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The effect of frailty on residential/nursing home admission in the Netherlands independent of chronic diseases and functional limitations

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Abstract The aim of this study was to determine the effect of frailty on the risk of residential/nursing home admission independently of chronic diseases and functional limitations. Frailty consists of multisystem decline and is considered to be a consequence of changes in neuromuscular, endocrine and immune system functioning that occur as people age. Frailty is a combination of multiple impairments in functioning that might lead to functional limitations and disability but it is not clear whether frailty has an independent effect on residential/nursing home admission. Data were used from the Longitudinal Aging Study Amsterdam. The respondents participated at both T_1 (1992/1993) and T_2 (1995/1996), lived independently at T_2 , and were aged 65 and over ($n=1,503$). Nine frailty markers were assessed at two cycles (T_1 and T_2). The frailty markers were defined in two ways: low functioning at T_2 (static frailty); and change in functioning between T_1 and T_2 (dynamic frailty). The outcome variable was residential/nursing home admission between T_2 and T_4 (2001/2002). Cox proportional hazard analyses were used adjusting for chronic diseases, functional limitations, care received,

partner status, income, age and sex. Static (RR 1.93, 95%CI 1.36–2.74) and dynamic frailty (RR 1.69, 95%CI 1.19–2.39) were associated with institutionalization in both men and women independently of the effect of chronic diseases and functional limitations. Additional analyses of the total number of both sets of frailty markers present revealed an increased risk of institutionalization when the number increased. In conclusion, frailty is associated with institutionalization, independently of the effect of chronic diseases and functional limitations.

Keywords Frailty · Nursing home admission · Functional limitations · Aging and epidemiology

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Introduction

Frailty is a term often used to describe a dynamic state of reduced physiologic reserve (Buchner and Wagner 1992), disability, co-morbidity (Strawbridge et al. 1998) and multisystem decline (Campbell and Buchner 1997; Fried et al. 2001a; Walston and Fried 1999). There are no widely accepted criteria to identify frail persons (Bortz 2002; Brown et al. 1995; Morley et al. 2002). Frailty is considered to be a consequence of changes in neuromuscular, endocrine and immune system functioning (Fried et al. 2001a). Frailty can be seen as a position on a continuum from healthy at one end and slightly frail, moderately frail to very frail at the other (Brown et al. 1995; Chin A Paw et al. 2003; Fried and Walston 1998). It can lead to adverse outcomes such as institutionalization and mortality. Some studies defined frailty as the sum of a number of frailty markers (Buchner and Wagner 1992; Campbell and Buchner 1997; Fried et al. 2001a; Puts et al. 2005; Raphael et al. 1995; Rockwood et al. 2000).

Frailty, disability and chronic diseases are related to each other but they are different concepts (Fried et al. 2004). Frailty is a dynamic state in which an older person is at high risk of adverse outcomes due to reduced

physiological reserve capacity; small changes in health may push them across the threshold of frailty. Frailty includes decline in multiple systems (for example decline in sensory functioning, cognitive functioning, physical functioning, psychological functioning) (Fried et al. 2001a; Walston and Fried 1999; Strawbridge et al. 1998; Campbell and Buchner 1997) which occurs as people age (Walston and Fried 1999; Ferrucci et al. 2002). In the model of the disablement process by Verbrugge and Jette (1994), the pathway from pathology to disability is described. Verbrugge reported recently that frailty could be seen in the disablement process as a constellation of impairments, a syndrome that can lead to functional limitations and disability. Functional limitations include restrictions in basic physical and mental actions such as reaching, stooping, whereas disability is difficulty in doing activities in daily life, such as household activities, job and personal care (Verbrugge 2005). Frailty can be seen as a precursor state of functional limitations and disability. Disabled persons can become frail when more areas of functioning decline with aging. Frail people can become disabled due to decline in multiple systems, suffering from the adverse outcomes of frailty. Likewise, people with one chronic disease can be very stable but when the number or severity of chronic diseases even mildly increases, then people can become frail (Fried et al. 2004). Another concept concerning disability is subclinical disability which is described when persons do not report having difficulty with ADL activities or physical functioning but have changed their routine (Wolinsky et al. 2005; Fried et al. 2001b). These changes in functioning can be the result of frailty and eventually cause adverse outcomes such as disability.

As frailty is a precursor state of functional limitations and disability, it is important to study whether frailty has a unique effect. Frailty is a combination of multiple impairments in functioning, which might lead to disability, but it is not clear whether frailty has an independent effect on residential/nursing home admission.

Frailty has been shown to be correlated with increasing length of hospital stay and nursing home institutionalization in hospitalized patients (Winograd et al. 1991). Rockwood et al. (1999) showed a dose-response relation between increasing frailty and increasing risk of subsequent institutionalization in a community sample. Although frailty is assumed to be a dynamic state, most studies so far have used static definitions of frailty (Campbell and Buchner 1997; Fried et al. 2001a; Mitnitski et al. 2002a, b; Rockwood et al. 1999; Winograd et al. 1991; van Campen and van Gasteren 2003). No study has to the best of our knowledge investigated the relation between change in frailty and nursing home admission. However, the use of baseline predictors offers little insight into the course of events leading to institutionalization and the effect of deteriorating health status (Gaugler et al. 1999; Wolinsky et al. 1993). A few studies have focused on the effect of change in predictors other than frailty and found that change in care needs (Tomiak et al. 2000), such as an

deterioration in advanced ADL's and in increase of lower body limitations, (Wolinsky et al. 1993; Scott et al. 1997), predicted institutionalization.

Several authors state that relatively few longitudinal data are available on predictors for institutionalization in representative community-based populations (Bharucha et al. 2004; Nuotio et al. 2003; Tomiak et al. 2000; Wang et al. 2001). One of those studies with representative longitudinal data was conducted in the USA (Bharucha et al. 2004), the other studies were conducted in Finland (Nuotio et al. 2003), Canada (Tomiak et al. 2000) and Australia (Wang et al. 2001). Bharucha et al. (2004) found that dementia and medical burden were important predictors for institutionalization in the USA. In Canada Tomiak et al. (2000) showed that age and specific medical conditions and functional limitations predicted nursing home admission. Nuotio et al. (2003) found that age, urge incontinence, depressive symptoms for men only and living alone only for women predicted institutionalization in Finland. Wang et al. (2001) found that a range of non-cognitive factors predicted nursing home placement in Australia. In each of these countries, the care system is organized differently and therefore the results cannot be compared easily across countries.

The Netherlands have a high institutionalization rate compared to other countries (Hoek et al. 2000). In 2003 100,799 persons lived in residential homes and 56,699 lived in nursing homes (Ministry of Health 2005), which was 7.1% of all persons aged 65 and older in the Netherlands in 2003 (<http://statline.cbs.nl>). In the Netherlands, the expenses for long-term care facilities are covered by the 'Exceptional Medical Expenses Act' (AWBZ) (National insurance) so that long-term care is accessible for all citizens.

Huge costs are associated with residential/nursing home admission. Frailty may be a potentially reversible state and may be prevented or postponed (Wilson 2004). If persons who are frail can be easily identified and treated, institutionalization may be postponed and frail elderly can live longer in the community, which also corresponds to the wishes of older people.

The aim of this study was to investigate the effect of frailty on the risk of residential/nursing home admission among men and women in the general population in the Netherlands independent of the effect of chronic diseases and functional limitations. We investigated frailty both in a dynamic as well as in a static sense to examine whether static or dynamic frailty increased the risk of institutionalization more and whether these definitions had own unique effects.

Methods

Study sample

The data were collected in the context of the *Longitudinal Aging Study Amsterdam* (LASA). LASA is an ongoing multidisciplinary study of predictors and

consequences of changes in physical, emotional, cognitive and social functioning in older people in the Netherlands (see also <http://ssg.scw.vu.nl/lasa>). A random sample stratified by age and gender according to expected mortality after 5 years, was drawn from population registers of 11 municipalities in three geographical areas in the Netherlands. At each cycle, data were collected in a face-to-face main interview followed by a medical interview 2–6 weeks later. The details of the LASA study have been described elsewhere (Deeg et al. 1993, 2002; Kriegsman et al. 1996; Smit et al. 1998). The Medical Ethical Review Board of the VU University Medical Center approved the study and informed consent was obtained from all respondents.

The sample for this study (see Fig. 1) consisted of respondents who participated in the face-to-face main baseline interview (1992/1993, T_1 , aged 62 and over) and at first follow-up (1995/1996, T_2) and were aged 65 years and older ($N=1,944$). In the Netherlands persons are rarely admitted to a residential/nursing home under the age of 65 and the circumstances and reasons for admission are likely to be different than admission at old age, therefore all respondents aged younger than 65 were excluded. Respondents were excluded at T_2 if they were already institutionalized (110, 5.7%). Respondents who had no face-to-face main interview (206, 10.6%) were excluded because in a telephone or proxy interview no frailty markers were measured.

If the respondent refused a normal face-to-face main interview at T_3 (1998/1999) or T_4 (2001/2002), the respondent was offered a short telephone interview

(48 at T_3 , 67 at T_4) and if the respondent was incapable due to cognitive or physical problems, a proxy (38 at T_3 , 63 at T_4) was asked some questions about the respondent. In both these interviews, it was asked if the respondent lived in an institution. Respondents were excluded if they refused or were unable to participate (due to physical or cognitive problems) or could not be contacted at T_3 (53, 2.7%), because no information was available on institutionalization. Those who refused at T_4 were kept in the study sample until T_3 (22, 1.1%). One respondent was excluded because the residential status before death was unknown (1, 0.1%). Finally, respondents were excluded if they had no complete data on functional limitations, income, care received or chronic diseases at T_2 (56, 2.9%). Fifteen respondents (0.8%) were excluded from the analyses because they were censored before the first event (institutionalization) happened. The final sample included 1,503 respondents (77.3%). As compared to those included, the non-respondents were significantly older, and had lower cognitive functioning, more depressive symptoms and lower sense of mastery (according to the Pearlin and Schooler Mastery scale) at T_2 . There were no differences concerning sex or the number of chronic diseases.

For all respondents who participated at T_2 , lived independently, and died before the next measurement cycle, it was determined whether this respondent had been admitted to a residential/nursing home before death. For 18 of these respondents the residential status was unknown. The analyses are performed with these 18 respondents classified as non-institutionalized and as

Fig. 1 Study participants and dropouts

institutionalized to investigate whether these respondents influenced the estimates of the risks of institutionalization.

Measures

Residential/nursing home admission

The face-to-face main interview took place at the home of the respondent. The interviewer recorded if this was a residential home or nursing home. With the information about residential status of the respondent at the interviews before, a variable institutionalization (yes/no) was constructed.

Frailty markers

Nine frailty markers were used to study the effect of frailty on residential/nursing home admission [see Puts et al. (2005) for an extensive description]. The nine frailty markers were body weight (calibrated bathroom scale), peak expiratory flow [Mini Wright peak flow meter (Cook et al. 1995)], cognition [MMSE (Folstein et al. 1975)], vision and hearing ability (asking the respondent are you able to recognize someone's face at a distance of 4 m and are you able to follow a conversation with one and four persons, both with aid if needed (Central Bureau of Statistics 1989), incontinence (asking the respondent whether he or she lost urine unintentionally), sense of mastery [short version of Pearlin and Schooler Mastery scale (Pearlin and Schooler, 1978)], depressive symptoms [CES-D (Radloff 1977)] and physical activity [LASA Physical Activity Questionnaire (Stel et al. 2004)]. These nine frailty markers were selected because the concept of frailty was conceived as more than only physical functioning. The frailty markers selected are based on previous studies (Brown et al. 1995; Chin A Paw et al. 1999, 2003; Fried et al. 2001a; Hogan et al. 2003; Miles et al. 2001; Rockwood et al. 1999; Strawbridge et al. 1998). The validated model of Fried et al. (2001a) is often used in studies on frailty and it includes five frailty markers. The five frailty markers are weight loss, exhaustion, low physical activity, slowness and weakness. In this study, in addition to a comparable measure of frailty, we also wanted to include psychological frailty markers which have often been neglected (Hogan et al. 2003; Markle-Reid and Browne 2003).

In addition, other studies examined the effect of different frailty markers and some of those frailty markers are included as well. The studies of Chin A Paw et al. (1999, 2003) showed that inactivity and weight loss were good criteria for selecting frail people. The study of Strawbridge et al. (1998) showed that frail persons reported fewer activities, poorer mental health and lower life satisfaction. Strawbridge et al. (1998)

defined frailty as involving problems or difficulties in two or more functional domains (physical, nutritive, cognitive as well as sensory). Miles et al. (2001) showed that prevalent and new-onset incontinence were associated with disability. The study of Rockwood et al. (1999) showed that a frailty scale including ADL-activities, continence and cognitive functioning had a dose-response relationship with mortality. First, measurement instruments in the LASA were selected comparable to the frailty markers of Fried et al. (2001a). The first frailty marker weight loss could be calculated from body weight. The second frailty marker, exhaustion was measured with two items of the Center for Epidemiological Studies-Depression scale that is available in LASA. However, these two items are somatic items (Radloff 1977). The total score of the CES-D was included as a psychological marker of frailty. The third frailty marker, physical activity was available in LASA. The fourth frailty marker, slowness (walk time) was not included in this study. Walk time increases when frailty increases. Physical decline was used as an adverse outcome of frailty and not as a marker for frailty. The fifth frailty marker was grip strength as a measure of weakness, which was not available at the baseline of LASA. We included peak expiratory flow as a surrogate marker of weakness. At first follow-up of LASA, grip strength was available and correlated with peak expiratory flow (Spearman $\rho=0.55$). Furthermore, vision and hearing capacity were included as suggested by Strawbridge et al. (1998). Depressive symptoms and mastery were included as psychological frailty markers. Incontinence was selected because of the study of Miles et al. (2001) and Rockwood et al. (1999). Also poor cognitive functioning was included from the scale of Rockwood et al. (1999). However, markers such as ADL-activities were not included in our frailty markers as they are conceived to be adverse outcomes of frailty.

Cut-offs for the frailty markers

Nine frailty markers were assessed at two cycles, T_1 and T_2 . For each of the frailty markers the cut-off distinguishing the frail respondents from the non-frail respondents was determined in two different ways. For the cut-off for the static frailty markers low functioning at T_2 was used and a dynamic frailty marker was defined as relevant decline in functioning between T_1 and T_2 . First, we determined from the distribution of each marker at T_2 , the lowest quintile of functioning at that moment for the continuous variables (mastery, peak flow and physical activity). For the other variables (BMI < 23, MMSE < 24, CES-D ≥ 16 , any difficulty with vision and hearing, and incontinence) cut-offs for low functioning were based on the literature (Brown et al. 1995; Chin A Paw et al. 1999, 2003; Fried et al. 2001a; Hogan et al. 2003; Miles et al. 2001; Rockwood et al. 1999; Strawbridge et al. 1998).

Second, change in the markers was determined between T_1 (1992/1993) and T_2 (1995/1996). For the continuous variables, CES-D, MMSE, mastery and physical activities, the Edwards-Nunnally index was used to determine decline (Speer and Greenbaum 1995). The Edwards-Nunnally index calculates individual significant change based on the reliability of the measurement instrument, the confidence interval and the population mean (Speer and Greenbaum 1995). This index has been developed to determine pretest–posttest recovery. It classifies pre–posttest change as improved or deteriorated using the confidence interval. If the posttest score lies outside of this confidence interval it is considered to be significantly different from the pretest score. The pre–posttest change is adjusted for regression to the mean. In this study the 90% confidence interval is used for the independent frailty markers. The scores were dichotomized into decline as (1) versus no decline (0). For decline in peak flow more than 0.5 standard deviation of the difference was used because reliability analysis of the peak flow measurement is not possible as it is not a scale, and thus the Edwards-Nunnally index cannot be calculated. The other cut-offs were for perception, increasing difficulty with vision and hearing, new-onset incontinence, weight loss > 4 kg in 3 year. All independent variables were dichotomized so they can be counted and have a straightforward clinical interpretation (the appendix with all frailty markers and cut-off is available on request). Missing values on the frailty markers were not imputed.

Frailty

Frailty was defined as present when a subject had scores above the cut-off on three or more frailty markers described above, which is in accordance with Fried et al. (2001a). The static definition was based on the frailty markers at T_2 . The dynamic definition was based on the change in the frailty markers between T_1 and T_2 .

Covariates

Age at T_2 was divided into tertiles in this study. The functional limitations score was measured by self-reports at the first follow-up. The respondents were asked about the degree of difficulty they experienced with six activities: climbing stairs, walking 5 min outdoors without resting, getting up from and sitting down in a chair, dressing and undressing oneself, using own or public transportation, and cutting one's own toenails (van Sonsbeek 1988). Response categories ranged from (1) “No I cannot” to (5) “Yes without difficulty”. The total score was calculated by summing the scores. This score was recoded ($6 = 30$), such that an increase in the score reflects an increase in functional limitations. The sum score of functional limitations was divided into tertiles for the analyses.

Seven chronic diseases were asked: chronic obstructive pulmonary diseases, cardiac disease, peripheral arterial disease, diabetes mellitus, cerebrovascular accidents, rheumatoid arthritis or osteoarthritis and cancer. The total number of chronic diseases was used (Kriegsman et al. 1996).

Household real monthly income was determined by showing a card with 12 possible income categories at T_2 . The categories were recoded to the median monthly income and the last category was set at 2,614 euros. The household real monthly income of respondents living with a partner was multiplied by 0.7 to make it comparable to respondents who lived alone (Schiepers 1988). If the income data was missing at T_2 , data of T_1 was used to prevent missing values. Income was divided into tertiles for the analyses.

The care received was determined at T_2 . The respondents were asked if they received help with household activities or personal care. If so they were asked from whom they received help. The responses were divided into the categories no care (0), informal care (1), professional care paid out of the pocket (2), and professional subsidized care (3). If respondents had help with both household and personal care from informal and professional caregivers, they were categorized as having professional care.

Partner status was categorized into living with a partner in household at both time points (T_1 and T_2), no partner at both time points, and the loss of the partner between T_1 and T_2 , due to death or admission in a care facility.

Statistical analysis

Time to admission was calculated in days from the date of the face-to-face main interview at first follow-up (1995/1996). The design of LASA with three-yearly measurement cycles limits the exact determination of admission date. For the statistical analyses, for all respondents, the date of institutionalization was assumed to be the midpoint between the previous assessment (before the respondent was institutionalized) and the subsequent assessment when the respondent was institutionalized. If the respondent died between two assessments and his last residence was a residential/nursing home, the date of institutionalization was assumed to be the midpoint between last assessment and death. The respondents were censored at the date of death or the last interview at T_3 or T_4 .

The assumption of the Cox proportional hazard analysis, a constant hazard ratio, was checked using LML plots and interaction terms between frailty and time (using different cut-off points of the months of follow-up) in the analyses. The assumption of a constant hazard ratio over time was not violated. The presence of informative censoring was checked by comparing the mean follow-up time of both the frail and the non-frail group that were censored (no event) to each other.

It appeared that there was informative censoring, i.e. the mean follow-up duration of the censored people in the frail group was less than for the non-frail group.

The association between frailty and admission to a residential/nursing home was examined in several ways. First, for all single static frailty markers the association with institutionalization was examined using Cox proportional hazard analysis adjusted for age and sex. For all single dynamic frailty markers, the association was also adjusted for baseline values.

In order to examine if frailty predicted institutionalization, Cox regression analysis were performed for the static and dynamic definition of frailty. It was investigated if there was interaction between independent variables and sex. The analyses were adjusted for age, sex, income, partner status, and care received. In a next step, the analyses were additionally adjusted for functional limitations and number of chronic diseases. Subsequently, the analyses were additionally adjusted for the other definition of frailty to study the unique effect of both definitions of frailty (dynamic frailty when investigating static frailty and vice versa).

Thirdly, the association between the total number of frailty markers using both definitions and institutionalization were examined. Dummies were used for each count of frailty markers to study the effect of the different numbers of frailty markers with the reference group, the group with no frailty markers. Respondents with four or more markers were pooled together because of small numbers.

As a consequence of the small number of respondents in the youngest age group (the reference category with few respondents institutionalized), the confidence intervals for the other age groups were large. Therefore, we repeated all analyses with the middle tertile of the age group as the reference, excluding the youngest group from the analyses. Finally, we performed sensitivity analyses in which the 18 respondents with unknown residential status classified as not institutionalized in the main analyses, now were classified as institutionalized. All analyses were carried out using SPSS version 12.0.1.

Results

Table 1 shows the characteristics of the study sample. More women ($N=104$, 13.1%) than men ($N=49$, 6.9%) were admitted to a residential/nursing home. Women had more frequently a low income and more often no partner in the household ($P<0.05$). Women had more static frailty markers than men and had more functional limitations ($P<0.05$). Respondents who were admitted were older, lived more often alone, had more frailty markers, more chronic diseases and more functional limitations ($P<0.05$). In particular, those who were institutionalized had more often decline in weight, had more often low peak flow, low cognition, vision problems, were more often incontinent, had more often low

mastery, and suffered more often from symptoms of depression ($P<0.05$) than the non-institutionalized.

Frailty and institutionalization

For all single frailty markers the association with institutionalization was studied adjusting for age and sex (Table 2). Concerning the static frailty markers, low cognition, incontinence, low mastery, and low physical activity were significantly associated with institutionalization. There was an interaction between sex and symptoms of depression. Symptoms of depression were significantly associated with institutionalization in men but not in women. Concerning the dynamic frailty markers, weight loss, decline in peak flow, decline in cognition, decline in physical activity and an increase in depressive symptoms were significantly associated with institutionalization.

In men ($N=712$), 103 (14.5%) were frail according to the static definition, and 164 (20.7%) in women ($N=791$). There were 144 (20.2%) men and 169 (21.4%) women who met the criteria for dynamic frailty. In men, 56 (7.9%) fulfilled the criteria for both static and dynamic frailty. In women, 88 (11.1%) met the criteria for both static and dynamic frailty.

Next, Cox's regression analyses were performed to determine whether frailty increased the risk of being institutionalized (Table 3). The relative risk (RR) for the static definition of frailty, adjusted for age, sex, income, partner status, care received, number of chronic diseases and the functional limitation score was 1.93 (95%CI 1.36–2.74). The RR for the dynamic definition of frailty was 1.69 (95%CI 1.19–2.39) for both men and women. There was a significant interaction between functional limitations and sex. In women, functional limitations were not associated with institutionalization, but men with the most functional limitations had an increased risk of institutionalization. Additionally the other definition of frailty was added to the analyses to investigate whether both definitions of frailty had a unique effect. The RR of static frailty adjusted for the presence of dynamic frailty changed into 1.73 (95%CI 1.19–2.50). The RR for dynamic frailty changed into 1.42 (95%CI 0.98–2.06).

The analyses were repeated with the youngest age tertile excluded and the middle age tertile as the reference group. The RR for static frailty was 1.95 (95%CI 1.36–2.80), and the RR for dynamic frailty was 1.79 (95%CI 1.25–2.56) for both men and women. Again significant interaction was found between the functional limitations score and sex. In women, the functional limitation score was not associated with institutionalization. Men with the most functional limitations had an increased risk of institutionalization. Subsequently sensitivity analyses were performed for those 18 respondents for whom residential status was unknown. This did not change the results (results not shown).

The number of frailty markers and the risk of institutionalization

Cox's regression analysis was performed using dummies for each count of frailty markers to study the effect of different numbers of frailty markers based on the static and dynamic definition of frailty. In both men and women the risk of institutionalization increased when the number of static frailty markers increased (Table 4). A similar trend was shown for an increase in dynamic frailty markers but this was less consistent. These results were similar when the youngest age tertile was excluded (results not shown).

Discussion

In this prospective study, the influence of frailty on admission to a residential/nursing home was investigated in a representative population-based study. Moreover, the effects of a static and dynamic definition of frailty were investigated whereas other studies so far have used a static definition of frailty only (Fried et al. 2001a; Mitnitski et al. 2002a, b; Rockwood et al. 1999). In this study we found that static and dynamic frailty increased the risk of institutionalization independently of the effect of functional limitations and the number of

Table 1 Characteristics of study participants

	Male <i>N</i> = 712 <i>N</i> (%)	Female <i>N</i> = 791 <i>N</i> (%)	Not admitted <i>N</i> = 1,350 <i>N</i> (%)	Admitted <i>N</i> = 153 <i>N</i> (%)
Socio-demographics				
Institutionalized	49 (6.9%)	104 (13.1%)*		
Mean age at T_2 (SD)	75.6 (6.5)	75.3 (6.5)	74.8 (6.4)	80.6 (5.2)*
Low income ^a	184 (25.8%)	352 (44.5%)*	462 (34.2%)	74 (48.4%)*
Middle income ^a	244 (34.3%)	219 (27.7%)	425 (31.5%)	38 (24.8%)
High income ^a	284 (39.9%)	220 (27.8%)	463 (34.3%)	41 (26.8%)
Partner in hh ^{a,b}	534 (75.0%)	301 (38.1%)*	787 (58.3%)	48 (31.4%)*
No partner in hh ^{a,b} T_1 and T_2	144 (20.2%)	418 (52.8%)	472 (35.0%)	90 (58.8%)
Loss of partner ^a $T_1 - T_2$	34 (4.8%)	72 (9.1%)	91 (6.7%)	15 (9.8%)
No care at T_2 ^a	343 (48.2%)	398 (50.3%)*	688 (51.0%)	53 (34.6%)*
Informal care at T_2 ^a	228 (32.0%)	154 (19.5%)	346 (25.6%)	36 (23.5%)
Formal care at T_2 ^a	52 (7.3%)	82 (10.4%)	104 (7.7%)	30 (19.6%)
Private care at T_2 ^a	89 (12.5%)	157 (19.8%)	212 (15.7%)	34 (22.2%)
Static frailty markers^c				
Body Mass Index < 23 T_2	101 (15.6%)	111 (16.4%)	186 (15.6%)	26 (20.3%)
Low Peak flow T_2	89 (13.7%)	175 (26.2%)*	228 (19.1%)	36 (28.6%)*
Cognition, MMSE < 24 T_2	76 (10.7%)	87 (11.0%)	124 (9.2%)	39 (25.7%)*
Poor vision at T_2	24 (3.4%)	60 (7.6%)*	67 (5.0%)	17 (11.1%)*
Poor hearing at T_2	104 (14.8%)	78 (10.0%)*	161 (12.1%)	21 (14.2%)
Incontinent at T_2	107 (15.0%)	256 (32.4%)*	298 (22.1%)	65 (42.5%)*
Low mastery at T_2	118 (17.1%)	196 (25.8%)*	265 (20.2%)	49 (34.5%)*
Symptoms of depression at T_2	62 (8.9%)	160 (20.7%)*	185 (14.0%)	37 (25.2%)*
Low physical activity (< 65 min/day T_2)	194 (28.0%)	87 (11.4%)*	245 (18.6%)	36 (24.8%)
Dynamic frailty markers^c				
Weight loss $T_1 - T_2$	93 (15.1%)	107 (17.4%)	164 (14.7%)	36 (31.9%)*
Peak flow decline $T_1 - T_2$	249 (40.5%)	192 (31.5%)*	394 (35.4%)	47 (42.0%)*
Decline cognition ^c	117 (16.5%)	125 (15.9%)	193 (14.4%)	49 (32.2%)*
Loss of vision $T_1 - T_2$	69 (9.9%)	111 (14.5%)*	153 (11.6%)	27 (18.2%)*
Loss of hearing $T_1 - T_2$	174 (25.1%)	140 (18.6%)*	282 (21.6%)	32 (22.4%)
New incontinence $T_1 - T_2$	64 (9.0%)	86 (10.9%)	129 (9.6%)	21 (13.7%)
Decline mastery ^c	95 (14.1%)	144 (19.4%)*	207 (16.2%)	32 (22.9%)
Increase depressive symptoms ^c	61 (8.8%)	133 (17.3%)*	166 (12.6%)	28 (19.3%)*
Decline physical activity ^c	180 (26.5%)	201 (27.2%)	344 (26.9%)	37 (27.0%)
Frailty				
Static Frail	103 (14.5%)	164 (20.7%)*	209 (15.5%)	58 (37.9%)*
Dynamic Frail	144 (20.2%)	169 (21.4%)	261 (19.3%)	52 (34.0%)*
Dynamic and static frail	56 (7.9%)	88 (11.1%)*	114 (8.4%)	30 (19.6%)*
Covariates				
Functional limitation score T_2 ^d	8.3 (SD3.9)	10.1 (SD5.1)	9.0 (SD4.4)	12.2 (SD5.7)
Number of chronic diseases at T_2	1.2 (SD1.1)	1.3 (SD1.1)	1.2 (SD1.1)	1.5 (SD1.2)

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

^a P -value overall chi-square test for income, partner status and care received

^bhh Household

^cDecline calculated with the Edwards-Nunnally index

^dScore range 6–30, a higher score indicates more functional limitations

^eStatic frailty refers to low functioning at T_2 and dynamic frailty refers to change in functioning between T_1 and T_2

Table 2 Associations between single frailty markers and institutionalization

	RR (95%CI) ^c
Static Frailty markers T_2 ^a	
BMI < 23	1.30 (0.84–2.00)
Low peak flow	1.12 (0.75–1.66)
Cognition, MMSE < 24	2.53*** (1.74–3.66)
Poor vision	1.62 (0.97–2.72)
Poor hearing	1.12 (0.70–1.78)
Incontinence	1.83*** (1.32–2.54)
Low mastery	1.59* (1.11–2.25)
Symptoms of depression men ^d	3.14** (1.60–6.18)
Symptoms of depression women ^d	1.29 (0.82–2.01)
Low physical activity	1.80** (1.22–2.66)
Dynamic Frailty markers $T_1 - T_2$ ^{a,b}	
Weight loss	2.13** (1.41–3.20)
Decline peak flow	1.53* (1.04–2.25)
Decline cognition	2.15*** (1.50–3.07)
Loss of vision	1.32 (0.86–2.01)
Loss of hearing	0.88 (0.59–1.32)
New incontinence	1.45 (0.89–2.34)
Decline in mastery	1.36 (0.91–2.02)
Increase depressive symptoms	1.55* (1.02–2.36)
Decline in physical activity	1.71* (1.11–2.65)

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

^aStatic frailty refers to low functioning at T_2 and dynamic frailty refers to change in functioning between T_1 and T_2

^bAll frailty markers with change between T_1 and T_2 are corrected for the baseline measurement

^cAdjusted for age and sex

^dDue to significant interaction between depression and sex these results are reported separately for both genders

chronic diseases. Moreover, the static definition of frailty had a unique effect independently of the dynamic definition of frailty. Furthermore, this study included both physical and psychological measures of frailty whereas most studies used only physical frailty markers. Each of the psychological frailty markers increased the risk of admission.

The women in this study had more often more functional limitations than men, fulfilled the criteria for frailty more often and had more frailty markers present. However, there was a significant interaction between functional limitations and sex, showing an increased risk of the most impaired men for institutionalization. In women functional limitations had no effect on the risk of institutionalization. Men more often than women still had a partner in the household and received more informal care, whereas women received more professional care. Women also more frequently lost their partner. It seems that men were admitted to a nursing home with less severe health problems than women. It is possible that women have better learned to take care of themselves and others and to arrange care at home, and are therefore more inventive in creating solutions for health problems that enable them to stay at home.

Our results should be compared to studies in other countries with caution. The health care system in the Netherlands differs from that of other countries, e.g. in that the decision to institutionalize is related to the

availability of other community services for the elderly. In the Netherlands older persons are often admitted after hospital admission to recover and rehabilitate before they go home (Hoek et al. 2000). In this study, however, all respondents admitted were still institutionalized at follow-up. With these caveats, our study supports evidence from previous studies in several ways. First, we found a risk of institutionalization for frailty similar to that found by (Rockwood et al. 1999) in Canada. Tomiak et al. (2000) found for Canada that after old age, medical conditions and functional limitations were the best predictors of nursing home admission. However, in our study, functional limitations were predictive only for men, not women, and the total number of chronic diseases was not associated with institutionalization. Bharucha et al. (2004) found for the USA that the most important risk factor for institutionalization was dementia. In our study no diagnosis of dementia is available but the frailty marker low cognitive functioning increased the risk of institutionalization. Furthermore, in the study by Nuotio et al. (2003) in Finland, living alone was found to increase the risk of institutionalization for women and not in men, and in their study more women than men lived alone. In our study, respondents who had no partner in the household or who lost their partner, which were more frequently women, had an increased risk for institutionalization. In the study by Nuotio et al. (2003) also in men, incontinence predicted institutionalization which is also in accordance with our study. Moreover, this study confirms the importance of inactivity, incontinence, and weight loss as frailty markers predictive of institutionalization (Chin A Paw et al. 1999; Fried et al. 2001a; Miles et al. 2001; Rockwood et al. 1999; Strawbridge et al. 1998).

This study contributes to the literature in that it includes psychological frailty markers. Two recent reviews concluded that more psychological and social factors should be included in future research (Hogan et al. 2003; Markle-Reid and Browne 2003). In this study low mastery in men and women, depression in men and for both genders an increase in depressive symptoms increased the risk of admission. An important part of the definition of frailty is the high risk of adverse outcomes due to a precarious balance. Psychological resources will influence how people cope with their physical problems.

The dynamic definition of frailty is another important contribution to the measurement of frailty. Few studies have examined changes in health status (Gaugler et al. 1999; Miller et al. 1999; Scott et al. 1997; Wolinsky et al. 1993). It is possible to be frail in a dynamic but not static sense meaning that people decline from a high level of functioning to a lower level of functioning but not to a very low level of functioning (static frail). A person who declines from a high level of functioning to a lower level of functioning but not the lowest is defined as frail only if he or she declines in three or more areas, which represents multisystem decline. This person might experience a loss in reserve capacity threatening the

Table 3 The association between both definitions of frailty and institutionalization

	Static frailty ^a	Dynamic frailty ^a
Frailty	1.93*** (1.36–2.74)	1.69** (1.19–2.39)
Sex (0 women, 1 men)	0.50 (0.23–1.07)	0.45* (0.21–0.96)
Age ^b		
Age middle tertile	2.76** (1.46–5.23)	2.90*** (1.53–5.50)
Age old tertile	6.57*** (3.56–12.13)	7.15*** (3.88–13.17)
Income ^c		
Income middle tertile	1.36 (0.90–2.07)	1.34 (0.88–2.04)
Income low tertile	0.97 (0.61–1.54)	0.95 (0.60–1.51)
Care received ^d		
Informal care	1.11 (0.72–1.72)	1.17 (0.76–1.81)
Private care	1.19 (0.74–1.91)	1.24 (0.77–1.97)
Formal care	1.46 (0.90–2.36)	1.52 (0.93–2.46)
Partner status ^e		
No partner in hh T_1 & T_2	1.51* (1.01–2.27)	1.45 (0.97–2.19)
Partner moved out hh between T_1 – T_2	1.68 (0.92–3.08)	1.54 (0.86–1.15)
Functional limitations ^f		
Men middle tertile	1.43 (0.60–3.38)	1.37 (0.80–2.23)
Men high tertile	3.29*** (1.56–6.81)	1.93** (1.21–3.07)
Women middle tertile	1.30 (0.69–2.43)	1.09 (0.67–2.35)
Women high tertile	1.27 (0.73–2.22)	1.32 (0.76–2.29)
No. of chronic diseases	1.00 (0.86–1.15)	1.00 (0.86–1.15)

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

^aRR (95%CI) Relative Risk and the (95% confidence interval. Both columns of Table 3 represent separate analyses for each definition of frailty

^bAge, the young tertile is the reference group

^cIncome, the high tertile is the reference group

^dCare received, the group with no care is the reference group

^ePartner status, *hh* household, the group with a partner in the household is the reference group

^fFunctional limitations, due to interaction between functional limitations and sex the results for functional limitations are shown for both sexes, for both men and women the lowest tertile is the reference group

homeostatic balance. In this study those only frail in the dynamic sense, were in better health than those frail in a static sense. However, respondents who fulfilled criteria for both definitions of frailty (static and dynamic frailty), which means that these persons functioned poorly at first follow-up and had experienced decline in functioning between the baseline and first follow-up, had the most health problems. It seems that dynamic frailty has an effect additionally on frailty in a static sense.

Not only health status predicts nursing home admission but also the availability and relation with an informal caregiver. Gaugler et al. (1999) suggested that those who experience change or decline in health or

function while at home may pose greater challenges to caregivers than those who remain stable over time. In a Dutch study of 15 Municipal Committees on Need Assessment (RIO), the request for institutionalization was frequently done by the relatives of the older person (van Campen and van Gameren 2003). In this study we have no information on who requested the admission. However, it would be interesting to investigate if frail persons themselves ask for admission or if their relatives ask for admission.

The importance of developing an instrument for finding moderately frail people was shown in recent studies. An intervention study among physically frail

Table 4 Associations between number of frailty markers and institutionalization

Number of frailty markers	Number of static frailty markers RR (95%CI) ^a	Number of dynamic frailty markers RR (95%CI) ^a
0	1	1
1	1.24 (0.72–2.15)	1.50 (0.84–2.69)
2	1.71 (0.98–2.97)	1.67 (0.93–2.98)
3	2.52** (1.41–4.51)	2.48** (1.36–4.54)
4 or more	2.74** (1.47–5.11)	2.42* (1.19–4.93)

Analyses were adjusted for age, income, sex, functional limitations, number of chronic diseases, care received and partner status. (Results for these covariates are not substantially different from those in Table 3)

* $P < 0.05$, ** $P < 0.01$

^aRR (95%CI) Relative Risk and the 95% confidence interval

older persons living at home showed that persons who were moderately frail benefited the most from the intervention and that those with severe frailty had worsening disability over time despite the intervention (Gill et al. 2002).

A limitation of our study is that we have not examined the effect of combinations of frailty markers. It is possible that certain combinations increase the risk of institutionalization more than other combinations. The most frequent combination of the static frailty markers consisted of incontinence, low mastery and depression, and for the dynamic frailty markers the most frequent combination consisted of decline in peak flow, decline in cognition and decline in physical activity. However, the number of respondents in each combination was very low ($N=57$ and 19). Future studies should study the effect of specific combinations of frailty markers in larger samples. Another limitation is the non-response and exclusion of subjects lost to follow-up or because of missing values on questionnaires. The non-respondents and those lost to follow-up were older and more often cognitively impaired than those included. These subjects are more likely to be institutionalized. This may have biased our results, most likely resulting in an underestimation of the risk for institutionalization. Furthermore, some of the frailty markers were self-reports (incontinence, perception and physical activity). This might have biased the results too. A limitation is the lack of a more precise date of institutionalization, and therefore less precise estimates. A final limitation was the presence of informative censoring; i.e. the mean follow-up duration of the censored people in the frail group was less than for the non-frail group. Most likely, this informative censoring has underestimated the increased risk of frailty of institutionalization.

Despite its limitations, this study shows that both static and dynamic frailty were a predictor of institutionalization for both men and women, even when adjusting for functional limitations and chronic diseases.

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References

- Bharucha AJ, Pandav R, Shen C, Dodge HH, Ganguli M (2004) Predictors of nursing facility admission: a 12-year epidemiological study in the United States. *J Am Geriatr Soc* 52:434–439
- Bortz WM (2002) A conceptual framework of frailty: a review. *J Gerontol A Biol Sci Med Sci* 57:M283–M288
- Brown I, Renwick R, Raphael D (1995) Frailty: constructing a common meaning, definition, and conceptual framework. *Int J Rehabil Res* 18:93–102
- Buchner DM, Wagner EH (1992) Preventing frail health. *Clin Geriatr Med* 8:1–17
- Campbell AJ, Buchner DM (1997) Unstable disability and the fluctuations of frailty. *Age Ageing* 26:315–318
- van Campen C, van Gameren E (2003) Asking for help. Demand model nursing care (In Dutch: Vragen om hulp. Vraagmodel verpleging en verzorging) The Hague: Social and Cultural Planning Office of the Netherlands
- Central Bureau of Statistics (1989) Health interview questionnaire heeren: Central Bureau of Statistics
- Chin A Paw MJ, Dekker JM, Feskens EJ, Schouten EG, Kromhout D (1999) How to select a frail elderly population? A comparison of three working definitions. *J Clin Epidemiol* 52:1015–1021
- Chin A Paw MJ, de Groot LC, van Gend SV, Schoterman MH, Schouten EG, Schroll M et al (2003) Inactivity and weight loss: effective criteria to identify frailty. *J Nutr Health Aging* 7:55–60
- Cook NR, Albert MS, Berkman LF, Blazer D, Taylor JO, Hennekens CH (1995) Interrelationships of peak expiratory flow rate with physical and cognitive function in the elderly: MacArthur Foundation studies of aging. *J Gerontol A Biol Sci Med Sci* 50:M317–M323
- Deeg DJH, Knipscheer CPM, van Tilburg W (1993) Autonomy and well-being in the aging population: concepts and design of the Longitudinal Aging Study Amsterdam. NIG-trend-studies No.7. Netherlands Institute of Gerontology, Bunnik
- Deeg DJ, van Tilburg T, Smit JH, de Leeuw ED (2002) Attrition in the Longitudinal Aging Study Amsterdam. The effect of differential inclusion in side studies. *J Clin Epidemiol* 55:319–328
- Ferrucci L, Cavazzini C, Corsi A, Bartali B, Russo CR, Lauretani F et al (2002) Biomarkers of frailty in older persons. *J Endocrinol Invest* 25:10–15
- Folstein MF, Folstein SE, McHugh PR (1975) “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatry Res* 12:189–198
- Fried LP, Walston J (1998) Frailty and failure to thrive. In: Hazard WR, Blass J, Ettinger WH, Halter J, Ouslander J (eds) *Principles of Geriatric Medicine and Gerontology*, 4th edn. McGraw Hill, New York, pp 1387–1402
- Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J et al (2001a) Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci* 56:M146–M156
- Fried LP, Young Y, Rubin G, Bandeen-Roche K (2001b) Self-reported preclinical disability identifies older women with early declines in performance and early disease. *J Clin Epidemiol* 54:889–901
- Fried LP, Ferrucci L, Darer J, Williamson JD, Anderson G (2004) Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. *J Gerontol A Biol Sci Med Sci* 59:255–263
- Gaugler JE, Zarit SH, Pearlin LI (1999) Caregiving and institutionalization: perceptions of family conflict and socioemotional support. *Int J Aging Hum Dev* 49:1–25
- Gill TM, Baker DI, Gottschalk M, Peduzzi PN, Allore H, Byers A (2002) A program to prevent functional decline in physically frail, elderly persons who live at home. *N Engl J Med* 347:1068–1074
- Hoek JF, Penninx BW, Ligthart GJ, Ribbe MW (2000) Health care for older persons, a country profile: The Netherlands. *J Am Geriatr Soc* 48:214–217
- Hogan DB, MacKnight C, Bergman H (2003) Models, definitions, and criteria of frailty. *Aging Clin Exp Res* 15:1–29
- Kriegsman DM, Penninx BW, van Eijk JT, Boeke AJ, Deeg DJ (1996) Self-reports and general practitioner information on the presence of chronic diseases in community dwelling elderly. A study on the accuracy of patients’ self-reports and on determinants of inaccuracy. *J Clin Epidemiol* 49:1407–1417
- Markle-Reid M, Browne G (2003) Conceptualizations of frailty in relation to older adults. *J Adv Nurs* 44:58–68
- Miles TP, Palmer RF, Espino DV, Mouton CP, Lichtenstein MJ, Markides KS (2001) New-onset incontinence and markers of frailty: data from the Hispanic Established Populations for Epidemiologic Studies of the Elderly. *J Gerontol A Biol Sci Med Sci* 56:M19–M24

- Miller ME, Longino CF Jr, Anderson RT, James MK, Worley AS (1999) Functional status, assistance, and the risk of a community-based move. *Gerontologist* 39:187–200
- Ministry of Health, Welfare and sports (2005) Branch report Care: Nursing; facts and numbers (In Dutch: Brancherapport Care: Verpleging en Verzorging; Feiten en Cijfers). <http://www.brancherapporten.minvws.nl>
- Mitnitski AB, Graham JE, Mogilner AJ, Rockwood K (2002a) Frailty, fitness and late-life mortality in relation to chronological and biological age. *BMC Geriatr* 2:1
- Mitnitski AB, Mogilner AJ, MacKnight C, Rockwood K (2002b) The mortality rate as a function of accumulated deficits in a frailty index. *Mech Ageing Dev* 123:1457–1460
- Morley JE, Perry HM III, Miller DK (2002) Editorial: something about frailty. *J Gerontol A Biol Sci Med Sci* 57:M698–M704
- Nuotio M, Tammela TL, Luukkaala T, Jylha M (2003) Predictors of institutionalization in an older population during a 13-year period: the effect of urge incontinence. *J Gerontol A Biol Sci Med Sci* 58:756–762
- Pearlin LI, Schooler C (1978) The structure of coping. *J Health Soc Behav* 19:2–21
- Puts MTE, Deeg DJH, Lips P (2005) Sex differences in the risk of frailty for mortality independent of disability and chronic diseases. *J Am Geriatr Soc* 53:40–47
- Radloff LS (1977) The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas* 1:385–401
- Raphael D, Cava M, Brown I, Renwick R, Heathcote K, Weir N et al (1995) Frailty: a public health perspective. *Can J Public Health* 86:224–227
- Rockwood K, Stadnyk K, MacKnight C, McDowell I, Hebert R, Hogan DB (1999) A brief clinical instrument to classify frailty in elderly people. *Lancet* 353:205–206
- Rockwood K, Hogan DB, MacKnight C (2000) Conceptualization and measurement of frailty in elderly people. *Drugs Aging* 17:295–302
- Schiepers JMP (1988) Family equivalence scales using the budget distribution method (In Dutch Huishoudsequivalenten volgens de budgetverdelings-methode) Supplement Sociaal-economische Maandstatistiek, pp 28–36
- Scott WK, Edwards KB, Davis DR, Cornman CB, Macera CA (1997) Risk of institutionalization among community long-term care clients with dementia. *Gerontologist* 37:46–51
- Smit JH, De Vries MZ, Poppelaars JL (1998) Data collection and fieldwork procedures. In: Deeg DJH, Beekman ATF, Kriegsman DMW, Westendorp-de Serië M (eds) *Autonomy and well-being in the Aging Population II. Report from the Longitudinal Aging Study Amsterdam 1992–1996*. VU University Press, Amsterdam, pp 9–20
- van Sonsbeek JLA (1988) Methodological and substantial aspects of the OECD indicator of chronic functional limitations. (In Dutch) Maandbericht Gezondheid (CBS) 88:4–17
- Speer DC, Greenbaum PE (1995) Five methods for computing significant individual client change and improvement rates: support for an individual growth curve approach. *J Consult Clin Psychol* 63:1044–1048
- Stel VS, Smit JH, Pluijm SM, Visser M, Deeg DJ, Lips P (2004) Comparison of the LASA Physical Activity Questionnaire with a 7-day diary and pedometer. *J Clin Epidemiol* 57:252–258
- Strawbridge WJ, Shema SJ, Balfour JL, Higby HR, Kaplan GA (1998) Antecedents of frailty over three decades in an older cohort. *J Gerontol B Psychol Sci Soc Sci* 53:S9–S16
- Tomiak M, Berthelot JM, Guimond E, Mustard CA (2000) Factors associated with nursing-home entry for elders in Manitoba, Canada. *J Gerontol A Biol Sci Med Sci* 55:M279–M287
- Verbrugge LM (2005) Flies without wings. In: Carey R, Robine J-M, Michel J-P, Christen Y (eds) *Longevity and frailty*. Springer, Berlin Heidelberg New York, pp 67–81
- Verbrugge LM, Jette AM (1994) The disablement process. *Soc Sci Med* 38:1–14
- Walston J, Fried LP (1999) Frailty and the older man. *Med Clin North Am* 83:1173–1194
- Wang JJ, Mitchell P, Smith W, Cumming RG, Leeder SR (2001) Incidence of nursing home placement in a defined community. *Med J Aust* 174:271–275
- Wilson JF (2004) Frailty—and its dangerous effects—might be preventable. *Ann Intern Med* 141:489–492
- Winograd CH, Gerety MB, Chung M, Goldstein MK, Dominguez F Jr, Vallone R (1991) Screening for frailty: criteria and predictors of outcomes. *J Am Geriatr Soc* 39:778–784
- Wolinsky FD, Callahan CM, Fitzgerald JF, Johnson RJ (1993) Changes in functional status and the risks of subsequent nursing home placement and death. *J Gerontol* 48:S94–S101
- Wolinsky FD, Miller DK, Andresen EM, Malmstrom TK, Miller JP (2005) Further evidence for the importance of subclinical functional limitation and subclinical disability assessment in gerontology and geriatrics. *J Gerontol B Psychol Sci Soc Sci* 60:S146–S151