Frailty and use of health and community services by community-dwelling older men: the Concord Health and Ageing in Men Project

STEPHANE ROCHAT[1], ROBERT G. CUMMING[2], FIONA BLYTH[2], HELEN CREASEY[2], DAVID HANDELSMAN[3], DAVID G. LE COUTEUR[2], VASI NAGANATHAN[2], PHILIP N. SAMBROOK[4], MARKUS J. SEIBEL[3], LOUISE WAITE[2]

[1]Service of Geriatric Medicine & Geriatric Rehabilitation, University of Lausanne Hospital Center, Lausanne, Switzerland
[2]Center for Education and Research on Ageing, Concord Repatriation General Hospital, Sydney, New South Wales, Australia
[3]ANZAC Research Institute, Concord Repatriation General Hospital, Sydney, New South Wales, Australia
[4]Institute of Bone and Joint Research, Royal North Shore Hospital, Sydney, New South Wales, Australia

Address correspondence to: S. Rochat. Tel: (+41) 21 314 52 39; Fax: (+41) 21 314 38 58. Email: stephane.rochat@chuv.ch

Abstract

Background: frailty is a concept used to describe older people at high risk of adverse outcomes, including falls, functional decline, hospital or nursing home admission and death. The associations between frailty and use of specific health and community services have not been investigated.
Methods: the cross-sectional relationship between frailty and use of several health and community services in the last 12 months was investigated in 1,674 community-dwelling men aged 70 or older in the Concord Health and Ageing in Men study, a population-based study conducted in Sydney, Australia. Frailty was assessed using a modified version of the Cardiovascular Health Study criteria.
Results: overall, 158 (9.4%) subjects were frail, 679 (40.6%) were intermediate (pre-frail) and 837 (50.0%) were robust. Frailty was associated with use of health and community services in the last 12 months, including consulting a doctor, visiting or being visited by a nurse or a physiotherapist, using help with meals or household duties and spending at least one night in a hospital or nursing home. Frail men without disability in activities of daily living were twice more likely to have seen a doctor in the previous 2 weeks than robust men (adjusted odds ratio 2.04, 95% confidence interval 1.21–3.44), independent of age, comorbidity and socio-economic status.
Conclusion: frailty is strongly associated with use of health and community services in community-dwelling older men. The high level of use of medical services suggests that doctors and nurses could play a key role in implementation of preventive interventions.

Keywords: *frailty, older men, health services, elderly*

Introduction

Frailty is commonly defined as a state of increased vulnerability to stressors resulting from a cumulative decline in the physiological reserves of multiple systems [1–3]. A number of different methods for assessing frailty have been developed [1, 4, 5]. The most widely used frailty criteria are those from the Cardiovascular Health Study (CHS) [1]. These criteria comprise five core components: sarcopenia or weight loss, reduced muscular strength, slow walking speed, exhaustion and low activity level. In several prospective studies using this classification scheme, frailty has been associated with

functional decline, hospital or nursing home admission and death [1, 6–9].

There is some evidence that frailty is distinct from other conditions that are common among older people, such as disability (dependency in performing activities of daily life) and comorbidity (presence of several concurrent diseases in the same individual), even though there is a noticeable overlap between these conditions [1, 10]. In fact, most frail or disabled older people suffer from comorbid diseases [1, 4, 9, 10].

Disability and comorbidity are associated with adverse outcomes and with increased health service use and overall high health care costs [11–17]. In the USA, individuals with

two or more chronic diseases represented 65% of Medicare beneficiaries but were responsible for 95% of Medicare expenditures in 1999 [18]. The average number of annual physician visits was 3.5 when one chronic condition was present and 14.8 for five or more conditions [19]. In a cohort study examining the association between functional status and medical expenditures in older community-dwelling Americans, 10% of subjects who had functional dependency or functional decline in basic activities of daily life accounted for more than 20% of hospital and outpatient expenditures and 17% of home health expenditures [20]. Previous studies have shown that frailty is associated with increased long-term stays in nursing home and increased number of bedridden days before death in community-dwelling older adults [21, 22]; however, data on associations between frailty and use of specific health and community services are lacking in community-dwelling older men.

The primary aim of this study was to describe the relationship between frailty and use of several health and community services in a sample of community-dwelling older men. The secondary aim was to compare use of health services by frail older men and by older men with a disability in basic activities of daily living (BADL): if the type of services used is different this would provide evidence that disability and frailty are distinct conditions that need different clinical approaches.

Methods

The Concord Health and Ageing in Men Project (CHAMP) is an epidemiological study of a wide range of health issues in Australian men aged 70 years and over [23]. Baseline data were collected between January 2005 and June 2007. The study was approved by the Concord Hospital Research Ethics Committee. All participants gave written informed consent.

Population

The population selection has been described in detail elsewhere [23]. Briefly, CHAMP involves men living in a defined urban geographical region in Sydney, Australia. The sampling frame was the New South Wales Electoral Roll, on which registration is compulsory. The only exclusion criterion was living in a residential aged care facility. Eligible men were sent a letter describing the study and were telephoned about 1 week later. Of the 2,815 eligible men with whom contact was made, 1,511 participated in the study (54%). An additional 194 men aged 70 years or older volunteered to be in the study independently of the invitation letter. These men were told about the study by friends or read reports in newspapers.

Measurements

BADL and instrumental activities of daily living (IADL) were assessed using Katz's questionnaire and the Older American Resources and Services questionnaire, respectively. Comorbidities were assessed using a standardized

questionnaire in which subjects reported if a physician had ever told them that they had diabetes, thyroid dysfunction, osteoporosis, Paget's disease, stroke, Parkinson's disease, kidney stone, dementia, depression, epilepsy, hypertension, heart attack, angina, congestive heart failure, intermittent claudication, chronic obstructive lung disease, liver disease, chronic kidney disease, cancer, osteo-arthritis or gout. Depressive symptoms were evaluated by the Geriatric Depression Scale, short form (GDS) [24]. A total of five or more depressive symptoms was considered as indicative of possible depression. Cognition was evaluated by the Mini Mental State Examination (MMSE). Only MMSE data from subjects born in English-speaking countries ($n = 867$) were used, to avoid low scores due to language difficulties. Physical activity was assessed using the Physical Activity Scale for the Elderly questionnaire [25]. Subjects completed the Medical Outcomes Study 12-item Short Form (SF-12) [26]. Demographic data, weight at 25 years of age and heaviest weight ever were also recorded.

Health and community services use in the last 12 months (last 2 weeks for doctor consultation) were evaluated by a self-reported standardized questionnaire. Questions asked were 'Have you consulted a doctor about your health?', 'Have you visited or been visited by a nurse?', 'Have you visited or been visited by a physiotherapist?', 'Have you used services to help with your meals, or personal or household duties?', 'Have you spent at least one night in hospital?' and 'Have you spent at least one night in a nursing home?'.

Walking speed was measured over a 6-m course at participants' usual pace. The mean of two tests was recorded. Maximal grip strength was measured using a Jamar dynamometer (Promedics, Blackburn, UK), with subjects performing two trials on each side. The mean value of the side recording higher grip strength was used. Weight in light clothing was measured using electronic scales. Height was measured using a Harpenden stadiometer (Holtain Ltd, Crosswell, UK).

Frailty and disability definition

Frailty was defined according to the criteria used in the CHS: weight loss/shrinking, weakness, exhaustion, slowness and low activity. Subjects were considered frail if they had three or more frailty criteria, intermediate (pre-frail) with one or two criteria and robust (not frail) without any criteria [1]. See table in Appendix 1 in the supplementary data available in *Age and Ageing* online for the definitions and the prevalence of each frailty component. For the weakness and slowness components, the same criteria and the same cut-off as in the CHS were applied. Adapted criteria were used for weight loss, exhaustion and low activity as the exact measurements used in the CHS were not available in this study. Thirty-one subjects (1.8%) with more than one missing frailty criteria were not included in the analyses.

Disability in BADL, or dependency, was defined as needing help with one or more activities in Katz's ADL scale

Table 1. Characteristics of the population according to frailty status

	All (*n* = 1674)	Robust (*n* = 837, 50.0%)	Pre-frail (*n* = 679, 40.6%)	Frail (*n* = 158, 9.4%)	P^a
Age, mean (SD)	76.9 (5.5)	75.2 (4.5)	77.9 (5.4)	81.3 (6.6)	<0.0001
Age groups					
70–74	666 (39.8%)	427 (51.0%)	211 (31.1%)	28 (17.7%)	<0.0001
75–79	526 (31.4%)	258 (30.8%)	232 (34.2%)	36 (22.8%)	
80–84	307 (18.3%)	122 (14.6%)	144 (21.2%)	41 (26.0%)	
85–89	132 (7.9%)	25 (3.0%)	75 (11.1%)	32 (20.3%)	
≥90	43 (2.6%)	5 (0.6%)	17 (2.5%)	21 (13.3%)	
Disability					
≥1 BADL	128 (7.7%)	12 (1.4%)	53 (7.8%)	63 (40.1%)	<0.0001
≥1 IADL	668 (41.1%)	184 (22.5%)	342 (52.1%)	142 (93.4%)	<0.0001
Number of comorbidities, mean (SD)	2.5 (1.8)	2.1 (1.5)	2.7 (1.7)	3.9 (2.2)	<0.0001
MMSE, mean (SD)[b]	28.1 (1.9)	28.5 (1.5)	27.9 (2.0)	26.9 (2.7)	<0.0001
Depressive symptoms (GDS ≥5)	239 (14.3%)	51 (6.1%)	116 (17.1%)	72 (45.6%)	<0.0001
Live alone	311 (18.6%)	141 (16.9%)	127 (18.8%)	43 (27.2%)	0.009
Home ownership	1510 (90.4%)	776 (92.9%)	605 (89.2%)	129 (81.7%)	<0.0001
Post-school qualification	937 (56.4%)	513 (61.6%)	360 (53.5%)	64 (41.0%)	<0.0001
English-speaking country of birth	944 (56.5%)	472 (56.5%)	378 (55.8%)	94 (59.5%)	0.69

SD, standard deviation; BADL, Basic Activities of Daily Living; IADL, Instrumental Activities of Daily Living; MMSE, Mini Mental State Examination; GDS, Geriatric Depression Scale, 15-item version.
[a]Analysis of variance or chi-square statistical tests depending on the variable considered.
[b]In subjects born in English-speaking country only (*n* = 867).

(walking, bathing, personal grooming, dressing, eating, getting from bed to chair and using the toilet).

Statistical analysis

The bivariate associations between frailty and baseline characteristics were assessed by chi-squared tests for categorical variables and analysis of variance for continuous variables. Bivariate and multivariate logistic regression models were used to evaluate the associations between frailty and health and community services use, robust subjects being the reference category. The multivariate model was adjusted for age (continuous variable), number of comorbidities (continuous variable), living alone, home ownership, post-school qualification (yes/no) and English-speaking country of birth (yes/no). Disability in BADL or IADL and falls were not included as covariates in the final model, as they were potentially on the pathway between frailty and use of health and community services.

Further bivariate and multivariate logistic regression models, with the same covariates, were used to compare the associations between frailty alone, disability alone and both frailty and disability with use of health and community services. The reference category was subjects with neither frailty nor disability.

Results

The characteristics of the 1,674 men included in the study are shown in Table 1. Using our frailty criteria, 158 (9.4%) subjects were frail, 679 (40.6%) intermediate and 837 (50.0%) robust. The subjects' ages ranged from 70 to 97 years. The mean age was higher in frail subjects than intermediate or robust subjects (81.3 vs 77.9 vs 75.2 years, *P* <

0.0001). The prevalence of frailty was 5.4% in men aged 70 to 79 years and 19.5% in men 80 years or older. Frail subjects were more likely to have at least one reported disability in BADL, and their mean number of comorbidities was higher. Frail subjects were also more likely to report five or more depressive symptoms on the GDS. The mean MMSE score was lower in frail subjects (analysis restricted to subjects born in English-speaking countries). Frail subjects were more likely to live alone, in a home which they did not own and to have lower post-school qualifications. For all these analyses, intermediate subjects had results in between those for frail and robust subjects.

Most of the frail subjects (*n* = 158) had two or more comorbidities (87.3%, *n* = 138), but less than half of the frail subjects had concomitant BADL disability (39.9%, *n* = 63). Fifty-two frail subjects (32.9%) had both two or more comorbidities and BADL disability and nine frail subjects (5.7%) had neither. Of the 1,154 subjects with at least two comorbidities, only 12.0% (*n* = 138) were frail.

Frailty was associated with health and community services use in the last 12 months (Table 2). In bivariate analysis, the odds ratios (OR) for having used any health or community service were significantly higher for frail subjects than for robust subjects (reference category), ranging from 2.4 [95% confidence interval (CI) 1.58–3.50] for having visited or been visited by a physiotherapist to 11.5 (95% CI 7.22–18.44) for having used any services to help with meals, personal or household duties in the last 12 months. In multivariate analysis, frailty remained associated with use of all categories of health and community services in the last 12 months, independent of age, number of comorbidities, living alone, home ownership, post-school qualification and being born in an English-speaking country. The associations were particularly strong for having visited or been

Table 2. Odds ratios for health and community services use in the previous 12 months by frailty status[a]

Health services use	Frailty status	Yes	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[b]
Have you consulted a doctor about your health?	Robust	362 (46.2%)	1.00	1.00
	Pre-frail	363 (56.5%)	1.51 (1.23–1.87)	1.23 (0.98–1.54)
	Frail	108 (73.0%)	3.14 (2.13–4.63)	1.89 (1.23–2.90)
Have you visited or been visited by a nurse?	Robust	22 (2.7%)	1.00	1.00
	Pre-frail	36 (5.3%)	2.08 (1.21–3.56)	1.79 (1.01–3.17)
	Frail	34 (21.5%)	10.08 (5.71–17.81)	6.75 (3.42–13.30)
Have you visited or been visited by a physiotherapist?	Robust	121 (14.5%)	1.00	1.00
	Pre-frail	101 (14.9%)	1.04 (0.78–1.38)	1.11 (0.82–1.51)
	Frail	45 (28.5%)	2.35 (1.58–3.50)	2.60 (1.63–4.14)
Have you used any services to help with your meals, or personal or household duties?	Robust	36 (4.3%)	1.00	1.00
	Pre-frail	91 (13.4%)	3.44 (2.31–5.13)	2.46 (1.59–3.82)
	Frail	54 (34.2%)	11.54 (7.22–18.44)	4.82 (2.76–8.43)
Have you spent at least one night in hospital?	Robust	152 (18.2%)	1.00	1.00
	Pre-frail	174 (25.7%)	1.55 (1.22–1.99)	1.34 (1.03–1.74)
	Frail	81 (51.6%)	4.79 (3.35–6.86)	3.29 (2.18–4.96)
Have you spent at least one night in nursing home?	Robust	7 (0.8)	1.00	1.00
	Pre-frail	11 (1.6%)	1.95 (0.75–5.06)	1.45 (0.54–3.93)
	Frail	10 (6.3%)	8.00 (3.00–21.35)	3.42 (1.06–11.07)

OR, odds ratio; CI, confidence interval.
[a]Except for consulting a doctor, which relates to the previous 2 weeks.
[b]Adjusted for age, number of comorbidities, living alone, home ownership, post-school qualification and English-speaking country of birth.

Table 3. Odds ratios for health and community services use in the previous 12 months by frailty and disability status[a]

Health services use	Frailty status	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[b]
Have you consulted a doctor about your health?	Robust, not disabled	1.00	1.00
	Robust, disabled	1.26 (0.76–2.11)	0.91 (0.53–1.56)
	Frail, not disabled	3.20 (1.94–5.28)	2.04 (1.21–3.44)
	Frail and disabled	2.0 (1.14–3.50)	1.20 (0.66–2.18)
Have you visited or been visited by a nurse?	Robust, not disabled	1.00	1.00
	Robust, disabled	4.55 (2.13–9.73)	4.23 (1.91–9.38)
	Frail, not disabled	7.18 (4.02–12.80)	5.01 (2.60–9.67)
	Frail and disabled	8.85 (4.64–16.89)	6.63 (3.21–13.65)
Have you spent at least one night in hospital?	Robust, not disabled	1.00	1.00
	Robust, disabled	1.93 (1.14–3.29)	1.50 (0.86–2.62)
	Frail, not disabled	4.28 (2.80–6.54)	2.95 (1.86–4.66)
	Frail and disabled	3.53 (2.11–5.90)	2.58 (1.47–4.52)
Have you visited or been visited by a physiotherapist?	Robust, not disabled	1.00	1.00
	Robust, disabled	1.82 (1.0–3.20)	2.05 (1.11–3.79)
	Frail, not disabled	2.07 (1.28–3.37)	2.31 (1.40–3.91)
	Frail and disabled	3.02 (1.76–5.21)	3.28 (1.80–5.99)
Have you used any services to help with your meals, or personal or household duties?	Robust, not disabled	1.00	1.00
	Robust, disabled	5.12 (2.90–9.05)	4.19 (2.15–8.17)
	Frail, not disabled	4.74 (2.90–7.76)	2.04 (1.14–3.66)
	Frail and disabled	9.92 (5.81–16.92)	4.89 (2.64–9.06)
Have you spent at least one night in nursing home?	Robust, not disabled	1.00	1.00
	Robust, disabled	2.84 (0.64–12.62)	2.11 (0.43–10.24)
	Frail, not disabled	1.94 (0.44–8.58)	0.84 (0.17–4.2)
	Frail and disabled	13.00 (5.34–31.69)	6.92 (2.44–19.58)

OR, odds ratio; CI, confidence interval.
[a]Except for consulting a doctor, which relates to the previous 2 weeks.
[b]Adjusted for age, number of comorbidities, living alone, home ownership, post-school qualification and English-speaking country of birth.

visited by a nurse (adjusted OR 6.7, 95% CI 3.42–13.30) and use of services to help with meals, personal or household duties (adjusted OR 4.8, 95% CI 2.76–8.43).

Table 3 shows the comparison of health and community services use in the last 12 months for four groups of subjects: robust and not disabled (reference category), robust and disabled (one or more BADL disabilities), frail but not disabled and both frail and disabled. After adjusting for age, number of comorbidities, living alone, home ownership, post-school qualification and being born in an English-speaking country, frailty without disability remained independently associated with all health and community ser-

vices, except for having spent a night in a nursing home. In contrast, disability without frailty was only associated with having visited or been visited by a nurse, having visited a physiotherapist or having used any services to help with meals, personal or household duties. In subjects with both frailty and disability, the OR were particularly high for having spent at least one night in nursing home (adjusted OR 6.9, 95% CI 2.44–19.58) and for having been visited by a nurse (adjusted OR 6.6, 95% CI 3.21–13.65).

Discussion

In this large population of community-dwelling older men, the prevalence of frailty was 9%. Frail men were older and generally in poorer health, with more disabilities, comorbidities, depressive symptoms and lower cognition than robust men.

We found that frailty in men was strongly associated with use of health and community services in the last 12 months. After adjusting for potential confounders, including age and comorbidities, these associations remained statistically significant for all the health and community services that we studied. Associations were weaker for intermediate subjects, but this group still had higher OR of having used health or community services than robust subjects. These results suggest that frailty is associated with extensive use of health and community services by older men, resulting in a high burden on health systems. This is supported by the results of a study in Medicare beneficiary older adults discharged from the emergency department, which shows that the frailest participants were at higher risk of hospitalization, nursing home admission or death at 30 days [27].

By including frailty and disability in BADL in the same model, we were able to show that frailty and disability were associated with use of different types of health and community services. Frailty (without disability) was strongly associated with medically oriented health services, like consultations with GPs, visits from community nurses or admission to hospital. Disability in BADL (without frailty), on the other hand, was mostly associated with community-oriented services, like meals and home help. It appears that frail people, because of their vulnerability to new or worsening health problems, need more medical care than disabled people, who experience difficulties in their activities of daily living and so mostly need help in these domains. These differences contribute to the growing knowledge of the specificity of frailty compared to other geriatric conditions and support the hypothesis that frailty is a distinct condition that might have its own aetiological factors and treatments.

Considering the costs and the various adverse outcomes associated with frailty in aged people, developing and implementing interventions to prevent or treat frailty is crucial. This study shows that community-dwelling frail older men, independent of the presence of comorbidities, were very likely to be in contact with health professionals in the previous 12 months. This contact clearly provides a good opportunity to recognise and address frailty. Treating only medical conditions, without specific frailty interventions, is likely to be insufficient for improving the adverse outcomes associated with frailty. Furthermore, for similar comorbidities, the optimal treatment could be very different in frail or robust older patients [28]. Unfortunately, there is still a lack of evidence about the appropriate treatment of frailty [29, 30].

Some strengths and limitations of this study should be mentioned. Our study was designed to produce a representative sample of Australian community-dwelling older men, with no exclusion criteria related to the frailty syndrome as defined in the CHS study, which improves the generalisability of our findings. However, because men living in residential aged care facilities were excluded, the study would not have included many frail and very dependent men. Another weakness is that we used a cross-sectional design; longitudinal studies are needed to confirm our findings. The criteria used to measure frailty were adapted and slightly different from the original CHS definition, in particular for weight loss, exhaustion and physical activity. These changes are consistent with the original criteria and are comparable with other studies which have used these kinds of minor adaptations [7–9]. Data on comorbidities and disability in BADL were self-reported, which could introduce ascertainment bias.

In summary, our study found that frailty is strongly associated with use of health and community services in community-dwelling older men. This association was independent of the existence of comorbidities or disability in BADL. Moreover, frailty and disability were associated with use of different kinds of health and community services, which emphasises the distinction between these geriatrics conditions. The current findings suggest that frailty-specific interventions will be needed to reduce the overall demand on health services by older people. Once such interventions have been developed, the high level of use of medical services by frail older men suggests that doctors and nurses could play a key role in their implementation.

Key points

- Frailty in community-dwelling older men was strongly and independently associated with use of health and community services in the last 12 months.
- Frailty and disability were associated with use of different kinds of health services.
- The high level of use of medical services by frail older men suggests that doctors and nurses should play a key role in implementation of future preventive and treatment interventions for frailty.

Conflicts of interest

The authors declare no conflicts of interest.

Funding

Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

References

1. Fried LP, Tangen CM, Walston J *et al*. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001; 56: 146–56.
2. Walston J, Hadley EC, Ferrucci L *et al*. Research agenda for frailty in older adults: toward a better understanding of physiology and etiology: summary from the American Geriatrics Society/National Institute on Aging Research Conference on Frailty in Older Adults. J Am Geriatr Soc 2006; 54: 991–1001.
3. Bergman H, Ferrucci L, Guralnik J *et al*. Frailty: an emerging research and clinical paradigm—issues and controversies. J Gerontol A Biol Sci Med Sci 62: 731–7.
4. Rockwood K, Song X, MacKnight C *et al*. A global clinical measure of fitness and frailty in elderly people. CMAJ 2005; 173: 489–95.
5. Studenski S, Hayes RP, Leibowitz RQ *et al*. Clinical Global Impression of Change in Physical Frailty: development of a measure based on clinical judgment. J Am Geriatr Soc 2004; 52: 1560–6.
6. Bandeen-Roche K, Xue QL, Ferrucci L *et al*. Phenotype of frailty: characterization in the women's health and aging studies. J Gerontol A Biol Sci Med Sci 2006; 61: 262–6.
7. Cawthon PM, Marshall LM, Michael Y *et al*. Frailty in older men: prevalence, progression, and relationship with mortality. J Am Geriatr Soc 2007; 55: 1216–23.
8. Boyd CM, Xue QL, Simpson CF *et al*. Frailty, hospitalization, and progression of disability in a cohort of disabled older women. Am J Med 2005; 118: 1225–31.
9. Ottenbacher KJ, Ostir GV, Peek MK *et al*. Frailty in older Mexican Americans. J Am Geriatr Soc 2005; 53: 1524–31.
10. Fried LP, Ferrucci L, Darer J *et al*. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. J Gerontol A Biol Sci Med Sci 2004; 59: 255–63.
11. Anderson G, Knickman JR. Changing the chronic care system to meet people's needs. Health Aff (Millwood) 2001; 20: 146–60.
12. Carpenter I, Bobby J, Kulinskaya E *et al*. People admitted to hospital with physical disability have increased length of stay: implications for diagnosis related group re-imbursement in England. Age Ageing 2007; 36: 73–8.
13. Ferrucci L, Guralnik JM, Pahor M *et al*. Hospital diagnoses, Medicare charges, and nursing home admissions in the year when older persons become severely disabled. JAMA 1997; 277: 728–34.
14. Gijsen R, Hoeymans N, Schellevis FG *et al*. Causes and consequences of comorbidity: a review. J Clin Epidemiol 2001; 54: 661–74.
15. Menotti A, Mulder I, Nissinen A *et al*. Prevalence of morbidity and multimorbidity in elderly male populations and their impact on 10-year all-cause mortality: the FINE study (Finland, Italy, Netherlands, Elderly). J Clin Epidemiol 2001; 54: 680–6.
16. Rochon PA, Katz JN, Morrow LA *et al*. Comorbid illness is associated with survival and length of hospital stay in patients with chronic disability. A prospective comparison of three comorbidity indices. Med Care 1996; 34: 1093–101.
17. Vogeli C, Shields AE, Lee TA *et al*. Multiple chronic conditions: prevalence, health consequences, and implications for quality, care management, and costs. J Gen Intern Med 2007; 22: 391–5.
18. Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. Arch Intern Med 2002; 162: 2269–76.
19. Partnership for Solutions. *Chronic Conditions: Making the Case for Ongoing Care*. The Johns Hopkins University 2002.
20. Fried TR, Bradley EH, Williams CS *et al*. Functional disability and health care expenditures for older persons. Arch Intern Med 2001; 161: 2602–7.
21. Rothman MD, Leo-Summers L, Gill TM. Prognostic significance of potential frailty criteria. J Am Geriatr Soc 2008; 56: 2211–6.
22. Dupre ME, Gu D, Warner DF *et al*. Frailty and type of death among older adults in China: prospective cohort study. BMJ 2009; 338: b1175.
23. Cumming RG, Handelsman D, Seibel MJ *et al*. Cohort profile: the Concord Health and Ageing in Men Project (CHAMP). Int J Epidemiol 2009; 38: 374–8.
24. Shiekh J, Yesavage J. , edGeriatric Depression Scale: recent findings and development of a short version. *Clinical gerontology: a guide to assessment and intervention*. New York: Howarth Press.
25. Washburn RA, Smith KW, Jette AM *et al*. The Physical Activity Scale for the Elderly (PASE): development and evaluation. J Clin Epidemiol 1993; 46: 153–62.
26. Ware J, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care 1996; 34: 220–33.
27. Hastings SN, Purser JL, Johnson KS *et al*. Frailty predicts some but not all adverse outcomes in older adults discharged from the emergency department. J Am Geriatr Soc 2008; 56: 1651–7.
28. Ferrucci L, Guralnik JM, Cavazzini C *et al*. The frailty syndrome: a critical issue in geriatric oncology. Crit Rev Oncol Hematol 2003; 46: 127–37.
29. Binder EF, Schechtman KB, Ehsani AA *et al*. Effects of exercise training on frailty in community-dwelling older adults: results of a randomized, controlled trial. J Am Geriatr Soc 2002; 50: 1921–8.
30. Gill TM, Baker DI, Gottschalk M *et al*. A program to prevent functional decline in physically frail, elderly persons who live at home. N Engl J Med 2002; 347: 1068–74.