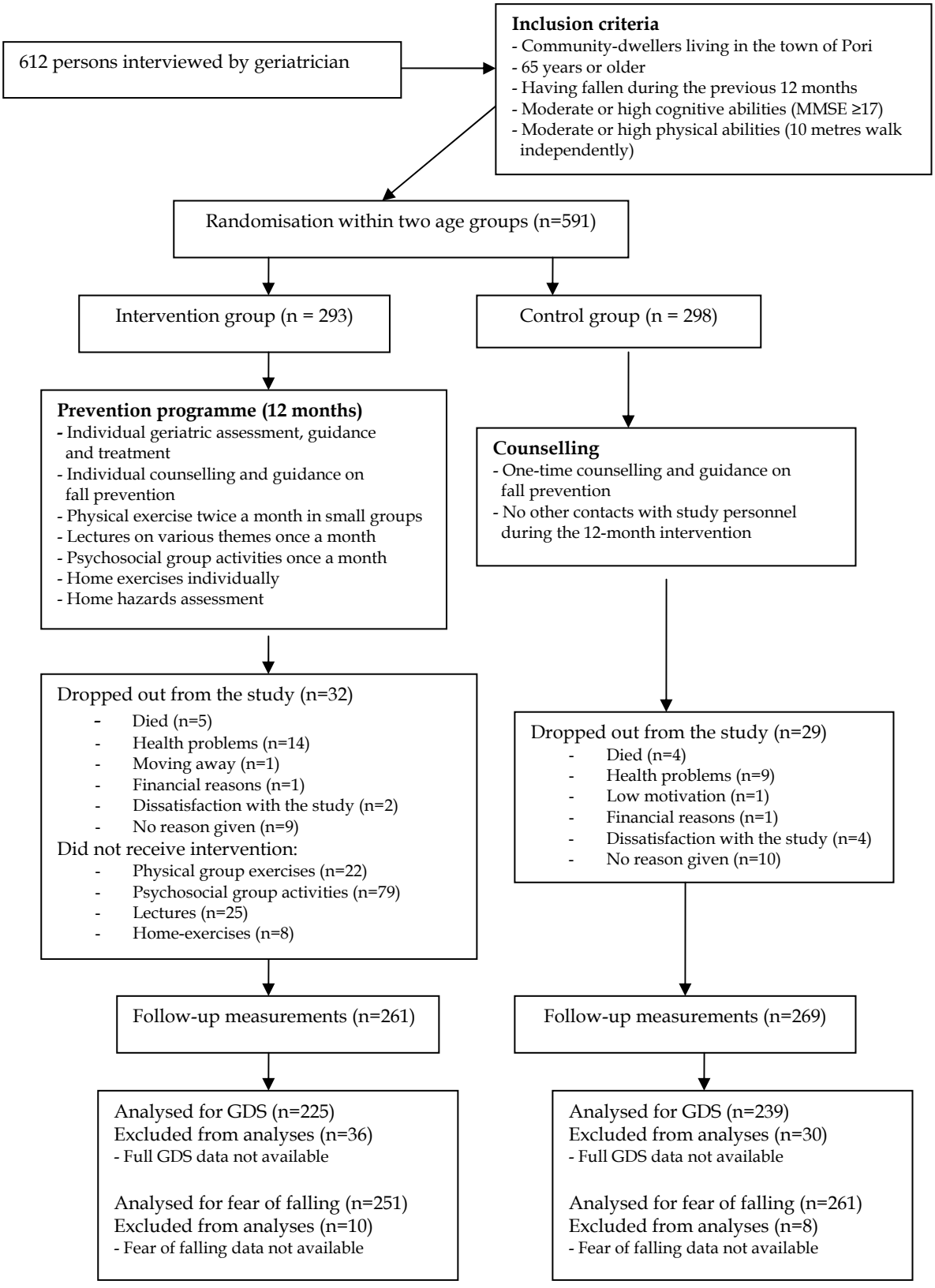

Figure 1. Progression of the study

4.4 Intervention

The prevention programme was based on an individual risk factor analysis and it was tailored for each participant according to the specified risk factors, functional abilities and health status. The intervention consisted of seven parts and included both group- and home-based activities.

Individual geriatric assessment, guidance and treatment

All subjects in the IG were thoroughly assessed by an experienced geriatrician. The individual geriatric assessment, guidance and treatment included measurements of specific risk factors of falling and injuries due to falls such as polypharmacy, use of psychotropic and other medications affecting the central nervous system, diseases and disorders affecting balance and gait, low bone mass, poor eye sight, difficulties in hearing, poor nutritional status and depressiveness. The individual geriatric assessment was followed by instructions to reduce or withdraw psychotropic medications and a prescription of calcium (500 mg) and vitamin D_3 (400 IU) supplements for the winter and calcium (500 mg) for the summer. Alendronate medication (Fosamax®, 70 mg/week) was prescribed according to the bone density test results measured by Bone Densitometry, DEXA®.

In addition, a referral to a specialist (e.g. ophthalmologist or audiometrician) was given if the subject had symptoms or diseases needing examination, treatment or rehabilitation.

Psychological support was given if a subject's GDS sum score (Yesavage et al. 1982/1983) was over 10 or if the participant was determined to be depressed according to the interviews. These subjects were also advised to join the smaller psychosocial group ("support group") in the intervention.

Individual guidance on fall prevention

All subjects in the IG were given oral and written information about fall and fracture prevention by a trained public health nurse. The oral information consisted of discussion about risk factors of falling and fractures, home hazards, safe environment, healthy diet, the importance of calcium and vitamin D supplement and use of hip protectors. The activities of the individual prevention programme were explained to each subject and appointments for bone density measurement and laboratory tests were made. The subjects were given four brochures about calcium and vitamin D supplements, home hazards and prevention of falls in general. In addition, fall and exercise diaries were given with appropriate instructions.

Physical exercise in groups

For the exercise groups the subjects were divided into three levels according to their physical performance (balance, muscle strength and respiratory function). Each exercise session began with warm up exercises (5–10 min), followed by exercises designed to improve lower leg muscle strength, balance and coordination (30 min) and ended up by cool-down exercises (5–10 min). The intensity of the exercises was increased progressively in each group. The intensity was measured after each session by the Borg Rating of Perceived Exertion Scale (RPE), which is based on the physical sensations a person experiences during physical activity (Borg 1998). Exercises could be performed in a sitting or standing position according to the subject's health and functional status.

Lectures

The subjects in the IG were offered lectures once a month on preventive aspects of falling. Lectures included themes such as causes of falling, walking aids and fall prevention, nutrition in old age, home hazards, physical exercise and overall fall prevention. All lectures were given by health professionals.

Psychosocial groups

Psychosocial group activities were designed to offer recreational activities and psychological support. Subjects were divided into two groups according to their psychological health, amount of depressive symptoms, feelings of loneliness and level of social activity. Those having few contacts with other people and feeling themselves lonely and whose sum score was over 10 in GDS were advised to join a smaller "support" group. All the others were advised to join a bigger psychosocial group. The sessions were organized approximately once a month and held by trained nursing students. Activities included discussions on different themes and actual events, group singing, quizzes, reading poems and a summer party organized in July.

Home exercises

The subjects were advised to carry out physical exercises similar to those performed in groups 3 times a week at home. The subjects were given a brochure based on the exercise class content and encouraged to record the amount of their physical activity in the physical exercise diaries on a daily basis.

Home hazard assessment

Home hazard assessment included a thorough assessment of the home environment with a detailed form. The form consisted of questions about lighting, stairs, thresholds, corridors, floors, carpets, furniture and availability

of handrails. Written suggestions for modifications were given to each subject and an additional home visit was performed approximately a half year after the first one to reinforce the modifications. Assessments were performed by trained nursing students.

Control group

All subjects in the CG were given one-time counselling on fall and fracture prevention by a trained public health nurse. The oral information consisted of similar issues than information given to the intervention participants (e.g. risk factors and prevention of falls, home hazards and healthy diet). The subjects were given brochures about calcium and vitamin D supplements, home hazards and physical exercise.

The CG participants also had one visit with the geriatrician, who surveyed their current health status, medication and diagnoses. The geriatrician also made recommendations to use calcium (500 mg) and vitamin D_3 (400 IU) supplements during the winter and calcium (500 mg) supplement during the summer. A referral to own physician was made whenever considered appropriate. No further contacts with the control group participants were made during the intervention period.

4.5 Measures

Data were collected by self-administered questionnaires, interviews, clinical tests, medical records and diaries. Same questionnaires or other measures were used at both baseline and follow-up assessments.

4.5.1 Background variables

Demographic data (age, marital status, living circumstances, educational level) were collected using questionnaires. Marital status was classified in three categories as follows; (1) unmarried, (2) married or common-law marriage and (3) widowed, divorced or judicial separation. Living circumstances were dichotomised to (1) living alone and (2) living with spouse or some other person. Educational level was classified in three categories (1) less than middle school, (2) middle school and (3) more than middle school.

Physical functional abilities were collected by the questionnaire, which included eight questions about BADL and IADL. Both scales consisted of eight items (BADL: using the toilet, bathing (including washing up, taking sauna or shower), dressing, transferring to and from the bed, eating and cutting toenails; IADL: preparing meals, light housework, heavy housework (such as window cleaning), bearing heavy loads, managing finance, using public transportation, taking daily medication, using telephone). The answers were

rated as (4) able to perform without any difficulties, (3) able to perform with some difficulties, (2) able to perform with an assistive device, (1) able to perform with a help of some other person and (0) not able to perform, even with another person's help. The summed score, 32 at the maximum, reflects, therefore, higher capabilities for higher scores in both scales. *Walking ability* was measured by a 10-metre walking test which could be performed with or without walking aids.

Functional balance was measured by the Berg's Balance Scale (BBS) consisting of sixteen questions with a maximum sum score of 56 (Berg et al. 1992).

Cognitive function was measured by the MMSE (Folstein et al. 1975).

Clinical characteristics were assessed by measuring the blood pressure (mmHg), pulse, weight (kg) and height (cm) of the subjects. Blood pressure was measured twice and the mean of these two values was used in this study.

Self-reported *number of falls and injurious falls* during the past 12 months were asked during the interview by the study nurse. In addition, circumstances of a last fall were asked by one question classified into three categories (1) at home (inside or outside), (2) inside other than home and (3) outside other than home.

Medication All regularly and irregularly used prescribed *medications* were recorded during the geriatric assessment by asking the participants and by verifying the information from the medical records at health centre. The antidepressants were determined according to the Anatomical Therapeutic Chemical Classification System (ATC); codes N06A and N06CA01 were included.

4.5.2 Adherence and predictors of adherence

To calculate the adherence rates separately for each organised activity (group exercises, psychosocial groups and lectures), the number of sessions attended was divided by the number of sessions offered during the intervention period and multiplied by 100 to get the percentage. An intervention period was determined for each subject individually as a time scale from signing the consent form to the first follow-up visit or the date the person informed he/she was not continuing in the study. For the predictor analyses participants were classified as persons with (1) 0% adherence rate, (2) 0.1%–33.3% adherence rate, (3) 33.4%–66.6% adherence rate and (4) 66.7%–100% adherence rate.

To calculate home-exercise adherence, the total amount of performed home exercise sessions over the intervention period (determined as above) was calculated. This amount was then divided by the number of monthly returned exercise diaries to get monthly home-exercise rates. The monthly rates were then divided by 30 and multiplied by 7 to get weekly home-exercise rates.

Participants were then classified as persons performing home-exercises (1) 0–0.99, (2) 1–2.99 and (3) ≥ 3 times a week.

A total of ten potential predictors were tested. *Demographic data* (age, gender) were collected as mentioned above. For the predictor analyses age was dichotomised as follows; (1) 65–74-year-olds and (2) ≥75-year-olds.

Cognitive abilities (MMSE) was dichotomised as follows; (1) persons scoring 17–24 sum points were considered to have lowered cognitive abilities and (2) those with 25 or more sum points to be cognitively intact.

Depressive symptoms were measured by the 30-item GDS which represents a valid and reliable self-rating scale for depressive symptoms among the aged. Depression was defined according to the validated cut off score; 11 and above indicating a high amount of depressive symptoms (Brink et al. 1982; Yeasavage et al. 1982/1983).

Fear of falling was measured by one question "Do you nowadays have fear of falling?" with a dichotomised response-format ("no"/"yes").

Feelings of loneliness were measured with the question "How often do you feel loneliness?" The answers had five classes, and they were dichotomised as follows; (1) never, seldom or only sometimes and (2) often or always.

Self-perceived probability of falling at home was measured with the question "What is your self-perceived probability of a falling event at home?" The five classes of the answers were dichotomised to (1) very unlikely or quite unlikely and (2) very likely, likely or quite likely.

Self-perceived health was measured by a question with five possible answers classified to (1) good or very good, (2) average and (3) poor or very poor.

Physical functional abilities were graded from (1) very good, (2) average to (3) poor on the basis of three different measures; balance measured with BBS, muscle strength measured by adjustable dynamometer chair (Good Strength®, Metitur, Finland; classified as very good, average or poor) and peak expiratory flow (PEF). Those having a sum score of BBS 50–56, muscle strength classified as "very good" and PEF over 300 litres (l)/minute (min.) were classified as having good physical functional abilities (1). Those having a sum score of BBS 40–49, muscle strength classified as "average" and PEF 200–300 l/min. were classified as having moderate physical functional abilities (2). Those with a sum score of BBS under 40 and muscle strength classified as "poor" or using walking aids and PEF under 200 l/min. were classified as having poor physical functional abilities (3). In the case of overlapping classes, the final classification of the subject was based on the consensus of the physiotherapist and the geriatrician.

Medication All regularly used prescribed *medications* were recorded during the geriatric assessment by asking the participants and by verifying the information from the medical records at the health centre. The amount of the medications was dichotomised to (1) < 4 medications and (2) ≥ 4 medications.

4.5.3 Effect measures

Depressive symptoms and fear of falling were measured as mentioned above.

4.6 Ethics

The study was supported by the Ethics Committee of Satakunta Hospital District, and the permission for the study was given by the chief physician of the Pori Health Centre. A written informed consent was received from each participant.

4.7 Statistical analyses

Study III: Baseline differences in continuous variables between the IG and CG were tested by the Student two-sample t-test or the Mann-Whitney U-test, when appropriate. Associations between groups in categorical variables were analysed using Chi Square (χ^2) test or Fisher's Exact Test, when appropriate.

Study IV: The associations between potential predictors and adherence rates were first analysed by univariate cumulative logistic regression (Hosmer & Lemeshow 2000). Cumulative logistic regression was used instead of the traditional binary logistic regression due to the ordinal-type dependent variables consisting of more than two categories (home-exercises and organized activities). In the second phase, variables significantly related to the adherence in univariate logistic regression analysis were used as predictors in the multivariate logistic regression analysis. The results of logistic models were quantified by cumulative odds ratios (COR) and their 95% confidence intervals (95% CI).

Study V: Differences in background variables between the IG and CG were tested in a similar manner to *Study III* (see above) among all participants and in subgroups classified according to age, gender and baseline depression level. The Kruskall-Wallis test was used when assessing the differences in background variables between the IG classified according to adherence and the CG. In the case of significant differences between the groups in background variables, paired comparisons, where each adherence group was separately compared with the control group, were conducted by the Mann-Whitney U-test with Bonferroni correction.

If a significant difference in background variables between the IG and CG was found in any subgroup, differences in depressive symptoms were also tested.

Effects of intervention: The analyses were first conducted by the intention to treat principle, so that all participants were analyzed as randomized, regardless of compliance. In the second phase the analyses were conducted according to adherence to different activities of the programme. When analyzing according to adherence, participants were classified as persons with (1) 0% adherence rate (non-adherence), (2) 1%–29% adherence rate (low adherence), (3) 30%–69% adherence rate (moderate adherence) and (4) ≥70% adherence rate (high adherence).

The distributions of the GDS sum scores at baseline and follow-up were highly positively skewed. However, the distributions of the change of the GDS sum score were normally distributed and parametric tests were chosen to analyze the changes. The changes within the groups were analyzed by the Student's paired t-test and the differences in the change between the groups from baseline to 12-month follow-up by the Student's two-sample t-test. The mean differences in the changes between the groups and their 95% CIs were calculated. In addition, analysis was adjusted for age, gender and baseline level of depressive symptoms by using analysis of covariance.

When analysing the changes in different adherence groups nonparametric tests were chosen. Within group changes in depressive symptoms from baseline to 12-month follow-up were analyzed by the Wilcoxon Signed Rank test suitable for repeated measures. Between-group comparisons were conducted by the Kruskall-Wallis test which is appropriate when comparing more than 2 groups. If a significant difference in the change between the groups was detected, each (adherence) group was compared with the control group separately by using the Mann Whitney U-test with Bonferroni correction.

Fear of falling data (Unpublished data/Vaapio et al. 2007, in press): Between-group differences in the categorical outcome variable (fear of falling) were analyzed at baseline by using binary logistic models. Repeated measures during the follow-up were analysed by using binary logistic regression with generalized estimation equations (GEE-estimation), which takes into account the correlation of repeated measurements. Differences in the changes between the IG and CG were tested with interaction terms between group and measurement (group x measurement). The results were quantified by odds ratios (OR) and their 95% confidence intervals (95% CI).

All statistical analyses were performed with the SAS System for Windows® version 9.1 (SAS Institute Inc., Cary; NC, USA). P-values of less than 0.05 were considered statistically significant.

5. Results

5.1 Drop-out analyses

Nine persons (5 in IG, 4 in CG) died during the study period and 52 dropped out from the whole study due to other reasons (Figure 1). Those who dropped out before the follow-up assessments (n=52; 27 from the IG and 25 from the CG) were significantly older, and had poorer physical and cognitive functional abilities, poorer self-rated health, more depressive symptoms and they were more often living alone, widowed, divorced or living in judicial separation than those who remained in the study (Table 7). There were no significant differences between the participants continuing in the study and the drop-outs according to gender, presence of fear of falling, feelings of insecurity, or the amount of falls and injurious falls during the previous year.

Table 7. Significant differences in background variables (at baseline) between persons who completed the study (n=530) and those who dropped out (n=52)

Variable	Completers (n=530) Mean (SD[1])	Drop-outs (n=52) Mean (SD[1])	p-value
Age (yrs)	72.9 (5.8)	77.6 (7.4)	< 0.001
MMSE[2]	27.4 (2.2)	26.4 (2.7)	0.006*
GDS[3]	5.3 (5.2)	7.9 (7.3)	0.021*
ADL sum score[4]	30.4 (3.1)	26.8 (6.1)	<0.001*
IADL sum score[5]	28.6 (5.1)	23.5 (8.2)	<0.001*
	n (%)	n (%)	
Marital status			
Unmarried	34 (6)	3 (6)	0.008
Married or common-law marriage	247 (47)	13 (25)	
Widowed, divorced or judicial separation	249 (47)	36 (69)	
Living circumstances			
Living alone	275 (52)	35 (67)	0.041**
Living with spouse or some other person	255 (48)	17 (33)	
Self-perceived health			
Good or very good	140 (26)	14 (27)	0.010
Average	344 (65)	27 (52)	
Poor or very poor	45 (9)	11 (21)	
Circumstances of last fall			
At home (inside or outside)	189 (36)	33 (63)	<0.001
Inside else than home	30 (6)	4 (8)	
Outside else than home	311 (59)	15 (29)	

1 SD = Standard Deviation
2 MMSE = Mini Mental State Examination
3 GDS = Geriatric Depression Scale
4 ADL = Activities of Daily Living (Higher values indicate more independency in functional abilities.)
5 IADL = Instrumental Activities of Daily Living (Higher values indicate more independency in functional abilities.)

Differences between completers and drop-outs in continuous variables were tested by Student's two-way t-test or Mann-Whitney's U-test* and by Chi-Square ($\chi 2$) test or Fisher's Exact Test** in categorical variables.

Variables tested included also gender, fear of falling, feelings of insecurity, amount of falls and injurious falls during the year previous to randomisation.

The full baseline and follow-up data of GDS was available for 464 and of fear of falling for 512 persons (78.5% and 86.6% of the original study population, respectively). Those who dropped out from the analyses were significantly older, had more depressive symptoms, poorer physical and cognitive functional abilities and were more often widowed, divorced or living in judicial separation (both analyses) and more often living alone (only depression analyses), than those who remained (Tables 8 and 9).

Table 8. Significant differences in background variables (at baseline) between persons with full depression data (n=464) and persons who dropped out from analyses (n=118)

Variable	Completers (n=464) Mean (SD[1])	Drop-outs (n=118) Mean (SD[1])	p-value
Age (yrs)	72.8 (5.6)	75.5 (7.2)	<0.001
MMSE[2]	27.5 (2.2)	26.5 (2.5)	<0.001
GDS[3]	5.3 (5.1)	6.9 (6.5)	0.042
ADL sum score[4]	30.6 (2.9)	28.3 (5.3)	<0.001
IADL sum score[5]	28.8 (4.8)	25.6 (7.7)	<0.001
	n (%)	n (%)	
Marital status			
Unmarried	30 (7)	7 (6)	0.038
Married or common-law marriage	219 (47)	41 (35)	
Widowed, divorced or judicial separation	215 (46)	35 (59)	
Living circumstances			
Living alone	236 (51)	74 (63)	0.023*
Living with spouse or some other person	228 (49)	44 (37)	

1 SD = Standard Deviation
2 MMSE = Mini Mental State Examination
3 GDS = Geriatric Depression Scale
4 ADL = Activities of Daily Living (Higher values indicate more independency in functional abilities.)
5 IADL = Instrumental Activities of Daily Living (Higher values indicate more independency in functional abilities.)

Differences between completers and drop-outs in continuous variables were tested by Mann-Whitney's U-test and by Chi-Square ($\chi 2$) test or Fisher's Exact Test* in categorical variables.

Variables tested also included gender, fear of falling, educational level, feelings of insecurity and the amount of falls and injurious falls during the year previous to randomisation.

Table 9. Significant differences in background variables (at baseline) between persons with full fear of falling data (n=512) and persons who dropped out from analyses (n=70)

Variable	Completers (n=512) Mean (SD[1])	Drop-outs (n=70) Mean (SD[1])	p-value
Age (yrs)	72.8 (5.7)	77.3 (7.2)	<0.001
MMSE[2]	27.4 (2.2)	26.2 (2.7)	0.001
GDS[3]	5.3 (5.2)	7.3 (6.8)	0.030
ADL sum score[4]	30.5 (3.0)	27.2 (6.0)	<0.001
IADL sum score[5]	28.7 (4.9)	23.9 (8.4)	<0.001
	n (%)	n (%)	
Marital status			
Unmarried	33 (7)	4 (6)	
Married or common-law marriage	239 (47)	21 (30)	0.021
Widowed, divorced or judicial separation	240 (47)	45 (64)	

1 SD = Standard Deviation
2 MMSE = Mini Mental examination
3 GDS = Geriatric Depression Scale
4 ADL = Activities of Daily Living (Higher values indicate more independency in functional abilities.)
5 IADL = Instrumental Activities of Daily Living (Higher values indicate more independency in functional abilities.)

Differences between completers and drop-outs in continuous variables were tested by Mann-Whitney's U-test and by Chi-Square ($\chi 2$) test in categorical variables.

Variables tested also included gender, fear of falling, educational level, living circumstances, feelings of insecurity and the amount of falls and injurious falls during the year previous to randomisation.

5.2 Baseline characteristics of the participants and the success of randomization

The differences in background variables between the IG and CG in total sample (n=591) are shown in Tables 10 to 12.

Table 10. Baseline demographic characteristics of all participants (n=591) and occurrence of falls during 12 months previous to randomisation

Variable	Intervention group (n=293) Mean (SD[1])	Control group (n=298) Mean (SD[1])	p-value
Age (yrs)	73.4 (6.0)	73.5 (6.3)	0.891
Falls during previous 12 months			
All falls	2.4 (2.7)	2.6 (3.8)	0.742*
Falls requiring medical treatment	0.4 (0.7)	0.4 (0.9)	0.700*
	n (%)	n (%)	
Women	251 (86)	246 (83)	0.313**
Marital status			
Unmarried	19 (7)	18 (6)	0.194
Married or common-law marriage	120 (41)	144 (48)	
Widowed, divorced or judicial separation	154 (53)	136 (46)	
Living circumstances			
Living alone	168 (57)	147 (49)	0.058**
Living with spouse or some other person	125 (43)	151 (51)	
Educational level			
Less than middle school	224 (77)	234 (79)	0.635
Middle school	41 (14)	42 (14)	
More than middle school	28 (10)	22 (7)	
Circumstances of last fall			
At home (inside or outside)	117 (40)	113 (38)	0.573
Inside else than home	14 (5)	20 (7)	
Outside else than home	162 (55)	165 (55)	

1 SD = Standard Deviation

Differences between intervention and control groups were tested by Student's two-sample t-test or Mann Whitney U-test* in continuous variables and by Chi-Square ($\chi 2$) test or Fisher's Exact Test** in categorical variables.

Table 11. Baseline clinical characteristics of all participants (n=591)

Variable	Intervention group (n=293) Mean (SD[1])	Control group (n=298) Mean (SD[1])	p-value
Blood pressure (mmHg)			
Systolic	154.9 (23.1)	154.7 (23.7)	0.905
Diastolic	84.5 (10.4)	84.6 (10.7)	
Pulse	69.8 (11.9)	69.8 (11.9)	0.986
Weight (kg)	74.4 (13.1)	75.6 (13.1)	0.290
Height (cm)	161.2 (7.9)	161.7 (7.7)	0.419

1 SD = Standard Deviation

Differences between intervention and control groups were tested by Student's two-sample t-test.

Table 12. Risk factors of falling, physical and cognitive functional abilities of all participants (n=591)

Variable	Intervention group (n=293) Mean (SD[1])	Control group (n=298) Mean (SD[1])	p-value
Risk factors of falling			
BBS[2] sum score	50.2 (7.6)	50.3 (6.3)	0.358
Prescribed medications			
Regularly taken medicines	4.2 (3.1)	3.7 (3.0)	0.028
Irregularly taken medicines	1.7 (1.8)	1.5 (1.6)	0.395
GDS[3] sum score	5.9 (5.7)	5.5 (5.6)	0.322
Fear of falling [n (%)]			
Yes	124 (42)	121 (41)	0.738*
No	169 (58)	176 (59)	
Physical functional abilities			
10-metre walking test (s)	8.3 (7.6)	7.6 (3.2)	0.568
Functional ability sum score			
ADL[4]	29.7 (4.0)	30.2 (3.6)	0.009
IADL[5]	27.7 (6.2)	28.2 (5.7)	0.260
Cognitive functional abilities			
MMSE[6] sum score	27.3 (2.3)	27.2 (2.3)	0.295

1 SD = Standard Deviation
2 BBS = Berg's Balance Scale
3 GDS = Geriatric Depression Scale
4 ADL = Activities of Daily Living (Higher values indicate more independency in functional abilities.)
5 IADL = Instrumental Activities of Daily Living. (Higher values indicate more independency in functional abilities.)
6 MMSE = Mini Mental State Examination

Differences between intervention and control groups were tested by Mann Whitney U-test in continuous variables and by Chi-Square ($\chi 2$) test or Fisher's Exact Test* in categorical variables.

Altogether 591 persons participated, 293 were assigned to the IG and 298 to the CG. The mean age of the participants was 73.5 years and 84% of the subjects were women. The majority (57%) of the subjects in the IG and almost a half in the CG (49%) were living alone. Approximately 60% of the subjects in both groups had fallen at least twice during the previous 12 months and 171 of the subjects had experienced a fall requiring medical treatment.

Groups were well-balanced at baseline. The subjects in the IG tended to live alone more often (p=0.058). The subjects in the CG had better functional abilities (ADL) (p=0.009) and a lower amount of regularly taken medicines (p=0.028).

Among persons with full fear of falling data (n=512), the subjects in the CG had slightly better functional abilities (ADL) (p=0.043) (Table 13). In subgroups, older CG participants (≥75-year-olds) had slightly better functional abilities (ADL) (p=0.040). The differences found in ADL functions were, however, minimal in absolute terms. Among older participants, persons in the IG had more previous falls (p=0.017).

Table 13. Differences in baseline characteristics between intervention and control groups among persons with full fear of falling data (n=512)

Variable	Intervention group (n=251) Mean (SD[1])	Control group (n=261) Mean (SD[1])	p-value
Age (yrs)	72.8 (5.5)	72.8 (5.9)	0.882
ADL[2] sum score	30.4 (2.9)	30.6 (3.1)	0.043
IADL[3] sum score	28.9 (4.4)	28.6 (5.3)	0.926
MMSE[4] sum score	27.6 (2.1)	27.3 (2.2)	0.117
Falls during previous 12 months	2.4 (2.8)	2.5 (2.7)	0.813
Injurious falls during previous 12 months	0.4 (0.7)	0.4 (0.8)	0.699
	n (%)	n (%)	
Women	215 (86)	215 (82)	0.336*
Marital status			
Unmarried	16 (6)	17 (7)	0.320
Married or common-law marriage	109 (43)	130 (50)	
Widowed, divorced or judicial separation	126 (50)	114 (44)	
Living circumstances			
Living alone	137 (55)	128 (49)	0.217*
Living with spouse or some other person	114 (45)	133 (51)	
Educational level			
Less than middle school	194 (77)	205 (79)	0.729
Middle school	35 (14)	38 (15)	
More than middle school	22 (9)	18 (7)	

1 SD = Standard Deviation
2 ADL = Activities of Daily Living (Higher values indicate more independency in functional abilities.)
3 IADL = Instrumental Activities of Daily Living (Higher values indicate more independency in functional abilities.)
4 MMSE = Mini Mental State Examination

Differences between intervention and control groups were tested by Mann Whitney U-test in continuous variables and by Chi-Square ($\chi 2$) test or Fisher's Exact Test* in categorical variables.

Among persons with full depression data (n=464), there were no statistically significant differences in background variables between the IG and CG at baseline among all participants (Table 14) or when classified by gender. Among younger participants (65–74-year-olds) persons in the IG had better functional abilities (ADL) (p=0.022). Among older participants (≥75-year-olds) persons in the CG were older (p=0.046) and they had had more injurious falls (p=0.006) during the past 12 months.

Table 14. Differences in baseline characteristics between intervention and control groups among persons with full data of depressive symptoms (n=464)

Variable	Intervention group (n=225) Mean (SD[1])	Control group (n=239) Mean (SD[1])	p-value
Age (yrs)	72.7 (5.4)	72.8(5.9)	0.927
ADL[2] sum score	30.5 (2.8)	30.6 (3.0)	0.064
IADL[3] sum score	29.0 (4.4)	28.7 (5.1)	0.923
MMSE[4] sum score	27.6 (2.1)	27.4 (2.2)	0.192
Falls during previous 12 months	2.4 (8.9)	2.5 (2.8)	0.745
Injurious falls during previous 12 months	0.3 (0.7)	0.4 (0.8)	0.431
	n (%)	n (%)	
Women	191 (85)	197 (82)	0.474*
Marital status			
Unmarried	14 (6)	16 (7)	
Married or common-law marriage	99 (44)	120 (50)	0.349
Widowed, divorced or judicial separation	112 (50)	103 (43)	
Living circumstances			
Living alone	121 (54)	115 (48)	0.229*
Living with spouse or some other person	104 (46)	124 (52)	
Educational level			
Less than middle school	169 (75)	187 (78)	0.722
Middle school	36 (16)	34 (14)	
More than middle school	20 (9)	18 (8)	
Regular use of antidepressant medication[5]			
Yes	18 (8)	25 (10)	0.424*
No	207 (92)	214 (90)	

1 SD = Standard Deviation
2 ADL = Activities of Daily Living (Higher values indicate more independency in functional abilities.)
3 IADL = Instrumental Activities of Daily Living (Higher values indicate more independency in functional abilities.)
4 MMSE = Mini Mental State Examination
5 Codes N06A and N06CA01 were included according to Anatomical Therapeutic Chemical Classification (ATC) System.

Differences between intervention and control groups were tested by Mann Whitney U-test in continuous variables and by Chi-Square ($\chi 2$) test or Fisher's Exact Test* in categorical variables.

5.3 Adherence rates and predictors of adherence

The mean adherence rate was 58% (SD 30.2) in the physical exercise groups, 25% (SD 24.6) in the psychosocial groups and 33% (SD 28.2) in lectures. Subjects performed home-exercises on average 3 (SD 2.1) times per week. 45% of the participants were highly adherent (70%–100% adherence rates) in the physical exercise groups, 8% in the psychosocial groups and 14% in lectures, and 36% performed home-exercises at least three times a week (Tables 15 and 16).

Table 15. Adherence to organised activities (n=293) among intervention group participants

Adherence (% of offered activities)	Participants in physical exercise groups n (%)	Participants in psychosocial groups n (%)	Participants in lectures n (%)
0	22 (8)	79 (27)	73 (25)
1-29	40 (14)	110 (38)	69 (24)
30-69	99 (34)	82 (28)	110 (38)
70-100	132 (45)	22 (8)	41 (14)

Table 16. Adherence to weekly performance of home exercises among intervention group participants (n=262)

Home-exercise sessions per week	Participants in home-exercises n (%)
0-0.99	80 (31)
1-2.99	88 (34)
≥3	94 (36)

Predictors of adherence were analysed in four key activities of the intervention programme (exercise groups, psychosocial group activities, lectures and home-exercises) among all persons in the IG (n=293). Significant associations and predictors of more active adherence in organised activities and home-exercises are shown in Table 17.

In the univariate analysis, lower age, low self-perceived probability of falling at home and better physical functional abilities had the strongest associations with more active physical exercise group adherence ($p<0.001$). Lower age and higher physical and cognitive functional abilities had the strongest associations with the more active psychosocial group and lecture adherence ($p\leq0.001$). Using less than four prescribed medications was the only variable significantly associated with home-exercise adherence and was thus omitted from further analyses.

In the multivariate analyses, lower self-perceived probability of falling at home and better physical functional abilities were significant predictors of more active physical exercise group adherence. Good physical and cognitive functional abilities predicted more active psychosocial group adherence. Female gender and good physical and cognitive functional abilities remained significant predictors of more active lecture adherence.

Table 17. Significant associations (univariate analysis) and predictors of more active adherence in organised activities and home-exercises in cumulative logistic regression analysis (multivariate analysis)

Variable	Univariate analysis			Multivariate analysis		
	COR[1]	95% CI	p-value	COR[1]	95% CI	p-value
Physical exercise groups						
Age (65-74 vs. ≥75 years)	2.2	1.4 -3.5	<0.001	1.3	0.8-2.2	0.256
Cognitive abilities (≥25 vs. 17-24 in MMSE[2])	2.4	1.2-4.8	0.010	1.7	0.8-3.5	0.141
Depressive symptoms (0-10 vs. ≥ 11 in GDS[3])	2.2	1.2-3.8	0.006	1.2	0.6-2.4	0.528
Feelings of loneliness (infrequent vs. frequent)	4.0	1.6-9.9	0.003	2.6	0.8-8.2	0.106
Self-perceived probability of falling (low vs. high)	2.3	1.5-3.5	<0.001	1.6	1.0-2.6	0.047
Prescribed medications (<4 vs. ≥4)	1.6	1.0-2.4	0.046	0.9	0.5-1.4	0.609
Physical functional abilities			0.001			0.006
- Good vs. poor	4.7	2.8-7.9	<0.001	2.7	1.5-4.8	0.001
- Average vs. poor	2.4	1.2-4.6	0.010	1.6	0.8-3.2	0.199
Psychosocial group activities						
Age (65-74 vs. ≥75 years)	2.3	1.5-3.5	<0.001	1.5	0.9-2.4	0.113
Cognitive abilities (≥25 vs. 17-24 in MMSE[2])	3.6	1.8-7.5	0.001	2.4	1.1-5.1	0.025
Depressive symptoms (0-10 vs. ≥11 in GDS[3])	1.8	1.0-3.1	0.041	1.3	0.7-2.3	0.433
Prescribed medications (<4 vs. ≥4)	1.7	1.1-2.6	0.013	1.2	0.7-1.9	0.482
Physical functional abilities			<0.001			0.003
- Good vs. poor	4.3	2.5-7.2	<0.001	2.8	1.5-5.0	<0.001
- Average vs. poor	2.6	1.3-5.1	0.005	2.3	1.1-4.6	0.025
Lectures						
Gender (women vs. men)	1.9	1.0-3.4	0.039	2.1	1.1-3.9	0.021
Age (65-74 vs. ≥75 years)	2.0	1.3 -3.1	<0.001	1.4	0.9-2.3	0.163
Cognitive abilities (≥25 vs. 17-24 in MMSE[2])	3.2	1.6- 6.4	0.001	2.4	1.2-5.0	0.019
Depressive symptoms (0-10 vs. ≥11 in GDS[3])	1.8	1.0-3.1	0.037	1.1	0.6-2.1	0.705
Feelings of loneliness (infrequent vs. frequent)	2.6	1.0-6.5	0.049	2.5	0.8-7.7	0.097
Physical functional abilities			<0.001			0.040
- Good vs. poor	3.1	1.9-5.1	<0.001	2.1	1.3-3.6	0.012
- Average vs. poor	1.9	1.0 -3.6	0.053	1.5	0.7-3.0	0.262
Home exercises						
Prescribed medications (<4 vs. ≥4)	1.8	1.1-2.8	0.014	-	-	-

CI = Confidence interval

1 COR = Cumulative odds ratio, COR >1 indicates more active adherence. More active adherence was compared to less active adherence (second value in parentheses has been used as reference value in all variables).

2 MMSE = Mini Mental State Examination

3 GDS = Geriatric Depression Scale

All significant variables in bivariate models were included in the multivariate models.

5.4 Effects of fall prevention on depressive symptoms

The amount of depressive symptoms reduced significantly during 12 months both in the IG and CG, but the difference in the change between the groups was not statistically significant (mean difference in the change between the groups -0.7; 95%CI -1.5 – 0.2; p=0.110) (Table 18). When adjusted for age, gender and baseline level of depressive symptoms, the difference in the change remained non-significant (mean difference in the change -0.7; 95%CI -1.4 – 0.1; p=0.093).

5.4.1 According to age and gender

Among men and older subjects (aged ≥75 years) depressive symptoms decreased statistically significantly in the IG, while they increased slightly in the CG. The differences in the changes were statistically significant.

When women and men were separately analysed in different age groups, the greatest difference in the change between the IG and CG was found among the older men (mean difference in the change between the groups -3.7; 95% CI -6.7– (-0.8); p=0.015).

No statistically significant between-group differences were found among female and younger (<75) subjects.

5.4.2 According to baseline level of depressive symptoms

The amount of depressive symptoms decreased most in absolute terms among persons with a high amount of depressive symptoms at baseline (sum score of GDS ≥11 at baseline) in both groups. However, the change did not significantly differ between the groups.

Table 18. Depressive symptoms (GDS[1] sum points) at baseline and follow-up, and changes in the symptoms during the 12-month fall prevention programme among all participants and according to gender, age and baseline level of depressive symptoms; in intervention (IG) and control groups (CG)

	IG GDS SUM POINT					CG GDS SUM POINT						
	n	Baseline Mean(SD[2])	12-month Mean(SD[2])	Change Mean(SD[2])	p-value[3]	n	Baseline Mean(SD[2])	12-month Mean(SD[2])	Change Mean(SD[2])	p-value[3]	Mean difference in change (95% CI)	p-value[4]
All	225	5.4 (5.1)	4.0 (4.6)	-1.4 (4.7)	<0.001	239	5.2 (5.2)	4.5 (5.2)	-0.7 (4.6)	0.018	-0.7 (-1.5 – 0.2)	0.110
Gender												
Men	34	4.6 (4.2)	2.5 (2.4)	-2.1 (3.4)	0.001	42	4.6 (4.6)	4.9 (6.5)	0.3 (4.0)	0.593	-2.5 (-4.2 – -0.7)	0.005
Women	191	5.5 (5.2)	4.2 (4.8)	-1.3 (4.8)	<0.001	197	5.3 (5.3)	4.4 (5.0)	-0.9 (4.7)	0.006	-0.3 (-1.3 – 0.6)	0.486
Age												
65- 74 yrs	150	5.2 (5.3)	3.5 (4.4)	-1.7 (4.9)	<0.001	160	5.2 (5.3)	3.8 (4.6)	-1.4 (4.4)	<0.001	-0.3 (-1.3 – 0.7)	0.564
≥ 75 yrs	75	5.7 (4.5)	4.9 (4.7)	-0.8 (4.0)	0.077	79	5.2 (5.1)	5.8 (6.2)	0.6 (4.8)	0.238	-1.5 (-2.9 – -0.6)	0.042
Baseline depression level												
GDS sum score 11–30	34	14.9 (3.9)	8.8 (5.6)	-6.1 (6.1)	<0.001	35	15.3 (4.0)	11.1 (7.0)	-4.2 (6.4)	<0.001	-1.9 (-5.0 – 1.1)	0.200
GDS sum score 0–10	191	3.6 (2.9)	3.1 (3.8)	-0.6 (3.8)	0.043	204	3.4 (3.0)	3.3 (3.9)	-0.1 (4.0)	0.672	-0.4 (-1.2 – 0.3)	0.135

CI = Confidence interval
1 GDS = Geriatric Depression Scale
2 SD = Standard Deviation
3 Statistical significance of change within the groups during the follow-up (Student's paired t-test)
4 Statistical significance of difference of the changes between IG and CG during follow-up (Student's two-sample t-test)

5.4.3 According to adherence

Lectures A statistically significant decrease in depressive symptoms was found among persons who participated in at least 30% of the lectures organised during the 12-month intervention. However, no statistically significant differences in the change between the groups were found (Table 19).

Psychosocial group activities A statistically significant decrease in depressive symptoms was found among persons who participated in organised psychosocial group activities. Even among persons with a 1%–29% adherence rate, a significant reduction in depressive symptoms was found. The difference in the change was also statistically significant between the groups.

In paired comparisons, each adherence group was separately compared with the control group. These tests revealed that the difference in the change was greatest between the persons with high adherence (≥70%) and the controls (p=0.022). However, this difference was not significant after the Bonferroni correction (p=0.088).

Physical exercise groups A statistically significant decrease in depressive symptoms was found among those who participated in at least 30% of the physical exercise sessions. The effect on depressive symptoms was strongest among persons adhering to at least 70% of the physical exercise groups. The difference in the change was also significant between the groups.

In paired comparisons, the difference in the change was greatest between persons with high adherence (≥70%) and the controls (p=0.021). However, this difference was not statistically significant after the Bonferroni correction (p=0.084).

Table 19. Depressive symptoms (GDS[1] sum points) at baseline and follow-up, and changes in the symptoms during the 12-month fall prevention programme among according to adherence rates; in intervention (IG) and control groups (CG)

	IG GDS SUM POINT					CG GDS SUM POINT					
	n	Baseline Mean(SD[2])	Follow-up Mean(SD[2])	Change Mean(SD[2])	p-value[3]	n	Baseline Mean(SD[2])	Follow-up Mean(SD[2])	Change Mean(SD[2])	p-value[3]	p-value[4]
Adherence in lectures (%)											
0	42	4.7 (4.7)	4.1 (5.3)	−0.5 (4.1)	0.364	239	5.1 (5.2)	4.5 (5.2)	−0.7 (4.6)	0.007	0.192
1-29	55	4.8 (4.8)	5.0 (5.4)	−0.7 (5.3)	0.162						
30-69	92	5.8 (5.8)	3.7 (4.1)	−2.1 (4.6)	<0.001						
70-100	36	4.5 (3.6)	2.7 (3.0)	−1.8 (4.1)	0.007						
Adherence in psychosocial group activities (%)											
0	46	5.2 (4.8)	5.3 (6.2)	0.2 (5.1)	0.755	239	5.2 (5.2)	4.5 (5.2)	−0.7 (4.6)	0.007	0.033
1-29	89	5.8 (5.2)	4.0 (4.3)	−1.9 (4.6)	<0.001						
30-69	70	4.7 (4.9)	3.4 (3.9)	−1.2 (3.7)	0.011						
70-100	20	6.1 (5.7)	2.6 (2.7)	−3.5 (5.8)	0.005						
Adherence in physical exercise in groups (%)											
0	11	6.7 (5.3)	6.9 (5.9)	0.2 (6.0)	0.805	239	5.2 (5.2)	4.5 (5.2)	−0.7(4.6)	0.007	0.022
1-29	22	4.6 (4.6)	5.5 (5.4)	0.9 (3.9)	0.438						
30-69	72	5.5 (5.5)	4.0 (5.1)	−1.5 (5.2)	0.003						
70-100	120	5.2 (4.9)	3.4 (3.8)	−1.8 (4.1)	<0.001						

1 GDS = Geriatric Depression Scale

2 SD = Standard Deviation

3 Statistical significance of change within the groups during the follow-up (Wilcoxon Signed Rank test)

4 Statistical significance of difference in the changes between IG (with 0%, 1%–29%, 30%–69% and 70%–100% adherence) and CG during follow-up (Kruskall-Wallis test)

5.5 Effects of fall prevention on fear of falling

Fear of falling reduced significantly during the follow-up in both groups. The percentage of the subjects suffering from fear of falling reduced slightly more in the IG (32%; $p<0.001$) than in the CG (17%; $p=0.041$), but the difference in the change was not statistically significant (Table 20).

5.5.1 According to age and gender

Among younger participants (65–74-year-olds), fear of falling reduced statistically significantly in both groups. The amount of persons suffering from fear of falling reduced slightly more in the IG (40%; $p<0.001$) than in the CG (27%; $p=0.008$), but the difference in the change was not statistically significant.

Among older participants (≥75-year-olds), no statistically significant within or between-group differences in the change were detected.

In women, fear of falling reduced statistically significantly only in the IG ($p<0.001$). At baseline 46% reported having fear of falling while at 1-year follow-up only 31% reported having fear. The reduction of fear also tended to be statistically significant in the CG ($p=0.070$). No between-group differences in the change were detected.

In men, no statistically significant within or between group differences in the change were detected in either group.

5.5.2 According to adherence

Lectures A statistically significant decrease in fear of falling was found among persons who had participated in 1%–69% of the lectures organised during the 12-month intervention. However, no statistically significant differences in the change between the groups were found (Table 21).

Psychosocial group activities A statistically significant decrease in fear of falling was found among persons who had participated in organised psychosocial group activities. The highest decrease in fear of falling was found among persons with a 70%–100% adherence rate. However, no statistically significant differences in the change between the groups were found.

Physical exercise groups A statistically significant decrease in fear of falling was found among persons who had participated in at least 30% of the physical exercise sessions. However, the difference in the change was not significant between the groups.

Table 20. The amount of fear of falling at baseline and follow-up, and changes during the 12-month fall prevention programme among all participants and according to age and gender; in intervention and control groups

	Intervention group					Control group					Change
	n	Baseline n (%)	12-month n (%)	OR[1] (95% CI)	p-value[2]	n	Baseline n (%)	12-month n (%)	OR[1] (95% CI)	p-value[2]	p-value[3]
All											
Fear of falling											
No	251	148 (59)	181 (72)	1.8 (1.3-2.4)	<0.001	261	156 (60)	174 (67)	1.3 (1.0-1.8)	0.041	0.167
Yes		103 (41)	70 (28)				105 (40)	87 (33)			
65- 74-year-olds											
Fear of falling											
No	165	95 (56)	123 (75)	2.2 (1.5-3.1)	<0.001	173	100 (58)	120 (69)	1.6 (1.1-2.4)	0.008	0.315
Yes		70 (42)	42 (25)				73 (42)	53 (31)			
≥75-year-olds											
Fear of falling											
No	86	53 (62)	58 (67)	1.3 (0.8-2.2)	0.335	58	56 (64)	54 (61)	0.9 (0.6-1.4)	0.655	0.304
Yes		33 (38)	28 (33)				32 (36)	34 (39)			
Men											
Fear of falling											
No	36	32 (89)	32 (89)	1.0 (0.3-3.9)	1.000	46	34 (74)	37 (80)	1.5 (0.7-3.0)	0.315	0.638
Yes		4 (11)	4 (11)				12 (26)	9 (20)			
Women											
Fear of falling											
No	215	116 (54)	149 (69)	1.9 (1.4-2.6)	<0.001	215	122 (57)	137 (64)	1.3 (1.0-1.8)	0.070	0.112
Yes		99 (46)	66 (31)				93 (43)	78 (36)			

CI = Confidence interval

1 OR = Odds Ratio, OR >1 indicates positive change

2 P-value for difference in the change within the group

3 P-value for difference in the change between the groups

Table 21. Changes in fear of falling during the 12-month fall prevention programme according to adherence; in intervention and control groups

	Intervention group			Control group			Change
	n	OR[1] (95% CI)	p-value[2]	n	OR[1](95% CI)	p-value[2]	p-value[3]
Adherence in lectures (%)							
0	49	1.2 (0.7-2.2)	0.526	261	1.3 (1.0-1.8)	0.041	0.463
1-29	59	2.1 (1.1-4.0)	0.030				
30-69	102	2.0 (1.3-3.2)	0.004				
70-100	41	1.7 (0.9-3.6)	0.126				
Adherence in psychosocial group activities (%)							
0	51	1.0 (0.5-2.0)	1.000				
1-29	100	2.0 (1.2-3.3)	<0.001	261	1.3 (1.0-1.8)	0.041	0.137
30-69	78	2.0 (1.2-3.3)	0.006				
70-100	22	3.8 (1.1-13.2)	0.040				
Adherence in physical exercise in groups (%)							
0	11	1.0 (0.4-2.8)	1.000	261	1.3 (1.0-1.8)	0.041	0.444
1-29	25	1.2 (0.4-2.6)	0.705				
30-69	84	2.0 (1.2-3.3)	0.007				
70-100	131	1.9 (1.2-2.9)	0.003				

CI = Confidence interval

1 OR = Odds Ratio, OR >1 indicates positive change

2 P-value for difference in the change within the group

3 P-value for difference in the change between the groups

6. DISCUSSION

6.1 Study design and population

Design

This fall prevention trial conducted among the community-dwelling aged used a randomised design and sought to apply the best available evidence on the prevention of falls. The preventive methods were multifactorial, individually tailored and based on an individual risk factor assessment performed by geriatrician, nurse and physiotherapist. The duration of the intervention was long (12 months) and the effects on injurious falls and use of health services will be followed up for five years. The outcome assessments were wide and the methods may be suitable for primary care at least with some modification.

Population

A total of 591 persons were accepted to participate in the study and 293 were randomised into the IG and 298 into the CG. The groups were well-balanced at baseline indicating the success of randomisation. The few differences found between the IG and CG at baseline were small in absolute terms and were not associated with outcome measures. The majority of the population consisted of the home-dwelling aged with few functional or cognitive disabilities. It is very challenging to implement an intervention programme intensive enough to produce changes in outcome variables in this kind of sample.

When implementing a trial in a small town, the contamination of the control group has to be taken into account. It is possible that some persons in the control group have been affected by the information aimed only for the intervention group, for example, by family members, friends or newspapers.

6.2 Methods

Randomisation and blinding

Randomisation was carried out by the geriatrician, not blinded to the study protocol or patient status. A concealed method (sealed envelopes) was, however, used. Outcome assessments (most risk factors) were conducted by physiotherapist, nurse and geriatrician not blinded to the group allocation. It is thus possible that during the measurements of strength and balance for example, the assessors motivated the intervention participants more because they had become acquainted with the participants during the physical exercise groups. Blinding at outcome assessments would have required an extra person to carry out these assessments, which was, unfortunately, not possible in this study.

Measures

Adherence was collected by the instructor in group-based activities. During the lectures a name list was circulated and participants verified their presence with their own signature, meaning that the information concerning group attendance should be valid. When measuring adherence to home-exercises we had to rely on self-reports. Subjects were given daily calendars to mark all physical activities they carried out during each day (only home-exercises were analysed in this study). There may be differences between persons in accuracy and how the information was marked on calendars. Despite these shortcomings, a similar method has been used in many previous studies (Hornbrook et al. 1994; Tinetti et al. 1994a; Campbell et al. 1997; Yates & Dunnagan 2001; Helbostad et al. 2004; Campbell et al. 2005).

The outcome measures (depressive symptoms, fear of falling) used in this study were based on self-reported data, susceptible to source bias. The self-report has been traditionally used when assessing depression due to the highly subjective characteristics of depression (Montorio & Izal 1996). The GDS is a standardised screening measure of depressive symptoms especially designed for the aged, and it has been widely used in previous studies in different populations and settings. It has been described as an internally consistent measure (Cronbach's alpha coefficient .94) with good validity and test-retest reliability among the community-dwelling and institutionalised aged (Brink et al. 1982; Yesavage et al. 1982/1983; Parmalee et al. 1989). Its accuracy to detect depression when using 11 as a cut-off point has been good among healthy and patient populations, with a sensitivity varying from 83% to 89% and specificity from 68% to 95% (Brink et al. 1982; Watson & Pignone 2003). It seems, however, that among the demented and healthy community-dwelling "old-old" (persons averaging 80 years of age) accuracy declines (Montorio & Izal 1996; Watson et al. 2004). It has been suggested that even mild cognitive impairment may cause inaccuracy in recalling affective status during past weeks (Montorio & Izal 1996). Approximately 10% of the participants in the present study had a sum score of MMSE between 17 and 24, which may have affected the validity of their responses.

The GDS was originally designed to be easily completed with simple questions and a dichotomised ("no"/"yes") response format. However, in this study, a considerable amount of information was lost due to missing data. Some of those losses could have been avoided if interviewers had been used to help the participants.

Fear of falling was measured by one single question with a dichotomised response format. Even though this method has been used in many previous studies (Cwikel et al. 1989; Cumming et al. 2000; Friedman et al. 2002; Murphy

et al. 2002; Chu et al. 2005; Andresen et al. 2006), it has often been combined with other measures of fear of falling or falls efficacy. A single question may be a good way to start the charting of a problem in a clinical situation, but relying solely on it in a research context is a potential concern. The positive answer may be an indication of more generalised fearfulness and anxiety, referring thus to a "global state" of fear rather than fear related to falling (Lawrence et al. 1998). The wording of the sentence may also be important. It has been suggested that the word "fear" may be too loaded and better if replaced with words, such as "worry" or "concern" (Jørstad et al. 2005). In addition, single-item measures seem to predict poorly the actual behaviour and very little evidence is available about their psychometric properties (Tinetti & Powell 1993; Jørstad et al. 2005). The fear itself may also have different meanings for different persons and a single dichotomised question never covers all the aspects of falling that may actually be feared. It might be that an aged person is actually afraid of incapacity, pain or losing independence. It has also been suggested that social embarrassment after a fall might hinder older people from participating in activities (Yardley 1998). In the study of Yardley and Smith (2002) both loss of functional independence (e.g. feelings of helplessness, disabled and injured) and damage to identity (e.g. feelings of embarrassment, foolishness and pain) were the most commonly feared consequences of falling. Interestingly, concerns about damage to identity were as prevalent as fear about functional limitations and more often reported by the older members of the study sample.

Thus, when planning an intervention to prevent falls, it is highly important to understand what the persons are actually afraid of to be able to provide the right kind of help and support.

The use of falls efficacy measures, such as FES, may be reasonable in fall prevention since self-efficacy is strongly related to function. In addition, the concept itself has a strong theoretical base in social cognitive theories, and is free of psychological connotations of fear or phobias, which may influence responses (Tinetti & Powell 1993). Many reliable and valid measures of falls efficacy exist currently (Jørstad et al. 2005) and the use of self-efficacy scales, especially modified FES (mFES), is recommended by Prevention of Falls Network Europe (ProFaNE) in future fall prevention studies (Lamb et al. 2005). A Finnish version of this scale was not available when designing this study.

However, even though theoretically sound, self-efficacy scales have some inherent limitations (Arfken et al. 1994). The items of these scales are usually strongly correlated with scores of daily functioning scales (e.g. ADL/IADL), which may actually be an indication of a tautological relationship, since both measures consist of similar items (Tinetti et al. 1994b). The actual level of performance and one's confidence in the ability to perform the task may be

very hard to differentiate by an older person. Thus, at least a highly skilled interviewer is a necessity.

In addition, even if these two different measures of fear of falling probably capture different aspects of fear they are highly correlated suggesting that some part of the phenomenon captured by these measures is common (Cumming et al. 2000).

Analyses

The data of this study could only partly be analysed according to the "intention-to-treat" principle (Hollis & Campbell 1999). No deviations from randomisation occurred during the study, but one false inclusion (MMSE <17) was omitted from the analyses and a total of 118 persons (20% of the original sample) dropped out from the analyses due to missing data. Since persons with more physical and cognitive impairments and higher amount of depressive symptoms at baseline dropped out from the analyses, the results can only be generalised to the fit group of the aged, who had fallen previously. Full application of the intention-to-treat principle would provide a more realistic indication of the generalizability and effectiveness of the intervention (Hollis & Campbell 1999).

Depressive symptoms were a secondary outcome in this study and power calculations were conducted after the data collection. These indicated, however, that our sample size was large enough to detect a difference between the groups in the GDS.

6.3 Results

6.3.1 Adherence rates and predictors of adherence

The highest adherence rate (58%) was found in the physical exercise groups. Altogether 92% attended at least one exercise session and 63% took part in at least 50% of the sessions. This finding is consistent with previous single and multifactorial fall prevention studies reporting moderate adherence rates in physical exercise groups among the aged (Day et al. 2002; Barnett et al. 2003; Lord et al. 2003). Even higher adherence rates have been attained in short-term single exercise-focused interventions (Rubenstein et al. 2000; Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002; Brouwer et al. 2003; Liu-Ambrose et al. 2004; Morgan et al. 2004), while in longer interventions adherence has tended to decline (Barnett et al. 2003; Lord et al. 2003).

In psychosocial group activities and lectures the adherence rates were lower than in the physical exercise groups. While 73% and 75% attended at least one session, only 16% and 26% attended more than 50% of the psychosocial group activities and lectures, respectively. These rates are, however, in accordance

with the results of previous studies. Hornbrook and co-workers (1994) reported that 78% of the subjects attended at least one health behaviour session in a multifactorial fall prevention intervention. In contrast to our study, the total adherence rate was high; 61% of the subjects attended at least 75% of the sessions, while in our trial only 4%–9% attended at least 75% of the psychosocial groups and lectures, respectively. This may be due to the differences in the populations; Hornbrook and co-workers (1994) implemented a population-based intervention while we implemented prevention among subjects at increased risk of falling. Five percent of the intervention group participants in our study lived in sheltered housing and had problems in participating in psychosocial and lecture activities due to poor functional abilities or financial reasons. Our budget did not allow us to organise transportation to the sessions, which might have increased adherence. However, the physical exercise group sessions were organised in sheltered housing to facilitate participation.

Higher adherence in different group activities than attained in our study has been reported in studies conducted among persons at increased risk of falling. Therefore the type of population is not the only determinant of successful intervention (e.g. Tennstedt et al. 1998; Clemson et al. 2004).

Home-based exercises appealed to the participants; the average rate of exercising being three times per week during the one-year intervention. In addition, 36% of the participants performed home-exercises at least three times a week. Similar results have been reported in previous studies (Tinetti et al. 1994a; Yates & Dunnagan 2001; Shaw et al. 2003) indicating that home exercises may be a suitable form of activity among the aged, even among those with functional limitations.

Good physical functional ability was the strongest predictor of more active adherence in all organised activities. Those with good physical functional abilities were 2 to 3 times more likely to adhere compared to those with poor physical functional abilities. A similar association was not found between physical functional abilities and home-exercise adherence. Cognitive abilities were another strong predictor. Higher cognitive abilities remained a significant predictor of psychosocial group and lecture adherence. Those with a MMSE sum score of 25 or over were almost 2.5 more likely to adhere in psychosocial groups and lectures than those with a MMSE sum score from 17 to 24. Unlike many other fall prevention trials (Nowalk et al. 2001; Barnett et al. 2003; Wolf et al. 2003a; Clemson et al. 2004; Huang et al. 2004; Davison et al. 2005; Devereux et al. 2005), we also accepted persons with somewhat impaired cognitive abilities (MMSE 17–24) into our study. This may partly explain low adherence, especially in cognitively demanding activities (psychosocial groups and lectures).

No significant associations were found between the psychosocial group or lecture adherence and self-perceived probability of falling or self-perceived health. In fact, a low self-perceived probability of falling was associated with higher physical exercise group adherence and remained a significant predictor of adherence in the multivariate model. These findings are in contrast with HBM, which states that a perceived susceptibility of getting a particular condition (here a fall) and its perceived severity predict changes in health behaviour (Janz et al. 2002). In a qualitative study of Yardley et al. (2006a) on older person's self-perceived barriers for adherence in multifactorial fall prevention trials, it was found that many older persons, clearly at increased risk of falling, do not perceive being at high risk. However, in our study, 51% considered their probability of falling at home high. Thus the problem was quite well perceived, but probably not its severity. Even if the fear of falling was quite common among the intervention participants, falls not leading to medical treatment might not be serious enough to produce a threat needed to fuel the motivation for fall prevention.

According to HBM (Janz et al. 2002), perceived benefits (i.e. one's belief in the efficacy of action to reduce the risk) of a prevention programme may also predict behaviour. In our study, the subjects' perceived benefits of psychosocial group activities and lectures were probably lower than the perceived benefits of physical exercise activities, where the adherence rates were highest. However, no definite conclusion can be made, since similar activities do not seem to appeal to everyone, and programmes should be planned according to individual wishes and the needs of the participants. The primary aim of this study was not to assess adherence and its predictors, so our data did not allow the full application of the theoretical model.

Significant bivariate associations were found between depressive symptoms and adherence in all organised activities. However, when adjusting for other factors (multivariate modelling), these associations disappeared suggesting that the association between depressive symptoms and adherence is mediated by other factors. In earlier studies among aged patients, depression or a high amount of depressive symptoms has been a major barrier to adherence. Persons with persistent depression have reported poor self-care behaviour and lower rates of adherence to exercising, quitting smoking and attending rehabilitation or education programmes than the non-depressed (Park et al. 2004; Bonnet et al. 2005). Depression or a high amount of depressive symptoms has also been associated with an unhealthy life style, which may be especially hard to modify (Bonnet et al. 2005). Great difficulties have also been described in the recruitment and maintenance of the depressed aged in intervention programmes (Mather et al. 2002; Chou et al. 2004).

Somewhat surprisingly, no associations were found between fear of falling and adherence, suggesting that these kinds of activities were not restricted due to the fear. Fear-induced restriction of activities has been described in earlier prospective studies (Tinetti et al. 1994b).

6.3.2 Effects of fall prevention on depressive symptoms

Depressive symptoms decreased significantly in the IG and CG, but no between-group differences in the change were detected. Our intervention consisted of similar parts than two previous multifactorial fall prevention trials using depressive symptoms as an outcome measure (Newbury et al. 2001; Yates & Dunnagan 2001). The intervention of the present study was, however, more intensive (group meetings four times a month) and included both group and home-based physical exercise. In addition, special attention was focused on persons with a high amount of depressive symptoms at baseline. Despite these efforts, the effects of the programme remained small and non-significant in the total sample. In previous studies, both aerobic and anaerobic exercises have been effective in reducing depressive symptoms. Older persons suffering from clinical depression or from a high amount of depressive symptoms have especially benefited from exercise interventions (McNeil et al. 1991; Netz et al. 1994; Singh et al. 1997; Blumenthal et al. 1999; Mather et al. 2002; Penninx et al. 2002; Chou et al. 2004). In fall prevention such effects have not usually been found, which is in accordance with our own findings. The intensity of the exercise programme in our study was low and may partly explain the negative results, but is unlikely the only determinator, since programmes of high intensity have also failed to produce significant changes in depressive symptoms (e.g. Hauer et al. 2001, 2002).

One reason for the negative results may be that the participants of our study were fit older persons already functioning at an optimal level (mean GDS score within normal range) where further benefits are especially hard to achieve. This explanation is concordant with the results of previous studies assessing the effects of physical exercise on depression or depressive symptoms. Studies producing no effects have often been conducted on healthy, non-depressed samples (Emery & Gatz 1990; McMurdo & Burnett 1992; King et al. 1993; Chin A Paw et al. 2004).

Similarly, in most previous fall prevention studies reporting no effects on depressive symptoms, the level of depressive symptoms at baseline has been within a normal range (Coleman et al. 1999; Hauer et al. 2001; Wolf et al. 2001; Hauer et al. 2002). In fact, the only randomised controlled trial (found during the systematic literature searches) producing positive results regarding the amount of depressive symptoms was carried out among persons whose initial mean level of depressive symptoms was just above the cut-off point (mean

sum score of GDS-15 = 5.8) (Sohng et al. 2003). Further evidence of the significance of the initial depression level was demonstrated by Means and co-workers (2003) in a clinical trial. They found a significant reduction in depressive symptoms (GDS) after a 6-week group-based training programme conducted among fallers with an elevated initial level of depressive symptoms (mean GDS sum score = 14.7 in the intervention group) compared to a control group consisting of non-fallers without any activities.

However, the positive results in the study by Sohng and co-workers (2003) may also be explained by other factors. The programme was carried out at a high frequency (four times a week) and consisted of various exercises (range-of-motion, strength, balance and coordination, endurance, breathing, relaxation) along with teaching of self-care skills. Improvements in balance and strength, found in this study, may have led to enhanced self-efficacy and mastery feelings which were further reinforced by education and finally led to increases in positive affect.

In our study, the amount of depressive symptoms decreased most among persons with the highest level of depressive symptoms. However, since a similar change was detected in both groups, this might be due to the phenomenon called regression to the mean (i.e. extreme values tend to decrease on subsequent measurements). This phenomenon occurs purely for statistical reasons, not because subjects have improved (Fletcher & Fletcher 2005).

Some positive changes were, however, also detected in our study. The subgroup analyses showed that fall prevention was effective in reducing depressive symptoms among men and older participants. There were no significant differences in the use of antidepressants between the IG and CG in total sample or when classified by gender and age at baseline or at follow-up. Thus, the changes in depressive symptoms could not be explained by the use of antidepressant medication. Several other mechanisms may, however, explain the positive effects of fall prevention on depressive symptoms among these subgroups. Our intervention was multifactorial and the effects of different parts cannot be separated. Some explanations may be suggested, however.

Depressive symptoms decreased significantly among men but not among women. It cannot be explained by the baseline depression level, which was actually lower among men than among women. There were no differences in participation rates between men and women. One possible explanation, also suggested previously (Salminen et al. 2005), may be that Finnish men are socially less active than women and, thus, the relative increase in their social contacts due to the intervention is higher than that among women producing

the positive changes. A similar mechanism may explain the significant decrease of depressive symptoms among the older but not the younger subjects, since social contacts tend to decline with increasing age (Savikko et al. 2005).

Physical exercise may lead to a decrease in depressive symptoms by increasing concentrations of circulating beta-endorphins and monoamines, and by increasing the body temperature and fitness level (Martinsen 1994; Arent et al. 2000). Physiological changes are, however, linked to intensive training and are probably not the most important mediator in the present study, since the exercise groups were organised only twice a month. More likely, physical exercise may have led to a better physical functioning in activities of daily living and improved the quality of life. These changes may lead to enhanced self-efficacy, increase in positive affects and feelings of mastery.

Psychosocial group activities and information given during lectures and individual guidance offered social contacts for the aged, often suffering from feelings of loneliness. By creating a sense of caring this may have alleviated feelings of loneliness and led to a decrease in depressive symptoms. It has been clearly shown that cognitive-behavioural therapy and interpersonal therapy are efficient in the treatment of depression among the aged. These methods may be especially useful as long-term treatments and when medication causes harmful side effects (Lebowitz et al. 1997). In addition, more informal psychosocial group activities, including health advocacy, counselling and activation have been effective in alleviating depressive symptoms among the aged coronary heart disease male patients suffering from a moderate or a high amount of depressive symptoms (Salminen et al. 2005).

Some further support for the programme effectiveness was found when analyses were conducted according to adherence. The benefits in depressive symptoms were strongest among persons with the highest adherence in organised group activities (especially in group-exercises and psychosocial groups). Only low to moderate adherence was, however, attained during this programme, which may limit its applicability for clinical practice.

6.3.3 Effects of fall prevention on fear of falling

Fear of falling decreased statistically significantly in the IG and CG among all participants and among younger subjects. In addition, a significant reduction was found among women in the IG. Fear of falling reduced somewhat more among women than among men, which may be explained by a higher initial level of fear among women. No between-group differences were, however, found suggesting that intensive prevention was no more effective than one-time counselling. Our results are in concordance with some previous single fall

prevention trials using single questions or subjective rating of fear as measures of fear (Hauer et al. 2001, 2002; Barnett et al. 2003).

One reason for negative results may be that the CG also received one-time counselling on fall prevention. This increased their awareness about fall risks and might have led to a change in their behaviour (e.g. more exercise, environmental modification) and to a reduction of fear. In addition, people do have a tendency to change their behaviour when they are the target of special interest and attention for such a simple reason as to please their doctors or caregivers (Fletcher & Fletcher 2005). This phenomenon, called the Hawthorne effect, has been noticed in many clinical trials and may have affected the results of this study as well.

The majority of previous multifactorial trials have produced positive results in regard to falls efficacy, measured by FES or ABC, after various multifactorial programmes compared to single oral or written information given on fall prevention (Tinetti et al. 1994a; Tennstedt et al. 1998; Yates & Dunnagan 2001; Clemson et al. 2004; Huang & Acton 2004; Davison et al. 2005). Both individual (Tinetti et al. 1994a; Yates & Dunnagan 2001; Huang & Acton 2004; Davison et al. 2005) and group-based (Tennstedt et al. 1998; Clemson et al. 2004) programmes, consisting of the adjustment of medication, home- or group-based exercises, assessment of the living environment and some education on fall prevention, thus similar items than our intervention, have been effective in reducing fear of falling. These results are in contradiction with our findings.

However, since different measures of fear were used, the results are not directly comparable with ours. Further limitation for comparisons between our results and the results from previous studies arises, since some confusions in the use of the concepts "fear of falling" and "falls efficacy", often referred to solely as "fear of falling", has been found in previous studies (Jørstad et al. 2005). These are, however, somewhat different constructs. Fear of falling may be seen as a lasting worry or concern (trait) about falling, which leads to a person to restrict activities that he/she is still capable of performing (Tinetti & Powell 1993), while falls efficacy relates to a person's perceived confidence to carry out different daily activities without this fear (Tinetti & Powell 1993). The latter concept refers, thus, to a person's own perception of the degree of his/her abilities and is thought to be activity specific, not generalizable to other functions and its use has been recommended in fall prevention by ProFaNE (Lamb et al. 2005). In this study, fear of falling was seen from a medical point of view and conceptualised as a risk factor of falling. While reducing it to a more easily manageable form, this reduction, undoubtedly, oversimplifies the rich and complex psychological phenomenon.

Unfortunately, it was not possible to evaluate the findings of this study with regard to falls and injurious falls, since these outcomes had not been analysed while writing this doctoral thesis. However, since both psychological risk factors of falls analysed in this study are prevalent among the aged and may affect the life of an older person on several levels, they should be seen as important outcomes of fall prevention trials per se.

7. Conclusions

1. It was possible to implement a multifactorial fall prevention programme among the community-dwelling aged at increased risk of falling. A large sample was initially reached and randomised successfully.
2. However, only low to moderate adherence rates were attained in this fall prevention study and persons with low physical functional abilities and impaired cognition were especially difficult to reach.
3. Very little evidence was gained about the effects of multifactorial fall prevention to reduce psychological risk factors of falling compared to one-time counselling session. With regard to depressive symptoms men and older persons benefited most.
4. Overall, few benefits were gained in regard to psychological risk factors of falling during this fall prevention programme and the need for such a large-scale prevention is questionable in relation to the attained benefits in the intervention group compared to the benefits attained only after one-time counselling. The application of the programme to clinical practice may also be limited, due to the efforts required from organisers and only low to moderate adherence rates attained.

8. Recommendations

1. More efforts should be focused on adherence to fall prevention during the whole study period, for example by motivating the participants, planning the activities appealing to the aged and by arranging transport to group sessions. Persons with low physical functional abilities and impaired cognition should especially be tempted to participate.
2. The reduction of depressive symptoms in some subgroups is a significant finding, since it is very important to discover non-drug methods to reduce depressive symptoms among the fall prone aged. More studies are, however, needed to verify this finding.
3. Since a tendency towards greater benefits was found among persons attending most, modifications of this programme may be amenable to clinical practice and worth testing at least in some subpopulations of the aged at increased risk of falling.
4. Reducing psychological risk factors of falls remains an important issue and should be taken into account in future fall prevention. The depressed aged, often suffering from simultaneous fear of falling, and persons receiving treatment for depression might be particularly good target populations for future studies. Recruiting and motivating these persons is, however, challenging and needs careful planning and commitment from the staff.

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Appendices

Liite 1.

The original questions and forms of Pysy pystyss- Study (in Finnish) used in this study:

Question a1m23: Self-perceived probability of falling at home
Question a1m34: Fear of falling
Question a2m70: Feelings of loneliness
Question a2m71: Self-perceived health
Question a5m2a-2r: Amount of prescribed medications
Questions a2m38-68: Geriatric Depression Scale (Yeasavage et al. 1982/1983)
Questions a4m23-38: Berg's Balance Scale (Berg et al. 1992)
Questions a14m1-19: Mini Mental State Examination (Folstein et al. 1975)
Form 9: Exercise diary

Kuinka todennäköisenä pidätte, että Teille sattuu kotonanne kaatumistapaturma? a1m23

a) erittäin todennäköisenä
b) todennäköisenä
c) jokseenkin todennäköisenä
d) melko epätodennäköisenä
e) erittäin epätodennäköisenä

Onko Teillä nykyisin kaatumisen pelkoa? a1m34

a) ei
b) kyllä

Kuinka usein tunnette itsenne yksinäiseksi nykyisin? a2m70

a) en koskaan
b) harvoin
c) silloin tällöin
d) usein
e) jatkuvasti

Millaiseksi koette oman terveydentilanne nykyisin? a2m71

a) erittäin huonoksi
b) huonoksi
c) keskinkertaiseksi
d) hyväksi
e) erittäin hyväksi

Lääkärin määräämä säännöllinen lääkitys ja sen annostelu viimeisen viikon aikana (tutkittavan itsensä ilmoittama + reseptit + sairauskertomukset) a5m2a-a5m5r

	Lääkkeen kauppamerkki Nimi (ja vahvuus)	annostelu/vuorokausi Annostus ja lääkemuoto (tabl, suihke, geeli)	ATC -koodi
a.	_____	_____	|__|__|__|__|__|__|__|
b.	_____	_____	|__|__|__|__|__|__|__|
c.	_____	_____	|__|__|__|__|__|__|__|
d.	_____	_____	|__|__|__|__|__|__|__|
e.	_____	_____	|__|__|__|__|__|__|__|
f.	_____	_____	|__|__|__|__|__|__|__|
g.	_____	_____	|__|__|__|__|__|__|__|
h.	_____	_____	|__|__|__|__|__|__|__|
i.	_____	_____	|__|__|__|__|__|__|__|
j.	_____	_____	|__|__|__|__|__|__|__|
k.	_____	_____	|__|__|__|__|__|__|__|
l.	_____	_____	|__|__|__|__|__|__|__|
m.	_____	_____	|__|__|__|__|__|__|__|
n.	_____	_____	|__|__|__|__|__|__|__|
o.	_____	_____	|__|__|__|__|__|__|__|
p.	_____	_____	|__|__|__|__|__|__|__|
q.	_____	_____	|__|__|__|__|__|__|__|
r.	_____	_____	|__|__|__|__|__|__|__|

The Geriatric Depression Scale a2m38-68

NYT KYSYMME MIELIALAANNE JA TUNTEITANNE

Nämä kysymykset koskevat jokapäiväistä mielialaa ja tunteita. Haluaisimme tietää, miltä Teistä on tuntunut viimeksi kuluneen seitsemän päivä (eli viikon) aikana, tämä päivä mukaan lukien. Toivomme Teidän vastaavan ”kyllä” tai ”ei”. Muistakaa, että kysymyksessä on viimeksi kuluneet seitsemän päivää.

1.	Oletteko pohjimmiltanne tyytyväinen elämäänne?	kyllä 0 ei 1	a2m38
2.	Oletteko joutunut luopumaan monista kiinnostavista asioista ja harrastuksista?	kyllä 1 ei 0	a2m39
3.	Tuntuuko elämänne tyhjältä?	kyllä 1 ei 0	a2m40
4.	Tunnetteko olonne usein ikävystyneeksi?	kyllä 1 ei 0	a2m41
5.	Oletteko toiveikas tulevaisuuden suhteen?	kyllä 0 ei 1	a2m42
6.	Vaivaavatko teitä ajatukset, jotka pyörivät jatkuvasti mielessänne?	kyllä 1 ei 0	a2m43
7.	Oletteko enimmäkseen hyvällä tuulella?	kyllä 0 ei 1	a2m44
8.	Pelkäättekö, että jotain pahaa tulee tapahtumaan Teille?	kyllä 1 ei 0	a2m45
9.	Oletteko useimmiten onnellinen?	kyllä 0 ei 1	a2m46
10.	Tunnetteko itsenne usein avuttomaksi?	kyllä 1 ei 0	a2m47
11.	Oletteko usein levoton ja onneton?	kyllä 1 ei 0	a2m48
12.	Oletteko mieluummin kotona sen sijaan, että lähtisitte ulos?	kyllä 1 ei 0	a2m49
13.	Oletteko usein huolissanne tulevaisuudesta?	kyllä 1 ei 0	a2m50
14.	Onko Teillä mielestänne enemmän muistivaikeuksia kuin muilla?	kyllä 1 ei 0	a2m51
15.	Onko elämä mielestänne ihanaa?	kyllä 0 ei 1	a2m52
16.	Tuntuuko Teistä usein synkältä ja alakuloiselta?	kyllä 1 ei 0	a2m53
17.	Tunnetteko olonne arvottomaksi?	kyllä 1 ei 0	a2m54
18.	Kannatteko paljon huolta menneestä?	kyllä 1 ei 0	a2m55
19.	Onko elämä mielestänne innostavaa?	kyllä 0 ei 1	a2m56
20.	Onko teidän vaikea aloittaa uusia asioita?	kyllä 1 ei 0	a2m57
21.	Tunnetteko itsenne tarmokkaaksi?	kyllä 0 ei 1	a2m58
22.	Tuntuuko elämäntilanteenne toivottomalta?	kyllä 1 ei 0	a2m59
23.	Tuntuuko teistä, että muiden asiat ovat paremmin kuin Teidän?	kyllä 1 ei 0	a2m60
24.	Saavatko pienet asiat Teidät usein pois tolaltanne?	kyllä 1 ei 0	a2m61
25.	Itkettääkö teitä usein?	kyllä 1 ei 0	a2m62
26.	Onko Teillä keskittymisvaikeuksia?	kyllä 1 ei 0	a2m63
27.	Onko mielestänne mukava nousta aamuisin?	kyllä 0 ei 1	a2m64
28.	Vältteletteko toisten ihmisten tapaamista?	kyllä 1 ei 0	a2m65
29.	Onko teidän helppo tehdä päätöksiä?	kyllä 0 ei 1	a2m66
30.	Kykenettekö ajattelemaan yhtä selkeästi kuin ennen?	kyllä 0 ei 1	a2m67
31.	Summapistemäärä |__|__|__|		a2m68

Bergin Balance Scale-Tasapaino

23. Istumasta seisomaan nousu
- 0. tarvitsee kohtalaista tai runsasta avustusta noustakseen
- 1. tarvitsee vähäistä avustusta noustakseen
- 2. nousee seisomaan useamman yrityksen jälkeen käsillä auttaen
- 3. nousee seisomaan itsenäisesti käsillä auttaen
- 4. nousee seisomaan ilman tukea ja saavuttaa tasapainoisen asennon itsenäisesti

24. Seisominen ilman tukea
- 0. ei pysty seisomaan ilman tukea 30 sekuntia
- 1. tarvitsee useita yrityksiä seisoakseen tuetta 30 sekuntia
- 2. pystyy seisomaan tuetta 30 sekuntia
- 3. pystyy seisomaan valvottuna 2 minuuttia
- 4. pystyy seisomaan turvallisesti 2 minuuttia

25. Istuminen ilman tukea jalkapohjat lattialla
- 0. ei pysy istumassa ilman tukea 10 sekuntia
- 1. pystyy istumaan tuetta 10 sekuntia
- 2. pystyy istumaan tuetta 30 sekuntia
- 3. pystyy istumaan valvottuna 2 minuuttia
- 4. pystyy istumaan varmasti ja turvallisesti 2 minuuttia

26. Istuutuminen
- 0. tarvitsee avustusta istuutumiseen
- 1. istuutuu itsenäisesti, mutta laskeutuu hallitsemattomasti
- 2. kontrolloi istuutumista reisien takaosia tuoliin painaen
- 3. kontrolloi istuutumista käsillä avustaen
- 4. istuutuu turvallisesti minimaalisesti käsiä käyttäen

27. Siirtyminen
- 0. tarvitsee kahden henkilön avustusta tai varmistamista siirtyessään
- 1. tarvitse yhden henkilön avustusta siirtyessään
- 2. pystyy siirtymään verbaalisen ohjeen ja varmistuksen turvin
- 3. pystyy siirtymään turvallisesti, mutta käsien tuki välttämätön
- 4. pystyy siirtymään itsenäisesti pienellä käsituella

28. Seisominen silmät kiinni
- 0. tarvitsee apua, ettei kaatuisi
- 1. ei pysty pitämään silmiään kiinni 3 sekuntia, mutta seisoo vakaasti
- 2. pystyy seisomaan 3 sekuntia
- 3. pystyy seisomaan varmistuksen turvin 10 sekuntia
- 4. pystyy seisomaan turvallisesti 10 sekuntia

29. Seisominen jalat yhdessä
- 0. tarvitsee apua alkuasennon saavuttamiseen eikä pysty seisomaan 15 sekuntia
- 1. tarvitse apua alkuasennon saavuttamiseen, mutta pysyy 15 sekuntia
- 2. pystyy laittamaan jalat yhteen itsenäisesti, mutta ei pysy 30 sekuntia
- 3. pystyy laittamaan jalat yhteen ja seisomaan varmistuksen turvin 1 minuutin
- 4. pystyy laittamaan jalat yhteen ja seisomaan itsenäisesti 1 minuutin

30. Seisten kurkottaminen eteen käsivarsi ojennettuna _____ cm
- 0. tarvitsee apua , ettei kaatuisi
- 1. kurkottaa eteen, mutta tarvitsee varmistuksen
- 2. pystyy kurkottamaan eteen varmasti > 5cm
- 3. pystyy kurkottamaan eteen varmasti > 12,5cm
- 4. pystyy kurkottamaan eteen varmasti >25cm

31. Seisten esineen nostaminen lattialta
- 0. ei pysty yrittämään / tarvitsee avustusta, ettei kaatuisi
- 1. ei pysty nostamaan esinettä, ja tarvitsee yritykseensä varmistuksen
- 2. ei pysty nostamaan esinettä, mutta kurkottaa 2-5cm päähän esineestä niin, että tasapaino säilyy
- 3. pystyy nostamaan esineen, mutta tarvitsee varmistuksen
- 4. pystyy nostamaan esineen helposti ja turvallisesti

32. Seisten kääntyen katsominen vasemmalle ja oikealle

0. tarvitsee avustusta, ettei kaatuisi
1. tarvitsee varmistusta kääntyessään
2. kääntyy vain sivulle, mutta säilyttää tasapainonsa
3. katsoo taakse vain toiselle puolelle / toiselle puolelle painonsiirto huonommin
4. katsoo taakse kummallekin puolille ja painonsiirrot hyvin / symmetrisesti

33. Kääntyminen 360 astetta

0. tarvitsee avustusta kääntyessään
1. tarvitsee tukevan varmistuksen ja verbaalista ohjausta
2. pystyy kääntymään 360 astetta turvallisesti, mutta hitaasti (yli 4 sekuntia mol. suuntiin)
3. pystyy kääntymään turvallisesti 360 astetta alle 4 sekunnissa ainoastaan toiseen suuntaan
4. pystyy kääntymään turvallisesti 360 astetta alle 4 sekunnissa molempiin suuntiin

34. Vuorottainen jalan nosto penkille

0. tarvitsee avustusta, ettei kaatuisi / ei pysty yrittämään
1. pystyy askeltamaan yli 2 kertaa, mutta tarvitsee vähäistä avustusta
2. pystyy askeltamaan 4 kertaa ilman apua varmistuksen kanssa
3. pystyy askeltamaan 8 kertaa, mutta aikaa kului yli 20 sekuntia
4. pystyy askeltamaan itsenäisesti ja turvallisesti 8 kertaa 20 sekunnissa

35. Seisominen jalat peräkkäin ilman tukea (huonomman jalan suoritus)

takana oleva jalka a) oikea, b) vasen

0. menettää tasapainon askelta ottaessaan tai seistessään
1. tarvitsee apua askeleen ottamisessa, mutta voi pitää asennon 15 sekuntia
2. pystyy ottamaan pienen askelen itsenäisesti ja pitämään 30 sekuntia
3. pystyy laittamaan jalan toisen eteen samalle viivalle ja pysymään 30 sekuntia
4. pystyy seisomaan jalat peräkkäin ja pitämään asennon 30 sekuntia

36. Seisominen jalat peräkkäin ilman tukea (paremman jalan suoritus)

takana oleva jalka a) oikea, b) vasen

0. menettää tasapainon askelta ottaessaan tai seistessään
1. tarvitsee apua askeleen ottamisessa, mutta voi pitää asennon 15 sekuntia
2. pystyy ottamaan pienen askelen itsenäisesti ja pitämään 30 sekuntia
3. pystyy laittamaan jalan toisen eteen samalle viivalle ja pysymään 30 sekuntia
4. pystyy seisomaan jalat peräkkäin ja pitämään asennon 30 sekuntia

37. Yhdellä jalalla seisominen (huonomman jalan suoritus) a) oikea b) vasen jalka

0. ei pysty suorittamaan tai tarvitsee avustusta, ettei kaatuisi
1. yrittää nostaa jalan, ei pysy 3 sekuntia, mutta pysyy asennossa itsenäisesti
2. pystyy seisomaan yhdellä jalalla 3-4 sekuntia
3. pystyy seisomaan yhdellä jalalla 5-10 sekuntia
4. pystyy seisomaan yhdellä jalalla yli 10 sekuntia

38. Yhdellä jalalla seisominen (paremman jalan suoritus) a) oikea b) vasen jalka

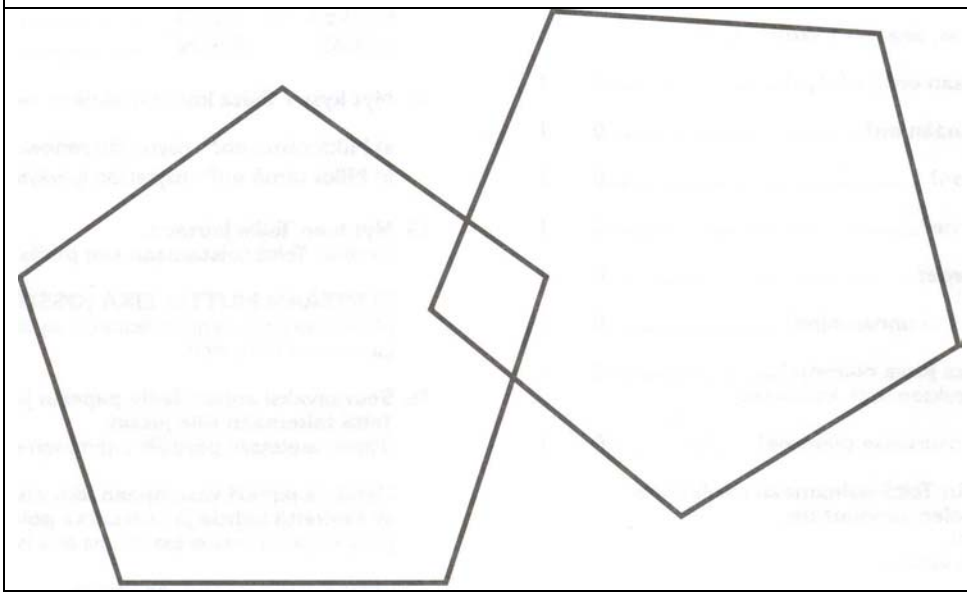
0. ei pysty suorittamaan tai tarvitsee avustusta, ettei kaatuisi
1. yrittää nostaa jalan, ei pysy 3 sekuntia, mutta pysyy asennossa itsenäisesti
2. pystyy seisomaan yhdellä jalalla 3-4 sekuntia
3. pystyy seisomaan yhdellä jalalla 5-10 sekuntia
4. pystyy seisomaan yhdellä jalalla yli 10 sekuntia

Mini Mental State Examination

a14m1-19

		ID |__|__|__|__|	id
MMSE-testilomake (lomake 14) Täyttöohjeita MMSE-testilomakenipun alla			
TUTKITTAVA:_____ SYNTYMÄAIKA:_____			a14tutki
TEKIJÄ:_____ PVM:_____			a14pv-vu
Seuraavassa on erilaisia pieniä muistiin ja älyllisiin toimintoihin liittyviä tehtäviä. Aloitamme kysymyksillä, kuten:			
	Väärin	Oikein	
1. Mikä vuosi nyt on?	0	1	a14m1
2. Mikä vuodenaika nyt on?	0	1	a14m2
(talvi = joulu,tammi,helmi			
kevät=maalis,huhti,touko			
kesä= kesä,heinä,elo			
syksy=syys,loka,marras; aina +/- I vko)			
3. Monesko päivä tänään on? (+/- I pv)	0	1	a14m3
4. Mikä viikonpäivä tänään on?	0	1	a14m4
5. Mikä kuukausi nyt on?	0	1	a14m5
6. Missä maassa olemme?	0	1	a14m6
7. Missä läänissä olemme?	0	1	a14m7
8. Mikä on tämän paikkakunnan nimi?	0	1	a14m8
9. Mikä on tämä paikka jossa olemme?	0	1	a14m9
(Sairaalan/terveyskeskuksen nimi, kotiosoite)			
10. Monennessako kerroksessa olemme?	0	1	a14m10
11. Seuraavassa pyydän Teitä painamaan mieleenne kolme			
sanaa. kun olen sanonut ne, toistakaa perässäni.			
(Kaksi vaihtoehtoista sarjaa.)			
PAITA - RUSKEA - VILKAS			
RUUSU – PALLO - AVAIN			
PAITA tai RUUSU	0	1	a14m11a
RUSKEA tai PALLO	0	1	a14m11b
VILKAS tai AVAIN	0	1	a14m11c
(Merkitään ensimmäisellä kerralla muistetut sanat. Jos ensimmäisessä toistossa tulee virheitä, sanoja kerrataan, kunnes kaikki kolme sanaa on opittu. Toistoja_____ . Enintään 5 kertaa.)			a14m11d
12. Nyt pyydän Teitä vähentämään 100:sta 7 ja saamastanne jäännöksestä 7 ja edelleen vähentämään 7, kunnes pyydän Teitä lopettamaan.			
93	0	1	a14m12a
86	0	1	a14m12b
79	0	1	a14m12c
72	0	1	a14m12d
65	0	1	a14m12e
(Kysymys voidaan toistaa kerran, jos sitä ei heti ymmärretä. Jos henkilö tekee välillä virheen, mutta jatkaa siitä oikein vähentäen 7 virheellisestä luvusta, tulee vääriä vastauksia 1. Kynää ja paperia ei saa käyttää.)			

	Väärin	Oikein	
13. Mitkä olivat ne kolme sanaa, jotka pyysin Teitä painamaan mieleenne.			
(Sanojen järjestyksellä ei ole merkitystä.)			
PAITA tai RUUSU	0	1	a14m13a
RUSKEA tai PALLO	0	1	a14m13b
VILKAS tai AVAIN	0	1	a14m13c
14. Nyt kysyn Teiltä kahden esineen nimeä.			
a) Mikä tämä on? - näytetään rannekelloa	0	1	a14m14a
b) Mikä tämä on? - näytetään lyijykynää	0	1	a14m14b
15. Nyt luen Teille lauseen.			
Pyydän Teitä toistamaan sen perässäni:			
EI MITÄÄN MUTTIA EIKÄ jOSSITTELUA	0	1	a14m15
(Annetaan piste vain, jos lause on täysin oikein.			
Lausetta ei saa toistaa.)			
16. Seuraavaksi annan Teille paperin ja pyydän Teitä tekemään sille jotain.			
(Paperi asetetaan pöydälle tutkittavan eteen.)			
Ottakaa paperi vasempaan käteenne. Taittakaa			
se keskeltä kahtia ja asettakaa polvienne päälle. (Ohjeita ja lausetta ei saa toistaa eikä henkilöä saa auttaa.)			
Ottaa paperin vasempaan käteen	0	1	a14m16a
Taittaa sen	0	1	a14m16b
Asettaa paperin polville	0	1	a14m16c
17. Näytän Teille tekstin "SULKEKAA SILMÄNNE". Pyydän Teitä lukemaan sen ääneen ja			
noudattamaan sen ohjetta	0	1	a14m17
(Annetaan piste vain, jos sekä lukee tekstin			
että sulkee silmänsä.)			
18. Kirjoittakaa kokonainen lyhyt lause			
mielenne mukaan	0	1	a14m18
(Yksi piste, jos lause on ymmärrettävä ja siinä on			
ainakin subjekti ja predikaatti.			
Kirjoitusvirheet eivät vaikuta.)			
19. Voisitteko piirtää tämän kuvion alapuolelle			
samanlaisen kuvion. (kääntöpuolella)	0	1	a14m19
(Annetaan piste, jos kaikki sivut ja kulmat ovat tallella			
ja leikkauspinta on nelikulmainen.)			
MMSE-TESTIN PISTEMÄÄRÄ	_____/30		a14summa

Kirjoittaisitteko lauseen tähän.
_____
Piirtäkää tämän kuvion alapuolelle samanlainen kuvio.


|__|__|__|__|

KAATUMISTEN EHKÄISYTUTKIMUS (lomake 9)

HARJOITTELU - JA OSALLISTUMISPÄIVÄKIRJA

Nimi _____Sotu |__|__|__|__|__|__|-|__|__|__|__|

Kuukausi _____Vuosi _____

Ohje: Merkitkää montako kertaa kyseisenä päivänä osallistuitte eri toimintoihin. Jos ette osallistuneet, merkitkää 0. Esimerkiksi: Jos kotona voimistelitte kyseisenä päivänä 3 kertaa ja kukin kerta kesti 15-20 minuuttia, merkitään kotijumpan kohtaan 3 ja kestoon 15-20.

Päivä-Määrä	Ohjattu Jumppa	Kotijumppa		Kävelyaika	Luento	Muu ryhmä, mikä
		kertoja	kesto			
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