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Document Version
Publisher's PDF, also known as Version of record

Publication date:
2014

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA):
Weening-Dijksterhuis, E. (2014). *Physical exercise to improve or maintain Activities of Daily Living performance in frail institutionalized older persons*. s.n.

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Physical exercise to improve or maintain Activities of Daily Living performance in frail institutionalized older persons

Elizabeth Weening - Dijksterhuis

The study presented in this dissertation was performed at the Professorship in Health Care and Nursing of the Hanze University of Applied Sciences, Groningen, the Netherlands and at the SHARE Graduate School for Health Research and the Department of Health Sciences of the University Medical Center Groningen, University of Groningen, the Netherlands.
Dissertation for the University of Groningen, the Netherlands, January 2014

Bookdesign Betsy Weening-Dijksterhuis
Cover Hans van de Leur
Printed by Gildeprint, Enschede
Publisher Betsy Weening-Dijksterhuis, Groningen
ISBN 978-90-367-6662-3

Publication of this dissertation was generously supported by
-Het Wetenschappelijk Genootschap Fysiotherapie

de Fysiotherapeut

- University of Groningen, University Medical Center Groningen
- Hanze University of Applied Sciences, Groningen, Professorship in Health Care and Nursing
- Research Institute SHARE
- Hanze University of Applied Sciences, Groningen, Department of Physiotherapy
- Fysiotherapeutencombinatie R. Bos, Groningen

rijksuniversiteit
groningen

Physical exercise to improve or maintain Activities of Daily Living performance in frail institutionalized older persons

Proefschrift

ter verkrijging van de graad van doctor aan de
Rijksuniversiteit Groningen
op gezag van de
rector magnificus, prof. dr. E. Sterken
en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op
woensdag 22 januari 2014 om 16.15 uur

door

Elizabeth Weening - Dijksterhuis

geboren op 13 augustus 1958
te Groningen

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"In de ouderdom zullen zij nog vruchten dragen,
zij zullen fris en groen zijn"

Psalm 92, vers 15

Voor alle ouderen, die ik in mijn werk als geriatriefysiotherapeut mag ontmoeten,
die, ondanks hun kwetsbaarheid, zo'n sterk getuigenis geven van de onschatbare waarde
van het leven

Paranimfen:
Mw. R. van Abbema
Dhr. J. S. Weening

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Chapter 1

Introduction

Introduction

Demographics of ageing

In Western European countries in the upcoming decades, the population of elderly will grow significantly. In The Netherlands in 2011, there were 2.6 million persons older than 65 years (15.6 % of the Dutch population). It is expected that this number will increase to 4.6 million people in 2040, being 25.9 % of the population (CBS statline, 2012). This situation will lay a burden on society, economically as well as socially, due to increasing care demand during the years of aging. Although not all older people need care from professionals, a certain number of older adults do, defined as elderly care recipients. The number of elderly care recipients is estimated based on the number of older adults that are statistically eligible for care due to age-related disability and it is estimated is that the care demand will increase between 2006 and 2030 (Jonker et al, 2007).

About 3 % of the Dutch population of 55 years of age and older lives in a long term care institution. Nearly 25 % of older adults between 85 and 90 years old, lives in an institution. The majority, 57 %, of the persons above 95 years of age lives in an institution (den Draak, 2010). In The Netherlands, institutions for the elderly can be divided into residential homes and nursing homes. In residential homes, older people receive only personal care whereas in nursing homes older people receive more intensive personal care as well as medical care. People living in nursing homes are more care dependent than people living in residential homes.

Characteristics of institutionalized older persons

Older persons living in residential homes are among the most vulnerable persons in society. Submission to a residential home is usually due to increased disability based on multiple health problems (de Klerk, 2005) which impairs the autonomy of these older persons. Almost 40% of the older persons living in a residential home reports that the loss of autonomy has adversely influenced their quality of life. Quality of life is suggested to be related to performance of daily tasks. Older persons, living in residential homes, suffer from multiple chronic conditions, resulting in disability and diminished health (Schram et al, 2008). According to Schram, one of the characteristics of a chronic condition is that it places limitations on self-care and independent living. This is the reason that multimorbidity can lead to disability. Disability and care dependency are related to each other. Over time, the impact of the chronic conditions on disability tend to increase. For this reason, institutionalized older persons tend to get less involved in the performance of daily tasks when they stay longer in a residential home. Moreover, the environment of a residential home places low demands on the abilities to take care of oneself, because the care is taken over by the nursing staff. Moreover, future developments in public health care indicate that institutionalization only will be possible for the most disabled older persons (Nihtila et al, 2008).

Health problems of older persons living in residential homes, leading to disability, are categorized, based on self-reported measures, either from the residents or from the nursing staff. Hearing problems contribute to 14 %, and vision problems to 12% of the health problems. Mobility problems are manifest in 78 % of the older adults living in residential homes, and are thereby the main cause of disability (den Draak, 2010). Physiotherapists can reduce mobility problems by exercise training, but it is still unclear which interventions are effective and how they will reduce disability. Because of their specific problems and needs, for the institutionalized older people a different approach is needed than for community-dwelling people. Therefore, a number of questions need to be answered. First: what reliable and valid instrument can measure the effects of the exercise intervention on disability? Second: what is an effective exercise intervention to reduce mobility problems? Third: when applied to institutionalized older persons, will the exercise intervention be appropriate to reduce disability and to increase quality of life? Fourth: how can perceived fitness be measured properly by a reliable and valid instrument? And fifth: what is the role of personal perceptions of institutionalized older persons regarding their physical fitness with respect to disability? These are the research questions of this dissertation.

A conceptual framework

To answer the questions in this dissertation, a framework in which the different steps or concepts that lead to disability in older persons are made visible, was used. As the focus of this dissertation lies on influencing disability in institutionalized older persons through physiotherapeutic exercise interventions, disability research should be linked to physical activity research. The standard for disability research is "the disablement process" by Verbrugge and Jette (1994), which addresses limitations leading to disability. Physical activity research, as modelled by Bouchard and Shephard (1994) addresses the pathway from physical activity and fitness to health. Stewart (2003) has made an effort to link both kinds of research, resulting in a conceptual framework. The aim of her study was to positively label the concepts leading to disability in older people, because physical activity researchers address health problems and subsequent disability as challenges rather than limitations. In the same way in this dissertation the pathway from aging to disability in institutionalized older persons shall be looked at. As described in the previous paragraph, institutionalized persons have specific needs and standards. Therefore, Stewart's framework is adapted by adding two different concepts, quality of life and personal perceptions. In the next paragraphs the concepts used in the framework will be explained and linked to the research questions of this dissertation. The framework is shown in Figure 1.

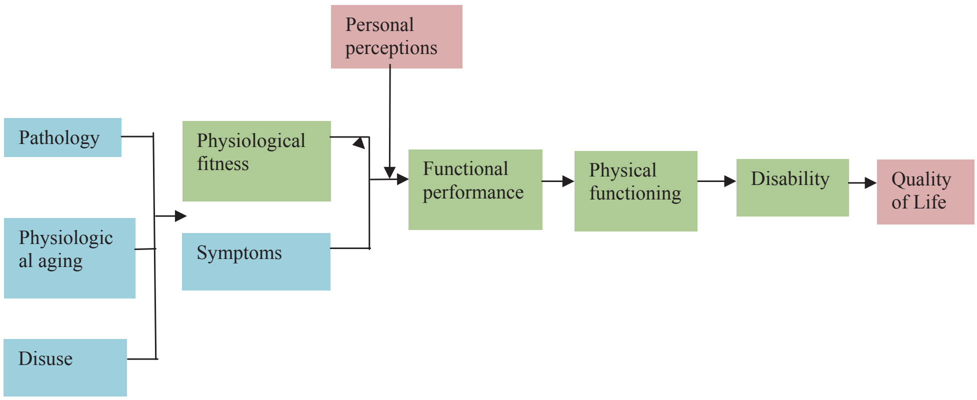

FIGURE 1. Adapted conceptual framework of Stewart presenting mechanisms leading to disability (Stewart, 2003).
Blue: included in the original framework, but no subject to the research questions addressed in this dissertation
Green: included in the original framework, and subject to the research questions addressed in this dissertation
Red: concepts added to the original framework

Pathology, physiological ageing, disuse

Pathology refers to causes, manifestations and consequences of chronic and acute health conditions. The clinical feature of pathology is a number of impairments that can negatively influence physical, mental, or social functioning. In institutionalized older persons, pathology manifests itself as multimorbidity or comorbidity. Multimorbidity refers to the presence of two or more chronic diseases in one older person, whereas in comorbidity at least one chronic condition is added to a primary disease in one person. In older persons, not only pathology is a key factor to subsequent disability but also physiological age and disuse. Physiological age refers to the multiple problems aging persons are confronted with due to chronic conditions and biological aging (Spiriduso et al, 2005) Relevant aspects are loss of muscle mass, strength, balance, and mobility problems (Stewart, 2003). Physiological age also covers the concept of frailty, referred to as age-related declines in body function (Fried et al, 2001). In the model presented by Fried et al, frailty is referred to as a biological syndrome. Other researchers rightfully note that the Fried model does not do justice to the whole picture of age-related decline. There are also psychosocial factors that may influence the aging process (Rockwood et al, 2007). Moreover, in one of the next paragraphs, the role of personal perceptions in the pathway to disability will be introduced. In old age, disuse or sedentary behavior, often combined with malnutrition, causes decline in physical function because it negatively influences mobility-related body structures (Fielding et al, 2011). Pathology, physiological aging and disuse are the foundations of changes in physical functioning in older people, and this is also true for institutionalized older persons. These features are not subject to the studies in this dissertation.

Physiological fitness and symptoms

According to Stewart, physiological fitness and symptoms determine functional performance. Physiological fitness refers to organ-level systems, such as musculoskeletal, cardiovascular, and neurological. In old age, there is a great variety in levels of organ functioning, causing inter-individual differences as well as intra-individual differences (Spiriduso et al, 2005). Physiological fitness is, to some extent, represented by physical fitness, being defined briefly as "the ability to perform muscular work satisfactory" (van Heuvelen et al, 2000).

Symptoms are included in the framework as they mediate the effects of chronic disease on ADL performance (Bennett et al, 2002). Examples of symptoms in elderly people include musculoskeletal pain, shortness of breath, depression, weakness, and fatigue (Stewart, 2003). The symptoms, rather than the diseases that cause them, may be held responsible for the burden laid on the older persons health. Consequently, physiological fitness together with symptoms determine the way older persons function in their daily life.

Functional performance and physical functioning

According to Stewart, two concepts are leading to disability: physical functioning and functional performance (Stewart, 2003). Functional performance reflects actual performance of basic functions, such as walking, stair climbing etc., while physical functioning refers to the perceptions that older persons have regarding their functioning and limitations. Fried et al concluded that measuring functional performance identified older persons in danger of becoming disabled and disability issues were predicted even before these became overt. Thus a larger proportion of older persons becoming disabled could be identified than by self-reported measures of physical functioning (Fried et al, 1996). Therefore, Stewart includes a distinct step indicated as functional performance in the conceptual model to distinguish these concepts. Conclusively, performance-based measures are not simply an alternative for self-reported measures of physical functioning.

For institutionalized older adults, distinguishing these concepts has another dimension. The perceptions older persons have regarding their physical functions not only are based on perceptions of present-day performance, but rather on former performance. For instance, older persons have difficulties to rate actual stair-climbing performance, because they may not have climbed the stairs for several years. The same is true for household tasks, because in residential homes these tasks are taken care of by associate professional nurses and nurse aids. Thus, the gap between the concept of functional performance and physical functioning is even greater in institutionalized older persons.

Disability

Disability, the final step in the pathway, is defined as the difficulty of doing activities in any domain of life due to a health or physical problem (Verbrugge et al, 1994). Disability refers to personal capacity and environmental demand. Older persons, after experiencing good health and independence throughout their life thus far, may experience loss of independence that can limit actual wellbeing. In this dissertation, disability is operationalized as problems with Activities of Daily Living (ADL) performance. ADL refer to two domains, e.g. Basic Activities of Daily Living (BADL) or personal care, and Instrumental Activities of Daily Living (IADL) or household management. BADL includes bathing, showering, getting dressed, eating, drinking, toileting, and walking about the house. IADL includes household tasks within the house, like washing the dishes, cleaning, preparing meals, as well as activities outdoors like walking outside the house, shopping, and gardening (van Heuvelen et al, 2000). For older persons living in homes for the elderly, only indoor IADL tasks are relevant. A major goal is to function as independently as possible, e.g. because older people experience that nursing staff increasingly lack sufficient time for basic care (de Klerk, 2005).

ADL performance can be measured with questionnaires or performance based tests. The latter reflect the actual performance of functioning, thus providing relevant information to the clinician (Guralnik et al, 1989). The existing ADL measurement instruments are less appropriate for institutionalized older persons because they either lack IADL items entirely or include irrelevant household tasks. Subsequently, a performance ADL test that meet the requirements of older persons living in residential homes has to be developed.

Quality of life

Stewart's framework was extended by adding the concept of Quality of Life. The World Health Organization's definition of quality of life is "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns." (WHOQOL group, 1993). Adding quality of life was done to emphasize the importance of this aspect, because nearly 40% of the older persons living in residential homes experience a decrease in their quality of life compared with the living situation before the institutionalization (Den Draak, 2010). According to Puts et al (2007), who did quality research to determine the aspects of quality of life in both frail and non-frail community- dwelling older persons, health is the most important aspect for non-frail, and social relationships for frail older persons. Experiences from physiotherapeutic practice suggest that these people shift their focus rather on ADL performance than on health or social relationships.

Personal perceptions of physical fitness

The question whether institutionalized older persons' personal perceptions regarding their physical fitness play a role in the pathway to disability needs exploration. As mentioned before, not only biological factors determine the steps toward disability, but also psychosocial factors. Especially where it comes to performance of daily activities, older persons perceptions may contribute to changes in the outcome. From clinical experience in physiotherapeutic practice is known that older persons, living in residential homes, have very strong convictions about their abilities to perform daily activities. These convictions are based on former experiences or beliefs about the way their fragile health will adversely influence performance of daily tasks. For instance, when an older person is asked to walk a stroll, he or she may be reluctant because of fear of falling. Or he/she may makes adjustments to the task by using a walking aid to cope for adverse events, even before the use of a walking aid is necessary. The influence of these convictions are stronger in frail older people because frailty has a dynamic character, resulting in fluctuations in physiological fitness (Puts et al, 2007). Therefore, Stewart's framework was extended by taking into account the mediating role of personal perceptions of physical fitness

It is possible that the way frail institutionalized older persons rate their physical fitness, influences their willingness to exercise. There may be two major options: Older persons with low perceptions of physical fitness are motivated to exercise because they want to increase their fitness. On the other hand may people with low perceptions of physical fitness be reluctant to exercise because they have no confidence that their fitness will change for the better. However, older persons with high perceptions of physical fitness may want to exercise because they wish to maintain their levels of fitness, or they refuse to take part in exercise regimens because they are satisfied with the current levels. Therefore, measuring perceived fitness is relevant for two reasons. First, in what way can perceptions of fitness be altered by exercise? Second, can perceived fitness predict ADL performance, independently from performance-based fitness?

To measure perceived physical fitness in institutionalized elderly, a reliable, valid, and feasible instrument should be applied. Perceived fitness is usually measured by questionnaires, however, the existing questionnaires include questions that are not relevant for institutionalized older persons. Moreover, they are not validated for this population. For this reason a measurement instrument to match the needs of institutionalized older persons has to be developed.

Effects of exercise on ADL performance

The core issue of this dissertation is to improve ADL performance by exploring the beneficial effects of physical exercise for institutionalized elderly with respect to the components of the pathway from physiological fitness to problems in ADL performance. Exercise is a subcategory of physical activity in which planned, structured, and repetitive bodily movements are performed to improve or maintain one or more components of physical fitness at a high level of intensity (Howley et al, 2001). Exercise can enhance physical fitness components such as muscle strength, aerobic endurance, coordination, balance, and flexibility. Improving muscle strength is very important because institutionalized older people often experience weakness which results in a slower walking speed and lower levels of physical activity (Fried et al, 2001). Very few data are available concerning the effects of exercise on ADL performance, physical fitness, as well as care dependency in frail institutionalized older adults. A recent Cochrane review emphasizes the great diversity of interventions aimed at reducing disability in institutionalized older persons with the following statement: "Many studies did not clearly link their findings with changes of clear clinical interest, in particular, reduction in disability. The supposition that physical rehabilitation interventions reduce disability still awaits emphatic empirical support" (Foster et al, 2011). Therefore, there is a need for a systematic review of the literature to compose an exercise program, based on scientific evidence.

To compose an exercise program, based on scientific evidence, a systematic review of literature has to be conducted and included in this dissertation. For older people, there are two different ways to improve muscle strength through exercise. One is by training localized muscle groups. The other is by training functions related to motor activities such as walking, stair climbing, standing up from a chair, rising from a bed, reaching, and bending. These functions are embedded in the daily tasks faced by older institutionalized persons. Exercise programs aimed to improve daily tasks should include functional training items to be as effective as possible (de Vreede et al, 2005). To monitor the impact of exercise on ADL performance, the relative impact of both perceived and performance-based fitness should be evaluated based on a conceptual model.

Research questions

In this dissertation, the following research questions are addressed:

1. What is the test-retest reliability, the internal consistency, and the construct validity of a performance-based measurement instrument for Activities of Daily Living?
2. Which components of an evidence based exercise program can increase ADL performance, physical fitness, and quality of life in frail institutionalized older persons?
3. What are the effects of an exercise intervention on ADL performance, physical fitness, and care dependency in frail institutionalized older persons?
4. What is the test-retest reliability and the validity of a perceived physical fitness measurement instrument?
5. Which conceptual model can be constructed to explain the relationship between perceived fitness, performance-based fitness, and ADL performance in institutionalized older persons?

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Chapter 2

Psychometric properties of the PAT: an Assessment Tool for ADL Performance of Older People Living in Residential Homes

Elizabeth Weening-Dijksterhuis, Yvo P.T. Kamsma, Marieke J.G. van Heuvelen

Gerontology. 2011; 57(5): 405-413

Abstract

Background: As the world population ages, the number of people with diminished performance on the Activities of Daily Living (ADL) increases. A reliable and valid measure needs to be developed to determine the effects of interventions focused at increasing self-care abilities. We developed the Performance ADL Test (PAT) for this purpose.

Objective: The aim of this study was to investigate the reliability and validity of the PAT in older people living in residential homes.

Methods: The PAT contains 16 test items, covering the entire range of Basic ADL and Instrumental ADL performance in elderly people. For this assessment, 40 older people (mean age of 85 ± 7.5 years) participated. All 40 subjects lived in residential institutions in the Netherlands, were able to walk at least 10 meters, could understand instructions spoken in Dutch, and had no cognitive impairment. During the first test session, subjects completed the PAT, the Groningen Activity Restriction Scale (GARS), and performance-based physical fitness tests. Two week later, subjects were re-tested on the PAT.

Results: Factor analysis revealed three subscales: Organization of Performance, Gross Motor Function, and Fine Motor Function. Internal consistency (Cronbach's alpha) of all scales and subscales ranged from 0.731 to 0.881. Test-retest reliability (intraclass correlation) ranged from 0.316 to 0.950. Paired sample t-tests revealed no significant differences between subject performance obtained during the two test periods. Pearson's correlations between the PAT and the GARS ranged from 0.490 to 0.831, and between the PAT and the fitness tests from 0.317 to 0.781.

Conclusion: Although the number of participants was limited (N=40), the PAT seems to be a useful instrument for assessing ADL performance in older people living in residential homes. In general, internal consistency, test-retest reliability, and validity were satisfactory.

Keywords: ADL performance, older people living in residential homes, assessment, reliability, validity

Introduction

In Western countries, ageing of the population will be the most striking demographic trend in the next decades. In these countries, the number of people aged 65 years and older will increase dramatically (Ouderenbeleid in het perspectief van vergrijzing, 2006). Worldwide, the growing number of older adults increases demands on the public health care system and on medical and social services. Chronic diseases, which affect older adults disproportionately, contribute to disability, diminish quality of life, and increase health- and long-term-care costs (Center for Disease Control, 2003). This often results in institutionalization. Many disabled older persons live in nursing homes because of their need for care (de Boer, 2006). Disability can be operationalized as limitations in Activities of Daily Living (ADL) with a physical component, including Basic Activities of Daily Living (BADL) and Instrumental Activities of Daily Living (IADL) (van Heuvelen, 1999). BADL concerns self-care activities and basic mobility such as getting up from a chair or walking at home, whereas IADL concerns household activities and advanced physical activities such as gardening or shopping. Research on preventing the deterioration of ADL performance is of major interest. For this purpose, adequate measures of ADL performance are required (Bouchard et al, 1994; Rydwik et al, 2004; Keysor et al, 2001; Chin A Paw et al, 2006). In the present study, measuring ADL performance was the core issue.

ADL performance is usually measured with questionnaires—either self-reports or proxy-reports—instead of with performance-based tests. However, major limitations in the use of self-report measures, especially in the elderly population, have been noted (Guralnik et al, 1989). First, a questionnaire is less sensitive to change than a performance-based measure. Second, self-report measures do not always clearly define the activity being assessed; therefore, even the most motivated respondents may have problems consistently reporting perceptions of their own performance difficulties over time (Guralnik et al, 1989). Third, it is unclear whether individuals rate their actual engagement in certain activities or their maximum capacity (Guralnik et al, 1989).

Performance-based measures of ADL performance can overcome limitations of self-report measures (Reuben et al, 2004). Moreover, performance-based measures have several other advantages over self- or proxy-report measures. They can detect pre-clinically expressed limitations, because before an individual's functional limitations lead to overt disability, the time required to perform a performance-based test item is increased (Rozzini et al; Reuben et al, 2004; Greiner et al, 1996). In that way, performance-based measures can predict clinical disability (Rozzini et al, 1997). Performance-based, time-scaled instruments can also provide a standardized measure of a particular physical domain, without the potentially confounding influence of cultural, language, and educational differences present in questionnaires (Kempen et al, 1996; Binder et al, 2001). These considerations imply that a performance-based assessment tool for ADL could be useful and more sensitive for detecting changes in ADL performance.

Three well-known performance-based measures for ADL are the Physical Performance Test (PPT) (Reuben et al, 1990), the Assessment of Motor and Process Skills (AMPS) (Fisher, 1993), and the Short Physical Performance Battery (SPPB) (Shumway-Cook et al, 2005). The AMPS is a very sophisticated instrument used by occupational therapists. One limitation of this instrument is that it is difficult to administer, is time consuming, and requires specially educated occupational therapists to be administered validly. Moreover, the SPPB assesses only lower extremity function and was not developed to measure a full range of ADL tasks. The 7- and 9-item versions of the PPT, although valid and reliable instruments, measure only BADL performance (Rozzini et al, 1993). This implies that the PPT cannot be used to assess the full range of ADL activities.

To address the limitations of existing performance-based instruments and to develop a performance-based assessment tool that includes both BADL and IADL tasks that are applicable in residential and nursing homes, we constructed a new assessment instrument, the Physical ADL Test (PAT). In this study, we describe the test-retest reliability, the internal consistency, and the construct validity of the PAT.

Methods

Research population

Participants were recruited from three residence institutions in the northern part of the Netherlands. The homes for the elderly were randomly selected from a list of residential homes in that part of the Netherlands. Homes for the elderly are residential institutions where people are not entirely care dependent, as in nursing homes most of the people are. We obtained consent from the board of directors of the institutions and the clients board. We included 40 older people from different homes for the elderly. To be eligible, participates had to be aged 65 years or older; be able to walk independently with or without walking aids; be able to follow instructions spoken in Dutch; and have no severe illness, cognitive impairment, progressive neurological diseases, stroke, severe cardiac failure, or high blood pressure. Severe illness refers to new acute disease or end-stage diseases. Blood pressure values were derived from patient's medical charts. Patients with severe cardiac failure and high blood pressure were excluded because performing the tests could be dangerous for the patient. Interference with test results caused by a medical condition itself was not reason for exclusion, except for progressive neurological diseases like Parkinson's' disease, because most of these patients are not able to perform the tests completely. Screening took place with the assistance of the nursing staff and by reviewing the patients' charts. Cognitive impairment was diagnosed by the nursing staff. Patients characteristics were: Mean age 85,88 +/- 7,6 years; 75 % women, 25 % man; all living alone within a residential home for the elderly people.

The PAT: Item Selection and Description

We constructed the PAT by selecting items from previously published literature concerning ADL performance. A literature search was performed to select relevant papers to guide our development. Studies concerning ADL questionnaires and ADL performance-based tests were considered. We searched PubMed and PsychINFO® using the search terms "performance-based ADL", "ADL test", "activities of daily living", and "ADL questionnaire". Twenty-one relevant articles were found, of which 2 included ADL questionnaires, 9 included performance-based measures, and 10 included questionnaires as well as performance-based measures. Test items were selected using the following criteria: An item had to be related to BADL or IADL and selected by authors at least five times, and items had to be feasible for older people to perform in their home environment. Feasibility was defined using the following criteria: (1) Performance of test items are standardized; (2) the test can be assessed within the participants homes; (3) the test can be assessed if the participants use walking aids; (4) total time needed to perform the test (test duration) is less than 30 minutes; (5) no sophisticated equipment is needed; and (6) the test is safe to perform and should not unduly exhaust the participants.

Twenty items were selected from existing assessment tools or questionnaires, of which 4 were not applicable or relevant for elderly living in an institution. Therefore, the final PAT test battery contained 16 items. The PAT comprised an equal number of BADL and IADL test items. The test was constructed in an increasingly demanding order, beginning with easy tasks and ending with difficult tasks. Easy tasks refer to tasks that are easy to perform. Difficult tasks are complicated tasks that demand more physical as well as cognitive abilities in patients. The PAT was also based on practical considerations. Table 1 shows an overview of the PAT test items and their classification into BADL and IADL items.

The PAT items were scored in two different ways. First, the time necessary to perform a test item was recorded in seconds. Second, the quality of the performance was scored. The quality score was assigned to describe the degree of difficulty in performing a task or the number of mistakes that were made during performance of the task. Scores range from 1 to 5 (1 = no difficulties or mistakes; 2 = few difficulties or 1 mistake; 3 = considerable difficulties or more than 1 mistake; 4 = not able to perform the task without assistance; 5 = not being able to perform the task at all).

Table 1. PAT[1] BADL[2] and IADL[3] test items listed in the order they are assessed

1	Writing a sentence	IADL[3]
2	Simulation of eating	BADL[2]
3	Counting money	IADL
4	Dialling a telephone number	IADL
5	Folding up a towel	IADL
6	Walking with a loaded handbag	IADL
7	Opening a bottle	IADL
8	Washing hands	BADL
9	Cleaning an object	IADL
10	Filling a glass of water	IADL
11	Putting on and taking off socks	BADL
12	Rising from a chair	BADL
13	Putting on and taking off a coat	BADL
14	Walking around the house	BADL
15	Climbing a step	BADL
16	Rising from a bed	BADL

[1] PAT is Performance ADL Test
[2] BADL is Basic Activities of Daily Living
[3] IADL is Instrumental Activities of Daily Living

Procedures

To select participants, we organized informational meetings for residents and derived additional information from nursing staff. All participants signed a written consent form. Basic characteristics were assessed, such as age, gender, and living situation. Researchers that conducted the tests were two students recruited from Hanze University Groningen, the Netherlands, under the supervision of the primary investigator. They were well-trained to standardize test performance. During the baseline test (T1), the following measures were obtained: the GARS, the PAT, baseline characteristics, and performance based fitness tests.
Test sessions lasted approximately 2 hours and were performed at the participants' apartments within the residential homes. The data obtained during the baseline test were used to establish construct validity (factor structure of the PAT and relationship of the PAT to self-reported ADL and physical fitness) and internal consistency.

To establish test-retest reliability, the PAT was measured again two weeks (T2) later on the same day of the week, at approximately the same time of day, and by the same researchers that performed the baseline test.

Other measures

Because there is no "golden standard" to measure performance-based ADL, we chose to compare the PAT with self-reported ADL and with performance-based measures of physical fitness. Associations between PAT and physical fitness tests are based on models that assume a relationship between physical fitness and performance-based ADL (van Heuvelen, 1999).

Self-reported ADL

Self-reported ADL was measured with GARS (Kempen et al, 1993). The GARS comprises 11 BADL and 7 IADL items. Each item is scored on a 4-point scale, from 1 (I can perform this task independently) to 4 (I need assistance to perform this task). The sum score was taken as the final score. Higher scores indicated a lower level of self-reported ADL functioning.

Physical fitness

Upper extremity muscle strength, lower extremity muscle strength, postural balance, gait, and endurance were measured with performance-based tests. Upper extremity muscle strength was assessed by the Arm Curl Test (Rikli et al, 2002), and grip strength test (Mathiowetz et al, 2002). Lower extremity muscle strength was assessed with the Chair Stand Test (Rikli et al, 2002), and postural balance was assessed with the Functional Reach Test (Duncan et al, 1992) standing parallel with eyes open, and standing parallel with eyes closed (Rossiter- Fornoff et al, 1995). Balance and gait was assessed with the Timed Up & Go Test (Podsiadlo et al, 1991), and endurance was assessed with the Two-minute Walk Test (Stewart et al, 1990).

Data analysis

Data was analyzed using SPSS, version 15.0. Exploratory factor analysis (principal component analysis with varimax rotation) was performed to investigate the factor structure of the PAT and to reduce the number of test scores. Internal consistency of the PAT was determined using mean inter-item correlation and Cronbach's alpha for the entire scale and the subscales, based on both the factor analysis and the BADL and IADL subscales. The relationship between PAT, self-reported ADL, and performance-based physical fitness was determined using Pearson's correlations with 95% Confidence Intervals. Correlations were determined for BADL and IADL subscales, the Organization of Activities subscale, the Gross Motor Function subscale, the Fine Motor Function subscale, and the PAT sum scale. Test-retest reliability was calculated with intra-class correlations, two-way random model, with 95 % Confidence Intervals, and with paired-sample *t*-tests. To illustrate the variance between the test and retest, we plotted Bland-Altman plots with reference lines indicating the limits of agreement (Bland et al, 1986).

Results

Factor analysis and internal consistency

We performed a factor analysis on the 16-item time-measured PAT scale. Five factors had eigenvalues greater than one. Because one factor contained only one item, a four-factor solution was calculated. However, there was little agreement on the content of the items loaded for the four factors. When three factors were forced, the test items seemed to contain substantive agreement. The factor loadings of this analysis are shown in Table 2. Only values above .300 are shown. Factor 1 test items are items that assume a certain level of organization of performance. Factor 2 items are test items that assume a certain level of gross motor function and muscle strength. Factor 3 items are test items that assume a certain level of fine motor function.

Table 2. Factor analyses results for the three components of the time-measured PAT scale[a]

	Principal Components		
	Organization of performance	**Gross motor function**	**Fine motor function**
Writing a sentence			.883
Simulation of eating			.615
Counting money	.422		.511
Folding a towel	.622		
Walking with a loaded handbag	.720		.388
Opening a bottle	.422	.708	
Rising from a chair		.859	
Putting on and taking off a coat	.439		.701
Walking around the house	.580	.643	
Climbing a step	.575		
Washing hands	.607		
Rising from a bed		.907	
Cleaning an object	.363	.302	.385
Filling a glass of water	.780	.390	
Putting on and taking off socks	.552		.422
Dialling a telephone number	.570		.375
Initial Eigenvalue	*5.96*	*2.05*	*1.45*
Explained variance after rotation[b]	*24.6%*	*18.1%*	*16.6%*

[a]Only values above .300 are shown.
[b]Varimax rotation.

For each factor, we calculated Cronbach's alpha values using the items that had the highest loading on the concerned factor compared with the other factors. Cronbach's alpha was 0.761 (0.820) for the Organization of Performance subscale, 0.749 (0.844) for the Gross Motor Function subscale, and 0.617 (0.743) for the Fine Motor Function subscale. The values within the parentheses are Cronbach's alpha values based on standardized items.

Cronbach's alpha values were also calculated for the PAT sum scale and for the BADL and IADL subscales. Cronbach's alpha was 0.832 (0.881) for the PAT time scores of the 16 items, 0.830 (0.832) for the PAT quality scores, 0.649 (0.757) for time scores of the BADL subscale, and 0.749 (0.844) for the quality score. Cronbach's alpha was 0.752 (0.813) for time scores of the IADL subscale and 0.725 (0.731) for the quality scores.

Table 3. Paired sampled t-test results for PAT time scores and PAT quality scores

	PAT time scores				**PAT quality scores**			
Test item	**T1 time Mean±SD**	**T2 time Mean±SD**	**t- value df=39**	**p-value**	**T1 quality Mean±SD**	**T2 quality Mean±SD**	**t- value df=39**	**p-value**
Writing a sentence	37.25 ± 23.85	36.10± 20.90	.53	.597	2.63± 1.51	2.55± 1.54	.68	.498
Simulation of eating	17.63 ± 5.61	19.00± 7.93	-1.27	.211	1.35± .83	1.50± .96	-1.062	.295
Counting money	69.33 ± 39.42	77.68± 42.94	-1.71	.095	2.33± 1.64	2.43± 1.68	-.662	.512
Dialling a telephone number	20.55 ± 8.30	20.48± 9.24	.07	.944	1.65± 1.231	1.60±1.22	.703	.486
Folding a towel	69.25± 24.64	67.50± 34.53	.56	.581	1.35± .921	1.35± .921	.000	1.00
Walking with a loaded handbag	48.08± 19.59	43.25± 20.22	2.08	.044	2.18± 1.43	1.98± 1.35	1.599	.118
Opening a bottle	48.30± 17.34	43.90± 17.99	2.32	.026	1.70± 1.14	1.60± .928	.813	.421
Washing hands	42.93± 18.12	36.35± 15.37	3.02	.004	1.68± 1.289	1.45± 1.218	2.296	.027
Cleaning an object	16.08 ± 6.17	15.55± 6.5	1.02	.313	2.10± 1.676	1.98± 1.625	1.152	.256
Filling a glass of water	29.50 ± 15.17	27.25± 13.67	1.51	.138	1.78± 1.143	1.83± 1.13	-1.433	.160
Putting on and taking off socks	66.30 ± 30.69	61.60± 24.05	1.33	.195	3.05±1.825	3.15± 1.861	-.598	.553
Rising from a chair	3.08 ± 2.29	3.35± 3.48	-.67	.506	2.15±1.10	2.25± 1.19	-.752	-.457
Putting on and taking off a coat	31.80 ± 13.32	35.85± 21.08	-1.75	.088	1.38± .838	1.58± 1.010	-2.726	.10
Walking around the house	24.43 ± 8.65	24.85± 9.63	-.59	.562	2.30± 1.137	2.43± 1.299	-1.044	.303
Climbing a step	12.25 ± 4.66	14.08± 8.97	-1.38	.175	3.33/ 1.492	3.55/ 1.518	-1.854	.071
Rising from a bed	10.58 ± 11.65	9.85± 10.32	1.32	.194	1.93/ 1.16	1.88/ 1.202	.374	.711
Sum BADL	.00 ± 4.878[a]	.53± 2.81[b]	-.60	.551	17.15/ 5.97	19.85/ 7.50	-1.74	.90
Sum IADL	.00 ± 5.26[a]	-.65± 2.31[b]	.71	.482	15.70/ 6.36	15.30/ 6.35	1.42	.163
Sum PAT	.00 ± 9.59[a]	-.12± 4.22[b]	.07	.943	32.85/ 11.09	33.08/ 11.94	-0.48	.64

[a] These scores are based on standardized values. [b] These scores are based on standardized values computed

Test-retest reliability

Test-retest reliability was measured at baseline (T1) and after 2 weeks, the so called retest (T2). Tables 3 and 4 show the results of the paired sampled t-test and the intraclass correlation (ICC) scores. ICC scores from the individual test items of the time scores of the PAT ranged between 0.316 and 0.950 for time scores. ICCs for the BADL subscale, the IADL subscale, and the total sum ranged between 0.836 and 0.900. ICCs for the quality scores of the PAT ranged between 0.507 and 0.981 for individual test items, and between 0.933 and 0.966 for the BADL, IADL, and total sum scores. Paired sampled t-tests revealed no significant difference between T1 and T2.

Table 4. ICCs with CI for PAT time scores and PAT quality scores

Test item	PAT time scores ICC[1] (95% CI[2])	PAT quality scores ICC (95% CI)
Writing a sentence	.815 (.68-.90)	.896 (.81-.94)
Simulation of eating	.504 (.23-.70)	.507 (.24-.71)
Counting money	.720 (.53-.84)	.834 (.71-.91)
Dialling a telephone number	.709 (.51-.84)	.932 (.88-.96)
Folding a towel	.780 (.62-.88)	.789 (.64-.88)
Walking with a loaded handbag	.729 (.54-.85)	.838 (.72-.91)
Opening a bottle	.769 (.60-.87)	.719 (.53-.84)
Washing hands	.664 (.45-.81)	.878 (.78-.93)
Cleaning an object	.868 (.77-.93)	.914 (.84-.95)
Filling a glass of water	.789 (.64-.88)	.981 (.97-.99)
Putting on and taking off socks	.670 (.46-.81)	.835 (.71-.91)
Rising from a chair	.612 (.38-.77)	.731 (.55-.85)
Putting on and taking off a coat	.655 (.43-.80)	.875 (.78-.93)
Walking around the house.	.874 (.78-.93)	.807 (.67-.89)
Climbing a step	.316 (.01-.57)	.870 (.77-.93)
Rising from a bed	.950 (.91-.97)	.744 (.57-.86)
Sum BADL	.836 (.71-.91)	.933 (.88-.96)
Sum IADL	.889 (.80-.94)	.961 (.93-.98)
Total sum PAT	.900 (.82-.95)	.966 (.94-.98)

[1] ICC= intraclass correlation
[2] CI= Confidence Interval

Bland-Altman plots

The Bland-Altman plots presented in Figure 1 show the relationship between the difference of test (T1) and retest (T2) measures and between the means of T1 and T2 scores for six measures: two of the total sums of the PAT time scores and PAT quality scores, two of the BADL sub scores, time- and quality measured, and two of the IADL sub scores time- and quality measured. The Bland-Altman plots show also the limits of agreement, which are 2 standard deviations of the mean difference between T1 and T2. The limits of agreement were

77.57 and -69.57 for the BADL subscale time measured, 108.91 and -95.65 for the IADL subscale time measured, 155.36 and -134.00 for the total sum PAT time measured, 3.91 and -5.17 for the BADL subscale quality measured, 3.96 and -3.16 for the IADL subscale quality measured, and 5.75 and -6.21 for the total sum PAT quality measured.

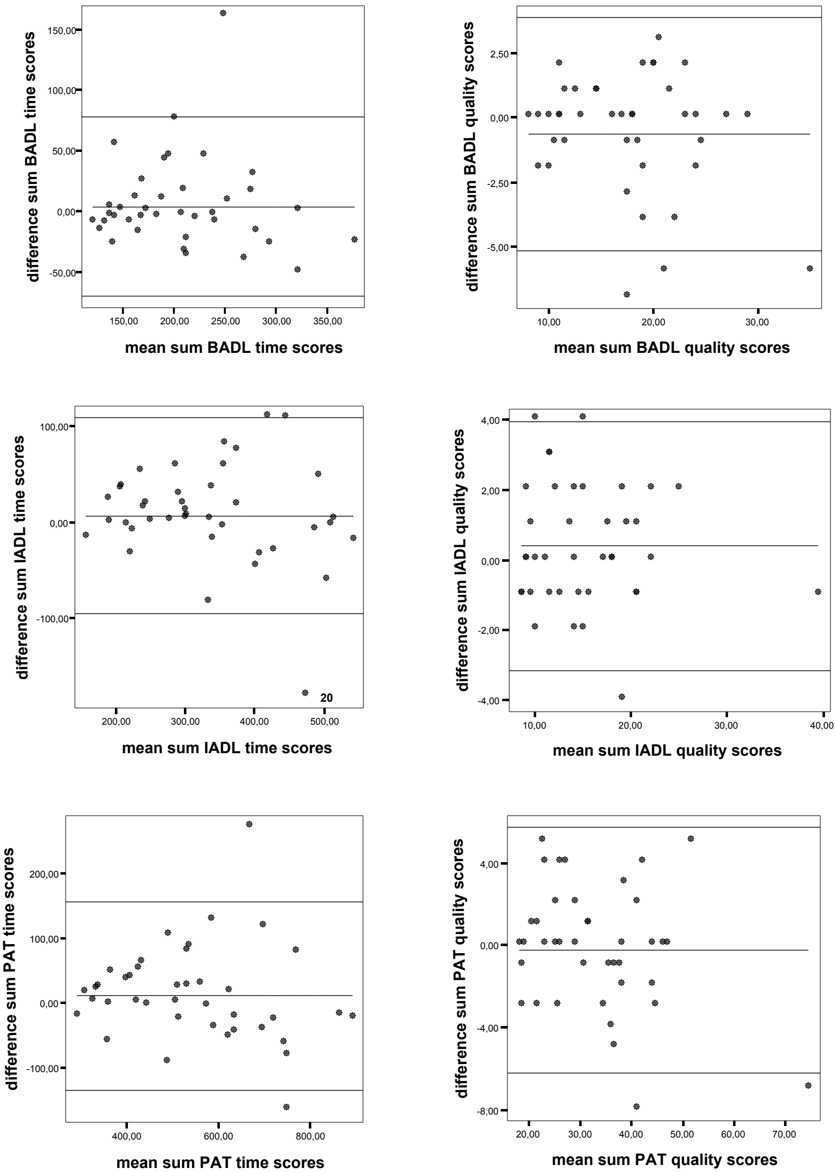

Fig. 1. Bland-Alman plots of PAT sum scores, BADL subscale scores, and IADL subscale scores for time needed to accomplish the item tasks (time scores) and for quality of task performance (quality scores)

Validity

Construct validity was determined by comparing the PAT instrument with the GARS and a number of performance-based physical fitness tests. Table 5 shows the results of our analyses. The Pearson's correlations between the PAT and the GARS ranged from 0.612 to 0.763. Pearson's correlations between the time and quality scores of PAT BADL subscales and those of the GARS BADL subscale ranged from 0.616 and 0.831, whereas Pearson's correlations between the time and quality scores of PAT IADL subscales and those of the IADL subscale ranged from 0.490 and 0.529. Pearson's correlations between the Organization of Performance subscale, the Gross Motor Function subscale, and the Fine Motor function subscale and the performance-based fitness tests were 0.446, 0.781, and 0.317, respectively.

Table 5. Pearson's correlations between sum scores of PAT time and quality measured, GARS, Fit tests, and factors, and between BADL and IADL subscales of the PAT and GARS

	PAT time Z scores			**PAT quality scores**			**Factors**		
	Total sum PAT time Z scores (sec)	Sum BADL time Z scores (sec)	Sum IADL time Z scores (sec)	Total sum PAT quality scores (points)	Sum BADL quality scores (points)	Sum IADL quality scores (points)	Organization of Activities (sec)	Gross Motor Functions (sec)	Fine Motor Function (sec)
GARS sum scores (points)	.612**			.763**					
GARS BADL (points)		.616**			.831**				
GARS IADL (points)			.490**			.529**			
Fit test sum Z scores	.645**			.758**			.446**	.781**	.317**

Note: * p<0.05 **p<0.01 *** p<0.001

Discussion

The PAT was developed to measure performance-based ADL in elderly people living in residential institutions. The aim of the present study was to establish the reliability and the validity of the PAT. We developed the PAT by selecting from the literature items pertinent to the ADL of elderly people. We identified 16 items that were relevant for the elderly population living in institutions. The selection of the 16 items was based on a consensus of 21 studies that constructed ADL tests for elderly people. These outcomes were according to the findings of Rozzini (1993), who stated that a performance-based ADL test should contain all relevant items referring to the ADL of elderly people (Rozzini et al, 1993). This is also the conclusion of Kempen et al. (1993), who emphasized the need to assess both Basic ADL and Instrumental ADL tasks (Kempen et al, 1993).

First, we discuss the feasibility of the PAT. One criterion we used to choose test items was whether the test items could feasibly be completed in the participants' apartments within the residential home. After observing the 40 participants perform the PAT, we can conclude that the PAT is a feasible instrument for measuring ADL in older people living in residential homes. The latter is based on the following criteria, which were mentioned in the methods section: It was feasible to use the PAT in the participants home, no special equipment was needed, performance of the test lasted less than 30 minutes, participants did not get exhausted, test items could be assessed even if the participants used walking aids.

To find agreement between test items and to reduce the number of test items, we performed a factor analysis. When forced into three factors (eigenvalues > 1), we found agreements among factor items with respect to physical fitness properties. Factor 1 subscale required a certain level of organization of performance, factor 2 subscale required a certain level of gross motor function and muscle strength, and the factor 3 subscale required a certain level of fine motor function. Using these subscales is of interest because motor skills can be improved by training, especially by muscle strength training (Seynnes et al, 2004). Dividing the PAT into a BADL subscale and an IADL subscale is also relevant, in view of the contents of the items. BADL items are mostly relevant for elderly people, living in residential homes, whereas IADL items are primarily relevant for elderly people living in a community-dwelling setting.

To establish the internal consistency of the PAT, we calculated Cronbach's alpha values for all subscales and factors. All values were between 0.731 and 0.881. Looking at the different outcomes, we see that internal consistency values for the BADL subscale time measured, the IADL subscale quality measured, and the factor Fine Motor Function were below 0.800. After performing a reliability analysis based on whether a scale item was deleted, we discovered that none of the single items affected these values. Although these results are not satisfactory, they can be stated based on the complexity of the construct ADL performance.

Test-retest reliability was measured by calculating ICCs and by performing paired sampled t-tests. For six items, ICCs ranged from 0.300 and 0.700, indicating a fair to moderate relationship. Correlations from 0.00 to 0.25 indicate little or no relationship, whereas those from 0.25 to 0.50 a fair relationship, those from 0.50 to 0.75 a moderate to good relationship, those above 0.75 a good to excellent relationship (Portney et al, 2000). These outcomes are due to the fact that there is a great variety in measurement outcomes of ADL tasks over time in elderly people living in institutions, because most of these people are more or less frail. Frailty, defined as a lack of ability of an older person to restore functions after sickness or handicap, leads to a situation in which people perform very differently on different days (Gleichgericht et al, 2009). Variability in performance can be due to minor disturbances that upset the balance of daily performance, such as a common cold or an infection of the urinary system. Frailty is also the reason for the wide variations in the measured values, as shown in the Bland-Altman plots (Fig. 1). All plots showed the same feature: a wide spread of scores around the mean difference of test-retest values. This feature has important consequences for the clinical relevance of test outcomes. If an intervention has clinically relevant effects, improvement in individuals' scores should lie outside the limits of agreement. Because the limits of agreement for the PAT showed a wide range, relevant effects cannot be stated confidently. Research on the effect of interventions on ADL performance measured by the PAT should shed light on this issue.

ICCs for the PAT total sum time and quality measured were very high at 0.90 and 0.97, respectively. These outcomes agree with the reliability outcomes of the PPT, which are 0.99 and 0.93 for the 7- and 9-item versions, respectively (Reuben et al, 1990). ICCs for the subscales ranged from 0.83 to 0.96, leading to the conclusion that overall the PAT is a reliable scale.

The PAT was validated by comparing it to the GARS and several physical fitness test items. Correlations between the PAT and the GARS show scores between 0.490 and 0.831. The latter is a high correlation between the BADL sum scores of the PAT, quality measured, and the BADL scores of the GARS questionnaire. These results prompt the question of whether using the questionnaire exclusively is unsatisfactory. In the introduction, we explained the restrictions of a questionnaire that measures ADL in elderly people (Guralnik et al, 1989). Thus, we may conclude that there is a relationship between the constructs, but they are complementary. Comparison between the Fit test scores and the PAT show moderate correlations, indicating that there is a relationship between physical fitness and ADL performance. Of interest is the relationship between the Fit test scores and the Organization of Performance subscale, the Gross Motor Function subscale, and the Fine Motor Function subscale. In contrast to the Organization of Functions and the Fine Motor Function subscales, the correlation was good between the Fit test scores and the Gross Motor Function subscale. This can be explained in that Fit test items also measure gross motor function, namely upper and lower extremity muscle strength, balance, and gait. This is in accordance with the findings of Seynnes et al., who established the relationship between increased muscle strength and ADL performance (Seynnes et al, 2004). The Gross Motor Functions subscale is a promising instrument for assessing motor-function-related ADL tasks before and after physical interventions are implemented.

This study has a number of limitations. Firstly, we tested the PAT on only 40 older people living in residential homes. This number is rather small, considering frail elderly people can have a wide range of performance. We are aware of the factor that a principal component analysis requires at least 100 participants. Due to the vulnerability of frail elderly people living in residential homes, inclusion of residents willing to participate was very difficult. However, there are some studies available in literature with a limited number of participants who performed a principal component analysis also (Gleichgericht et al, 2009; Simon et al, 2002; Chatzitheodorou et al, 2008; Trouli et al, 2008). Future research should cover this issue by enlarging the research population. Secondly, we did not assess general health issues, education level, medication use, and level of frailty, all of which can influence the outcomes of this validation study (Fried et al, 2001). We also did not examine psychological issues (e.g., depression and anxiety), which can also affect outcomes. These baseline characteristics could provide us with better insight into the reasons why the ADL performance of frail elderly people differs over time.

Further research should determine the value of this instrument in community- dwelling older people, in patients with specific age-related diseases, and in cognitively impaired elderly people. The value of this instrument should also be investigated as to whether it produces a useful outcome measure after an intervention based on improvement of ADL performance. Knowledge about the sensitivity to change of this instrument should be developed. In conclusion, the PAT can be used in older people living in residential homes to assess overall ADL.

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Chapter 3

Frail Institutionalized Older Persons: A Comprehensive Review on Physical Exercise, Physical Fitness, Activities of Daily Living, and Quality of Life

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American Journal of Physical Medicine and Rehabilitation. 2011; Febr. 90(2): 156-168

Abstract

The objective of this study was to perform a systematic review on training outcomes influencing physical fitness, ADL performance, and quality of life in institutionalized older people. We reviewed 27 studies on older people (age ≥70 years) in long-term care facilities and nursing homes. Our ultimate goal was to propose criteria for an evidence-based exercise protocol aimed at improving physical fitness, ADL performance, and quality of life of frail institutionalized older people. The interventions, described in the reviewed studies, that showed strong or very strong effect sizes, were used to form an exercise prescription. The conclusion is that there is firm evidence for training effects on physical fitness, functional performance, ADL performance, and quality of life. The training should contain a combination of progressive resistance training, balance training, and functional training. The proposed intensity is moderate to high, assessed on a 0 to 10-scale for muscle strengthening activities. The training frequency 3 times a week, and the total duration at least 10 weeks.

Key Words: Frail Elderly People, Institutionalized, Physical Exercise

Introduction

In the coming decades, the number of elderly people will increase due to aging of the population. Studies indicate that there is a growing need to care for people 65 years and older, with an emphasis on people exceeding 80 years old. Worldwide, the growing number of older adults continues to increase demands on the public health system and on medical and social services. Chronic diseases, which affect older adults disproportionately, contribute to disability, diminish quality of life, and increase health care and long-term care costs (Center for Disease Control, 2003).

In geriatric medicine, three terms are used to identify vulnerability in older persons: Comorbidity, disability, and frailty. Comorbidity is defined as: The medical condition in a patient that causes, is caused by or otherwise related to another condition in the same patient (Valderas et al, 2009). Disability is the major reason for institutionalization (Fried et al, 2004). Frailty is characterized by unintentional weight loss, exhaustion, low physical activity, slow walking speed, and muscle weakness (Fried et al, 2001). Although geriatricians consider these three measures of vulnerability—Comorbidity, disability, and frailty—to overlap, all three are different entities. Indeed, they influence each other, but their interactions and influence cannot be clearly represented by a single model (Fried et al, 2004). Another research group defined frailty as an accumulation of deficits related to old age (Rockwood et al, 2007). Although not all institutionalized elderly people are frail, we have chosen frailty as one of the core issues to be addressed in this review, because frailty adversely influences the quality of life of elderly people. Frailty is more and more recognized as a dynamic concept, as the pathway leading from non-frail to pre-frail to frail is reversible (Topinkova, 2008).

Because this review focuses specifically on institutionalized elderly persons, we assessed and differentiated pertinent studies on the basis of basic activities of daily living (BADL) and instrumental activities of daily living (IADL). As seen in the definitions of the concepts, BADL is more relevant to frail institutionalized older people than IADL. In research, BADL is distinguished from IADL by using different measures for BADL and IADL or different subscales from one overall scale for activities of daily living (ADL).

An important risk factor that contributes to decreased ADL performance is low levels of physical activity (Bouchard et al, 1994). One way to improve physical fitness is to exercise (Keyssor et al, 2001). Health-related physical fitness include physique characteristics that influence the state of health. The characteristics are; muscle strength, flexibility, coordination, balance, and endurance (Bouchard et al, 1994).

A literature search revealed one prior review with the focus on the effects of exercise on physical fitness in a residential home population (Rydwik et al, 2004). Although that review provided some evidence that exercise influences functional performance positively, the evidence was limited due to the poor methodological quality of the studies included in the review (Rydwik et al, 2004). Thus, a systematic review of the effects of physical exercise on physical fitness, ADL performance, and quality of life does exist, but is not up to date. The purpose of our review, therefore, is to examine the effects of physical exercise on physical fitness, ADL performance, and quality of life. Our ultimate goal is to propose criteria for an evidence-based exercise protocol aimed at frail institutionalized older people.

Methods

Literature Search

Databases used for the literature search were Medline, Pubmed, Cochrane, and CINAHL®. MESH terms used in the search were *physical exercise, physical activity, frail older or elderly people, and institutionalized.* To cast a wider net across the full width of this research field, a number of synonyms were used for the MESH terms. To extend the search strategy on physical exercise and daily physical activity, the following terms were used: *strength training, flexibility training, balance training, and endurance training.* We extended our search further to the list of references of the included articles and the list of related articles on relevant items.

Definitions of Search Terms and Outcome Variables

We defined search terms and outcome variables as follows:

- *ADL performance:* The carrying out of activities of daily living, like bathing, clothing oneself, shopping, and housework
- *Balance:* Dynamic or static balance, postural sway
- *Basic Activities of Daily Living (BADL):* Self-care activities and basic mobility
- *Coordination:* The coordination of movements, usually between different subsequent parts of the same movement or movements of several limbs or even several actors. Motor coordination arise from a complex coordination between muscles or limbs or neutral circuitry
- *Disability*: Difficulty or dependency in carrying out activities necessary for independent living (e.g., roles, tasks needed for self-care and household chores), and other activities important for a person's quality of life
- *Endurance:* Maximal exercise duration and/or maximal attained work load
- *Flexibility:* Range of motion, measured in a specific joint
- *Frail elderly*: Older adults or aged individuals who lack normal strength and are unusually susceptible to disease or to other infirmity
- *Functional performance*: Physical aspects of daily functioning in older adults.
- *Instrumental Activities of Daily Living (IADL):* household activities and advanced physical activities

- *Institutionalization:* The caring for individuals in institutions and their adaptation to routines characteristic of the institutional environment, and/or their loss of adaptation to life outside the institution
- *Muscle strength:* Strength measured in a specific muscle or muscle group
- *Physical activity:* Activity performed by the human body
- *Physical fitness:* Health related physical fitness is the capacity to perform daily tasks
- *Quality of Life:* A generic concept reflecting concern with the modification and enhancement of life attributes, e.g., physical, political, moral, and psychosocial environment; the overall condition of a human life

Criteria for Inclusion

Inclusion criteria used to select the relevant studies were the use of a Randomized Controlled Trial (RCT) design, written in English, published from 1955 to 2008 in peer-reviewed journals catalogued in databases, and including participants 70 years and older living in long-term care facilities and nursing homes. We chose the year 1955 because of the availability of published studies listed in Medline databases. Included were studies describing frail older people with all different kinds of illnesses or diseases. Comorbidity was listed in the articles, but we excluded studies with a primarily focus on specific diseases like stroke, rheumatism, Alzheimers' disease, and psychological diseases. We included RCTs that examined the effects of exercise training or physical activity on the primary aging characteristics physical fitness, ADL performance, and quality of life. Additionally, we included all studies referring to the effects of physical exercise on the prevention of falls, because the interventions used to prevent falls are very similar to the interventions to increase physical fitness.

Methodological Quality

The quality of the selected RCTs was assessed by the guidelines of the Dutch Cochrane Institution for Assessment of Quality of Randomized Controlled Trials. The assessment form was shortened, because single and double blinding is usually not possible in these types of intervention studies. In class exercise programs, neither therapists nor patients can be blinded. Consequently, seven original criteria remained. These are: 1. Was a randomization procedure performed? 2. Was the person who includes participants blinded for randomization order? 3. Was the outcome assessor blinded? 4. Were groups at the start of the trial equal on baseline characteristics? 5. Was there a sufficient proportion loss- to- follow up? 6. Did the analysis include an intention-to-treat analysis? 7. Were both groups, apart from the intervention, treated equally? We added the following question: 8. Was a baseline assessment performed before randomization? We assigned the following original items 2 points instead of 1 point: 1.Was a randomization procedure performed? 2. Was the person who includes participants blinded for randomization order? 3. Was the outcome assessor blinded? 6. Did the analysis include an intention-to-treat analysis? This adjustment was made because of the large methodological impact of these items. We called the new assessment tool for determining the quality of RCTs the adapted Dutch Cochrane Qualification (aDCQ) form. We classified the articles into low-, moderate-, or high-quality categories, based on their total quality score. Cut-off scores used were 0-4 score (low); 5-8 score (moderate); and 9-12 score (high).

Quality of Interventions

The following criteria were used to classify the quality of the exercise interventions analyzed in this review. For this procedure, we included studies that scored moderate or high and we excluded studies that scored low on the aDCQ. Next, we determined means and standard deviations of relevant outcome measures, which we used to calculate effect sizes. These outcome measures were strength, flexibility, endurance, balance, coordination, functional performance, ADL performance, and quality of life. To classify the results from the selected studies, we used the cut-off scores of effect sizes described by Cohen (Cohen, 1998) and by Middel and van Sonderen (Middel et al, 2002), who proposed the clinical relevance of this classification scheme. Finally, we took into account whether researchers performed an intention-to-treat analysis.

Results

Search Results

Figure 1 illustrates the search and inclusion process. Search results on search term physical exercise and synonyms showed 7700 hits. Search results on frail elderly people with synonyms showed 339 hits, while search results on institutionalized elderly with synonyms showed 2267 hits. The combination of these three search terms resulted in 89 hits. Firstly, titles were screened on matching the inclusion criteria. 69 titles were left out because they did not match the inclusion criteria (see Methods) 20 potential articles remained. Examination of the reference lists of the 20 potential studies produced another 35 relevant titles, from which 9 study titles were considered useful after using the same inclusion criteria. The search for relevant related articles in Pubmed produced another 16 titles, which were similarly evaluated for inclusion. This resulted in 45 potential articles; The second step was reading the abstracts. 32 studies met the inclusion criteria. 13 Studies were excluded because they only described outcomes in patients with specific diseases. Of the 32 articles, one was excluded, because by reading the entire article, it described only community-dwelling elderly people. In the end, 31 articles fulfilled the inclusion criteria and were assessed further for this study. Literature search in the Medline, Cinahl, and Cochrane databases did not add any relevant studies. These 31 articles were based on 27 studies, because Chin A Paw *et a*l (Chin A Paw et al, 2004; Chin A Paw et al, 2006a; Chin A Paw et al, 2006b) and Jensen *et al* (Jensen et al, 2003; Jensen et al, 2004, Jensen et al, 2002) wrote 3 articles based on one research study. In that way, 27 studies were included in the final review.

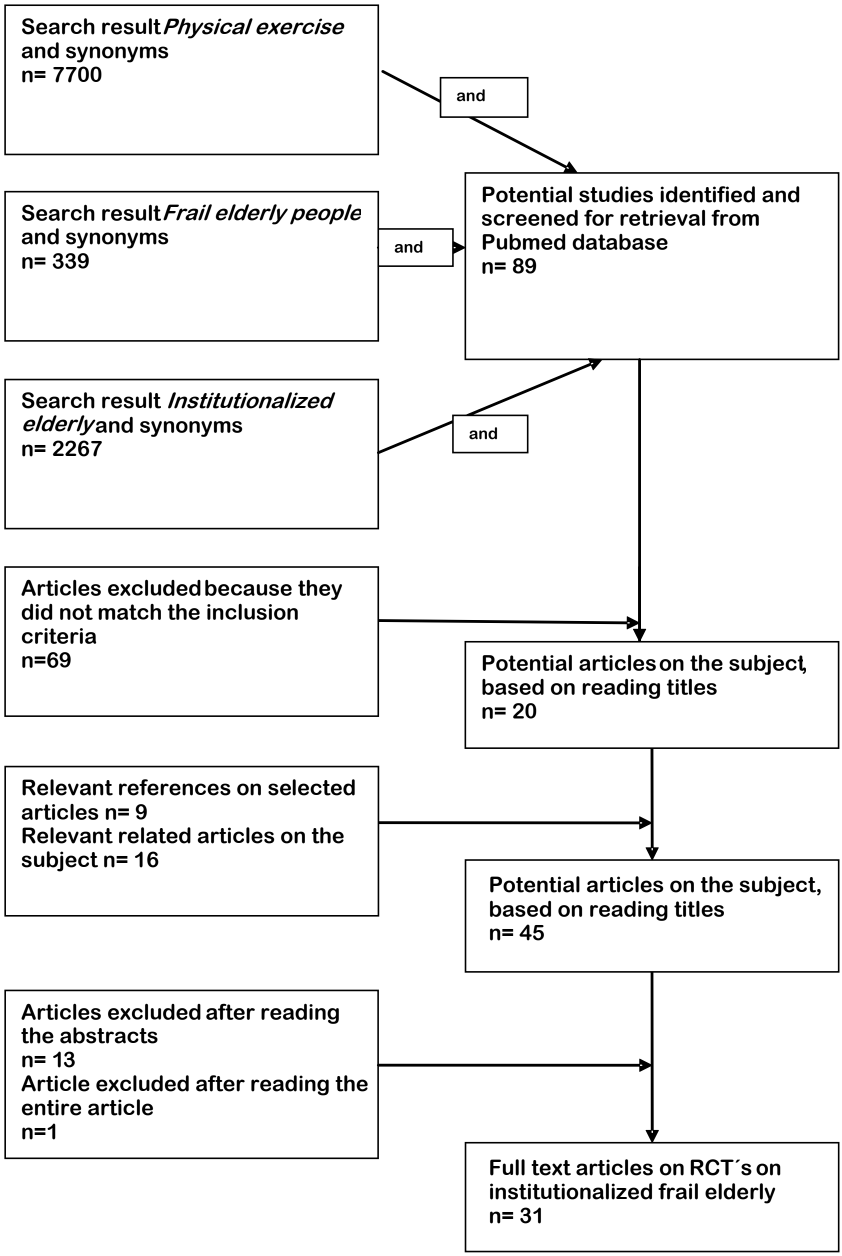

FIGURE 1. Flow diagram of search strategy used in Pubmed

Methodological Quality

Low-quality RCTs

We deemed three studies to be low-quality RCTs for the following reasons. One study was not a RCT after all (Brill et al, 1999). The second study provided no description of randomization; the assessors were not blinded; the groups were not equal before intervention; no baseline assessment was done before randomization; it lacked an intention-to-treat analysis; and the control and experimental groups were not treated equally (Hinkka et al, 2006). The third study similarly provided no description of randomization; the assessors were not blinded; the groups were not equal before intervention; there was an insufficient description of loss-to-follow-up; it lacked an intention-to-treat analysis; and the control and experimental groups were not treated equally (Landi et al, 2004). An overview of these low-quality studies is shown in Table 1.

Moderate-quality RCTs

Twelve studies were categorized as moderate quality for the following reasons. There was no description of randomization (Fiatarone et al, 1994); the assessors were not blinded (Jensen et al, 2004; Fiatarone et al, 1994; Hruda et al, 2003; Sihvonen et al, 2004), the groups were not equal before intervention (Jensen et al, 2004; Fiatarone et al, 1994; Hiroyuki et al, 2003; Dyer et al, 2004) there was no baseline assessment before randomization (Fiatarone et al, 1994; Hruda et al, 2003; Sihvonen et al, 2004; Hiroyuki et al, 2003; Dyer et al, 2004; Lord et al, 2003; Meuleman et al, 2000) there was an insufficient description of loss-to-follow-up (Jensen et al, 2004; Fiatarone et al, 1994; Hruda et al, 2003; Sihvonen et al, 2004; Lord et al, 2003; Lazowski et al, 1999) they lacked an intention-to-treat analysis (Sihvonen et al, 2004; Hiroyuki et al, 2003; Dyer et al, 2004; Meuleman et al, 2000; Lazowski et al, 1999; Faber et al, 2006; Ouslander et al, 2005; Seynnes et al, 2004) and the control and experimental groups were not treated equally (Jensen et al, 2004; Hruda et al, 2003; Sihvonen et al, 2004; Hiroyuki et al, 2003; Dyer et al, 2004; Meuleman et al, 2000; Lazowski et al, 1999; Faber et al, 2006; Ouslander et al, 2005). An overview of these moderate-quality studies is shown in Table 1.

High-Quality RCTs

Twelve high-quality RCT studies were identified. Two were qualified as high quality because they contained all quality demands (Chin A Paw, 2004; Baum et al, 2003) . Four studies did not mention the blinding of assessors (Becker et al, 2003; Littbrand et al, 2006; Nowalk et al, 2001; Mulrow et al, 1994). For one study the groups were not equal before intervention (McMurdo et al, 1994). Four studies described no baseline assessment before randomization (Wolf et al, 2001; Rosendahl et al, 2006; McMurdo et al, 1994; Schoenfelder et al, 2004). Two studies lacked description of loss-to-follow up (Nowalk et al, 2001; Schoenfelder et al, 2004). Two studies performed no Intention-to-treat analysis (McMurdo et al, 1994; Hauer et al, 2003). Four studies treated control and experimental groups not equally (Becker et al, 2003; Littbrand et al, 2006; Schoenfelder et al, 2004; Kerse et al, 2004). An overview of these high-quality studies is shown in Table 1.

Quality of Interventions

Design of the Interventions

The number of participants in the studies varied widely, ranging from 20 to 981, with a mean of 207. The types of interventions, assessment instruments, and outcome measures also varied considerably. Table 1 provides an overview of the type of interventions, outcome measures, and methodological quality of the assessed studies.

Outcomes

Eight relevant outcome measures were found: strength, flexibility, endurance, balance, coordination, functional performance, ADL, and quality of life. We selected the studies from which we could calculate the effect sizes of the interventions. Of the 27 assessed studies, 12 reported sufficient data enabling us to calculate effect sizes. Table 2 provides an overview over the studies with outcomes, outcome measures, and effect sizes.

TABLE 1 Interventions, outcome measures, adjusted Dutch Cochrane Assessment (aDCA)

Author	Participants	Type of intervention	Relevant outcome measures	aDCA
Baum et al., 2003	20	Range of Motion Strength	Functional performance ADL Balance Cognition	High
Becker et al., 2003	981	Balance Resistance	Balance Endurance Functional performance	High
Brill et al., 1999	35	-		Low
Chin A Paw et al., 2004	173	Resistance Functional	Perceived health Depression Cognition Vitality ADL	High
Chin A Paw et al., 2006	157	Resistance Functional	ADL Physical activity	High
Chin A Paw et al., 2006	224	Resistance Functional	ADL Physical fitness Agility Reaction time	High
Dyer et al., 2004	196	Strength Balance Flexibility Gait	Functional performance Balance	Moderate
Faber et al., 2006	278	Functional Tai Chi	Functional performance ADL Balance	Moderate
Fiatarone et al., 1994	100	Strength	Strength Gait Balance Functional performance ADL	Moderate

Author	Participants	Type of intervention	Relevant outcome measures	aDCA
Hauer et al., 2003	57	Balance Resistance Functional Functional performance	Strength Functional performance (including balance)	High
Hinkka et al., 2006	741	-		Low
Hiroyuki et al., 2003	34	Balance Gait	Functional performance Balance	Moderate
Hruda et al., 2003	25	Resistance	Strength Endurance Functional performance	Moderate
Jensen et al., 2003	187	Strength Balance Functional Flexibility Endurance	Functional performance Balance	High
Jensen et al., 2004	439	Strength Balance Functional	Functional performance Balance	Moderate
Jensen et al., 2002	439	Strength Balance Functional	Functional performance Balance	Moderate
Kerse et al., 2004	628	-		High
Landi et al., 2004	30	-		Low
Lazowski et al., 1999	68	Strength Balance Functional Flexibility	Strength Functional performance ADL Flexibility Balance	Moderate

Author	Participants	Type of intervention	Relevant outcome measures	aDCA
Littbrand et al., 2006	191	Strength Balance Gait	Physical performance Balance	High
Lord et al., 2003	551	Strength Balance Functional Endurance Flexibility	Strength Functional performance Balance Reaction time Endurance Coordination	Moderate
McMurdo et al., 1994	65	Strength	Strength Cognition	High
Meuleman et al., 2000	58	Resistance Endurance	Strength Endurance ADL Depression	Moderate
Mulrow et al., 1994	194	Strength Flexibility Balance Functional Gait training	Strength ROM (flexibility) Balance ADL Mobility	High
Nowalk et al., 2001	110	Tai-Chi Resistance-Endurance	Strength Functional performance ADL Depression Cognition	High
Ouslander et al., 2005	107	Strength Endurance	Functional performance Endurance	Moderate
Rosendahl et al., 2006	191	Strength Balance Gait Functional performance	Strength Balance Gait Functional performance	High

Author	Participants	Type of intervention	Relevant outcome measures	aDCA
Schoenfelder et al., 2004	81	Strength Functional	Strength Functional Balance Quality of Life	High
Seynnes et al., 2004	22	Strength	Strength Balance Functional performance ADL Endurance	Moderate
Sihvonen et al., 2004	28	Balance	Balance	Moderate
Wolf et al., 2001	49	Strength Endurance Flexibility	Balance Gait Depression	High

TABLE 2 Overview of general outcomes, outcome measures, and effect sizes[a]

Author	N	General outcome	Outcome measure (unit of measure)	Effect sizes	Effect sizes	Effect sizes
Baum et al., 2003[32-]	20	functional	TUGT (sec)	0.54		
		ADL	PPT (sec)	0.40		
		balance	BBS (scores)	0.32		
Chin A Paw et al., 2004[12-]	173			Strength group	Functional group	Combination group
		quality of life	Subjective health	0.30	0.08	0.54
Chin A Paw et al., 2006[13-]	224			Strength group	Functional group	Combination group
		ADL	ADL 17 item (scores)	-6.03[b]	0.19	0.38
		functional	Eye-hand coordination (sec)	-0.06[b]	0.14	0.29
		functional	Reaction time (sec)	0.00	-0.18[b]	0.06
		functional	Sit and reach test (sec)	-0.14[b]	0.10	-0.16[b]
		functional	Shoulder flexibility (cm)	-0.18[b]	-0.35[b]	-0.27[b]
		balance	Tandem stand (sec)	-0.03[b]	-0.24[b]	-0.31[b]
		balance	One leg stand (sec)	-0.26[b]	-0.31[b]	-0.24
		strength	Leg extension (N)	-0.08[b]	0.00	-0.20[b]
		strength	Arm extension (N)	0.00	-0.27[b]	-0.13[b]
		strength	Ankle flexion (N)	-0.18	0.04	0.03
Faber et al., 2006[29-]	278			Functional walking training		In balance training
		balance	POMA (scores)	0.28		-0.02[b]
		functional	PPS (scores)	0.09		0.02
		ADL	GARS (scores)	0.13		1.10
Hauer et al., 2003[41-]	57	strength	Leg press, 1 repetition maximum (kg)	2.08		
		strength	Leg extensor (N)	0.92		
		strength	Leg flexor (N)	0.60		
		strength	Foot extensor (N)	0.54		
		strength	Hand grip (kPa)	0.08		
		balance	POMA total (scores)	1.26		
		functional	Step height, both legs (cm)	1.11		

Author	N	General outcome	Outcome measure (unit of measure)	Effect sizes	Effect sizes	Effect sizes
		balance	Balance test (scores)	0.57		
		functional	Gait speed (m/s)	1.18		
		functional	Step frequency (steps/min)	1.61		
		functional	Stride length (cm)	0.64		
		functional	Stair climbing (sec)	-2.08[b]		
		functional	TUGT (sec)	1.51		
		functional	Chair rise (sec)	1.20		
		ADL	ADL (scores)	-0.11[b]		
		ADL	IADL(scores)	0.16		
		functional	Physical activity (scores)	2.48		
Hiroyuki et al., 2003[24-]	34			Balance exercise		Gait exercise
		balance	One-leg stand (sec)	0.49		-0.32[b]
		balance	Functional reach (cm)	0.66		0.20
		balance	Manual perturbation test (scores)	-0.40		0.73
		functional	TUGT (sec)	0.13		0.18
		balance	Functional balance test (scores)	0.34		0.24
		functional	Stair climbing (sec)	0.05		0.03
		functional	Stair descending (sec)	0.05		0.22
		balance	POMA (scores)	-0.10[b]		0.33
Hruda et al., 2003[22-]	25	strength	Eccentric peak torque	0.89		
		strength	Eccentric average power	0.70		
		strength	Concentric peak torque	0.71		
		strength	Concentric average power	0.80		
		functional	8 ft. Up and Go (sec)	0.54		
		functional	30 sec. Chair stand (scores)	1.13		
		endurance	6-meter walk (sec)	0.85		

Author	N	General outcome	Outcome measure (unit of measure)	Effect sizes	Effect sizes	Effect sizes
Lazowski et al., 1999[28-c]	68	functional	Mobility (TUGT)	0.61		
		balance	Balance (BBS)	0.37		
		functional	Sit and reach (cm)	0.49		
		flexibility	Shoulder flexibility (cm)	0.42		
		functional	Gait (normal)	0.00		
		functional	Gait (fast)	0.00		
		functional	Stair climbing	0.06		
		ADL	Functional capacity (FIM scores)	0.42		
		strength	Hand grip strength (kPa)	0.06		
		strength	Elbow flexion (kg)	0.28		
		strength	Shoulder abduction (kg)	0.15		
		strength	Upper extremity total (kg)	0.19		
		strength	Knee extension (kg)	1.00		
		strength	Hip flexion (kg)	0.64		
		strength	Hip extension (kg)	0.58		
		strength	Hip abduction (kg)	0.53		
		strength	Hip adduction(kg)	1.52		
		strength	Total hip (kg)	0.88		
		strength	Lower extremity total (kg)	2.55		
		strength	Quads 1 repetition maximum	1.33		
Lord et al., 2003[26-]	551	functional	Stepping reaction time (m/s)	0.20		
		endurance	6-min walk distance (m)	0.15		
		strength	Knee-extension strength (kg)	0.06		
		functional	Simple reaction time (m/s)	0.20		
		balance	Sway, eyes open, floor (mm)	0.21		
		balance	Sway, eyes closed, floor (mm)	-0.19[b]		
		balance	Sway, eyes open, foam (mm)	0.27		
		balance	Sway, eyes closed, foam (mm)	0.07		
		balance	Maximum balance range (cm)	0.05		
		coordination	Coordination stability (errors)	-0.20[b]		

Author	N	General outcome	Outcome measure (unit of measure)	Effect sizes	Effect sizes	Effect sizes
Mulrow et al., 1994[36]	65	ADL	PDI (cm; sec)	0.12		
		flexibility	Range of motion(cm)	0.24		
		strength	Strength(N)	0.19		
		balance	Balance	0.17		
		functional	Mobility	0.32		
Rosendahl et al., 2006[38-c]	191	balance	BBS (scores)	0.24		
		functional	Gait speed (m/s)	0.36		
		functional	Gait speed, max. (m/s)	0.17		
		strength	1 repetition maximum in lower-limb strength (kg)	0.23		
Schoenfelder et al., 2004[40-]	81	balance	Parallel stand (sec)	0.12		
		balance	Semi-tandem stand (sec)	0.08		
		balance	Tandem stand (sec)	0.15		
		strength	Ankle strength (N)	0.33		
		functional	Walking speed (m/s)	0.05		
		Quality of Life	Psychosocial (scores)	0.09		
		Depression	GDS	0.08		
Seynnes et al., 2004[31-c]	22			High Intensity training		Low Intensity training
		strength	Muscle strength (kg)	2.02		1.46
		strength	Muscle endurance (Number of repetitions with 90% workload)	5.00		2.64
		functional	Chair-rising time (sec)	0.69		0.61
		functional	Stair-climbing power (W)	0.74		0.59
		endurance	6 min. walk distance (m)	1.73		0.38
		ADL	Disability (scores)	0.68		0.78

[a]For cut-off score effect sizes, please see Table 3
[b]Adverse outcome: control group performed better than the exercise group.
TUGT, Timed Up and Go Test; PPT, Physical Performance Test; BBS, Berg Balance Scale; POMA, Performance Oriented Mobility Assessment; ADL, Activity of Daily Living test; IADL, Instrumental Activity of Daily Living test; FIM, Functional Independence Measure; PPS, Physical Performance Scale; GARS, Groningen Activiteiten Restrictie Schaal.
[c] Studies that performed an Intention to Treat analysis

TABLE 3 Cut-off score effect sizes for data shown in Table 2

External criterion	Corresponding Effect Size	Score
No change	0- 0.20	Limited
A little better	0.20- 0.50	Moderate
Moderate better	0.50-0.80	Strong
A great deal better	0.80- maximum	Very strong

Strength

Nine studies reported strength as an outcome measure. We found that for four studies the interventions employed had either very strong or strong effects on strength [22-,28-,31-,41-]. One study was of high methodological quality [41-]. The other three were of moderate methodological quality [22-,28-,31-]. Five studies showed moderate or limited effects on strength [13-,26-,36-,38-,40-].

Flexibility

Two studies showed a moderate effect with regard to flexibility. One study was classified as high methodological quality,[36-] and the other as moderate methodological quality[28-].

Endurance

Three studies showed effects on endurance. In two studies the effects were classified as very strong or strong. These studies were classified as moderate methodological quality[22-,31-]. The third study, which showed limited effects, was also classified as moderate methodological quality[26-].

Balance

Ten studies reported balance as an outcome measure. One study showed strong and very strong effects on outcome measures related to balance. This study was of high methodological quality,[41-] In 9 studies, moderate or limited effects were shown. Of these studies, 5 were classified as high methodological quality[13-,32-,36-,38-,40-] and 4 were classified as moderate methodological quality.[24-,26-,28-,29-] .

Functional Performance

Four studies showed very strong or strong effects with regard to functional performance. Two of them were of high methodological quality,[32-,41-] and two were of moderate methodological quality.[22-,31-] Eight studies showed moderate or limited effects. Of these studies, 4 were classified as high methodological quality[13-,36-,38-,40-], Four studies were classified as moderate methodological quality[24-,26-,28-,29-].

Coordination

One study classified as moderate methodological quality showed contradictory effects on coordination, because the experimental group performed worse than the control group[26-].

ADL Performance

Seven studies used ADL as an outcome measure of a physical intervention. In this review, we made an effort to distinguish BADL from IADL. Although all studies assessed BADL, 2 studies did not distinguish between BADL and IADL[13-,29-] . Five studies assessed BADL separately[28-,31-,32-,36-,41-]. Hauer et al assessed IADL also.[41-] .One of the 7 studies classified as moderate methodological quality showed very strong or strong effects.[31-] Five studies showed moderate or limited effects[28-,29-,32-,36-,41-]. Three studies were classified as high methodological quality[32-,36-,41-] Two studies were of moderate quality[28-,29-]. One study of high methodological quality showed an adverse effect, because the control group performed better than the experimental group. [13-]

Quality of Life, Operationalized As Depression, Vitality, and Perceived Health

Two studies classified as high methodological quality showed effect sizes on depression and general well-being. One of the studies assessed psychosocial function,[12-] whereas the other study assessed perceived health[40-]. The effects on depression were limited. The effects on perceived health and psychosocial function varied from limited to strong, depending on the type of intervention[12-,40-].

Adjustment for Intention-To-Treat Analysis

It is of utmost importance to consider whether a study performed an intention-to-treat analysis to interpret the relevance of the effect sizes to the outcome measures. For strength, three studies with very strong and strong effects performed an intention-to-treat analysis[28-,31-,41-]. For balance, one study performed an intention-to-treat analysis[41-] For functional performance, two studies performed an intention-to-treat analysis[38-,41-]. The outcome measures flexibility, endurance, coordination, and ADL performance showed no strong effects or studies failed to perform an intention-to-treat analysis on these measures. Studies that performed an intention-to-treat analysis are marked as indicated in Table 2.

Evidence-Based Exercise Recommendations

On the basis of our review results, the following exercise recommendations are made (type, intensity and/ or volume, frequency, duration per session, and total duration) for frail elderly people. Only interventions with strong or very strong effect sizes were chosen to form the basis of the exercise recommendations. The outcome measures are summarized below. An overview is shown in Table 4.

Strength

For strength, 4 studies meet these criteria. All used progressive resistance training. Hauer *et al* [41] recommend high intensity training, 3 times a week, 60 minutes for at least 3 month. Hruda *et al* [22-] recommend lower body resistance training, 1 set of 4-8 repetitions, 3 times a week, 60 minutes for at least 10 weeks. Seynnes *et al* [31-] recommend high intensity training of 80 % 1 Repetition Maximum (RM), or low intensity training of 40 % 1 RM, 3 sets of 8 repetitions, 3 times a week for at least 10 weeks. Lazowski *et al* [28-] recommend moderate intensity training, from 1 set of 5 repetitions to 2 sets of 10 repetitions, 3 times a week, 45 minutes per session for at least 4 months.

Endurance

For endurance, two studies meet the criteria. Hruda *et al* [22-] recommends lower body resistance training, 1 set of 4-8 repetitions, 3 times a week, 60 minutes for at least 10 weeks. Seynnes *et al* [31-] recommends high intensity resistance training of 80 % 1 Repetition Maximum (RM), 3 sets of 8 repetitions, 3 times a week for at least 10 weeks.

Balance

For balance, the study of Hauer *et al* [41-] recommend high intensity progressive balance training, adjusted at individual needs and possibilities , for 3 times a week, 60 minutes for at least 3 month.

Functional performance

For functional performance, 4 studies meet the criteria. Hauer *et al* [41-] recommend high intensity functional training, adjusted at individual needs and possibilities, for 3 times a week, 60 minutes for at least 3 month. Hruda *et al* [22-] recommend lower body resistance training, 1 set of 4-8 repetitions, 3 times a week, 60 minutes for at least 10 weeks. Seynnes *et al* [31-] recommend high intensity resistance training of 80 % 1 Repetition Maximum (RM), or low intensity resistance training of 40 % 1 RM, 3 sets of 8 repetitions, 3 times a week for at least 10 weeks. Baum *et al* [32-] recommend moderate intensity resistance training, from 1 set of 5 repetitions to 2 sets of 10 repetitions , 3 times a week, 60 minutes for at least 12 month.

ADL performance

For ADL performance, the study of Seynnes *et al* [31-] recommend low intensity resistance training of 40 % of 1 Repetition Maximum (RM) or high intensity training of 80 % 1 RM, 3 sets of 8 repetitions, 3 times a week for at least 10 weeks.

Quality of Life

For quality of life, the study of Chin A Paw *et al* [12-] shows a strong effect of combined resistance and functional training. Resistance training consisted of 2 sets of 8 to 12 repetitions with a frequency of one time a week, and a duration per session of 60 minutes. Functional training consisted of 60 minutes of game- like activities, one time a week. Resistance training and functional training were combined to a two- times a week program, with a total duration of 6 months. Positive results were reported for depression, vitality and perceived health.

Flexibility and Coordination

With respect to flexibility, and coordination, we did not detect strong effects in the reviewed studies, so we cannot recommend specific training that would improve these three outcome measures.

TABLE 4 Type, intensity and volume, frequency, and duration of physical interventions with strong or very strong effect sizes

Author	N	Type	Intensity, volume	Frequency (per week)	Duration	Total duration
Baum et al., 2003 [32-]	20	Strength	Moderate 1 set, 5 repetitions to 2 sets, 10 repetitions	3x	60 min.	12 months
Chin A Paw et al., 2004[12]	173	Strength	Moderate 2 sets, 8-10 repetitions	2x	45-60 min.	6 months
		Functional	Moderate walking, ADL, games, standing	2x	45-60 min.	6 months
		Combination	Moderate	2x	45-60 min.	6 months
Chin A Paw et al., 2006[13-]	224	Strength	Moderate 2 sets, 8-10 repetitions	2x	45-60 min.	6 months
		Functional	Moderate walking, ADL, games, standing	2x	45-60 min.	6 months
		Combination	Moderate	2x	45-60 min.	6 months
Hauer et al., 2003[41-]	57	Balance	High intensity Progressive	3x	60 min.	3 months
		Strength	High intensity 70-90% workload Progressive	3x	60 min.	
		Functional	High intensity Progressive	3x	60 min.	
Hruda et al., 2003[22-]	25	Strength	1 set, 4-8 repetitions	2-3x	60 min.	10 weeks
Lazowski et al., 1999[28]	68	Strength	Moderate 1 set 5 repetitions to 2 sets 10 repetitions, increase in weight	3x	45 min.	4 months
		Balance	Increase individually	3x	45 min.	
		Functional	-	3x	45 min.	
		Flexibility	-	3x	45 min.	
Seynnes et al., 2004[31-.]	22	Strength	High intensity 80% range of motion 3 sets, 8 repetitions Low intensity 40% range of motion 3 sets, 8 repetitions	3x	-	10 weeks

Discussion

The purpose of this study was to examine the effects of physical exercise on physical fitness, ADL performance, and quality of life in frail institutionalized older persons. Our ultimate goal was to propose criteria for an exercise protocol, based on evidence from the reviewed studies. Only studies that provided strong or very strong effects, calculated with effect sizes, were included in the criteria for an exercise proposal. From the 27 reviewed studies, based on randomized controlled trials, 12 studies showed effect sizes or data on which effect sizes could be calculated. The proposed criteria for exercise include types of intervention, outcome measures, training intensity and/ or volume, frequency of training sessions, duration of a session, and total duration of the intervention.

With regard to training principles, a few remarks should be made. In the first place, most authors are not very specific in their training description. "Strength training" or "Progressive resistance training" is not further specified. In general, progressive resistance training is defined as a strength training method in which the overload is constantly increased to facilitate adaptation. Several authors describe the increase of loads in terms of increase in repetition numbers and sets of repetitions[12-],[13-],[22-],[26-],[28-],[32-],[36-],[38-],[40-]. [-].Some mention a percentage of 1 RM. [31-],[41-]. One other author refers to the intensity of the training as moderate or high without providing a definition[30-]. According to the American College of Sports Medicine (ACSM) / American Heart Association (AHA) guidelines, the level of intensity should be specified as follows: on a 10- point scale, where no movement is 0 and maximal effort of a muscle group is 10, moderate-intensity effort is a 5 or 6, and high- intensity effort is a 7 or 8[43-]. In the guideline, low-intensity effort is not specified [43-]. Frequency is mentioned by all, duration of a session by all except for one author [31-], and total duration by all except for one author[41-]. Balance training and functional training are referred to as high intensive, progressive, without further explanation.[41-]. Functional training is a classification of exercise which involves training the body for the activities in daily living.

The proposed criteria for exercise are based on study outcomes and effect sizes.
The criteria can be used to build a valid and feasible training program. We summarized the recommendations from the studies into one uniform proposal. It is important to note that we aim at a training program that is effective for all outcome measures at the same time. Recommendations for exercise programs with a focus on separate outcome measures lie beyond the scope of this review.

- Strength: Type: progressive resistance training; intensity: 40% to 80% of 1 RM; volume: increasing from 1 set of 8 repetitions to 3 sets of 8 repetitions; frequency: 3 times a week; duration per session: 60 minutes; total duration: at least 10 weeks.
- Balance: Type: adjusted at individual needs and possibilities balance exercises, progressively challenging; Balance exercises refer to exercises that challenge one's

balance, like standing with feet together without assistance of hands, walking on a parcour with obstacles etc.; frequency: 3 times a week; duration per session: 60 minutes; total duration: 3 month.

- Endurance: Type: progressive resistance training; intensity: 80% of 1 RM; volume: increasing from 1 set of 8 repetitions to 3 sets of 8 repetitions; frequency: 3 times a week; duration per session: 60 minutes; total duration: 10 weeks.
- Functional performance: Type: progressive resistance training or progressive functional training (i.e. walking, stepping, game-like exercises, and sport-like exercises) Intensity for progressive resistance training: 40% to 80% of 1 RM; volume for progressive resistance training: increasing from 1 set of 8 repetitions to 3 sets of 8 repetitions; intensity for progressive functional training should be increased over time based on individual needs and abilities.
- ADL performance: Type: progressive resistance training; intensity: 40 % to 80 % of 1 RM; volume: increasing from 1 set of 8 repetitions to 3 sets of 8 repetitions; frequency; 3 times a week; duration per session: 60 minutes; total duration: 10 weeks.
- Quality of Life: Type: combination of progressive resistance training and progressive functional training; intensity: 40 % to 80 % of 1 RM; volume: increasing from 1 set of 8 repetitions to 3 sets of 8 repetitions; frequency; 3 times a week; duration per session: 60 minutes; total duration: 6 month.

With regard to this exercise proposal a number of remarks can be made: First, looking at the results, the intervention described by Seynnes et al[31-] prioritized, because it was effective for the outcomes strength, endurance, functional performance, and ADL performance. The intervention was also clearly described, which is helpful for clinicians.

Second, the proposed intensity for progressive resistance training is 40 % to 80 % of 1 RM because evidence demonstrates that is effective for the outcome measures strength, functional performance, and ADL performance.

For endurance, the effect of a progressive resistance training intensity of 40% 1 RM is only moderate.[31-] Because the ACSM and AHA guidelines [43-] pose that endurance is important for frail elderly people, we recommend a progressive resistance training with a more effective intensity of 80 % of 1 RM. In doing so, we should make the following restrictions: Because of the heterogeneity of the frail population, an intensity of 80 % of 1 RM is not applicable for every frail older individual. Clinicians who are specialists in frailty in older adults should assess the exercise tolerance of participants in exercise programs.

Third, according to the ACSM and AHA guidelines, endurance training should also be included in exercise programs. Based on our findings, this recommendation cannot be supported with evidence from randomized controlled trials. Endurance training alone showed only limited effects [26-] . Endurance was increased though by addition of progressive resistance training. [22-],[31-] Fourth, the ACSM and AHA guidelines prescribe training to increase flexibility. We found no evidence to support an exercise program that increases flexibility effectively. Finally, for quality of life, our results show that only the recommendations of Chin A Paw can be used for an effective exercise program[13-]. For consistency, we adjusted the author's proposal into a progressive resistance program with the same intensity, volume, and frequency prescribed for improvements in strength, endurance, functional performance, and ADL performance. In addition, a progressive functional training program, including walking, stepping, game-like exercises, and sport-like exercises was recommended. However, to improve quality of life, the total duration of the training should be extended to 6 months.

There are some methodological issues relating to our review that need to be addressed. We explored multiple outcomes, which can lead to false positive findings occurring by chance. It was difficult to compare the outcomes of the selected studies because the assessment of the outcomes varied among the studies. For example, muscle strength was measured through various ways: leg press equipment[13-],[39-]dynamometer[21-],[26-],[27-],[28-],[35-],[36-]; functional performance tests[21-],[22-],[29-],[30-],[31-],[35]; and a variety of walking-related tests, such as the chair stand test[27-]. Less diversity in assessment tools should lead to a better comparison of effects of interventions. This is also stated in a systematic review by Freedman et al. [44-]

Another methodological issue is the diversity in numbers of subjects, type of interventions, outcome measures, and training protocols among the studies we reviewed. For this reason, performing a meta-analysis was not possible. Therefore, to compute outcomes we calculated the effect sizes of the interventions. Effect size calculations were based on 12 of 27 studies of high or moderate methodological quality. Despite the aforementioned problems, our conclusions were based on studies that had sufficient methodological quality to provide evidence of the effects of physical interventions on physical fitness in frail institutionalized older persons.

A third methodological issue concerns the characteristics of exercise training in the reviewed studies. Most studies combined strength training with balance, flexibility, and functional training. However, the frequency, intensity, and total duration of training interventions differed in the studies. One author specifies muscle strength training as progressive resistance training,[41-] whereas the others refer to strength or resistance training without mentioning progression in the training protocol[21-],[31-],[32-],[33-]. For this reason, we used the term resistance training in this review. Another complication of combined intervention studies is that positive results cannot be derived from single fitness- component training, which focuses on only one component, such as strength training or flexibility training. Future research should focus on single- component- trainings interventions in elderly people.

We should acknowledge another limitation of our review. We only focused on physical exercise and not on physical activity in general. An increase of endurance by increasing physical activity therefore lies beyond the scope of the underlying study.

In conclusion, this review provides promising insight into the possibilities to compose an effective training program to increase physical fitness, ADL performance, functional performance, and quality of life in institutionalized frail older adults. With regard to physical fitness, this systematic review shows that physical training including progressive resistance training, balance training, and functional training, has significant positive effects on physical fitness outcomes in frail elderly people in long-term care institutions. The results of this review therefore provide the basis for an effective physical exercise program that specifically focuses on frail elderly.

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Chapter 4

Group exercise has little effect on ADL, physical fitness, and care dependency in frail institutionalized elderly people: a randomized controlled trial

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Abstract

Questions: Does an evidence-based exercise program increase activities of daily living (ADL) scores and physical fitness in institutionalized older adults? Does this program decrease the care dependency of institutionalized older adults?

Design: A randomized control trial using group-based exercise was performed in 14 assisted-living facilities for the elderly (>70 years old).

Outcome measures: Outcome measures were performance on ADL, physical fitness, and care dependency measures. The exercise program comprised group-based progressive resistance training, balance training, and functional training. The control intervention comprised social group meetings.

Results: A total of 164 individuals took part in the study (mean age: 84 years). There were no significant differences between the experimental and control groups over a 16-week period, although >50% of the subjects in the experimental group improved in muscle strength and performance-based ADL.

Conclusion: A group-based exercise program is ineffective in reducing disability and care dependency in frail institutionalized older adults. However, individual participants may benefit from the exercise program.

Introduction

In western countries the number of very old individuals continues to increase dramatically, as does age-associated health problems. In the Netherlands, for example, in 2007, 24% of independent-living older persons had health or disability problems, and 80% of older persons living in institutions had disability problems. This obviously poses a major social issue that is only becoming more into focus. In the US the trend is similar: In 2007, 36.6% of people 65 years and older reported disabilities (Centers for Disease Control and Prevention and the Merck Company Foundation 2007).

Disability is the main factor for institutionalization in older adults (De Klerk 2005). Disability together with comorbidity and frailty are used in geriatric medicine to identify vulnerability in older persons (Topinkova 2008). Although geriatricians sometimes view these three concepts of vulnerability as overlapping, disability, comorbidity, and frailty are different entities that interact with each other (Fried et al 2004). This relationship, however, cannot be clearly represented by a single model (Fried et al 2004). Frailty can be defined as an accumulation of deficits related to old age (Rockwood et al 2007). Given the heightened awareness that disability, comorbidity, and frailty disproportionately affect older people, much research has been done on interventions that aim to delay or reverse the consequences of this “unsuccessful” ageing.

Vulnerable older persons who experience disability need care. Fifty percent of this population use regular care facilities such as home care (The Netherlands Institute for Social Research, 2011). All institutionalized older persons are to some extent care dependent. Disability in older persons can be operationalized and quantified in their scores on activities of daily living (ADL) (Van Heuvelen et al 2000). An important risk factor that contributes to decreased ADL performance is a low level of physical activity (Van Heuvelen et al 1997). On the other hand, increased physical activity is positively related to physical fitness (Keyssor et al 2001), which is defined as the capacity to perform daily tasks. For institutionalized older persons, the ability to perform daily tasks is often their sole physical activity, because physical and psychological conditions limit their performance of physical activities beyond these tasks.

The concept of physical fitness includes physical characteristics such as muscle strength, flexibility, coordination, balance, and aerobic endurance (Van Heuvelen et al 1997). These characteristics can be improved by physical exercises that aim to improve ADL scores (Chin A Paw et al 2008). Although much is known about the theoretical relationship between exercise and ADL performance of frail older persons, little is known about the effects of exercise on ADL performance in institutionalized older persons. The literature reveals that exercise is beneficial for older persons, even for the most severely frail (Weening et al 2011).

In order to improve physical fitness, a combined exercise program that includes progressive resistance training, balance training, and functional training should be offered

to institutionalized elderly people (Weening et al 2011). This exercise program is performed twice a week for a total of 16 weeks. It is moderate in intensity, as measured on a scale of perceived exertion, on 12-14 point level (Borg et al 1998). There is currently insufficient evidence to indicate that a combined exercise program developed to improve physical fitness can improve ADL scores and reduce care dependency.
We posed the following research questions in this study:

1. Will a program devised according to the above-described exercise program increase ADL scores and physical fitness of institutionalized older adults?
2. Will this program decrease care dependency in institutionalized older adults?

We also examined the characteristics of participants who benefit from the exercise program.

Method

Setting

The study was performed in 14 assisted-living facilities for the elderly in the northern part of the Netherlands. The homes for the elderly were either private apartments with access to the care facilities or in-home apartments with full-time nursing and care. All of the institutions gave consent, the board of directors as well as the client counsels.

Participants

Inclusion criteria were as follows: older persons who were aged 70 years or over and receiving personal care; who were able to walk at least 10 metres with or without walking aids; who were able to understand Dutch-spoken instructions; and who had no severe cognitive impairment or dementia, defined as scoring 21 points or greater on the Mini Mental State Examination (MMSE) (Folstein et al 1975). All residents meeting these inclusion criteria were invited to participate in the trial. Residents who agreed to participate signed an informed consent form. The Ethics Committee of the Medical Faculty of the University of Groningen approved this study.

Study design

A single-blinded, non-stratified randomized controlled trial was used. Each residential home had an experimental group and a control group. Assessors were blinded to group allocation. Trainers for both experimental and control groups were also not aware of the test results.

Randomization

Randomization was performed by randomly allocating participants by drawing lots in sealed non-transparent envelopes. The lots were drawn by persons who did not take part in the research. Randomization took place after baseline assessments.

Exercise intervention

Training occurred in groups and comprised a combination of progressive resistance training of the upper extremities, lower extremities, and trunk; static and dynamic balance training; and functional training. Training intensity was moderate, according to exercise recommendations for frail older adults (Weening et al 2011). For the progressive resistance training Thera-bands® were used. The following muscle groups were trained: arm and shoulder muscles, back and abdominal muscles, hip muscles, knee, and foot muscles. The volume of the resistance training was increased progressively from 1 set of 8 repetitions for weeks 1 to 5, 2 sets of 8 repetitions for weeks 6 to 10, and 3 sets of 8 repetitions for weeks 11 to 16. Balance training was individually adjusted. Level of difficulty was established by observing the participants performing a balance task, e.g., walking on a fitness mat. Every 2 weeks we challenged the participants' balance progressively by increasing the level of difficulty based on the same observations. Functional training was composed of exercises related to daily activities, like chair stands, walking, turning, and walking on a course with obstacles.

Training frequency was two times a week for a duration of 16 weeks. Each training session lasted one hour. The training started with a warm-up and ended with a cool-down. Exertion was assessed with the Rating of Perceived Exertion Scale (Borg et al 1998). The assessment of perceived exertion took place after the chair stand exercise, which was the most tiring exercise. Participants received instructions during the first training session. The instructions included the following: "Please choose the drawing that reflects the level of exertion you are experiencing. Drawing no. 6 indicates no exertion at all; drawing no. 20 indicates maximum exertion. Which drawing reflects most accurately your level of exertion?" Participants were challenged to perform the exercises on a 12-14-point level, reflecting moderate-intensity training. The number of repetitions was individually increased or decreased in order to meet these requirements.

Control group program

Students from Hanze University Groningen conducted the control group sessions. The program had leisure time activities, like conversation, playing board games, watching videos, etc. No physical activity was involved. The program lasted 16 weeks, with a frequency of two times a week, with each session lasting one hour.

Procedure

The training was performed in the homes of the elderly. Five to eight persons were included in one group. Participants did not have to leave the facility. The training of both experimental and control groups was performed by trained students and supervised by the primary researcher, who is a geriatric physiotherapist. The exercises for the experimental group were performed according to a strict protocol. For both experimental and control groups, absence of participants was noted. Before admission to the experimental or the control group, a baseline assessment took place. Baseline assessment included the MMSE; the Groningen Frailty Indicator (GFI); demographic characteristics such as gender, age, marital status, level of education; and medical and psychosocial characteristics such as body mass index (BMI); motivation, which was measured with the Self-Regulation Questionnaire for Exercise (SRQ-E); health problems, which was measured with the Health Assessment Questionnaire (HAQ); and anxiety and depression, which was measured with the Geriatric Depression Scale (GDS). In addition, the participants had to complete several other questionnaires and scales: the Groningen Activity and Restriction Scale (GARS), the Self-Assessment of Physical Fitness (SAPF) scale, and the Care Dependency Scale (CDS). Participants also had to perform a test for ADL performance: the Performance ADL Test (PAT) and some physical fitness test items. These latter items were the Arm Curl Test (ACT), the Chair Stand Test (CST), the Functional Reach Test (FRT), the Frailty and Injuries: Cooperative Studies of Intervention Techniques 4-item test (FICSIT-4) balance test, the Timed Up & Go (TUG) test, and the adjusted Six-Minute Walk Test (6MWT). The assessment battery was repeated one week after completing the training period.

Outcome measures

Baseline descriptive assessment

Baseline descriptive assessment included age, gender, marital status, educational attainment, BMI, cognitive status (measured with the MMSE), and frailty (measured with the GFI) (Steverink et al 2001). The GFI is a 15-item questionnaire that assesses different aspects of frailty. General health was assessed with the HAQ (Fries et al 1982). This 11-item questionnaire assesses general health symptoms, recent hospital admittances, polyclinic visits, and emergency room visits. Participants' motivation to exercise was measured with the SRQ-E (Ryan and Connell 1989). This questionnaire includes 16 items and is scored on a 1-7–point Likert scale. The summary score for the SRQ-E is the Relative Autonomy Index (RAI) score, which is calculated as follows: 2 x [sum of the Intrinsic Motivation subscale (items 3,8,10, and 15)] + [sum of the Identified Regulation subscale (items 5, 9, 12, and 16)] + [sum of the Introjected Regulation subscale (items 1, 4, 6, and 13)] + 2 x [sum of the External Regulation subscale (items 2, 7, 11, and 14)]. Depression was assessed by the GDS (Yesavage et al 1982), a 30-item questionnaire that assesses depression in older people.

Physical fitness

Objective physical fitness comprised the following fitness components: muscle strength, balance, agility, coordination, and aerobic endurance. Upper extremity muscle strength was measured with the ACT (Rikli and Jones 1991), in which seated participants had to perform as many biceps curls as possible within 30 seconds with a one-kilogram hand weight. Lower extremity muscle strength was measured with the CST (Rikli and Jones 1991), in which participants had to stand up from a chair and sit down as often as possible within 30 seconds. Balance was measured with the Functional Reach Test for static balance (Duncan et al 1992). In this test, participants had to stand in an upright position alongside a wall with one arm stretched forward. They were then instructed to reach as far forward as possible and the distance of their reach in centimetres was measured (i.e., the distance between the upright position and the position in which the person had reached forward). Static balance was also measured with the FICSIT-4 (Rossiter-Fornoff et al 1995). Participants had to maintain their balance in four positions: standing with feet together, standing in a semi-tandem position, standing in a tandem position, and standing on one leg. Participants were given a positive item score if they were able to maintain their position for 10 seconds. Balance, agility, and coordination were measured with the TUG test (Podsiadlo and Richardson 1991). Participants were asked to rise from a chair, walk a distance of 3 metres, turn around, walk back, and sit down on the chair again. The use of a walking aid was permitted. Aerobic endurance was measured with the adjusted 6MWT (Rikli and Jones 1991). For this test, we adjusted the protocol to the participants' housing circumstances by using a 50 meter-long parcourse instead of the standard four-sided parcourse. Subjects had to walk this distance, turn around, walk back, and repeat the walk for six minutes. Perceived fitness was measured with the Self-Assessment of Physical Fitness (SAPF) scale. Finally, the participants had to rate their physical fitness on a 0-10 scale (Weening et al, accepted for publication 2011).

ADL performance

ADL performance was measured with the Groningen Activity Restriction Scale (GARS) (Kempen et al 1996), which includes 18 questions and scores on a 4-point Likert scale. We also used a performance-based assessment tool for ADL performance: the PAT (Weening et al 2011). This 16-item test measures ADL tasks within the participants' homes. PAT items were scored in two different ways. First, the time necessary to perform a test item was recorded in seconds. Second, the quality of the performance was scored by assigning each participant a quality score, which encompassed the degree of difficulty a participant experienced while performing a task or the number of mistakes made while performing the task. Scores range from 1 to 5.

Care dependency

Care dependency was assessed with the CDS (Dijkstra et al 2000). This 16-item questionnaire is scored on a 5-point Likert scale; it assesses the level of care dependence of institutionalized older people. A high score reflects a high level of care dependency.

Statistics
Data were analyzed using SPSS for Windows, version 17.0. Descriptive data were reported for the following baseline characteristics: age, gender, marital status, level of education, height, weight, HAQ (number of symptoms), SRQ-E (RAI score), BMI, MMSE, and GFI. The effects of the experimental intervention were determined using random effect models (Pinheiro and Bates 2000). Number of participants, means, and standard deviations were presented from the original data file. The significance of random effects was estimated by pooling (Rubin 1987) over the results obtained from repeating data imputation five times (Van Buuren and Groothuis-Oudshoorn 2011). We performed data imputation due to the large number of missing values. Analyses were conducted by using intention-to-treat, with participants analyzed according to the initial randomized assignment. Subgroup analysis was performed to establish the characteristics of participants in the experimental group who benefited from the training. Individual effect sizes (Cohen's d) were calculated for the F tests of outcome measures, e.g., physical fitness (ACT, CST, FICSIT-4, FRT, TUG, 6MWT, and SAPF); ADL performance measures (PAT time, PAT quality, GARS); and care dependency (CDS) (Cohen 1992, Rosnow and Rosenthal 1996) in the experimental group. A cut-off value of $d > .20$ indicated that the given outcome measures had a small positive effect (Cohen 1992). The outcome measures were recoded as two categories: effect ($d > .20$) and no effect ($d \leq .20$). In addition, we performed Chi-square analysis, with age, gender, frailty (GFI), anxiety and depression (GDS), number of symptoms (HAQ), cognition (MMSE), motivation (SRQ-E), and BMI as independent variables, and the outcome variables as dependent variables.

Results

Participants
Of the 1061 eligible residents, 164 participants were included from the 14 homes for the elderly. The mean (SD) age of the participants was 84 (6) years; 69% were women. Table 1 shows the baseline characteristics of all participants, together with the baseline characteristics of the participants in the experimental and control groups that completed the trial. At baseline, the marital status of the experimental and control groups differed significantly. Twenty-six percent of participants in the experimental group were married versus 9% of participants in the control group (Chi-square = 7.8; [df =1]; $p<0.005$).

TABLE 1. Baseline characteristics of the entire study population and of experimental and control group participants that finished the trial

		Residents willing to participate			Experimental group			Control group		
		Mean (SD)	N	percentage	$Mean_{exp}$ (SD)	N_{exp}	percentage	$Mean_{contr}$ (SD)	N_{contr}	percentage
Age in years		84.2 (6.3)	164		83.7 (5.7)	53		84.6 (5.7)	31	
Gender	male		47	29 %		15	28%		11	36%
	female		117	71 %		38	72%		20	64%
Marital status	married, living together		29	18%		10	18%		4	14%
	married, living apart		18	11%		8	16%		7	25%
	widowed		97	59%		28	53%		12	39%
	divorced		6	3%		2	4%		2	7%
	single		14	9%		5	9%		4	14%
Level of education	primary school		84	54%		26	49%		14	46%
	secondary school		70	44%		27	51%		17	54%
	university		3	2%		0	0%		0	0%
Body mass index		27.3 (6.0)			27.4 (5.3)			26.5 (7.9)		
MMSE		24.9 (3.9)			25.5 (3.4)			25.6 (3.3)		
GFI		5.0 (2.6)			4.6 (2.6)			4.4 (2.3)		
SRQ-E (RAI-score)		29.8 (20.7)			32.9 (18.6)			27.8 (26.9)		
HAQ (symptoms)		8 (5)			8 (4)			8 (5)		
GDS		7 (5)			8 (5)			7 (4)		

MMSE = Mini Mental State Examination, GFI = Groningen Frailty Indicator, SRQ-E (RAI score) = calculated score of the Self-Regulation of Exercise scale, HAQ = Health Assessment Questionnaire, GDS = Geriatric Depression Scale

Compliance

Fig. 1 shows a flow chart detailing the inclusion and dropout of participants; compliance to experimental and control group sessions is expressed as absence (temporary) or dropout (final). Reasons for absence from the group sessions were illness, lack of motivation, other appointments, and other pursuits. Reasons for dropout from the group sessions were illness, death, nursing home admission, lack of motivation, and lack of time. The main reason for absence from the experimental group sessions was illness (41%), followed by other pursuits (28%), other appointments (27%), and lack of motivation (4%). The main reason for absence from the control group sessions was illness (67%), followed by other appointments (22%) and other pursuits (11%). The main reason for dropout from the experimental group sessions was illness (76%), followed by nursing home admission (12 %), lack of motivation (6%), and lack of time (6%). The reason for dropout from the control group sessions was lack of motivation. Total dropout rate of the trial was 35% for the experimental group and 52% for the control group.

Effects of training

The results were based on a random effects test that compared the experimental group to the control group at posttest (T_2). The random effects test was calculated by repeating data imputation five times. Table 2 shows means and standard deviations of the original data and the p-values of the random effects test. All p-values were significantly greater than 0.05, indicating no significant differences between experimental and control groups on the 11 outcome variables. The 11 outcome measures were categorized into physical fitness measures (ACT, CST, FICSIT-4, FRT, TUG, 6MWT, and SAPF); ADL performance measures (PAT time, PAT quality, and GARS); and care dependency (CDS).

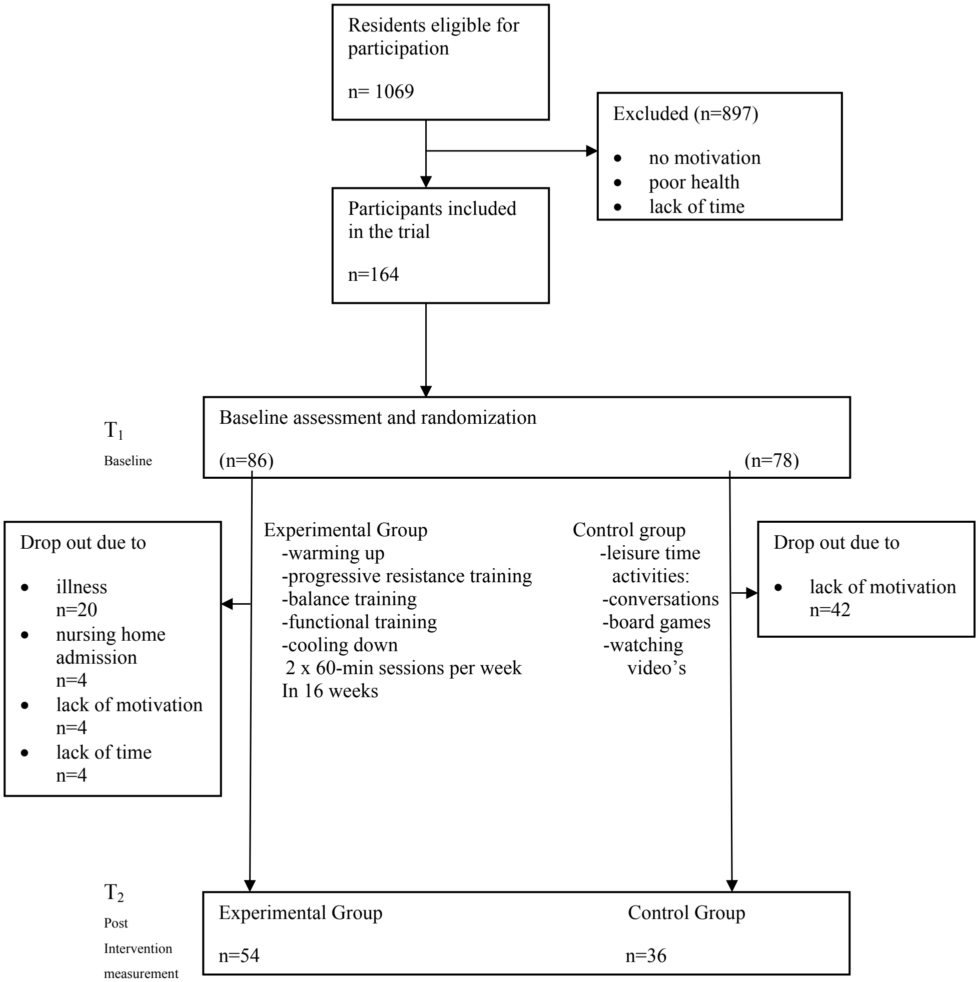

FIGURE 1. Flow of participants through the study

TABLE 2. Number of persons in the experimental and control groups, means and standard deviations, and p-values from random effects test on pooled groups

		Pretest				Posttest				
		Experimental		Control		Experimental		Control		
		N_{exp}	mean (sd)	N_{contr}	mean (sd)	N_{exp}	mean (sd)	N_{contr}	mean (sd)	p-values
Physical fitness	ACT	77	14 (7)	61	13 (6)	50	15 (6)	29	15 (8)	.76
	CST	75	7 (5)	62	7 (4)	49	7 (3)	27	8 (3)	.43
	FICSIT	77	34 (22)	63	37 (18)	50	37 (21)	29	33 (21)	.96
	FRT	72	24 (23)	58	20 (18)	46	20 (14)	28	17 (10)	.45
	TUG	73	27 (32)	61	25 (24)	48	22 (18)	26	20 (14)	.73
	6MWT	68	207 (121)	53	208 (114)	43	237 (112)	23	256 (98)	.94
	SAPF	72	7 (1)	61	6 (1)	53	6 (2)	31	7 (1)	.77
ADL performance	PAT quality	74	23 (10)	62	25 (10)	47	22 (9)	31	22 (10)	.70
	PAT time	74	430 (173)	62	468 (218)	47	337 (172)	31	334 (281)	.35
	GARS	74	38 (12)	57	37 (10)	49	37 (12)	29	39 (12)	.97
Care dependency	CDS	74	64 (14)	59	66 (12)	46	68 (8)	31	61 (16)	.57

ACT = Arm Curl Test (number of times/30 sec), CST = Chair Stand Test (number of times/ 30 sec), FICSIT-4 = Frailty and Injuries: Cooperative Studies of Intervention Techniques 4-item test (sec), FRT = Functional Reach Test (cm), TUG = Timed Up and Go test (sec), 6MWT = Six-Minute Walk Test (m), SAPF = Self-Assessment of Physical Fitness scale (scores), PAT quality = Performance ADL Test quality scores (scores), PAT time= Performance ADL Test time scores (sec), GARS = Groningen Activity and Restriction Scale (scores), CDS = Care Dependency Scale (scores)

Subgroup analysis

The effect sizes subgroup analysis for the experimental group revealed that a percentage of the participants actually benefited ($p<0.05$) from the training: 50% had a d ≥0.20 on the ACT, 54% on the CST, and 50% on the PAT time score. Subgroup analysis related to the baseline characteristics of participants who benefited from the training revealed no significant correlates, except for participants with MMSE scores (20 vs. 25 points) and for those living together with a partner. The former group scored significantly higher on the CDS, and the latter group scored significantly higher on the GARS.

Discussion

Our study indicates that physical training does not significantly affect ADL performance, physical fitness, and care dependency in old subjects. There are at least four possible explanations for the lack of beneficial effects of exercise training in older adults (Foster et al 2011). First, frailty may explain why frail older adults benefited little from a group-based exercise program. In our sample, the frailty status of the participants was high, as based on a mean (SD) GFO score of 5.0 (2.6) (Steverink et al 2001). Thus, the group-based nature of the exercise program may explain why the participants generally did not benefit from the program. An individual exercise program may therefore be more beneficial for frail older adults.

Second, our sample of frail older adults was heterogeneous in terms of their physical condition and mental status, factors that could have limited the beneficial effects of the program. Indeed, a single generic intervention may not be appropriate for all older participants (Foster et al 2011). Moreover, Chin A Paw and others (2006) suggested that a generic exercise program for frail older adults fails to address the multifactorial causes of disability. This notion is consistent with the findings of Seynnes and others (2004), who reported marginal effects of generic, high-intensity resistance training on disability, even though there are significant positive effects on muscle strength.

Third, dropout due to poor health and little intrinsic motivation may explain why we did not observe a beneficial effect in this study. Both of these factors are considered to be confounders in most trials examining frail older adults. The high dropout rate may be due to the fact that frail older people are highly vulnerable to illness. Dropout may have also been accentuated by the limited life expectancy of this population. Reluctance and apathy most likely contributed to the high dropout in our study. This is consistent with the results of a Cochrane study showing that reluctance and apathy may adversely affect trials (Foster et al 2011). In the study of Fielding et al (2011), 49 to 76% of frail older adult subjects participated in a moderate-intensity physical activity program, in which health issues were the core reason for dropout. In our study, attendance varied from 65% in the experimental group to 48% in the control group. The main reason for dropout was health problems in the experimental group and lack of motivation in the control group.

Fourth, the intensity level of our exercise program may be a reason why we did not observe a beneficial effect in this study. Indeed, available evidence indicates that only high-intensity exercise programs affect disability outcomes in moderately frail older persons (Daniels et al 2008). Thus, the fact that we employed a moderate-intensity exercise program may explain the lack of a measurable effect.

Methodological issues may also be responsible for the lack of an effect. First, the study was performed in 14 homes for the elderly. Multilevel analysis is appropriate for controlling differences between the homes. However, due to the limited number of participants, using multilevel analysis to control for heterogeneity within the sample was not possible. Second, it is possible that the measures used to establish ADL performance and physical fitness outcomes are not sensitive enough to identify significant changes after training, which is consistent with the conclusion of Peri and colleagues (Peri et al 2008). Third, the intention-to-treat principle, which includes a post-intervention measurement for all participants regardless of dropping out of the trial or not, was rarely applied. Only a limited number of older adults who were originally included in the trial were able and/or willing to take a post-intervention measurement. Control group participants especially refused to be tested. This was also found to be true in a previous study of older persons (Hughes et al 2009). These facts may have left our study with little statistical power.

Our study offers implications for clinical practice and future research. Although there were no significant differences between the experimental and control groups, subgroup analyses indicated that at least 50% of the experimental group participants improved in muscle strength and performance-based ADL. Moreover, our findings indicate that physical exercise interventions for improving ADL performance should be tailored to an individual's goals and should be offered individually to match the needs of frail institutionalized older persons.

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Chapter 5

Self-reported physical fitness in frail older persons: reliability and validity of the Self-Assessment of Physical Fitness (SAPF)

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Perceptual and Motor Skills. 2012; Dec. 115(3): 797-803

Summary.— In very old and/ or frail older people living in long-term care facilities, physical inactivity negatively affects activities of daily living. The main reason to assess older adults' perceived fitness is to establish the relation with their beliefs about their ability to perform physical activity adjusted to daily tasks. The Self-Assessment of Physical Fitness scale was developed to address these needs. The aim of this study was to estimate the test-retest reliability and construct validity of the scale. 56 elderly people (*M* age=86.0 yr., *SD*= 6.3) completed the test. Cronbach's α was .71. One-week test-retest reliability ICC's ranged from .66 (SAPF aerobic endurance and SAPF balance) to .70 (SAPF sum score). Concurrent validity with the Groningen Fitness Test for the Elderly was fair to moderate. Despite the limited number of participants (*N*=76), results suggest that the scale may be useful as an assessment of perceived fitness in older adults.

Older people living in long-term care facilities are among the most physically inactive. For this population physical inactivity negatively affects Activities of Daily Living (ADL) as well as physical fitness (Chin A Paw, van Poppel, & van Mechelen, 2006). Such performance is the most frequently used operationalization of disability (van Heuvelen, Kempen, Brouwer, & de Greef, 2000). ADL includes Basic Activities of Daily Living and Instrumental Activities of Daily Living (van Heuvelen, Kempen, Brouwer, & de Greef, 2000). The former concerns self-care activities and basic mobility, such as getting up from a chair or walking within a home for the elderly. The latter concerns household activities and advanced physical activities such as gardening or shopping. Limitations in such performance, related to frailty, is the most important reason for institutionalization (De Boer, 2006). Frailty can be defined as an accumulation over the years of deficits related to old age (Rockwood, & Mitnitski, 2007). Frailty is recognized as a dynamic concept, and the status of non-frail to pre-frail and frail is generally reversible (Topinkova, 2008). Frailty, an overall concept, is related to physical inactivity and poor fitness being characterized by unintentional weight loss, exhaustion, meager physical activity, slow walking speed, and muscle weakness (Fried, Tangen, Walston, 2001). Frailty is prominent in elderly persons living in long-term care facilities (de Boer, 2006). Although not all institutionalized older people are frail, it is an important issue, because frailty adversely influences quality of life (Weening, de Greef, Scherder, Slaets, & van der Schans, 2011). Physical fitness in older adults is considered to be a measure of the body's ability to function efficiently and effectively in basic and instrumental activities as well as in leisure activities. Health- related physical fitness can be divided into performance- based fitness and perceived fitness. Performance- based physical fitness is operationalized by muscle strength, aerobic endurance, flexibility, balance, speed, and full body coordination (van Heuvelen, Kempen, Ormel, & de Greef, 1997). According to Rikli and Jones (2002) muscle strength, flexibility, balance, and aerobic endurance are most relevant to older people and should be measured in a functional setting. Perceived physical fitness reflects an older person's beliefs about personal fitness, while performance-based fitness measures assess older person's capacity to perform special tasks. Perceived fitness is seen as a multidimensional construct that includes performance-based fitness, perceived health, objective health, functional independence, and comparison with other relevant groups (van Heuvelen, Kempen, Ormel, & de Greef, 1997; Lamb, 1992; Deveraux, Futrell, Williamson, Chamberlain, Bourque, MacDonell & Phanoef, 1996). Van Heuvelen Kempen, Ormel, de Greef, 1997 examined the relation between performance-based fitness and perceived fitness in an elderly, community-dwelling population having a mean age of 68.9 yr. They found a mean correlation of 0.25 for men and 0.23 for women between performance- based and perceived fitness items, with the strongest relation (r= .52 for men and r=.43 for women) between perceived endurance and performance-based endurance. These findings were supported by Schuler& Marzilli (2003). Clearly, perceived fitness measures are not likely to replace performance-based fitness measures. A reason for the discrepancy between performance-based and perceived fitness measures is that the former does not take into account adaptations made in people's everyday living situations. The two types of measures reflect different kinds of information, which should be viewed as complementary rather than contradictory (Kempen, van Heuvelen, Van den Brink, Kooijman, Klein, Houx, Ormel, 1996). The question is whether the discrepancy is also observable among very old and frail institutionalized older people, and if so, whether the findings will be similar to those of the aforementioned studies. Another reason to assess older adults' perceived fitness is to establish the relation with their beliefs about the ability to perform physical activities in daily tasks. Moreover, Mitnitski , Song, and Rockwood (2004) concluded based on previous research and conformed by their own results that self-reported data can form the basis of a frailty assessment.

Perceived fitness usually is measured with questionnaires, such as the Perceived Physical Fitness Scale (Abadie, 1988), the Physical fitness subscale of the Physical Fitness and Exercise Activity of Older Adults Scale (Deveraux, Williamson, Futrell, & Chamberlain, 1997), and the self-reported fitness section of the Groningen Fitness test for the Elderly (Lemmink, de Greef, van Heuvelen, Bult, Brouwer, Stevens, Rispens, 1995). The Perceived Physical Fitness Scale is a 12-item scale, using a 5- point rating scale with anchors 1: Strongly agree, and 5: Strongly disagree. The scale was validated by comparison with performance-based physical activity for a population ranging in age from 21 to 68 years. However, it includes questions that are not relevant for older institutionalized persons. The Physical fitness subscale of the Physical Fitness and Exercise Activity of Older Adults Scale is a 9 item subscale using a 4- point rating scale with anchors 1: Strongly agree and 4: Strongly disagree. The scale was validated by estimating the predictive validation for a population ranging from 63 to 82 years. The self-report section of the Groningen Fitness test for the Elderly is a 10-item scale using a 5-point rating scale with anchors varying per item. The scale has a reasonable interrater and intrarater reliability for a population 55 years and older.

The extant scales are not validated nor feasible for frail persons or persons older than 85 years of age living in homes for the elderly. To assess effectively perceived fitness in this population, the Self-assessment of Physical Fitness (SAPF) scale was developed. The aim of the present study was to estimate the 1-week test-retest reliability and the construct validity of the SAPF scale.

Method

Participants

The sample consisted of 76 frail elderly adults living in five residential homes and two assisted living homes for the elderly in the northern part of the Netherlands. A residential home refers to a home were older people live with assistance for basic and instrumental tasks, but who are not completely care-dependent. An assisted living home refers to a home where people are less care-dependent, but where they get assistance for some more complicated basic daily living tasks, like showering. Inclusion criteria were as follows: older than 69 years, able to understand instructions spoken in Dutch, and able to walk at least 10 meters with or without a walking aid. People with cognitive impairment measured with the Mini Mental State Examination were excluded from participation. A score of 21 was taken as the cutoff for inclusion (Folstein & Folstein, 1975). All participants were disabled in the sense that they needed at least some assistance to perform daily tasks. Sample characteristics are presented in Table 1. The mean age of the sample was similar to the Dutch population of elderly housed in such facilities (de Klerk, 2005). The mean Groningen Frailty Indicator score was 4 (SD=3), indicating the measure of frailty (Schuurmans, Steverink, Lindenberg, Frieswijk, Slaets, 2004). The scores range from 0: Non frail to 15: Most frail. According to the authors, a frailty score of 4 can be regarded as moderately frail.

Study Design

Participants were asked to sign an informed consent form after the Ethical Board of the University Medical Center Groningen, the Netherlands had approved the research. To measure test-retest reliability, participants were assessed at two time points (T1 and T2) with exactly one week between them. They were tested at approximately the same time of day and by the same research assistants. To estimate concurrent validity of the scale, scores were correlated with the self-reported fitness section of the Groningen Fitness test for the Elderly and with the following performance-based physical fitness measures: Chair Stand test, Arm Curl test, Six Minute Walking test, Timed Up and Go test, and the Frailty and Injuries Cooperative Studies of Intervention Techniques. To examine the association of age, sex, subjective health, frailty, depression with the SAPF scale, Pearson's partial correlations were calculated.

TABLE 1. Baseline characteristics of sample

Demographic		*M*	*SD*	*n*	%
Age		86.0	6.26	76	
Sex	male			19	25%
	female			57	75 %
Marital status	married			21	28%
	single			55	72%
Level of education					
	primary school			41	54%
	secondary school			32	42%
	university			3	4%
Height		1.68 m	8.39		
Weight		74.5 kg	14.1		
Body mass index		26.5	4.64		
Mini Mental State Examination		26.43 points	3.53		
Groningen Frailty Indicator		4 points	3.0		
No. of Health problems		7	4.9		
Geriatric Depression Scale		7 points	3.4		
Type of facility	Care facility			51	72%
	Assisted living			20	28%
No. of years living in facility		4	3.6		

Scale Construction

The SAPF has three items. These questions were chosen based on their relevance to the construct of perceived physical fitness. Item 1, "How do you rate your strength?" is related to the domain 'muscle strength' of the physical fitness construct. Item 2, "How do you rate your aerobic endurance?" is related to the domain 'aerobic endurance' of the physical fitness construct. Item 3, "How do you rate your balance?" is related to the domain 'dynamic and static balance' of the physical fitness construct. The SAPF uses a rating method graphically laid out in the form of a ladder of ten steps labeled 0 (the ground below the ladder) to 10 (the highest rung of the ladder). Participants were requested to indicate their responses on the ladder for each of the three items. The SAPF rating scale was derived from Cantril's Self anchoring Ladder Striving Scale for perceived happiness (Cantril, 1965). The main idea is that it is easier for people to rate their fitness by visualizing a ladder than by a visual analogue scale or a 10-point numeric scale. The problem with visual analogue scales is that older people have difficulties rating themselves by indicating a rank on a line. For people living in the Netherlands, another problem with a 10-point numeric scale is that, in line with the Dutch education system, a 6 or higher indicates having passed a test and a 5 or lower not having passed a test.

Procedure
Participants were recruited from five residential homes and two assisted living homes for the elderly in the northern part of the Netherlands. After applying the selection procedure, 76 persons were eligible for participation. Selection took place by interviewing the nursing staff to prevent having to reject older people from participation. The main researcher instructed students, who assisted participants in completing the tests. On the first day (T1) participants completed seven questionnaires, including the SAPF. The second day (T2), they performed the six physical fitness test items. Testing took place in the residential home in which the participant lived.

Measures
Mental state.—The Mini Mental State Exam (MMSE; Folstein & Folstein 1975) measures cognitive performance, represented as scores between 0 and 30. MMSE scores between 0 to 10 indicate severe cognitive impairment, scores 11 to 20 indicate moderate cognitive impairment, and 21 to 24 indicate minor cognitive impairment. Cronbach's alpha is .82, intra-rater reliability .89, and inter-rater reliability .89 over a 24 hours' time period.

General health.— The Health Assessment Questionnaire (HAQ; Fries, Spitz, & Young, 1982) concerns general health of older persons by measuring the number and kind of medications being used, the kind of symptoms a person is experiencing, recent hospital admittances, and emergency room visits in cases of injury. The questionnaire is an enumeration which can be scored yes or no. Cronbach's alpha is .91 (Doeglas, Guillemin, Suurmeijer, Sanderman, Smedstad, Briançon, van den Heuvel, 1995). Intra-rater reliability is .91, and inter-rater reliability .83 The time period over which was measured is not available. (Ferraz, Oliveira, Araujo, Atra, Tugwell, 1990).

Perceived health.—The Short Form Health Survey (SF-36) is a questionnaire on self-reported health (Garrett & Ruta, 1993). For the present study, Items 1, 2, and 11 were chosen to measure perceived health. The questionnaire uses a 5-point rating scale. Anchors for Item 1, "How do you rate your health," are: 1: Excellent and 5: Bad; for Item 2, "How do you rate your health, compared with a year ago," the anchors are 1: Much better than a year ago and 5: Much worse than a year ago. Anchors for Item 11, four statements on comparing one's health with others, are 1: Completely true and 5: Completely untrue. Cronbach's alpha is .80 and test-retest reliability .88 over a 2 weeks period (Ruta, Abdalla, Garrett, Coutts, Russell, 1994). The SF-36 was translated into Dutch and called the Rand-36. Cronbach's alpha is .81, and test-retest reliability .80 over a 2 months period (Aaronson, Muller, Cohen, Essink-Bot, Fekkes, Sanderman, Sprangers, te Velde & Verrips, 1998).

Frailty.—The Groningen Frailty Indicator (GFI) measures the magnitude of frailty in older persons (Steverink, Slaets, Schuurmans, & van Lis, 2001). The questionnaire includes 15 items concerning functional state, general health, and psychological factors. Responses are yes, no, or sometimes. 0 reflects a non-frail situation, and 15 a most-frail situation. Cronbach's alpha is .77; no test-retest reliability has been reported.

Depression.—The Geriatric Depression Scale is a 30-item scale developed to measure depression in older adults (Yesavage & Brink, 1983). This scale is used because depression can influence self-reported physical fitness. Responses are yes or no. A summary score ranging from 0-10 reflects no depression, from 11-20 mild depression, and from 21-30 severe depression. Cronbach's alpha is .94, and test-retest reliability .91 over a 1-6 days period (Kim, Park, Lee, Huh, Lee, Han, Choi, Lee, Kim, Woo, 2008).

Perceived fitness.—The self-reported fitness section from the Groningen Fitness test for the Elderly (GFE) measures self-reported fitness in older persons in ten items which pertain to self-comparison to relevant other older people (Lemmink, de Greef, van Heuvelen, Bult, Brouwer, Stevens, Rispens, 1995). The items include perceptions about mobility, flexibility, strength, aerobic endurance, fitness, agility, reaction, balance, health, and level of activity. The questionnaire uses a 5- point rating scale, with anchors differing per item. Test-retest reliability is .94 for men and .84 for women over a 1 week period.

Performance-based physical fitness measures.—The Chair Stand test is the functional measure for lower-extremity muscle strength. Participants are asked to stand up from a chair as many times as possible in 30 sec. (Jones, Rikli, & Beam, 1999). Use of armrests is allowed and noted in the protocol. Test-retest reliability is .84 for men and .92 for women over a 2-5 days period. The Arm Curl test measures upper extremity muscle strength functionally. Seated participants are asked to lift a 1-kg weight, starting with the elbow outstretched laterally and bringing the weight toward the shoulder as many times as possible within 30 sec. Test-retest reliability is .81 over a period of 2-5 days. (Rikli & Jones, 2001). The Timed Up and Go test measures dynamic balance. Participants are required to rise from a seated position in a chair, walk for three meters, turn, walk back, and sit back down on the chair. Use of a walking aid is allowed and noted in the protocol. The more time (measured in sec.) needed to complete the test, the worse the balance. Intra-rater reliability is .99, and inter-rater reliability .97. The measurement was administered twice on the same day (Bennie, Bruner, Dizon, Fritz, Goodman, Peterson, 2003). Static balance is measured by the FICSIT-4 test in which participants stand for 10 sec. in four different positions: with feet close together, in a semi-tandem position, in a tandem position, and on one leg. Test-retest reliability is .66 (Rossiter, Wolf, Wolfson, & Buchner, 1995) over a 3-4 month time period. The Six-minute walk test is used to measure aerobic endurance. Participants have to walk as many meters as possible in 6 min. on a parcourse (Rikli & Jones, 1999). Test-retest reliability is .93 over a 1-2 weeks period of time (King, Judge, Whipple, Wolfson, 2000). For this test the protocol was adjusted to the living circumstances of the elderly involved by building a 50 meter-long parcourse instead of the standard 4-sided parcourse. Participants walk this distance, turn around, walk back, and repeat the walk for six min.

Statistical Analyses

Statistical analyses were performed using the Statistical Packages for Social Sciences (SPSS) Version 17.0. Internal consistency was estimated by Cronbach's α. Test- retest reliability over one week was evaluated by Intraclass Correlation Coefficients (ICC) with 95% confidence interval (CI). The difference in means between the two time points was tested by the Paired samples *t* test. Probability values less than .05 were accepted as statistically significant. Pearson correlation coefficients and their 95% CIs estimated associations among the Groningen Fitness test for the Elderly self-reported fitness scale, the Chair Stand test, the Arm Curl test, the Six-Minute Walk test, the FICSIT-4, the Timed Up and Go test. Partial correlations were calculated to control for age, sex, Items 1,2, and 11 of the SF-36, the Groningen Frailty Indicator, and the Geriatric Depression Scale.

Results

SAPF Psychometrics

Cronbach's α for the SAPF was .70. ICCs ranged from .66 to .69 for the three items. The results of the *t* tests and test-retest analyses are shown in Table 2.

TABLE 2. Comparisons[a] of scores at Times 1 and 2 for Self-Assessment of Physical Fitness Scale

SAPF Test item	Time 1		Time 2		*t*	*df*	*p*	ICC	95 % CI
	M	*SD*	*M*	*SD*					
Perceived strength	6.41	1.41	6.62	1.22	-1.77	75	.08	.69	.55, .79
Perceived aerobic endurance	5.89	1.59	5.95	1.41	-0.37	75	.71	.66	.51, .77
Perceived balance	5.46	1.76	5.70	1.63	-1.46	75	.15	.66	.50, .76
Summary score	17.76	3.78	18.26	3.51	-1.53	75	.13	.70	.56, .80

[a]Paired samples t test results and Intraclass correlations with 95% confidence intervals.

Table 3 shows the correlations between the SAPF and the three items of the Groningen Fitness test for the Elderly. Pearson's correlations were .41 (perceived strength), .56 (perceived aerobic endurance), and .59 (perceived balance); correlation with the total scale was .64. All correlations were positive and significantly different from zero. The highest correlation was between SAPF perceived balance and Groningen Fitness test for the Elderly self- reported balance.

TABLE 3. Pearson's correlations between items of the Self-Assessment of Physical Fitness (SAPF) and relevant Groningen Fitness Test for the Elderly (GFE)

Self-Assessment of Physical Fitness	Groningen Fitness Test for the Elderly			
	Self-reported strength (95 % CI)	Self-reported aerobic endurance (95 % CI)	Self-reported balance (95 % CI)	3-item sum score (95 % CI)
Perceived strength	.41** (.20, .58)			
Perceived aerobic endurance		.56** (.38, .70)		
Perceived balance			.59** (.42, .72)	
Sum score				.64** (.48,.76)

Note.—CI = confidence interval. **p*<.05. ** *p*<.01.

Correlations between performance-based fitness measures and self-reported measures represented by the SAPF are shown in Table 4. The negative correlation represents the direction of Timed Up and Go test scores: higher scores indicate worse balance. There were no changes when statistical controls for age, sex, subjective health, frailty, and depression were applied.

TABLE 4. Pearson's correlations between Self-Assessment of Physical Fitness items and objective fitness measures from the Frailty and Injuries Cooperative Studies of Intervention Techniques (FICSIT-4)

Self-Assessment of Physical Fitness	FICSIT-4				
	Strength		Aerobic endurance	Balance	
	Chair Stand Test (times/30 sec.) (95 % CI)	Arm Curl Test (times /30 sec.) (95 % CI)	6-Minute Walk Test (meters) (95 % CI)	Timed Up and Go (sec) (95 % CI)	FICSIT-4 (sec) (95 % CI)
Perceived strength	.37** (.15, 56)	.21 (-.02, .42)			
Perceived endurance			.31* (.08, .51)		
Perceived balance				-.39** (-.58, -.17)	.27* (.04, .47)

Note.—CI = confidence intervals. **p*<.05. ** *p*<.01.

Discussion

The aim of this study was to establish the 1-week test-retest reliability and the concurrent validity of the Self- assessment of Physical Fitness scale in older, most frail, adults living in residential and assisted living homes. Results of the study show an internal consistency of α = .71 and the ICC ranged from .66–.70. The results support previous evidence of a discrepancy between performance-based and perceived physical fitness in older adults (Schuler, Marzili & Kozusko, 2004). We suggest the weak association between performance-based and perceived fitness may be due to the ambiguous perceptions of older adults of the association between weakness and ageing (Rush, Watts, & Stanbury, 2011). Although the results generally corroborated those of van Heuvelen, Kempen, Ormel, and de Greef (1997), a significant difference between perceived and performance-based fitness was observed. While the responses of community-dwelling older adults (mean age 69 years) in the study of van Heuvelen, *et al.* showed a moderate association between performance-based and self-reported aerobic endurance, in the current study, older and frail older adults living in residential and assisted living homes (*M* age= 86 yr.) rate their fitness according to a broad range of physical fitness, e.g., lower extremity strength, aerobic endurance, and dynamic balance. A number of characteristics of this study are relevant for the interpretation of the results. Heterogeneity of physical fitness in frail institutionalized older adults may affect the association between perceived and performance-based fitness (Montero-Odasso, Bergman, Béland, Sourial, Fletcher, & Dallaire, 2009; Young, Xiong, Pruzek, & Brant, 2010; Yeung, Woo, Wai- Ting Yim. Hudson Rainer, 2009). Second, due to the limited number of very old persons included in this study, the power of the study does not meet the criteria. This could limit the variance in the SAPF results and may partially explain the weak associations encountered in this study. Future research should endeavor to examine the sensitivity to change of the SAPF scale in institutionalized older adults.

This study provides insight in perceptions of physical fitness in frail institutionalized older adults (>85 years of age). The day-to-day variation in perceived physical fitness in older adults, due to the dynamics of ageing, may hamper a clear view of actual performance-based fitness. The preliminary conclusion is that the SAPF is a useful efficient instrument to measure perceived fitness in very old and/or frail older people living in residential of assisted living homes for the elderly.

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Appendix 1.

The Self Assessment of Physical Fitness

10
9
8
7
6
5
4
3
2
1
0

Instruction for item 1:
Rate your actual strength on this ladder from zero to ten. Zero applies to feeling as weak as can be, and ten applies to feeling as strong as can be. On which step of the ladder you feel you are standing right now?

Instruction for item 2: Rate your actual aerobic endurance on this ladder from zero to ten. Zero applies to feeling as weak as can be, and ten applies to feeling as strong as can be. On which step of the ladder you feel you are standing right now?

Instruction for item 3: Rate your actual balance on this ladder from zero to ten. Zero applies to feeling as weak as can be, and ten applies to feeling as strong as can be. On which step of the ladder you feel you are standing right now?

Chapter 6

The relationship between perceived fitness, performance-based fitness, and ADL performance in institutionalized older adults: a path analysis

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Submitted

Abstract

Background: Causes for the decrease in ADL performance in institutionalized older persons are a decrease in physical fitness and non-use of body structures due to residential home policy and a lack of time for nursing care. The question in this study was whether a perceived fitness measure could be an independent predictor of ADL performance of a performance-based fitness measure in an institutionalized older population.

Method: older persons residing in seven homes for the elderly and assisted- living apartments were selected. Inclusion criteria consisted of being at least 70 years old, being able to understand spoken instructions in Dutch, not being cognitively impaired, and being able to walk at least ten meters. A short battery of performance-based fitness measures, the SAPF perceived physical fitness scale, and the GARS ADL performance questionnaire were administered, and a model was estimated using a path analysis.

Results: The path analysis revealed that performance-based fitness significantly predicted ADL performance for 87 percent while perceived fitness non significantly predicted ADL by seven percent.

Conclusion: Physiotherapists should assess performance- based fitness to provide information about the ADL capacity of institutionalized older persons.

Introduction

Disability, as well as comorbidity and frailty, are common phenomenons in older adults and increases the adverse consequences of aging (Fried, Tangen, Walston, Newman, Hirsch, Gottdiener, Seeman, Tracy, Kop, Burke & McBurnie, 2001). Late-life disability occurs as a result of chronic diseases which place a burden on older persons commanding their ability to function in their social context. In this study, disability is operationalized as Activities of Daily Living (ADL) performance, according to Van Heuvelen, Kempen, Brouwer & de Greef, 2000. ADL performance is related to physical fitness and is often negatively affected by aging (Hardy & Grogan, 2009). The concept of physical fitness includes muscle strength, flexibility, coordination, balance, and aerobic endurance (Van Heuvelen, Kempen, Ormel & de Greef, 1997), and all are adversely influenced by the aging process.

Physical fitness can be gauged by performance-based measures and perceived measures. The former objectively assesses physical fitness characteristics, while the latter reflects an older person's beliefs about his or her individual personal fitness. Perceived fitness is construed as a multidimensional construct that includes performance-based fitness, perceived health, objective health, functional independence, and comparison with other relevant people (van Heuvelen, Kempen, Ormel, & de Greef, 1997; Lamb, 1992; Deveraux, Futrell, Williamson, Chamberlain, Bourque, MacDonell & Phanoef, 1996). There is a discrepancy between performance-based and perceived fitness measures in that the former does not take into consideration the modifications to a person's everyday living situation. Instead, the two types of measures should be viewed as complementary rather than contradictory (Kempen, van Heuvelen, van der Brink, Kooijman, Klein Houx & Ormel, 1996).

Numerous studies have enlightened the benefits of daily physical activity and exercise in older adults (Weening, de Greef, Scherder, Slaets, & v.d. Schans, 2011). In order to improve physical fitness, physical activity should be enhanced even though the heterogeneity in physical conditions and mental status in frail, older adults is considered to limit the beneficial effects of exercise. Therefore, it is suggested that one generic intervention is not appropriate for all older participants, and interventions should be tailored individually (Foster, Lambley, Hardy, Young, Smith, Green & Burns, 2011). For institutionalized elderly, there is a consensus guideline based on best practice stating that older people living in institutions should be physically active at least 15 minutes per day, however, epidemical results regarding the effects of meeting the guidelines are not yet available.

There is a well-established relationship between physical activity participation and ADL performance, such as self-reported difficulty in stooping or kneeling (Mullen, McAuley, Satariano, Kealey & Prohaska, 2012), however, physical activity depends on several determinants, one of which includes the environment of long-term care institutions. Nurses within these establishments often reduce ADL- related physical activity, overemphasizing limitations instead of independence due to time management. Additionally, participation in physical activity gradually declines over the years due to the aging process (McAuley, Hall, Motl, White, Wojcicki, Hu & Doerksen, 2009). To monitor the impact of physical activity on physical fitness and ADL performance, relevant outcomes should be measured on a regular basis. The question is whether perceived fitness, being a different construct than performance-based fitness, is an independent determinant of ADL performance in institutionalized older adults.

Methods

Participants and recruitment

Seventy five older persons residing in seven different homes for the elderly and assisted-living apartments in the Northern part of the Netherlands were enrolled in this study. Inclusion criteria consisted of being at least 70 years, being able to understand instructions spoken in Dutch, not being cognitively impaired, and being able to walk at least 10 meters. The participants were allowed to use a walking aid. Cognitive impairment was measured by the Mini Mental State Examination (MMSE) (Folstein, Folstein, Hugh, 1975). Persons with a score of 21 points and higher were eligible for participation. Participants signed an informed consent.

Measures

Demographic and health-related assessment

Demographics were established by gathering data about age, gender, height, weight, marital status, housing situation, and education. Anxiety and depression were measured by the Geriatric Depression Scale (GDS), a 30 item questionnaire (Yesavage, & Brink, 1983). Frailty was assessed using the Groningen Frailty Indicator (GFI), a 12 item scale including biomedical, psychological and social determinants of frailty in older persons (Steverink, Slaets, Schuurmans, & van Lis, 2001).

Self-reported ADL performance

ADL performance was assessed by the Groningen Activity and Restriction Scale (GARS), an 18 item questionnaire, and scored on a 4-point Likert scale in which participants could choose between 4 options: I can perform this without any difficulty; I can perform this with little difficulty; I can perform this with considerable difficulty; or I cannot perform this without help from others (Kempen, & Miedema, 1996).

Perceived fitness

Perceived fitness was measured by the Self-Assessment of Perceived Fitness (SAPF) (Weening, de Greef, Krijnen, & v.d. Schans, 2012). On this scale, in the form of a ladder, participants could rate their actual fitness by choosing a figure between 0 and 10 where 0 represents the ground under the ladder and 10 the highest step on the ladder. Participants rated their fitness in 3 categories: perceived strength, perceived aerobic endurance, and perceived balance.

Physical fitness measures

Actual performance-based fitness was measured by a number of fitness measures. Upper extremity strength was measured by the Arm Curl Test. Seated subjects were requested to lift a 1 kilogram weight beginning with their elbow out-stretched and repetitively bringing the weight toward their shoulder as many times as possible within 30 seconds (Rikli & Jones, 2001). The Chair Stand Test was used to measure lower-extremity muscle strength in a functional manner. Subjects were requested to rise up from a chair and return to a sitting position as many times as possible in 30 seconds (Jones, Rikli, & Beam, 1999). The Timed Up and Go Test was employed to measure dynamic balance; subjects were required to rise up from a seated position in a chair, walk three meters, turn, walk back, and sit back down on the chair. The more time (measured in seconds) required to complete the test indicated decreased balance (Bennie, Bruner, Dizon, Fritz, Goodman, Peterson, 2003). Static balance was measured by the FICSIT-4 Test. Subjects were required to stand for 10 seconds in four different positions: with feet close together; in a semi-tandem position; in a tandem position; and on one leg (Rossiter, Wolf, Wolfson, & Buchner, 1995). The Six Minute Walk Test was used to measure aerobic endurance. Subjects were asked to walk as many meters as possible in 6 minutes on a parcourse (Rikli & Jones, 2001). For this test, we adjusted the protocol to their living circumstances by constructing a 50 meter-long parcourse instead of the standard 4-sided parcourse. Subjects were then asked to walk this distance, turn around, walk back, and repeat the walk for six minutes.

Procedures

The design of the study was cross-sectional. Various homes for the elderly were selected, and the inhabitants were asked to participate. Selection took place according to the inclusion criteria. Participants completed all the tests within one day beginning with the questionnaires followed by the physical tests. All participants signed an informed consent form. The study was approved by the Ethics Committee of the Medical Faculty of the University of Groningen, registration number ABR NL 24558.042.09.

Statistical analyses

Statistical analyses were performed using Statistical Packages for Social Sciences (SPSS), version 17.0. Pearsons' correlations using 95 percent confidence intervals were calculated to establish the relationships between the SAPF, the Chair Stand Test, the Arm Curl Test, the Timed Up and Go Test, the FICSIT-4, the Six Minute Walk Test, and the GARS. A path analysis (LISREL 8.7) was employed to test the hypothesized model in which the direct effects of perceived fitness and performed based fitness on ADL were estimated. In this model, the latent constructs were conceptualized by "ADL", "Self perceived fitness" and "Performance based fitness". ADL was a latent construct estimated by BADL and IADL. The first was constructed by using the items 1-9 of the GARS and the second by using the items 10-18 of the GARS. Indicators of the latent variable "performance based fitness" are ACT, TUG, FICSIT and 6MWD and indicators for "perceived fitness" were the SAPF measurements (strength, endurance, and balance). These indicators were selected based on their significant correlation with ADL in the univariate analysis. To allow for mutual comparisons between the path coefficients, the completely standardized solution was used. For model fit, we utilized multiple criteria as suggested by Bentler & Bonett, 1980. The first criterion employed for model fit is a non-significant Chi ^{2}, indicating that only an insignificant amount of variance in the data remains unexplained. The last criterion used is the root mean square error of approximation (RMSEA) which assesses how well the model approximates the data by determining the lack of fit of the model to the population covariance matrix, expressed as the discrepancy per degree of freedom. An RMSEA of less than 0.05 indicates a good model fit, less than 0.08 acceptable, and larger than 0.10 indicates that the model fit is unsatisfactory.

Results

Sample characteristics

Seventy five residents living in 5 homes for the elderly in the northern part of the Netherlands participated in the study. These participants were residing in residential homes with full time care or in assisted living homes with partial care. Mean (SD) age was 84.8 (7.0) years, and the majority was women (67%). Compared to the general situation in residential homes in the Netherlands, measured in 2008/2009 in our sample there were more men (33 % compared to 23%), and more couples who did actually live together (29% compared to 9%). The level of education was similar to the general situation (Den Draak, 2010). The baseline characteristics are presented in Table 1.

TABLE 1. Baseline characteristics

		Mean (sd)	N	percentage
Age		84.8 (7.0)	75	
Gender	male		25	33 %
	female		50	67 %
Marital status	married, living together		22	29%
	married, living apart		9	12%
	widowed		32	43%
	divorced		2	3%
	single		10	13%
Level of education	primary school		37	49%
	secondary school		36	48%
	university		2	3%
Body mass index		26.3 (5.3)		
GFI[1]		4.2 (2.8)		
GDS[2]		6.8 (4.5)		

1= Groningen Frailty indicator, 2=Geriatric Depression Scale

Estimating associations performance-based fitness and perceived fitness with ADL

For perceived fitness and performance-based fitness, associations with ADL performance are calculated. Table 2 demonstrates the Pearson's correlations between the SAPF subscales (SAPF strength, SAPF aerobic endurance, and SAPF balance) and GARS total, GARS BADL, and GARS IADL, ranging from -.43 to -.15. The negative association is due to the scoring of the SAPF where higher values indicate higher fitness levels, whereas, on the contrary, higher GARS scores indicate lower ADL performance. Pearson's correlation between SAPF strength and GARS BADL was r= -.40, and between SAPF balance and GARS IADL r = -.43, both indicating a fair relationship. Pearson's correlations between performance-based fitness variables and GARS total, GARS BADL, and GARS IADL range from -.03 to .57. The negative association is due to the scores of the ACT, CST, FICSIT-4, and six MWT indicating that a higher score conveys a better performance, and the scores of the GARS which indicate that a higher score conveys a lower ADL performance. Pearson's correlation between the TUG and GARS BADL r = .50, and between the TUG and GARS IADL r= .53, both indicating a moderate relationship, Pearson's correlations between the CST and GARS BADL and GARS IADL were r = -.10 and r = -. 03 respectively, indicating a poor relationship.

TABLE 2. Pearson's correlation coefficients between perceived fitness, performance-based fitness, and ADL variables

		ADL performance		
		GARS Total	GARS BADL	GARS IADL
Perceived fitness	SAPF strength	-.396**	-.398**	-.352**
	SAPF aerobic endurance	-.244*	-.153	-.275*
	SAPF balance	-.423**	-.342**	-.428**
Performance-based fitness	ACT	-.454**	-.442**	-.413**
	CST	-.057	-.098	-.026
	TUG	.567**	.497**	.529**
	FICSIT-4	-.358**	-.244*	-.384**
	6MWT	-.465**	-.432**	-.434**

*p<.050 **p<.001

Analysis of covariance

To test the hypothesis that both perceived fitness and performance based fitness have a direct effect on the ADL of institutionalized older persons, a path model was estimated. Due to negative error coefficients the scores of the CST were omitted from the analyses. Path coefficients are indicated in Figure 1 and demonstrate the direct effects of the latent variables of performance based fitness and perceived fitness on ADL. The overall fit of the structural equation model describing the direct effects of performance-based fitness and perceived fitness on ADL performance was excellent (χ^2=31.74, df=32, p=.48, RMSEA= .00). The direct effect on ADL of performance-based fitness (β =-.87) was significant and that of perceived fitness (β=-.06) was not. The model is displayed in Fig. 1.

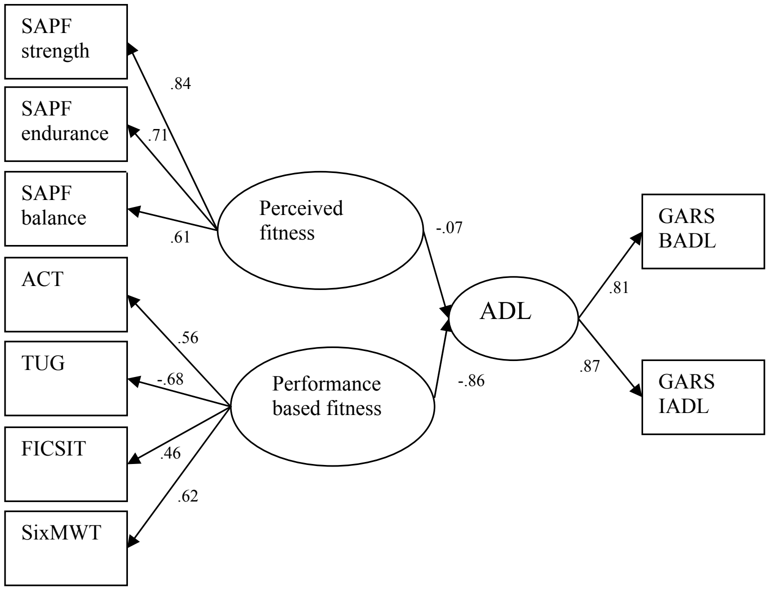

FIG. 1. Path analysis presenting predictive values of performance-based fitness and perceived fitness on ADL. All loadings are standardized
Chi-Square=26.68 , df=24, p-value=0.32, RMSEA=0.04

Discussion

The research question of this study was to determine whether a perceived fitness measure is an independent predictor of ADL performance in institutionalized older adults.

The results of a path analysis indicate that perceived physical fitness (β=-.06) does not significantly predict ADL performance as compared to performance- based fitness (β =-.87). The model demonstrates that performance-based fitness is predominantly the only significant predictor of ADL performance. The overall fit of the model was excellent ($\chi2$ =31.74, df=32, p=.48, RMSEA= .00). In the model presented the CST was omitted from the analysis, because there was a negative error coefficient.

Pearson's correlations indicate significant relationships between perceived fitness measures and self-reported ADL performance. The correlation (r=.40) between the SAPF strength and the GARS BADL subscale suggest that frail older people, living in residential homes may pretty well estimate their strength by their ability to rise from a chair (BADL). Strikingly only a poor relationship between performance-based strength, measured by the CST, and the GARS BADL and GARS IADL was found. Possibly frail institutionalized older persons overestimate their strength when it comes to the ADL performance. We suggest older adults do not experience a decrease in arm- and leg strength because they still are able to perform some daily tasks, like rising from a chair by using the armrests as an adaptive strategy. Frail institutionalized older persons may estimate their dynamic balance according to their ability to perform small household tasks (IADL), because walking, turning and carrying objects are the main features of these tasks. Performance-based dynamic balance, measured by the TUG, was moderately related to self-reported ADL, indicating that institutionalized older people actually use lower extremity strength as well as balance to perform daily tasks. This is in line with the findings of De Vreede et al, who reported positive effects of functional exercise on the performance of daily tasks, even after a 6 months period (De Vreede, Samson, van Meeteren, Duursma, Verhaar, 2005). Conclusively we suggest there is some evidence that frail institutionalized older persons estimate their abilities to perform ADL tasks according to their dynamic balance.

The results of our study reveal that performance- based fitness is strongly indicative for ADL whereas perceived fitness is not. The latter is confirmed by the study of Schuler who finds discrepancies in the perception of older adults and their actual level of fitness (Schuler, & Marzilli, 2003). A remark concerning the measurement of performance-based fitness has to be made. Performance-based testing, either in a clinical or a home setting, reflects little of actual functional performance. Because the observer uses standardized measurement instruments, the real life setting is only simulated (Glass, 1998). A closer examination at the construct of perceived fitness exposes that older adults' perceptions are dependent on a number of age related features. For example, the theory of selective optimization with compensation (Baltes, Baltes, 1990) suggests that older adults use three adaptive processes such as selection, optimization, and compensation to cope with aging. While selection refers to a limitation of activities, optimization includes efforts to increase natural resources, e.g. taking part in exercise classes in order to improve muscle function. Compensation refers to modification of behavior, e.g. substituting one way of performing an activity with another or using assistive devices, such as walking aids (Gignac, Cott, & Bradley, 2002). A study to evaluate the theory of Baltes and Baltes in older adults with osteoarthritis concludes that compensation is mainly applied by older adults to affect disability. Compensatory strategies influence peoples' perceptions of fitness and health (Kempen, van Heuvelen, van den Brink, Kooijman, Klein, Houx, & Ormel, 1996). A study of Rush et al. revealed that older adults related the general feeling of physical and mental weakness to the dynamics of aging. Most participants in this qualitative study referred to themselves as "a strong person" because they have coped with the situation over the years (Rush, Watts, & Stanbury, 2011) and often rated their health more positively than objectively could be based on the number and degree of chronic conditions.

Within the construct of perceived fitness, comparison with relevant others is an important determinant. Literature reveals that self-enhancement is a protective strategy employed to cope with deteriorating health and subsequent decrease in well-being (Cheng, Fung, & Chan, 2007). A strategy used in self-enhancement is social comparison. When a person compares himself to others, he may perceive himself as doing better, the same, or worse than others. Comparison to others exists as result of an inner drive in humans beings to evaluate their opinions and abilities. In absence of objective standards, humans evaluate themselves by looking at the performances of abilities of others close to their own position in society. Regarding personal abilities there is a strive to perform better than relevant others (Festinger, 1954). Therefore, older persons tend to overestimate their physical fitness level to enhance themselves. Frail older persons living in institutions are likely to overestimate themselves more than community dwelling older persons, because their beliefs about their functional performance are not in line with their actual performance because they are no longer involved in many activities and are, therefore, unaware of their actual capabilities or lack thereof. Third, perception of fitness is dependent on experiences. The conclusion of one study demonstrated that actual learning experiences improve self-perceptions (Klusmann, Evers, Schwarzer, & Heuser, 2011).

There are some methodological issues to address. Unfortunately, of the group of older persons eligible but refusing to participate no data is available. According to a recent Cochrane review, on average only almost 50 % of the persons, living in a long-term facility, was eligible for participation in a rehabilitation program. From that percentage, an average percentage of 62% actually participated (Foster et al, 2011). The limited number of participants may affect the modeling results (Boomsma, 2000), although it appeared sufficient for the estimation of directed effects in our path model. Future research should focus on enlarging the study population and also including community-dwelling, frail older people as there is a tendency in Western society to remain home as long as possible since institutionalization of frail older people may negatively influence quality of life and is very expensive (Den Draak, 2010).

In the future, the relationship of psychological variables to ADL performance in frail older persons should be studied because our study shows that, although not directly related to ADL performance, older persons' perceptions of physical fitness can form the basis of engagement in physical activity which, in turn, positively effects the performance of activities of daily living.

In conclusion, in the case of frail institutionalized older persons, actual performance-based fitness is a more adequate predictor of ADL performance than perceived fitness. Clinicians are recommended to measure fitness on a performed basis to provide actual information on the abilities of frail older persons.

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Chapter 7

General Discussion

General Discussion

Overview over the results in relation to Stewart's adapted framework
The core issue of this dissertation was to improve ADL performance and quality of life by exploring beneficial effects of physical exercise for frail institutionalized elderly with respect to the components of the pathway from physiological fitness to disability (problems in ADL performance) and quality of life. According to the adapted framework of Stewart, there are distinct steps from pathology, disuse, and physiological aging to disability and quality of life. These steps are physiological fitness & symptoms, functional performance, and & physical functioning, mediated by personal perceptions (Stewart, 2003). In the introduction to this dissertation, the research questions are linked to the framework.

To gain insight in the ability of physical exercise to influence disability and quality of life of frail institutionalized older persons a randomized controlled trial was performed. The exercise program was developed based on a comprehensive review of literature. In this dissertation, disability is operationalized as problems with ADL performance. To be able to measure the outcomes of the trial, a performance- based instrument for ADL performance was developed. In the development of this instrument the specific skills of institutionalized older persons were taken into account. The Performance ADL Test (PAT) has been considered reliable and valid to measure actual performance of ADL in institutionalized older persons. Based on clinical experience in physiotherapeutic practice, a mediating role for perceived fitness is suggested. Because perceived fitness should be measured properly, the Self-Assessment of Physical Fitness (SAPF) was developed and ascertained as reliable and valid. To establish the predictive role of the SAPF on ADL performance a conceptual model was estimated.

In the following paragraphs the answers to the research questions shall be dealt with.

Research question 1: What is the test-retest reliability, the internal consistency, and the construct validity of a performance-based measurement instrument for Activities of Daily Living?
ADL performance is a core issue in the lives of institutionalized elderly people. ADL performance can be measured with self-reported as well as performance-based measures which are complementary and covering different concepts. The Performance Based ADL test (PAT) is a performance-based instrument used to measure BADL and IADL in older institutionalized persons. The 16 items of the PAT were selected from the literature relevant to ADL performance of older persons. Factor analysis showed that there are three domains in the PAT consisting of organization of performance, gross motor function and muscle strength, and fine motor function. Moreover, a BADL subscale and an IADL subscale could be extracted in the psychometric analysis. Internal consistency as measured by the Cronbach's alpha ranged from 0.73 to 0.88. The test-retest reliability (ICC) ranged from 0.32 to 0.95.

The construct validity was established by comparing the PAT with the GARS. Pearson's correlations between the PAT and the GARS ranged from 0.49 to 0.83. In conclusion, the PAT, which was developed to measure the specific ADL issues in institutionalized older people is a valid instrument to assess ADL performance in institutionalized older persons, but has some limitations. Frailty, an obvious feature in old age, was not taken into account in the evaluation of the PAT scores. Frailty often causes great variability in physical fitness and function from one day to another (Gleichgerricht et al, 2009). Moreover, the length of the test, including 16 test items, needs some attention. On average, it takes almost one hour to perform the test. In severe frail persons, this length causes fatigue and, thereby, dropout from the test session. For severe frail persons, a shortened version of the test would be more appropriate.

Research question 2: Which components of evidence based exercise programs can increase ADL performance, physical fitness, and quality of life in frail institutionalized older persons?
A comprehensive review of literature was conducted to examine the effects of physical exercise on physical fitness, ADL performance, and quality of life in institutionalized older adults. In this systematic review, 27 randomized controlled trials were included that described outcomes of exercise interventions aimed at improving physical fitness such as muscle strength, flexibility, endurance, coordination, balance, functional performance, ADL performance, and quality of life. The studies were of moderate to high quality and measured by the adjusted Dutch Cochrane Qualification assessment. Studies of low quality were excluded from the study. The effects of the interventions in the studies were measured by calculating effect sizes of the main outcome measures. Of these 27 studies, only 12 provided data based on which effect sizes could be calculated. Results showed positive significant effects of low to high intensity progressive resistance training on strength, endurance, functional and ADL performance (effect size from high intensity resistance training on ADL was 0.68). Moreover, progressive functional training had positive significant effects on functional and ADL performance (effect size 0.13). Progressive balance training had positive significant effect on balance and a combination of progressive resistance training, and progressive functional training had beneficial effects on ADL (effect size 0.38) and on quality of life. No significant effects were shown on flexibility and coordination.

According to the review study, an effective exercise program should include the following frequency, intensity, duration, and composition principles:
- to improve strength: a progressive resistance training of 40 – 80 % of 1 RM (repetition maximum); three times per week; 1 hour sessions; at least 10 weeks is suitable;
- to improve balance: individually challenging balance exercises increasing during the weeks; three times per week; 1 hour sessions; at least 3 months is necessary;
- to improve endurance: progressive resistance training; 40 – 80 % of 1 RM; three times per week; 1 hour sessions; at least 10 weeks is required;

- to improve functional performance: progressive resistance training; 40 – 80 % of 1 RM; three times per week; 1 hour sessions; at least 10 weeks; or progressive functional training with increasing intensity over time based on the individual needs and abilities as a prerequisite. Functional training refers to task and context specific exercises in areas meaningful to the patient;
- to improve ADL performance: progressive resistance training; 40 – 80 % of 1 RM; three times per week; 1 hour sessions; at least 10 weeks is necessary;
- to improve quality of life: progressive resistance training: 40 – 80 % of 1 RM; three time per week; 1 hour sessions; at least 10 weeks; or progressive functional training with increasing intensity over time based on the individual needs and abilities.

The exercise program principles of studies enclosed in the review study exhibits shortcomings such as the lack of information about the FIT (frequency, intensity, time) of the interventions. In addition, the studies used a heterogeneous set of outcome measures which caused interpretation problems in comparing study results (Freedman, 2002). Moreover, the articles often lack detailed information on the contents of the exercise program and the characteristics of the participants. (Seynnes et al, 2004; Baum et al, 2003; Becker et al, 2003). Therefore, the above described exercise program to improve physical fitness, ADL performance, and quality of life can only be recommended.

Research question 3: What are the effects of an exercise intervention on ADL performance, physical fitness, and care dependency in institutionalized older persons?

We examined the effects of an exercise intervention developed on the basis of the literature review, on ADL performance, physical fitness, and care dependency in institutionalized older persons and evaluated the characteristics of persons who benefit by the exercise intervention. The randomized clinical trial reveals that on average there are no significant effects from group exercise on ADL performance, physical fitness, and care dependency in institutionalized older people. Still, within the experimental group, 50 % of the participants actually did significantly benefit from training on upper extremity muscle strength, lower extremity muscle strength, and performance-based ADL when measured in seconds. The general conclusion of the study is that group- based exercise does not meet the requirements of frail individuals living in homes for the elderly. The lack of significant, positive effects of the RCT study ADL performance, physical fitness, and care dependency is due to a number of methodological constraints.

Principal issues were the lack of motivation, drop out, and low adherence of participants. Although 14 homes for the elderly participated in the trial, the number of residents enrolled in the trial was relatively low (15 % on average). It is suggested that the length of the program, 16 weeks, although evidence based, was too long because, for institutionalized older people, a period of almost 4 months is barely foreseeable. Another reason for not participating was the randomization into the experimental or control group. Residents wanted to be able to choose the assignment to what program they preferred. The compliance to the study was limited due to health problems in the experimental group and motivation issues in the control group. These findings are in concordance with the findings of Fielding et al (2011), who reported a participant's withdrawal of 24% to 51 %. For this reason, the number of participants willing to participate in the post-intervention measurement was limited, as previously reported (Hughes, 2009).

Another issue was the group-based nature of the exercise program. As a recent Cochrane review on rehabilitation for institutionalized older people shows, group exercise programs are not the most effective interventions for frail older persons to improve physical fitness (Foster et al, 2011). The variability in physical fitness and health between persons makes an individual approach more effective than group exercise.

Research question 4: What is the test-retest reliability and the validity of a perceived physical fitness measurement instrument?

Personal perceptions are likely to mediate between physiological fitness and the subsequent concepts in Stewart's adapted pathway. As mentioned in the Introduction, older persons perceptions may contribute to changes in the outcome where it comes to performance of daily activities. From clinical experience in physiotherapeutic practice is known that older persons, living in residential homes, have very strong convictions about their abilities to perform daily activities. These convictions are based on former experiences or beliefs about the way their fragile health will adversely influence performance of daily tasks. To measure perceived physical fitness in institutionalized elderly, a reliable, valid, and feasible instrument should be applied. A Self-Assessment of Physical Fitness (SAPF) was developed and validated. The SAPF includes three items concerning older persons' perceptions about their strength, aerobic endurance, and balance. Internal consistency and test-retest reliability measured over 1 week are moderate. The validity of the SAPF compared with the perceived fitness section of the Groningen Fitness Test for the elderly is also moderate. The low associations between the perceived fitness items and performance- based measures of fitness indicates that these constructs are complementary. The study reveals that the SAPF is a useful instrument to measure perceived fitness in institutionalized older adults.

Research question 5: Which conceptual model can be constructed to declare the relationship between perceived fitness, performance-based fitness, and ADL performance in institutionalized older persons?

Modeling performance-based and perceived fitness with ADL performance show that perceived fitness is not a complementary and significant predictor of ADL performance. This is in line with the studies of Kempen et al (1996), Van Heuvelen et al (1997) and Schuler et al (2004). The studies reveal that an older person's view on their fitness is not in accordance with their actual fitness. On one hand, they underestimate their actual fitness due to lack of experience in a certain task, for instance, stair climbing. On the other hand, they overestimate their fitness because they use assistive devices, such as walking canes or walkers. The conclusion can be drawn that performance-based fitness may be a valid predictor of ADL performance. The restriction in boldness with respect to the conclusion is made because of what is found in research on measurement of functioning in older adults. Performance-based testing, either in a clinical or a home setting, hardly reflects actual performance. Because the observer uses standardized measurement instruments, the real life setting is only simulated (Glass, 1998).

General reflections

The research of which this dissertation reports, was confined by several points of attention. We will reflect on these points.

First, in the Introduction of this dissertation, attention is paid on quality of life, being of great importance for institutionalized older persons. Quality of life was suggested to be related to performance of daily tasks. In the systematic review quality of life was one of the outcome measure of physical exercise. For this reason quality of life actually was measured in the randomized controlled trial. However no significant effects of exercise on quality of life were found. Because a great number of outcome variables were used, only the primary outcomes were reported in Chapter 4.

Second, within-group heterogeneity, a common feature in frailty, may be the reason that little effect of exercise was shown as a result of the trial (Spiriduso et al, 2005). Because the intervention was group-based, inter-individual differences in health and function were not taken into account.

Third, the loss-to-follow up was a problem in the trial. Participants dropped out due to health problems or lack of motivation. This is in line with the results of a Cochrane study in which was concluded that reluctance to exercise and apathy due to limited life expectancy and ill health were the main confounders in frail elderly studies (Foster et al, 2011). Loss-to-follow up was in our trial the reason also that we cannot draw conclusions on long-term effects of the training.

Fourth, the issue of selection bias is related to the above mentioned reluctance to exercise and apathy. We estimated that only 15% of the institutionalized older persons that were eligible for participation in the trial, actually did participate.

Fifth, the mediating role of perceived fitness cannot be confirmed in the study. This is probably also due to loss-to-follow up in the trial or the limited number of participants in the different studies. Because the issue of personal perceptions of physical fitness keeps drawing our attention, this subject should be the focus on future research.

Sixth, this dissertation concentrate exclusively on exercise. Daily physical activity of frail institutionalized older persons was not included in this study. Especially daily physical activity, which can be accurately performance based assessed by different type of devices, may provide more insight in the relation between physical activity and disability, and in the mediating role of personal perceptions.

Personal reflections on elderly people

In this section, personal reflections and implications for the clinical practice of physiotherapists will be discussed. This dissertation ties scientific research to clinical practice in physiotherapy. The above studies reveal that research in the area of the most elderly persons living in homes for the elderly is very challenging. Many difficulties, questions, and challenges had to be addressed. Research in frail older people implies taking into account the vulnerability of the participants for whom every day is different, focusing on the weaknesses of frailty and old age. Disability, or narrowed down in our study to ADL performance, is a core issue in the lives of institutionalized elderly people. Through the many talks we had over the research period, we learned to admire this generation for its courage and perseverance. In western society, the older generation is often looked at as people who are expensive for society. The appreciation they may expect and earn is often not received. This is an important reason why older people are troubled by the idea of being dependent on the care of others. In my opinion, the oldest generation in society has to be treated not only with respect, but also with admiration for a lifetime of hard work. Our present society is built upon their labor and we do need their expertise right now.

Final considerations

The main issue of the studies in this dissertation was the question of how to find a way to keep frail older persons independent as long as possible from a physiotherapeutic perspective. Disability is mostly due to deterioration of muscles and joints which results in poor mobility. Mobility is the field of expertise of the physiotherapist, and mobility of frail institutionalized older adults in particular of the geriatric physiotherapist, who is educated to have a general view on the multiple health problems these people are experiencing.

Frail institutionalized older persons need an individual approach to improve strength, balance, and aerobic endurance aimed at prevention of the decrease of ADL performance. Exercise treatment should be provided as functionally as possible, home- based, and tailored to the state of actual fitness of the frail older persons. Not only should the physiotherapist address physical needs but also take into consideration psychological and social issues. Overall expertise on physical, psychological, and social health of frail older persons is essential to prevent them from becoming care dependent and experiencing decrease in quality of life. A geriatric physiotherapist is educated and well equipped to perform this task and to simultaneously cooperate with general practitioners, medical specialists, nurses, occupational therapists, dieticians, psychologists, and movement scientists to do justice to the multifaceted area of aging.

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Summary
Samenvatting
Dankwoord
Curriculum Vitae

Summary

This dissertation focuses on the ability of frail older persons, living in homes for the elderly, to stay as independent as possible. The quality of life in older adults depends for a great deal on whether they are dependent from care or not, and to what extent they are dependent. Care dependency is directly linked to ADL performance. Older people experience failure when they cannot look after themselves any longer, after a life of hard work and build up independence. From the view of a geriatric physiotherapist, optimalization of physical fitness characteristics like muscle strength, flexibility, aerobic endurance, coordination, and balance is the tool which may improve performance of activities of daily living (ADL).

To build an exercise program relevant to the use in an older person´s population, a systematic review was performed. The objective of this study was to perform a systematic review on training outcomes influencing physical fitness, ADL performance, and quality of life in institutionalized older people. 27 studies on older people (age ≥70 years) in long-term care facilities and nursing homes were reviewed. The ultimate goal was to propose criteria for an evidence-based exercise protocol aimed at improving physical fitness, ADL performance, and quality of life of frail institutionalized older people. The conclusion is that there is firm evidence for training effects on physical fitness, functional performance, ADL performance, and quality of life. The training should contain a combination of progressive resistance training, balance training, and functional training. The proposed intensity is moderate to high. The training frequency 3 times a week, and the total duration at least 10 weeks.

A study in this dissertation is a randomized controlled trial, in which an experimental group is compared with a control group. The experiment is built upon the hypothesis that an evidence- based training program should have a positive effect on ADL performance, physical fitness and care dependency in frail institutionalized older people. Frailty is a construct that includes physical, as well as psychological and social features, adversely affecting daily functioning of older people. As far as the physical aspects are concerned, weakness, under nutrition, slow walking speed, exhaustion, and a low level of physical activity are present, or at least three of these aspects. Not all institutionalized older persons are frail, but it is a growing problem among the older population and should be addressed by health professionals, under which physiotherapists. The trial, including group-based exercise, was performed in 14 assisted-living facilities for the elderly (>70 years old). Outcome measures were performance on ADL, physical fitness, and care dependency measures. The exercise program comprised group-based progressive resistance training, balance training, and functional training. The control intervention comprised social group meetings. A total of 164 individuals took part in the study (mean age: 84 years). There were no significant differences between the experimental and control groups over a 16-week period, although >50% of the subjects in the experimental group improved in muscle strength and performance-based ADL. A group-based exercise

program is ineffective in reducing disability and care dependency in frail institutionalized older adults. However, individual participants may benefit from the exercise program.

A path analysis was calculated to predict ADL performance. The question in this study was whether a performance based measure or a perceived fitness measure could predict ADL performance in a frail institutionalized older population. 75 older persons living in seven homes for the elderly and assisted- living apartments took part. A short battery performance-based fitness measures, the SAPF perceived physical fitness scale, and the GARS ADL performance questionnaire were taken and a path analysis was calculated. Performance-based fitness was significantly related with ADL performance. Clinicians should assess actual fitness on a regular basis to provide information on the ability of frail older persons to stay as care independent as long as possible.

In order to measure the effects of the experimental intervention and, more general, measure ADL performance and physical fitness, reliable and valid tools should be developed. Mostly assessment tools are validated for older people in general, and not specified for older persons living in residential institutions. Moreover, institutionalized older people have specific opportunities as well as limitations, which addresses the need to use specified tools.

The reliability and validity of the Self-Assessment of Physical Fitness (SAPF) was subject of a validation study. 76 elderly people (mean age 86 ± 6.3 year) completed the test. Cronbach's α was .71. One-week test-retest reliability ICC's ranged from .66 (SAPF aerobic endurance and SAPF balance) to .70 (SAPF sum score). Concurrent validity with the Groningen Fitness Test for the Elderly was fair to moderate. Despite the limited number of participants (N=76), results suggest that the scale may be useful as an assessment of perceived fitness in older adults.

To measure performance-based ADL the Performance ADL Test (PAT) was developed. The PAT contains 16 test items, covering the entire range of Basic ADL and Instrumental ADL performance in elderly people. In this study, 40 older people (mean age of 85 ± 7.5 years) participated. All 40 subjects lived in residential institutions in the Netherlands, were able to walk at least 10 meters, could understand instructions spoken in Dutch, and had no cognitive impairment. During the first test session, subjects completed the PAT, the Groningen Activity Restriction Scale (GARS), and performance-based physical fitness tests. Two week later, subjects were re-tested on the PAT. Factor analysis revealed three subscales: Organization of Performance, Gross Motor Function, and Fine Motor Function. Internal consistency (Cronbach's alpha) of all scales and subscales ranged from 0.73 to 0.88. Test-retest reliability (intraclass correlation) ranged from 0.32 to 0.95. Paired sample t-tests revealed no significant differences between subject performance obtained during the two test periods. Pearson's correlations between the PAT and the GARS ranged from 0.49 to 0.83, and between the PAT and the fitness tests from 0.32 to 0.78. Although the number of participants was limited (N=40), the PAT seems to be a useful instrument for assessing ADL performance in older people living in residential homes.

The general discussion gives an overview on the research questions and results of the studies, included in this dissertation. The most important message of this dissertation is that frail institutionalized older persons need an individual approach to improve strength, balance, and aerobic endurance. Exercise treatment should be given as functional as possible, home-based, and tailored to daily changing circumstances. Not only should the physiotherapist address physical needs, but also overlook psychological and social issues, and work together with other health care professionals. In my opinion, a geriatric physiotherapist is educated and well equipped to perform this task.

Samenvatting

Dit proefschrift richt zich op het vermogen van kwetsbare ouderen, wonende in verzorgingshuizen, om zo onafhankelijk mogelijk te blijven. Kwaliteit van leven van ouderen hangt voor een groot deel af van of zij afhankelijk zijn van zorg of niet en in welke mate zij afhankelijk zijn. Zorgafhankelijkheid is direct gerelateerd aan de uitvoering van activiteiten van het dagelijks leven (ADL) vaardigheden. Ouderen ervaren een gevoel van falen wanneer zij niet meer voor zichzelf kunnen zorgen, na een leven van hard werken en opgebouwde onafhankelijkheid. Vanuit het standpunt van een geriatriefysiotherapeut is het optimaliseren van fysieke fitheideigenschappen zoals spierkracht, lenigheid, uithoudingsvermogen, coördinatie en balans het instrument dat de uitvoering van ADL vaardigheden zouden kunnen bevorderen.

Om een trainingsprogramma te kunnen maken dat gebruikt kan worden door de oudere bevolkingsgroep werd een systematisch review uitgevoerd. Het doel van deze studie was een systematisch literatuuronderzoek naar training uitkomsten die fysieke fitheid, ADL vaardigheden en kwaliteit van leven van ouderen in instellingen kunnen beïnvloeden. 27 studies over ouderen (leeftijd ≥70 jaar) die in verzorgingshuizen en verpleeghuizen wonen werden beoordeeld. Het uiteindelijke doel was om criteria te kunnen opstellen voor een wetenschappelijk onderbouwd trainingsprotocol met als doel fysieke fitheid, ADL vaardigheden en kwaliteit van leven te verbeteren. De conclusie is dat er robuuste evidentie is voor effecten op fitheid, functionele en ADL vaardigheden en kwaliteit van leven. De training zou een combinatie moeten zijn van progressieve weerstandstraining, balanstraining en functionele training. De voorgestelde intensiteit is matig tot hoog. Trainingsfrequentie 3 x per week en de totale trainingsduur ten minste 10 weken.

Een van de studies in dit proefschrift is een gerandomiseerde gecontroleerde studie waarin een experimentele groep is vergeleken met een controlegroep. Het experiment was gebaseerd op de hypothese dat een wetenschappelijk onderbouwd trainingsprogramma een positief effect zou hebben op ADL vaardigheden, fysieke fitheid en zorgafhankelijkheid bij kwetsbare ouderen in verzorgingshuizen. Kwetsbaarheid is een construct dat zowel fysieke als psychologische en sociale aspecten, die het dagelijks functioneren van ouderen negatief beïnvloeden, in zich heeft. Voor zover het de fysieke aspecten betreft moeten spierzwakte, ondervoeding, verminderde loopsnelheid, uitputting en een laag niveau van fysieke activiteit aanwezig zijn, of tenminste 3 van deze aspecten. Niet alle verzorgingshuisbewoners zijn kwetsbaar in die zin, maar het is een groeiend probleem onder de oudere populatie en gezondheidszorg professionals waaronder geriatriefysiotherapeuten zouden met dit probleem aan het werk moeten gaan. De studie, die groepstraining inhield, werd uitgevoerd in 14 verzorgingshuizen (leeftijd deelnemers >70 jaar oud). Uitkomst variabelen waren ADL vaardigheden, fysieke fitheid en zorgafhankelijkheid. Het groepstrainingsprogramma omvatte progressieve weerstandtraining, balanstraining en functionele training. De controle interventie omvatte groepsbijeenkomsten met een sociaal doel. In het totaal deden 164 deelnemers (gemiddelde leeftijd 84 jaar) mee. Er waren geen significante verschillen tussen de experimentele en controlegroep na een periode van 16 weken, hoewel >50% van de deelnemers in de experimentele groep verbeterden in spierkracht en prestatie-gerelateerde ADL. Een groepstrainingsprogramma is niet effectief om zelfredzaamheid en zorgafhankelijkheid te verbeteren bij ouderen in verzorgingshuizen. Echter, individuele deelnemers zouden baat kunnen hebben bij het trainingsprogramma.

Om ADL vaardigheden te kunnen voorspellen werd een path-analyse uitgevoerd. De vraag gesteld in deze studie was of een prestatie-gerelateerd meetinstrument voor fitheid of een meetinstrument dat subjectieve fitheid meet ADL vaardigheden kan voorspellen bij kwetsbare ouderen in verzorgingshuizen. 75 ouderen, wonend in 7 verzorgingshuizen of aanleuncomplexen, namen deel aan de studie. Inclusiecriteria waren: tenminste 70 jaar, in staat om Nederlands gesproken instructies te kunnen begrijpen, zonder cognitieve beperkingen en in staat om tenminste 10 meter te lopen. Een kleine batterij prestatie-gerelateerde fitheid meetinstrumenten, de SAPF subjectieve fitheidschaal en de GARS zelfredzaamheid vragenlijst werden afgenomen en een path-analyse werd uitgevoerd. Prestatie-gerelateerde fitheid was significant gerelateerd aan ADL vaardigheden en voorspelt ADL vaardigheden voor 87%. Artsen en fysiotherapeuten zouden actuele fitheid regelmatig moeten meten om informatie te verkrijgen over het vermogen van ouderen om zo lang mogelijk onafhankelijk te blijven.

Om de effecten van de experimentele interventie, en meer algemeen, ADL vaardigheden en fysieke fitheid te kunnen meten zouden betrouwbare en valide meetinstrumenten ontwikkeld moeten worden. De meeste meetinstrumenten zijn gevalideerd voor ouderen in het algemeen, en niet specifiek voor ouderen die in verzorgingshuizen wonen. Bovendien hebben verzorgingshuisbewoners specifieke beperkingen, die het gebruik van specifieke meetinstrumenten noodzakelijk maken.

De betrouwbaarheid en validiteit van de Self-Assessment of Physical Fitness (SAPF) was het onderwerp van een valideringsstudie. 76 ouderen (gemiddelde leeftijd 86± 6,3 jaar) voltooiden de test. Cronbach's alpha was .71. De Intraclass correlatie van de test-hertest betrouwbaarheid met een week tussenruimte varieerde van 0.66 (SAPF uithoudingsvermogen en SAPF balans) tot 0.70 (SAPF totaalscore). Concurrent validiteit met de Groningen Fitheid test voor Ouderen (GFO) was matig tot gemiddeld. Ondanks het beperkte aantal deelnemers (N=76) suggereren de resultaten dat de schaal bruikbaar is als meetinstrument voor subjectieve fitheid van ouderen.

De Performance ADL Test (PAT) werd ontwikkeld om ADL vaardigheden te meten. De PAT omvat 16 onderdelen, die het gehele gebied van Basis ADL en instrumentele ADL omvatten. In deze studie waren 40 deelnemers geïncludeerd (gemiddelde leeftijd 85 ± 7,5 jaar). Alle deelnemers woonden in verzorgingshuizen in Nederland, waren in staat tenminste

10 meter te lopen, konden in het Nederlands gesproken instructies begrijpen en hadden geen cognitieve beperkingen. Gedurende het eerste testmoment voltooiden de deelnemers de PAT, de Groningen Activiteiten Restrictie Schaal (GARS) en een aantal fitheidtesten. Twee weken later was de hertest waarbij alleen de PAT werd uitgevoerd. Factor analyse bracht 3 subschalen aan het licht: Organisatie van uitvoering, grove motoriek en fijne motoriek . Interne consistentie (Cronbach's alpha) van alle onderdelen en de subschalen varieerde van 0.73 tot 0.88. De test-hertest betrouwbaarheid (intraclass correlatie) varieerde van 0.32 tot 0.95. De gepaarde t-test liet geen significante verschillen zien tussen de uitvoering van de test gedurende beide testmomenten. De Pearson's correlatie tussen de PAT en de GARS varieerde van 0.49 tot 0.83 en tussen de PAT en de fysieke fitheidtesten van 0.32 tot 0.78. Ondanks het beperkte aantal deelnemers (N=40), lijkt de PAT een bruikbaar instrument om ADL vaardigheden in oudere verzorgingshuisbewoners te meten.

De algemene discussie van het proefschrift geeft een overzicht over de onderzoeksvragen en resultaten van de studies die opgenomen zijn in het proefschrift. De belangrijkste boodschap van deze dissertatie is dat kwetsbare verzorgingshuisbewoners een individuele aanpak nodig hebben om kracht, balans en uithoudingsvermogen te verbeteren. Oefentherapie zou zo functioneel mogelijk gegeven moeten worden, het liefst in de thuissituatie en aangepast aan de dagelijks veranderende omstandigheden. De fysiotherapeut zou niet alleen fysieke problemen moeten behandelen, maar ook oog moeten hebben voor psychologische en sociale problemen en moeten samenwerking met andere professionals in de ouderenzorg. Naar mijn mening is een geriatriefysiotherapeut opgeleid en bekwaam om deze taak te vervullen.

Dankwoord

Een proefschrift schrijven, en het bijbehorend onderzoek uitvoeren, het is zoals al vaker gezegd, een klus waaraan je begint voordat je bezint. Alles is nieuw en toch door anderen al zo vaak gedaan. Als promovendus ben je de manager van je eigen project en de spin in het web, maar o, wat kan een spin zich eenzaam voelen. Gelukkig maar dat er promotoren, copromotoren, collega onderzoekers, familieleden, vrienden en bekenden zijn, die je begeleiden, steunen, opbeuren, troosten, bemoedigen, verder helpen, uitlachen en vooral in hun wijsheid laten delen. Zonder jullie was het allemaal niet afgekomen, en waarschijnlijk zelfs geen zinnige letter op papier.

Ik ben mijn begeleidersteam, Prof. dr. CP van der Schans, Prof. dr. JPJ Slaets, dr. MHG de Greef en dr. W. Krijnen van harte dankbaar voor hun goede begeleiding.

Cees, ik weet nog dat ik bij jou kwam omdat ik vond dat fysiotherapeuten iets meer van wetenschap af moesten weten. Alsof dat al niet lang door jou als lector van het Lectoraat Transparante Zorgverlening in gang was gezet en niet alleen voor fysiotherapie, maar ook voor de andere gezondheidstudies en verpleegkunde. Ik mocht een dag in de week komen werken, waar ik heel blij mee was. En langzamerhand kwamen de ideeën voor een promotietraject. Je hebt me altijd gesteund, ook vermaand als ik eigenwijs was en meende dat ik dingen niet eerst hoefde overleggen, tenslotte, ik was al 50! Uiteindelijk is het er toch van gekomen en dat is voor een groot deel aan jouw zeer goede begeleiding te danken.

Joris, de eerste keer dat we een afspraak hadden was ik als de dood voor jou. Jij was zo geleerd, een echte professor en ik was bang dat je vragen zou stellen waar ik het antwoord in de verste verte niet op zou weten. Bij de eerste vraag die ik je stelde bleef het dan ook heel lang stil. Ik dacht dat je niet zo goed wist hoe je onder woorden moest brengen waar ik überhaupt mee bezig was. Maar nee, je hebt me privécolleges gegeven over veroudering, frailty, zelfredzaamheid, kwaliteit van leven, waar ik heel veel aan gehad heb. Wat wij vooral delen is onze betrokkenheid bij de patiënt en dat waardeer ik erg in je: dat de patiënt de eerste plaats inneemt in alles wat wij ondernemen.

Mathieu, jij was de eerste die me enthousiast maakte voor wetenschappelijk onderzoek. “Bij toeval” kwam ik bij je terecht omdat ik tijdens de opleiding tot geriatriefysiotherapeut een paper moest schrijven over een oefenprogramma met een groep ouderen in een verzorgingshuis. En zo was Benenfit geboren. Ik heb genoten van al onze gesprekken over ouderen, de kunst van de zelfredzaamheid en de cyclus van gezondheid en frailty. Nooit was een vraag je te veel, nooit liet je merken dat ik dingen ook wel eerst even zelf uit kon gaan zoeken, altijd had je

een luisterend oor en was je weer bereid tot uitleg. Zonder jou was er zelfs geen wetenschap in mijn leven gekomen. Ik ben je zeer dankbaar.

Wim, hartelijk bedankt voor de begeleiding bij de statistiek, voor mij nog steeds letterlijk hogere wiskunde. Door jouw uitleg kon ik er nog een beetje soep van koken, maar het blijft een lastig onderdeel van onderzoek. Ik ben je dankbaar.

Erik Scherder ben ik dankbaar voor de start van het promotietraject. Jij was altijd enthousiast en het is jammer dat je terug moest naar Amsterdam en daardoor moeilijker bereikbaar werd. Hartelijk bedankt voor je bemoedigende woorden en begeleiding.

Geiske Steendam wil ik bedanken voor de mogelijkheid om betaald onderzoek te gaan doen bij het Lectoraat Transparante Zorgverlening. Ik heb geprofiteerd van het feit dat je wetenschappelijk onderzoek hoog in je vaandel had.

Collega's van de onderzoeksgroep, bedankt voor jullie vriendschap en collegialiteit. Om de beurt moesten we presenteren en ik vond dat wel lastig. Jullie hebben me gesteund en bemoedigd.

Vriendinnen van de onderzoekskamer A0.20. Wat hebben we een geweldige tijd gehad en ik heb gehuild toen Judith me kwam vertellen dat ik er niet meer mocht zitten vanwege ruimtegebrek. Gelukkig liep het niet zo'n vaart. Wat fijn waren onze vele gesprekken, over het werk en andere dingen, onze wandelingen door het park, onze etentjes (soms veel te duur), en zo vele andere dingen. Dank jullie wel!

Judith, ik dank je voor de begeleiding bij praktische zaken. Je efficiëntie is geweldig en je bent onmisbaar voor ons als onderzoekers.

Marieke en Yvo, dank jullie wel voor jullie begeleiding bij het artikel over de PAT. Ondanks dat jullie het erg druk hadden, konden we steeds overleggen en is de studie tot een goed einde gekomen.

En dan de onnoemlijke rij studenten, die meewerkt hebben als testleiders, trainers, assistent-onderzoekers enz. Ik denk dat het er meer dan 100 zijn geweest. Zonder jullie zou dit project niet zijn geslaagd. Hartelijk dank en succes met jullie verdere carrière.

Lieve collega's van A0.34. Dank jullie wel dat jullie me hebben geholpen in de eerste, best moeilijke maanden dat ik docent fysiotherapie was. Het promotietraject is niet vertraagd doordat ik met de andere vragen altijd bij jullie terecht kon. We hebben het geweldig samen.

Vrienden en vriendinnen, dank jullie wel dat je geduld had met een vriendin die maar bleef studeren en voor jullie belangstelling. Nu is er meer tijd voor kopjes koffie en shoppen. Hoewel….wetenschappelijk onderzoek blijft boeien.

Familie, broers en zussen, jullie hebben je vaak afgevraagd waar ik toch mee bezig was. Zoveel jaar studeren, onbegrijpelijk. Fijn, dat jullie bij de dag van de promotie aanwezig zullen zijn en dan kunnen zien wat zoiets inhoudt.

Mamma, jammer dat u het allemaal niet meer zo meekrijgt. Ik ben blij, dat u goed verzorgd wordt in de Diamant en dat u er, samen met pappa, voor heeft gezorgd dat ik kon studeren en fysiotherapeut kon worden. Ik wil u bedanken voor een hele fijne, onbezorgde jeugd.

Lieve Adriaan, Marianne, Siebrand, Linet, Eize, Marian en Marco. Heel hartelijk bedankt voor jullie liefde en aanhankelijkheid. Eindeloos veel sinterklaasgedichtjes hebben jullie op je naam staan waarin maar weer stond dat mamma nog niet zat was van studeren. En ik ben bang dat mamma er nog niet zat van is. Ik hou van jullie!

Lieve Jordy, Erwin, Matthias, Ieke en Lisanne. Ik ben een beetje een rare oma, die bijna nooit op jullie past en altijd aan het werk is. Ik hoop, dat jullie heel groot worden en het maakt voor mij helemaal niet uit wat je later gaat worden. Jullie zijn geweldig en oma houdt van jullie allemaal even veel.

Allerliefste Joop, al 35 jaar zijn we bij elkaar en tussen ons komt niets of niemand. Zonder jou was dit project niets geworden. Door jouw steun kon ik dit ondernemen, doorzetten en voltooien. Dank je wel voor je liefde, steun, bemoediging en trouw. Ik weet dat je hoopt op iets rustiger tijden en daar zal ik mijn best voor doen. Maar…retirement is not an option. Ik houd van je!

In de eerste en de laatste plaats dank aan God, mijn Vader. U bent het, die van mij houdt en mijn leven leidt. Aan U heb ik mijn bestaan te danken en U kent mij nog beter dan ik mijzelf ken, zodat U mijn vragen al kent voordat ik ze gesteld heb. Dank U wel voor uw goedheid en uw trouw. Dank U voor wetenschap, zodat wij uw schepping kunnen bestuderen. Ik leef voor U!

Curriculum vitae

Betsy Dijksterhuis werd geboren op 13 augustus 1958 in Groningen. Zij behaalde haar diploma VWO in 1976 en studeerde fysiotherapie aan de Academie voor Fysiotherapie te Groningen. In 1980 haalde ze haar diploma, waarna zij ging werken in een particuliere praktijk in Groningen. Na een jaar stopte ze met werken om thuis te zijn voor haar man en kind(eren) en maakte een herstart in de fysiotherapie in het jaar 2000. Zij kwam terecht in een particuliere praktijk waar veel ouderen behandeld werden en raakte geïnteresseerd in de geriatrie. In 2004 rondde zij de post-HBO opleiding geriatrie in de fysiotherapie in Utrecht af. Tijdens deze opleiding werd de interesse voor wetenschap gewekt en in 2005 werkte zij als trainer mee aan een wetenschappelijk onderzoek bij eenzame ouderen. In 2006 kwam zij bij het Lectoraat Transparante Zorgverlening van de Hanzehogeschool in Groningen onder lector Cees van der Schans. In het voorjaar van 2007 werd een start gemaakt met het promotieonderzoek met als onderwerp het effect van een trainingsprogramma op zelfredzaamheid, fitheid en zorgafhankelijkheid bij verzorgingshuisbewoners. Hierin werkten mee de Hanzehogeschool Groningen en de Rijksuniversiteit Groningen.

Betsy komt uit een gezin met een kind en is geboren en getogen in de stad Groningen. Na haar huwelijk op 6 juni 1980 is zij verder door het leven gegaan als Betsy Weening-Dijksterhuis. Zij heeft vier zonen in de leeftijd van 24 tot 32 jaar, en 3 schoondochters. Zij heeft 5 kleinkinderen in de leeftijd van 1 tot 7 jaar. In haar vrije tijd houdt zij zich bezig met haar gezin en de evangelische gemeente, waartoe zij behoort. Verder houdt ze van lezen en reizen. Betsy werkt op dit moment als geriatriefysiotherapeut in de particuliere praktijk in Groningen en als docent aan de opleiding fysiotherapie en hoopt zich te kunnen blijven inzetten voor wetenschappelijk onderzoek bij ouderen.

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