# Frail elderly

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## Towards an integral approach

Robbert Gobbens

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# Frail elderly

## Towards an integral approach

**PROEFSCHRIFT**

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in het openbaar te verdedigen ten overstaan van
een door het college voor promoties aangewezen commissie
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door

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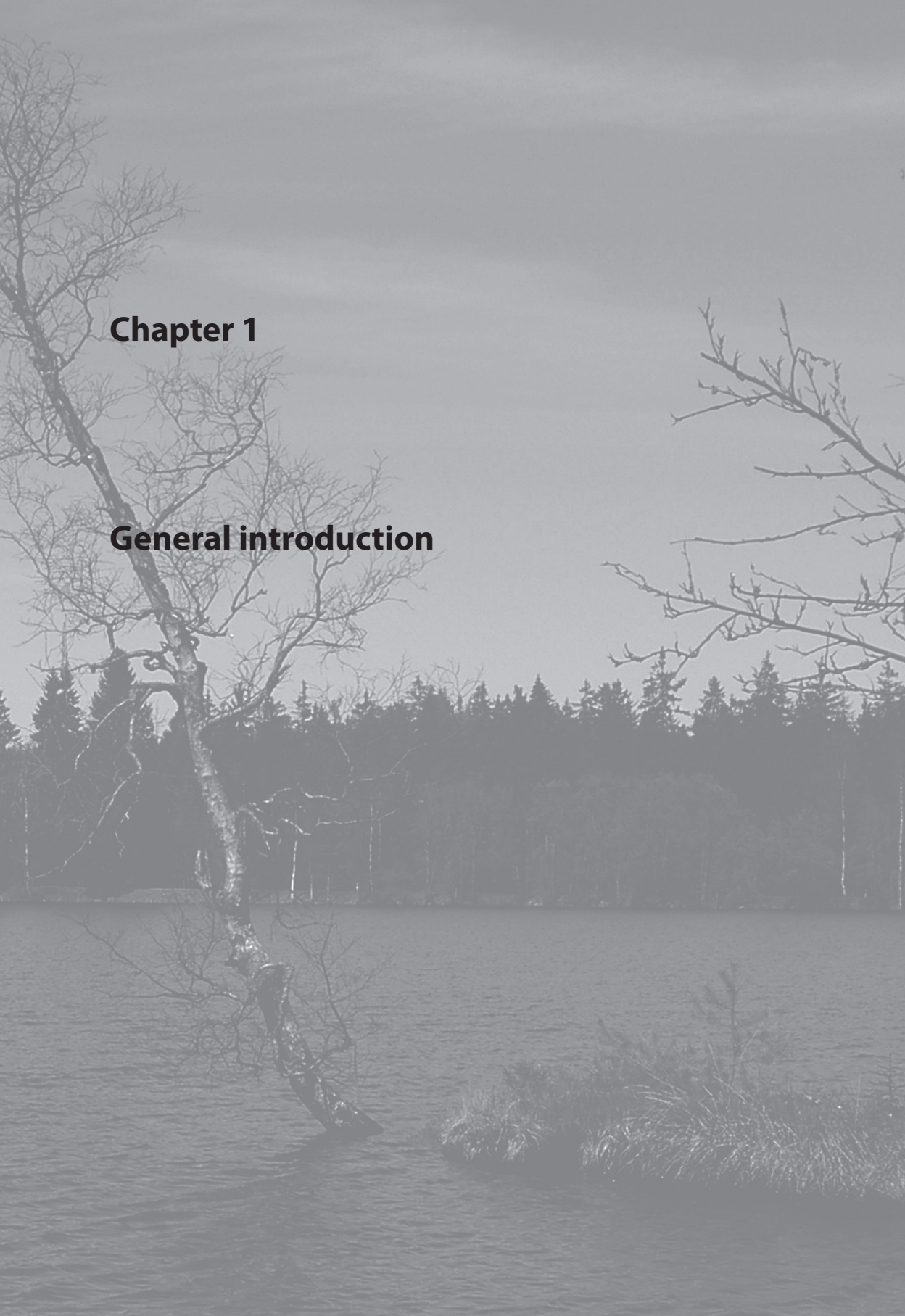
Prof. dr. J. De Lepeleire

*On and on the rain will fall*
*Like tears from a star like tears from a star*
*On and on the rain will say*
*How fragile we are how fragile we are*
(Sting)

*voor Marianne,*
*Isabella, Charlotte, Rebecca, Benjamin*
*en mijn ouders*

## Contents



# Chapter 1

# General introduction

## INTRODUCTION

Declining fertility rates and increasing longevity mean that the populations of most countries in the world are ageing rapidly. Projections suggest that by the year 2050 22% of the world population will be aged 60 or older, and 4.2% of that population will be aged 80 or over. This represents more than a doubling of the number of people aged 65 and older compared with 2005, and no less than a six-fold increase in the percentage of octogenarians.[1] By 2050, it is expected that 71% of all octogenarians will live in developing countries.[1] Currently, Europe has the highest proportion of older people. This is projected to remain the case until at least 2050, when around 34.5% of the European population is forecast to be aged 60 or older.[1]

In 2008 the Netherlands had a total population of 16,405,399 inhabitants, of whom 2,414,826 (14.7%) were aged 65 years or older.[2] In 2050, the percentage of older people (aged 60 or over) is forecast to be 30.7%.[1] The life expectancy of persons born in the Netherlands is also projected to increase, to 81.5 years for men and 84.2 years for women in 2050; this compares with 78 years and 82.3 years, respectively, in 2007.[2] These demographic changes can be broadly ascribed to increased prosperity and related aspects such as better education, nutrition, hygiene and housing, with fewer harmful environmental factors and better health care.[3] The rise in the percentage of older people in the population is also being driven by the post-World War II baby-boom generation, who are now approaching older age.

*Healthy ageing*

Healthy ageing is a prominent theme in several national and international policy documents and research programmes.[4] It promotes a process that enables older people to live a life of good quality, as independently as possible and characterised by continuous participation in society. Rowe & Kahn[5, 6] and Baltes & Baltes[7] put forward this view of growing old. They argued that old age, and even advanced age, can be a pleasurable time. As studies of successful ageing have shown, many older people possess the necessary capacities to enjoy their old age, such as personal effectiveness and resilience.[8]

The Leiden 85-plus study, in particular, has shown advanced age in a positive light. For example, 45% of the people aged 85 and over who were surveyed in this study met all the criteria for optimum well-being; and the presence of physical disabilities did not by definition undermine that feeling.[9, 10] Research among people aged 75 and over has shown that they are able to go on looking after themselves for a considerable period of time.[11]

*Multimorbidity and disability*

Despite these positive notes, there are and will continue to be many older persons who have to live with a disease or combination of diseases (multimorbidity) and physical disabilities. The same holds for psychological disorders. The incidence of multimorbidity increases with age; only 14% of people aged 55-64 years suffer from multimorbidity, while among people aged 75 and over this figure increases to 40%.[12] In the Netherlands, 850,000 persons aged 55 and over are confronted with moderate or severe physical disabilities for a prolonged period in their lives. That is 30% of the total population aged over 55.[8] Men spend an average of 6.4 years with disabilities, and women 11.2 years.[13] Physical disability is mostly diagnosed by self-reporting of difficulties in performing self-care tasks, Activities of Daily Living (ADL) and household management tasks, Instrumental Activities of Daily Living (IADL). Depression and cognitive disorders are the most common severe psychological disorders during old age. Depression affects 15% of people aged between 55 and 85 years, while cognitive disorders (mainly dementia) affect 11% of people in this age group.[8]

The higher age-related prevalence of multimorbidity, physical disabilities and psychological disorders will lead to higher health care utilisation and thus to higher health care expenditure. The challenge for many Western countries such as the Netherlands is to maintain and improve health services for the growing number of frail older persons whilst at the same time limiting the growth in health care expenditure. According to the Health Council of the Netherlands, a new perspective on prevention in elderly persons is needed in order to exploit the potential for healthy ageing.[4] This perspective is not focused on a specific disease, but looks at activities that may prevent disability.

## FRAILTY

Frailty is a relatively new concept for describing the multiple problems that older persons frequently experience with ageing. Over the years, frailty has developed into an increasingly relevant concept, both from the standpoint of clinical care for individual older people and in terms of research on ageing.[14] A recent PubMed search, performed in 2009, revealed an exponential rise in the number of publications containing the Medline MeSH heading 'frail elderly' during the last 30 years (see Table 1). The number of reviews on frailty has also grown over the years; this is shown by the figures between brackets.

**Table 1.** Number of PubMed publications containing the term 'frail elderly'

| | |
|---|---|
| prior to 1980 | 1 |
| 1981 – 1985 | 0 |
| 1986 – 1990 | 36 (1) |
| 1991 – 1995 | 795 (84) |
| 1996 – 2000 | 1102 (147) |
| 2001 – 2005 | 1438 (198) |
| 2006 – 2008, three years | 905 (154) |

Charles F. Fahey and the United States Federal Council on Aging (FCA) first introduced the term 'frail elderly'. In 1978 they defined frail elderly as "persons, usually but not always, over the age of 75, who because of an accumulation of various continuing problems often require one or several supportive services in order to cope with daily life".[15] Later, in 1991, Winograd et al.[16] introduced an operational definition of frailty; these researchers defined frail elderly as "individuals who meet any one of the following criteria: cerebrovascular accident, chronic and disabling illness, confusion, dependence in ADL, depression, falls, impaired mobility, incontinence, malnutrition, polypharmacy, pressure sore, prolonged bed rest, restraints, sensory impairment, socioeconomic or family problems".

*Definitions of frailty*

Several researchers have noted the absence of a uniform and broadly accepted conceptual and operational definition of frailty.[15, 17-21] The lack of a clear definition of frailty has resulted in significant controversy regarding its clinical usefulness,[22] but there is nonetheless agreement on the impact on the older individual and their family, as well as on society as a whole.[14, 20]

The prevalence of frailty in older people depends on the definition of frailty used, and in practice there are considerable differences between the currently available definitions.[21, 23] That is why different prevalence rates are reported in the literature. The American Medical Association reported a prevalence of 20% among people aged 65 years and older;[24] The Groningen Frailty Indicator classified 32% of community-dwelling elderly (65 years and older) as frail,[19] Fried et al. arrived at a prevalence of 7% for the same age group,[25] and Chin A Paw et al. found a prevalence of 6% in older men aged 65 and over.[26] Consequently, it is unclear precisely who these frail older people are. A universal definition of frailty could inform policy decisions on the allocation of, and eligibility for health care resources among the older population. In addition, it would enhance the comparability of research on frail older adults.[21]

The majority of definitions of frailty are heavily focused on physical diminution in elderly persons.[25, 27, 28] Some researchers have criticised these definitions.[15, 21, 29, 30] According to Bergman et al., frailty provides a conceptual basis for moving away from organ and disease-based approaches towards a health-based, integral approach.[31] In an integral approach the focus is not exclusively on physical problems in older people, but also incorporates psychological and social problems and the relationships between those problems. An overly narrow definition of frailty, focusing exclusively on physical frailty, can lead to fragmentation of care, jeopardising the attention for the individual as a whole.

According to Fried et al., frailty is not synonymous with multimorbidity and disability; each confers specific care needs on older persons.[32] Both Abellan van Kan et al.[33] and Morley et al.[34] consider frailty as a predisability state.

*The usefulness of the concept of frailty*

Research has shown that the degree of frailty is a better predictor or selection criterion for treatment or intervention than chronological age.[19, 35-37] Chronological age is a poor indicator for biological age, because the ageing process differs among people for genetic and environmental reasons.[38] Frailty is a proxy for the severity of the ageing process in an individual,[38] and is more directly related than chronological age to adverse outcomes.[19]

Fried et al. reported that persons who are classified as frail are at significantly higher risk of falls, loss of mobility, functional decline, hospital admission and death within three years.[25] It is therefore important when deciding on the amount of care or treatment needed, or when assessing risks, to look specifically at the person's frailty and the potential associated care needs. This makes it possible to select those people who are in need of extra attention or care.[19, 39] According to Slaets, frailty deserves to be given its own place in clinical thinking and actions.[40] This applies for all parts of the care system, whether in primary care, hospitals or nursing homes, and also applies for initial and follow-up training.[3]

*Frailty: a dynamic concept*

Frailty refers to a process whose course is unique for every individual. A systematic review emphasises that this process can be changed or reversed.[21] Frailty is a dynamic concept.[41, 42] There is mounting evidence to suggest that education, prevention and the promotion of a healthy lifestyle early in the ageing process may reduce the incidence of frailty.[43] The following factors can lead to prevention or reduction of frailty: nutritional support focusing on both calorie intake and vitamins; control of high blood pressure; prevention of atherosclerosis; avoidance of isolation by engaging in social contacts;

pain control; treatment of depression; and a variety of exercises designed to improve balance, flexibility, strength and power.[37]

A study by Visser et al. showed that the lifestyle of Dutch people aged 55-64 years in 2002/03 was less healthy than that of their counterparts in 1992/93.[44] Observation studies suggest (possible) links between lifestyle factors (such as nutrition, exercise, education, socioeconomic status, social/intellectual activities) and the onset of frailty. The findings of these observational studies offer opportunities for developing interventions to promote healthy ageing, reduce the incidence of frailty, delay its onset and reduce the number of years spent in dependence.[45] An integrated health care system with effective collaboration between health care professionals is essential in delaying or preventing the onset of frailty in older persons.[46]

*Measurement of frailty*

Since frailty is a potentially reversible state, it is important to develop a screening tool to enable the identification of frail older people. This would make it possible to initiate adequate intervention programmes rapidly.[47] A definition of frailty, and in particular an operational definition, must be capable of serving as a basis for the development of this measurement instrument. The definition and the measurement instrument must be broad enough to offer a framework for the provision of integral care.

The early stages of frailty are more commonly seen in community-dwelling older people.[25, 48] Consequently, screening for frailty should be carried out or start in the primary care setting.

## OBJECTIVES

This thesis focuses on definitions of frailty and the measurement of frailty. It aims to contribute to the literature in that it includes a new conceptual and operational definition of frailty, and a conceptual model of frailty; all based on an integral approach to human functioning. A further aim of this study was to develop a frailty assessment instrument, called the Tilburg Frailty Indicator (TFI). This instrument is based on the new conceptual model of frailty and has been tested in identifying frail community-dwelling older people. The reliability, construct validity, and predictive validity of the TFI have also been assessed. In addition, this instrument has also been used to examine the effects of life-course determinants on frailty and whether these effects were mediated by multimorbidity.

## RESEARCH QUESTIONS

The following central research question was formulated in this study: *"How can frailty be defined and measured as a means of identifying frail community-dwelling older people with regard to integral human functioning?"*

The specific research questions addressed in this thesis are:

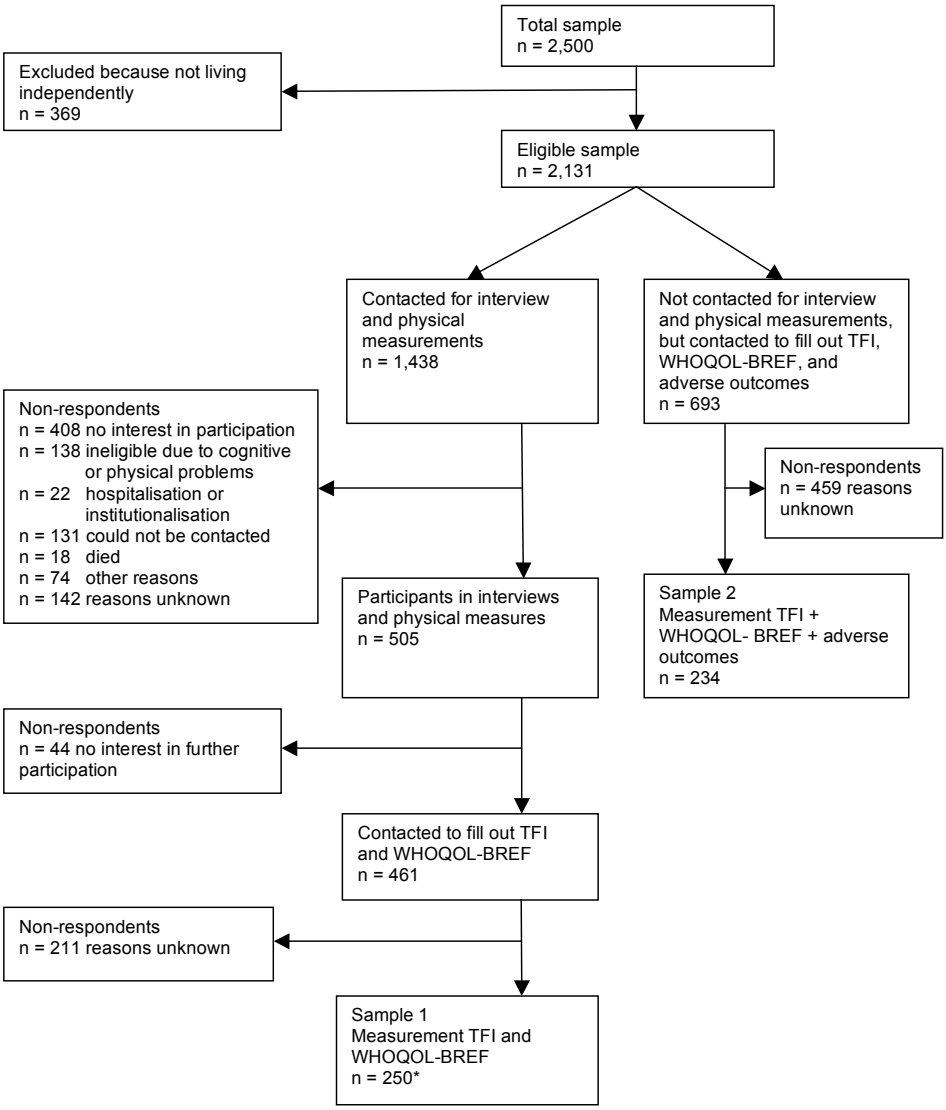
(1) Which conceptual and operational definitions of frailty have been used in the literature?
(2) Which definitions are most appropriate for identifying frail community-dwelling older people?
(3) Which existing conceptual definition of frailty places most emphasis on the integral functioning of older people?
(4) Which components of existing operational definitions of frailty should be included in an integral operational definition of frailty?
(5) What constitutes a scientifically sound and practicably relevant integral model of frailty?
(6) What are the psychometric properties of The Tilburg Frailty Indicator (TFI), which is based upon an integral model of frailty?
(7) What are the determinants of frailty in community-dwelling older people as measured using the TFI?

In order to answer research questions (1) to (5) inclusive, a literature search was carried out and a group of experts was consulted. Research questions (6) and (7) were answered using empirical research in a representative sample of community-dwelling older persons (see Figure 1).

In October 2007, a sample of 2,500 community-dwelling individuals aged 75 years and older was randomly drawn from the municipal register of Roosendaal (the Netherlands), a town of 78,000 inhabitants. The criterion for inclusion was that they had to be living independently; 369 persons (15%) were excluded because they did not meet this criterion, leaving a total of 2,131 eligible individuals.

Between November 2007 and June 2008 a part of this group (1,438; 67%) was contacted for interviews and physical measurements. Established scales were used by trained interviewers to measure frailty. Out of this group, 933 (65%) persons dropped out for various reasons (see Figure 1), and 505 (35%) participants remained. In June 2008, 461 of these participants (91%) were contacted to complete a questionnaire containing the TFI and the WHOQOL-BREF (a quality of life scale); 44 persons (9%) had no interest in further participation in the study.

**Figure 1.** Flow of the participants through the study




* In the study described in Chapter 5, Sample 1 contains 245 participants. The data on 5 participants were not useful for the purpose of this study.

In total 250 respondents (54%) completed this questionnaire within two weeks, while 211 persons (46%) dropped out for unknown reasons. The group of 250 respondents, in this dissertation denoted by Sample 1, is used in Chapter 5 to investigate the

construct validity of the TFI.

In June 2008, 693 persons from the original sample of 2,131 (33%) also received a questionnaire. This questionnaire contained the TFI, the WHOQOL-BREF and questions on adverse outcomes of frailty; 234 respondents (34%) completed this questionnaire in June 2008, while 459 (66%) dropped out for unknown reasons. The group of 234 respondents, in this dissertation denoted by Sample 2, is used in Chapter 5 to assess the predictive validity of the TFI.

A subset of all respondents from both samples completed the TFI again one year later (n = 343, 72%), and again two weeks later (n = 226, 66%). Both Sample 1 and Sample 2 (n = 484) were used in Chapter 6 to examine which determinants predict frailty.

In this thesis we did not use all the data collected from the interviews and physical measurements (n = 505). These data will be used in our future research on frailty (see Chapter 7).

## OUTLINE OF THE THESIS

An overview of the literature on conceptual and operational definitions of frailty is presented in Chapter 2. This chapter is particularly concerned with the question of which definitions are most appropriate for identifying frail community-dwelling older people.

Chapter 3 explores which existing conceptual definitions of frailty put most emphasis on the integral functioning of older people. In order to answer this question a literature search was carried out. Thereafter a group of experts from America, Canada and the Netherlands was consulted, both verbally during two expert meetings and via a written questionnaire.

Chapter 4 describes a new integral operational definition of frailty, based on a literature search and consultation of experts. This operational definition lies at the heart of an integral conceptual model of frailty, which expresses the relationships between three domains of frailty (physical, psychological, social), adverse outcomes and determinants.

Chapter 5 focuses on the study of the psychometric properties of the Tilburg Frailty Indicator (TFI). The TFI is a self-report questionnaire for measuring frailty in older persons. It was developed on the basis of the results of our previous research on frailty, namely the literature search (Chapter 2) and the consultation of experts (see Chapters 3 and 4). The objective of this study was to assess the reliability, construct validity and predictive validity of the TFI.

Chapter 6 describes the results of the study of determinants of frailty. The

study investigated which determinants predict frailty and the domains of frailty (physical, psychological, social) in a community-dwelling sample of elderly persons, and whether these effects were mediated by multimorbidity. The TFI was used to gather information about determinants and to assess frailty and the domains of frailty.

In the general discussion, Chapter 7 recaps the main findings of this study, and discusses the methodology used. It also puts forward recommendations for future research. Finally, the practical implications and recommendations to emerge from the main findings of the study are presented and discussed, and attention is given to the applicability of the TFI in practice.

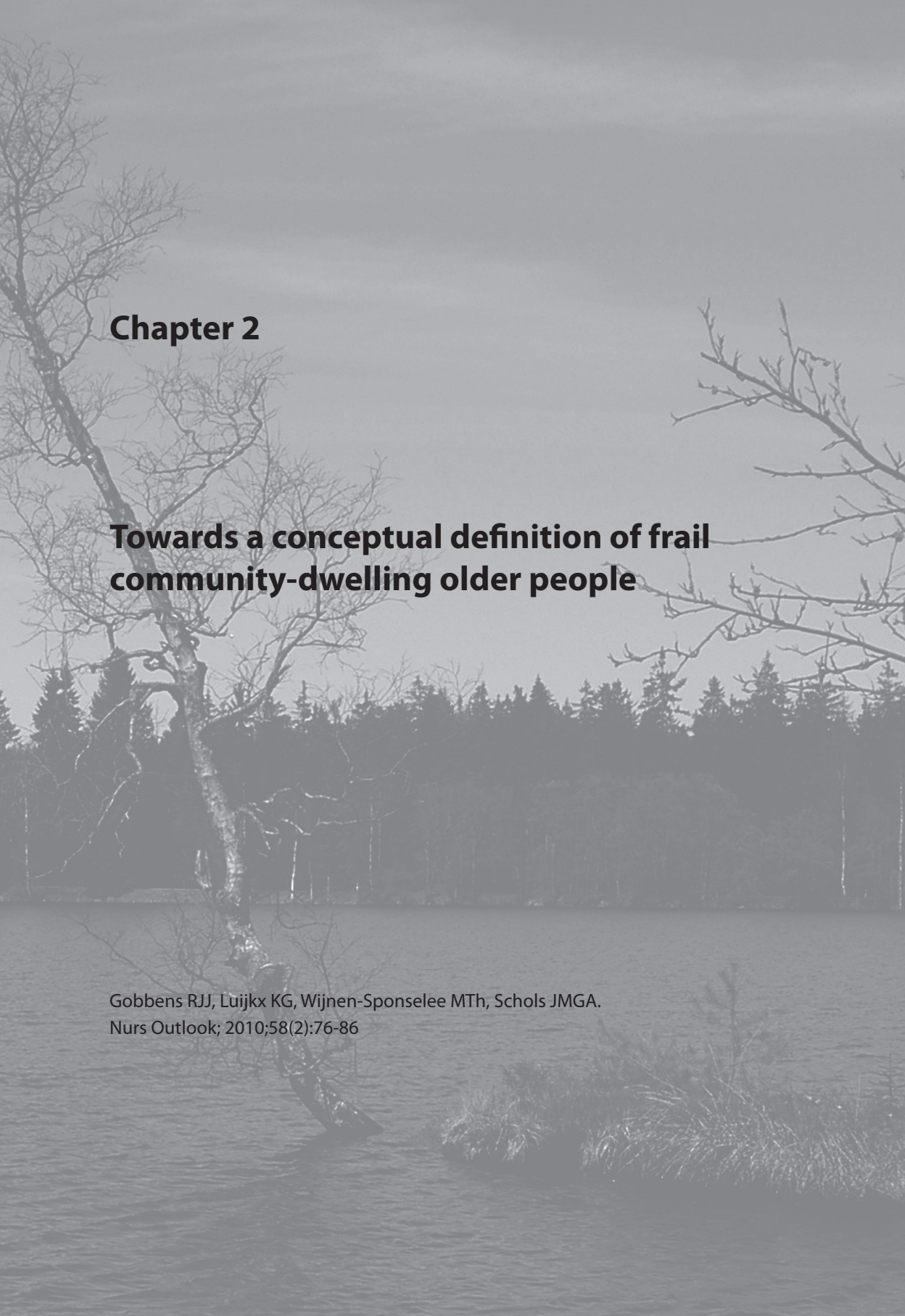
Chapters 2 to 6 inclusive were written as separate articles for publication in international scientific journals; all these articles were accepted for publication. The chapters can be read independently of each other; there is inevitably some overlap with respect to the background and the design of the study. There may be some minor differences in wording or lay-out between the articles as published in the journals and the corresponding articles presented in this thesis.

## REFERENCES


1. United Nations. Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2006 Revision, Highlights, Working Paper no. ESE/P/WP.202. New York, 2007.
2. CBS (http://statline.cbs.nl).
3. Health Council of the Netherlands. Ageing with ambition (In Dutch: Vergrijzen met ambitie), The Hague: 2005.
4. Health Council of the Netherlands. Prevention in the elderly: Focus on functioning in daily life (In Dutch: Preventie bij ouderen: focus op zelfredzaamheid). The Hague: 2009.
5. Rowe JW, Kahn RL. Human aging: usual and successful. Science 1987;237:143-149.
6. Rowe JW, Kahn RL. Successful aging. Gerontologist 1997;37:433-440.
7. Baltes PB, Baltes MM. Psychological perspectives on successful aging: The model of selective optimalization with compensation. In: Baltes PB, Baltes MM, eds. Successful aging: perspectives from the behavioural sciences. Cambridge: Cambridge University Press, 1990, pp. 1-34.
8. De Klerk MMY. Care and housing for the vulnerable elderly. Report on the elderly 2004 (In Dutch: Zorg en wonen voor kwetsbare ouderen. Rapportage ouderen 2004). Social and Cultural Planning Office of the Netherlands/Longitudinal Aging Study Amsterdam. The Hague: 2004.
9. Bootsma-van der Wiel A. Disability in the oldest old. The Leiden 85-plus study. Dissertation Leiden University: 2002.
10. Von Faber M. Measures of success among the elderly: health, adaptation and social well-being (In Dutch: Maten van succes bij ouderen: gezondheid, aanpassing en sociaal welbevinden). Dissertation University of Amsterdam: 2002.
11. Luijkx KG. Care: who is doing something about it. A study of care arrangements for the elderly (In Dutch: Zorg, wie doet er wat aan. Een studie maar zorgarrangementen van ouderen). Dissertation Wageningen Agricultural University: 2001.
12. Deeg DJH. Growing older: a vulnerable success (In Dutch: Ouder worden: een kwetsbaar succes). Longitudinal Aging Study Amsterdam, Inaugural lecture VU University Amsterdam: 2002.
13. RIVM (http//www.rivm.nl).
14. Bergman H, Béland F, Karunananthan S, et al. English translation of article published in 'Gérontologie et société'. Dévelopment d'un cadre de travail pour comprendre et étudier la fragilité. Gérontologie et société 2004;109:15-29.
15. Hogan DB, MacKnight C, Bergman H. Models, definitions, and criteria of frailty. Aging Clin Exp Res 2003;15:1-29.
16. Winograd CH, Gerety MB, Chung M, et al. Screening for frailty: criteria and predictors of outcomes. J Am Geriatr Soc 1991;39:778-784.
17. De Saint-Hubert M, Swine C. Evolving definitions of frailty. Aging Health 2007;3:589-593.
18. Kaethler Y, Molnar FJ, Mitchell SL, et al. Defining the concept of frailty: a survey of multi-disciplinary health professionals. Geriatrics Today: J Can Geriatr Soc 2003;6:26-31.
19. Schuurmans H, Steverink N, Lindenberg S, et al. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci 2004;59:M962-965.
20. Rockwood K. Frailty and its definition: a worthy challenge. J Am Geriatr Soc 2005;53:1069-1070.
21. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003;44:58-68.

22. Gillick M. Pinning down frailty. J Gerontol A Biol Sci Med Sci 2001;56:M134-135.
23. Aminzadeh F, Dalziel WB, Molnar FJ. Targeting frail older adults for outpatient comprehensive geriatric assessment and management services: an overview of concepts and criteria. Rev Clin Gerontol 2002;12:82-92.
24. American Medical Association white paper on elderly health. Report of the Council on Scientific Affairs. Arch Intern Med 1990;150:2459-2472.
25. 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:M146-156.
26. Chin APMJ, de Groot LC, van Gend SV, et al. Inactivity and weight loss: effective criteria to identify frailty. J Nutr Health Aging 2003;7:55-60.
27. Buchner DM, Wagner EH. Preventing frail health. Clin Geriatr Med 1992;8:1-17.
28. Hamerman D. Toward an understanding of frailty. Ann Intern Med 1999;130:945-950.
29. Levers MJ, Estabrooks CA, Ross Kerr JC. Factors contributing to frailty: literature review. J Adv Nurs 2006;56:282-291.
30. Rockwood K, Hogan DB, MacKnight C. Conceptualisation and measurement of frailty in elderly people. Drugs Aging 2000;17:295-302.
31. 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 2007;62:731-737.
32. 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;59:255-263.
33. Abellan van Kan A, Rolland Y, Bergman H, et al. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging 2008;12:29-37.
34. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-847.
35. Witz M, Witz S, Shnaker A, Lehmann JM. Carotid surgery in the octogenarians. Should patients' age be a consideration in carotid artery endarterectomy? Age Ageing 2003;32:462-463.
36. Mitnitski AB, Mogilner AJ, MacKnight C, Rockwood K. The mortality rate as a function of accumulated deficits in a frailty index. Mech Ageing Dev 2002;123:1457-1460.
37. Morley JE, Perry HM, 3rd, Miller DK. Editorial: Something about frailty. J Gerontol A Biol Sci Med Sci 2002;57:M698-704.
38. Slaets JP. Vulnerability in the elderly: frailty. Med Clin North Am 2006;90:593-601.
39. Olde Rikkert MGM. Development and research in geriatrics (In Dutch: Ontwikkeling en onderzoek in de geriatrie). Inaugural lecture Radboud University Nijmegen: 2004.
40. Slaets JPJ. The older patient (In Dutch: De oudere patient). In: Gans ROB, Hoorntje SUJ, Strack van Schijndel RJM (eds) Consultative internal medicine (In Dutch: Consultatieve inwendige geneeskunde). Bohn Stafleu Van Loghum, Houten: 2004.
41. Slaets JP. The importance of the 'frailty-concept' in geriatric assessment (In Dutch: Het belang van het 'frailty-concept' bij case-finding in de geriatrie). Tijdschr Gerontol Geriatr 1998;29:276-278.
42. Puts MT, Lips P, Deeg DJ. Static and dynamic measures of frailty predicted decline in performance-based and self-reported physical functioning. J Clin Epidemiol 2005;58:1188-1198.
43. 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;347:1068-1074.
44. Visser M, Pluijm SM, van der Horst MH, et al. Lifestyle of Dutch people aged 55-64 years less healthy in 2002/'03 than in 1992/'93 (In Dutch: Leefstijl van 55-64-jarige Nederlanders in 2002/'03 minder gezond dan in 1992/'93). Ned Tijdschr Geneeskd 2005;149:2973-2978.

45. Fries JF. Reducing disability in older age. Jama 2002;288:3164-3166.
46. Hirdes JP. Addressing the health needs of frail elderly people: Ontario's experience with an integrated health information system. Age Ageing 2006;35:329-331.
47. Nourhashémi F, Andrieu S, Gillette-Guyonnet S, et al. Instrumental activities of daily living as a potential marker of frailty: a study of 7364 community-dwelling elderly women (the EPIDOS study). J Gerontol A Biol Sci Med Sci 2001;56:M448-453.
48. Gill TM, Gahbauer EA, Allore HG, Han L. Transitions between frailty states among community-living older persons. Arch Intern Med 2006;166:418-423.



# Chapter 2

# Towards a conceptual definition of frail community-dwelling older people

Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MTh, Schols JMGA.
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## ABSTRACT

*Background*
In order to be able to identify frail community-dwelling older people, a reliable and valid definition of the concept of frailty is necessary.

*Objective*
The aim of this study was to provide an overview of the literature on conceptual and operational definitions of frailty, and to determine which definitions are most appropriate for identifying frail community-dwelling older people.

*Method*
A computerised search was performed in the PubMed database, Web of Science and PsychInfo.

*Results*
A definition of frailty that reflects a multidimensional approach, makes clear its dynamic state, predicts adverse outcomes, does not include disease, comorbidity or disability, and meets the criterion of practicability is most successful. None of the current conceptual and operational definitions meet these criteria.

*Discussion*
A new integral conceptual definition of frailty is proposed which meets the criteria of a successful definition.

## INTRODUCTION

Prior to 1980, the term 'frailty' was scarcely used at all in the literature in reference to older people. In 1978 the Federal Council on Aging (FCA) in the United States introduced the term 'frail elderly' to describe a specific segment of the older population. This group defined the frail elderly as 'persons, usually but not always, over the age of 75, who because of an accumulation of various continuing problems often require one or several supportive services in order to cope with daily life'.[1]

Over the years frailty has developed into a concept of increasing relevance, both from the standpoint of clinical care for individual older people and from the perspective of research on aging.[2] A recent PubMed search by Hogan et al.[1] revealed a huge increase in the number of publications containing the Medline MeSH heading 'frail elderly' during the last 20 years. Research has demonstrated that the degree of frailty is a good predictor or selection criterion for treatment or intervention.[3-5] The clinical relevance of the concept of frailty has also been confirmed in research. In a survey of 356 Canadian health care professionals (in fields such as nursing, medicine, psychology, social work), 69% considered frailty to be a clinically useful concept.[6]

Using data from the Cardiovascular Health Study, Fried et al.[7] reported that persons who are classified as frail are at significantly higher risk for falls, loss of mobility, functional decline, hospital admission and death within three years. According to Strawbridge et al.[8] the life satisfaction of frail older people is lower than that of their non-frail contemporaries. The early stages of frailty are more commonly seen in community-dwelling older adults.[7, 9] Consequently, screening for frailty should be carried out in the primary care setting. The prevalence of frailty in older people depends on the definition of frailty used, and in practice there have been considerable differences between the various definitions.[10, 11] Van Iersel et al.[12] reported prevalence figures ranging from 33% to 88%, depending on the definition used.

Therefore, it is unclear precisely who these frail older people are. A reliable and valid definition and measurement of the concept of frailty is necessary in order to be able to identify this high-risk population, and then, wherever possible, to prevent the onset of frailty, reduce frailty, or prevent it from worsening through intervention. This article seeks to provide an insight into the development of the definition of frailty in community-dwelling older persons. The central research questions addressed are:

1) What conceptual and operational definitions of frailty have been used in the literature?
2) Which definitions are most appropriate for identifying frail community-dwelling older people?

In order to formulate answers to these questions, a literature search was performed; this article summarises this descriptive literature search.

## METHOD

Initially, a computer search was performed in the PubMed database, Web of Science and PsychInfo (up to December 2008). Combinations of the following subject headings and words were used: 'frail' (and the related words 'frail elderly' and 'frailty'), 'definition', 'conceptual framework', 'patient identification', 'community-dwelling' and 'risk factors'. In addition, references cited in the articles were scanned to identify other relevant articles not found by the initial search.

A number of criteria were applied in the selection of literature by the first author of this article: the study had to relate to older adults (aged 65 years and over); the search was restricted to articles in English; no restriction was placed on year of publication. The published papers selected by the first author for inclusion represented the most relevant work dealing with the topics covered in this article, namely conceptual and operational definitions of frailty. Ultimately 41 articles were selected for the purpose of this overview.

## FINDINGS

### *Debate on frailty*

Frailty can be seen as increasing vulnerability associated with aging.[13] Precisely how it should be defined remains unclear.[1, 4, 14, 15] There is still a lack of consensus on a definition of frailty.[16] However, there is an urgent need for consensus on the definition of frailty among health care professionals in order that the screening and treatment of frailty can be more effective.[6, 17] The emphasis should be on those health care professionals such as general practitioners, nurse practitioners, physiotherapists, occupational therapists, and nurses who regularly treat community-dwelling older people, and who can often identify early stages of frailty before it is too late.[17] This part of the article discusses the main issues in the debate on frailty.

The debate has mainly focused on whether frailty should be defined purely in terms of biomedical factors or whether psychosocial factors should be included as well.[18] More and more researchers are becoming convinced of the multidimensional nature of frailty.[11, 19-21] Frailty provides a conceptual basis for moving away from organ and disease-based approaches towards a health-based, integrative approach.[22] This is an approach in which the focus is not exclusively on physical problems in older people, but which also incorporates psychological and social problems. The multidimensional nature of the concept of frailty demands an integrated view of human beings and a multidisciplinary approach. The authors of this article, together with other scientific researchers,[11] fear that if the definition of frailty home in exclusively on the physical

components of frailty (physical frailty), attention for the individual as a whole will be jeopardised. This could potentially lead to fragmentation of care and subsequently to a reduction in the quality of care provided to frail elderly persons. Results of evidence-based research suggest that integrated health and social service interventions for the frail elderly may have an important impact on health, quality of life, satisfaction, pattern of health care utilisation, and cost.[23] In addition, a measure of frailty that incorporates a diverse range of deficits (physical, psychological, social) is a better predictor of institutionalisation and death than chronological age.[3, 24]

Rather than thinking in terms of someone being frail or not, older persons should be placed on a continuum representing the risk of becoming more or less frail, with the possibility of adverse outcomes such as future hospital admission and, ultimately, death.[11] Frailty is a dynamic concept:[20] the process of frailty can be changed or reversed.[11] Transition to less frail clinical states, and even from being frail to non-frail, is possible. The following factors can lead to prevention or reduction of frailty: nutritional support with calories and vitamins, control of high blood pressure, prevention of atherosclerosis, avoidance of isolation by engaging in social contacts, pain control, treatment of depression, and a variety of exercises aimed at improving balance, flexibility, strength and power.[4]

Research has shown that frailty should be distinguished from disability and comorbidity, but that there is some overlap between the three concepts.[14] Comorbidity refers to the presence of two or more diseases. The relationship between frailty and chronic disease(s) is complex and poorly understood.[22] The development of diseases can precipitate frailty because they require the organism to mobilise available resources with the potential consequence of exhausting the reserve function of organ systems.[22] Fried et al. found that of the participants in their study who were frail, 68% reported having two or more chronic conditions.[14] Disability is defined as difficulty or dependency in carrying out activities that are essential to independent living; difficulties in performing activities of daily living (ADL) and/or instrumental activities of daily living (IADL). Disability exacerbates a person's frailty, and comorbidity can contribute to the development of frailty. However, not all older adults with disabilities are frail, nor do all frail older adults have disabilities.[14] In a study, only 27% of the frail elderly reported difficulties in activities of daily living.[14] Both Abellan van Kan et al.[16] and Morley et al.[25] regard frailty as a predisability state.

Clearly, any definition of frailty must meet the criterion of 'practicability'. Practicability refers to the inclusion of aspects at which (preventive) interventions can be targeted.[26] Furthermore, the definition of frailty should be able to serve as a basis for the development of an instrument for measuring and assessing frailty.[11] Finally, as Feinstein states, a successful definition must also be 'clinically sensible'.[27] This is a

reference to the acceptance of the definition of frailty by those who will be applying it in practice.

In conclusion, based on the literature search, the assumption of the authors of this article is that a definition of frailty that reflects a multidimensional approach, makes clear its dynamic state, predicts adverse outcomes, does not include disease, comorbidity or disability, and meets the criterion of practicability, is the most successful. Subsequently, these criteria were used by the authors of this article to determine the success of the current conceptual and operational definitions of frailty. It should be emphasised that the criterion 'a multidimensional approach' is most important, because the consequence for identifying frail older people is the greatest. More specifically, this criterion ultimately determines which people are frail or non-frail: only people with physical problems, or also people with problems in relation to the psychological and social domains of human functioning.

### *Conceptual definitions*

In a conceptual definition, the concept is defined in terms of other concepts. Table 1 presents a chronological summary of conceptual definitions of frailty. Several conceptual definitions were first described in a review of Aminzadeh et al., published in 2002.[10] For the purpose of the current study this review was completed.

**Table 1.** Conceptual definitions and conceptual models of frailty

| Author | Conceptual definition | Conceptual model |
|---|---|---|
| Winograd et al.[28] | A state of being neither 'too independent' nor 'too impaired' that puts the person at risk of adverse health outcomes | - |
| Buchner & Wagner[29] | A state of reduced physiological reserve associated with increased susceptibility to disability | Frailty and disability (medical sciences)<br>The process of becoming frail consists of a series of episodic, progressive and irreversible losses |
| Bortz[30] | Diminished energy flow (interaction) between the individual and their environment | The physics of frailty (physical sciences)<br>Frailty is reversible through the reestablishment of optimal energy flow |

**Table 1. Continued**

| Author | Conceptual definition | Conceptual model |
|---|---|---|
| Kaufman[31] | - | The social construction of frailty (medical anthropology)<br>Frailty is a quality and a dynamic adaptational process on the part of elderly persons, families and health care personnel |
| Rockwood et al.[15] | A vulnerability state resulting from a precarious balance between the assets maintaining health and the deficits threatening it | Dynamic model of frailty (medical sciences)<br>A dynamic process with interacting factors resulting in different degrees of frailty characterised by different levels of dependence on others |
| Raphael et al.[26] | Frailty is a diminished ability to carry out important practical and social activities in daily living | Frailty as a social construction (behavioral sciences)<br>The position on a frailty-hardiness continuum depends on the complex interaction among personal and environmental factors |
| Campbell & Buchner[32] | A syndrome of multi-system reduction in reserve capacity as a result of which an older person's function may be severely compromised by minor environmental stresses, giving rise to the condition of 'unstable disability' | Frailty and disability, expanded model (medical sciences)<br>Original model: Buchner & Wagner[29] |

**Table 1. Continued**

| Author | Conceptual definition | Conceptual model |
|---|---|---|
| Strawbridge et al.[8] | A syndrome involving grouping of problems and loss of capabilities in multiple domains that make the individual vulnerable to environmental challenge | - |
| Dayhoff et al.[33] | Frailty is diminished functioning combined with diminished self-rated health | - |
| Hamerman[34] | Complex and cumulative expression of altered homeostatic responses to multiple stresses resulting in metabolic imbalance | - |
| Rockwood et al.[19] | A combination of ageing, disease and other factors that make some people vulnerable | - |
| Fried et al.[7] | A biologic syndrome of decreased reserve and resistance to stressors, resulting from cumulative declines across multiple physiologic systems, causing vulnerability to adverse outcomes | The cycle of frailty (medical sciences)<br>Frailty is defined as a cycle, a process of declining energetic, including loss of muscle mass, falling metabolic rate, declining strength, energy expenditure and mobility |
| Nourhashémi et al.[35] | A combination of biological, physiological, social and environmental changes that occur with advancing age and increase vulnerability to changes in the surroundings, and to stress | - |

**Table 1. Continued**

| Author | Conceptual definition | Conceptual model |
|---|---|---|
| Bortz[36] | A state of muscular weakness and other secondary widely distributed losses in function and structure | - |
| Schuurmans et al.[3] | A loss of resources in several functional domains, that leads to reduced reserve capacity to deal with stress | - |
| Bergman et al.[2] | - | A working framework in development (multidisciplinary: several sciences)<br>Biological, psychological, social, and environmental factors that interact across the life course are the determinants of frailty. The pathway from frailty to its adverse outcomes is affected by various biological, psychological, social and societal modifiers. |
| Morley et al.[25] | - | The frailty cascade (medical sciences)<br>Frailty represents a form of predisability. The development of frailty depends on the interaction of disease processes with the normal physiologic processes of aging. Genes, environment, and lifestyle all play a role in the pathway to frailty. |
| Strandberg & Pitkala[37] | - | Pathways to frailty (medical sciences)<br>Frailty arises from declines in the molecular, cellular, and physiological systems of the aged body. The model shows a circular effect between primary frailty, secondary frailty, clinical disease and disability. |

In this part the following aforementioned criteria for a successful definition of frailty will be discussed: frailty as a multidimensional and dynamic concept, the exclusion of disease, comorbidity and disability, and the relationship between frailty and adverse outcomes. The criterion of practicability is not relevant for a conceptual definition.

*Frailty as a multidimensional concept*. Most of the conceptual definitions focus chiefly on physical problems affecting older people[7, 29, 30, 32, 34, 36]; there are only a few that also draw attention to other domains of human functioning, such as the psychological domain.[3, 8, 15, 19, 26, 35] Only the definition by Nourhashémi et al.[35] includes a reference to the different domains: 'a combination of biological, physiological, social and environmental changes'.

*Frailty as a dynamic concept*. A number of authors place the concept of frailty on a continuum. Bortz,[30] for example, puts frailty at one end of a continuum, with vitality at its other extreme. Raphael et al.[26] opt for a 'frailty-hardiness continuum'. According to Raphael et al.[26] a person's position on that continuum is determined by the complex interaction between personal and environmental factors. Personal factors include cognitive, physical, psychological, and spiritual factors, while environmental factors include financial, social, living situation, legal and, where relevant, institutional factors.

*Adverse outcomes*. Three conceptual definitions make explicit reference to adverse outcomes.[7, 28, 32] In the conceptual definition by Campbell & Buchner[32] the adverse outcome is 'unstable disability'. Winograd et al.[28] and Fried et al.[7] also describe the interrelationship between frailty and adverse outcomes, but they do not describe what the adverse outcomes in their conceptual definitions are.

*Exclusion of disease, comorbidity or disability*. The conceptual definition by Raphael et al.[26] includes disability, and the definition by Rockwood et al.[19] includes disease. These two definitions are therefore not regarded as satisfactory.

Table 1 also presents a number of conceptual models of frailty. Some of these models were first described in another review, published in 2003.[11] More recent models have been added. A conceptual model is defined as 'a set of concepts and the propositions that integrate them into a meaningful configuration'.[38] There are several models in existence and these are presented in various forms, such as an algorithm,[2, 25] a circle[7] and a balance.[15] Table 1 shows that not all researchers have developed both a conceptual definition and a conceptual model of frailty. Most of the conceptual models are based on the medical sciences, and as a result have a physical focus. However, this is not the case for the models devised by Bortz,[30] Raphael et al.,[26] Kaufman,[31] and Bergman et al.[2] The core of the model by Bergman et al.[2] 'A working framework in development' is based on medical sciences, but is characterised by a life course approach, which refers to a more integral approach to frailty. In general, the models do not address directly how various physical, psychological, social and environmental factors in combination can predict frailty.[11]

### *Operational definitions*

An operational definition, also known as an empirical definition, defines a concept on the basis on the criteria that must be applied in order to determine whether and to what extent that concept exists. In other words, an operational definition defines a concept in terms of observable data. Operational definitions of frailty are based on criteria that can be applied clinically to the older population.[6] Table 2 presents a chronological summary of operational definitions of frailty. This table is based on a review of Aminzadeh et al., published in 2002.[10] For the purpose of this article more recent operational definitions were added.

**Table 2.** Operational definitions of frailty

| Author | Operational definition | Validation |
|---|---|---|
| Winograd et al.[28] | Classification into three groups: 'independent' in all ADL (activities of daily living), 'frail' meeting ≥ 1 of the following criteria and 'severely impaired', suffering from terminal illness or severe dementia:<br>- impaired function<br>- common geriatric conditions (i.e. falls, depression, confusion, incontinence, polypharmacy, etc.)<br>- chronic and disabling illness<br>- social problems | Increasing frailty was significantly associated with increasing length of hospital stay, nursing home utilisation, and mortality in 1-year follow-up (hospital men 65 years and older, N=985) |
| Speechley & Tinetti[39] | Classification into three groups: 'frail' (possessed ≥4 frailty factors), 'vigorous'(<2 frailty factors), or 'transition' (not meeting the criteria for frail or vigorous):<br>- age over 80<br>- depression<br>- use of sedatives<br>- near vision loss<br>- balance and gait abnormalities<br>- infrequent walking<br>- decreased strength in shoulder<br>- decreased strength in knee<br>- lower extremity disability | Increasing frailty was significantly associated with fall incidence rates in 1-year follow-up (community-dwelling 75 years and older, N=336) |

**Table 2. Continued**

| Author | Operational definition | Validation |
|---|---|---|
| Buchner & Wagner[29] | Deficits in three major components of frailty:<br>- neurological control<br>- mechanical performance<br>- energy metabolism | - |
| Ory et al.[40] | The components of physical frailty are:<br>- severely impaired strength<br>- mobility<br>- balance<br>- endurance | - |
| Rockwood et al.[15] | Deficits in five major components of frailty:<br>- functional dependence<br>- restricted mobility<br>- poor self-rated health<br>- limited social resources<br>- increased use of health care services | - |
| Raphael et al.[26] | Developed an instrument to measure frailty, based on the definition of the diminished ability to carry out the important practical (21 items) and social activities (9 items) of daily living | - |
| Campbell & Buchner[32] | Deficits in the four key components of frailty:<br>- musculoskeletal function<br>- aerobic capacity<br>- cognitive/integrative neurological<br>- nutritional | - |

**Table 2. Continued**

| Author | Operational definition | Validation |
|---|---|---|
| Strawbridge et al.[8] | Deficiencies in >2 of the following domains:<br>- physical health (sudden loss of balance, weakness in arms, weakness in legs and orthostatic dizziness)<br>- nutritional (loss of appetite and unexplained weight loss)<br>- cognitive (attention deficit, trouble finding words and memory difficulties)<br>- sensory (visual and hearing problems) | Frailty was associated cross-sectionally with reduced activity, poorer mental health and lower life satisfaction (community-dwelling 65 years and older, N=574) |
| Dayhoff et al.[33] | Scoring 21 or more on the World Health Organization Assessment of Functional Capacity combined with a self-report of perceived health | - |
| Rockwood et al.[19] | Used a 'frailty scale' to classify older persons at four levels, representing 'fitness' to 'frailty', using the following four criteria:<br>- mobility<br>- ADL<br>- continence<br>- cognition | The frailty scale showed a dose-response relation between grades of frailty and subsequent institutionalisation and death (community-dwelling 65 years and older, N=9008) |
| Chin A Paw et al.[41] | Inactivity combined with weight loss | Predictive of death and functional decline in a 3-year period (community-dwelling aged from 75 to 80 years, N=849) |

**Table 2. Continued**

| Author | Operational definition | Validation |
|---|---|---|
| Brown et al.[42] | Developed an 'index of frailty' by classifying elderly in three groups of 'not frail', 'mildly frail', and 'moderately frail', based on scores on a physical performance test of:<br>- strength<br>- range of motion<br>- balance<br>- gait<br>- coordination & speed of reaction<br>- sensation | Scores on a frailty index were associated with results of more detailed functional measures of functional capacity (community-dwelling 77 years and older, N=107) |
| Fried et al.[7] | Proposed a 'phenotype of frailty' with the 'frail' presenting ≥3 and the 'intermediate of prefrail' group presenting 1 or 2 of the following criteria:<br>- unintentional weight loss or sarcopenia<br>- weakness (decreased grip strength)<br>- poor self-reported endurance<br>- slowness walking<br>- low physical activity | The frailty phenotype was predictive of falls, decline in mobility or ADL disability, hospitalisation and death in a 3 and 7 years follow-up (community-dwelling 65 years and older, N=5317) |
| Nourhashémi et al.[35] | Deficits in at least one IADL (instrumental activities of daily living) was used as a marker of frailty | IADL incapabilities were cross-sectionally associated with comorbidity, social inactivity, cognitive impairment, falls and nutritional deficits (community-dwelling women 75 years and older, N=7364) |
| Mitnitski et al.[43] | Made a list of 20 deficits (signs, impairments, symptoms or disabilities) observed after a structured clinical examination based upon comprehensive geriatric assessment (CGA) | Predictor of survival (community-dwelling and institution 65 years and older, N=2914) |

**Table 2. Continued**

| Author | Operational definition | Validation |
|---|---|---|
| Schuurmans et al.[3] | Developed a Groningen Frailty Indicator (GFI). This instrument measures frailty based on the following aspects:<br>- mobility<br>- physical fitness<br>- vision<br>- hearing<br>- nourishment<br>- morbidity<br>- cognition (perception)<br>- psychosocial (depression, anxiety, loneliness) | - |
| Studenski et al.[44] | Developed a Clinical Global Impression of Change in Physical Frailty Instrument (CGIC-PF). The CGIC-PF includes six intrinsic domains:<br>- mobility<br>- balance<br>- strength<br>- endurance<br>- nutrition<br>- neuromotor performance | - |
| Jones et al.[45] | Developed a Frailty Index (FI) based on a standard comprehensive geriatric assessment (CGA). The index results from the count of impairments in:<br>- cognitive status<br>- mood<br>- communication<br>- mobility<br>- balance<br>- bowel function<br>- bladder function<br>- nutrition<br>- activities of daily living (ADL)<br>- social status,<br>plus the comorbidity count of active diagnoses | The FI was predictive of institutionalisation and mortality (community-dwelling 70 years and older, N=169) |

**Table 2. Continued**

| Author | Operational definition | Validation |
|---|---|---|
| Bergman et al.[2] | The core components of frailty are:<br>- weight loss/under nutrition<br>- weakness<br>- endurance<br>- physical activity<br>- slowness<br>- cognitive decline<br>- depressive symptoms | - |
| Puts et al.[20] | Distinguished nine frailty markers:<br>- body weight<br>- peak expiratory flow<br>- cognition<br>- vision<br>- hearing<br>- incontinence<br>- sense of mastery<br>- depressive symptoms<br>- physical activity | Static frailty was associated with performance decline and decline in self-reported functioning; dynamic frailty was associated with decline in performance only in women and with self-reported functional decline (community-dwelling 65 years and older, N=1152) |
| Rockwood et al.[46] | Measured frailty with the CSHA Clinical Frailty Scale, a seven-point scale based upon a frailty index of 70 items | The Clinical Frailty Scale predicted mortality and institutionalisation in a five-year follow-up (community-dwelling and institution 75 years and older, N=2305) |
| Rolfson et al.[21] | Developed a Edmonton Frail Scale (EFS). The EFS samples ten domains:<br>- functional independence<br>- cognition<br>- self-rated health<br>- hospitalisation<br>- social support<br>- medication use<br>- nutrition<br>- mood<br>- continence<br>- functional performance | The EFS correlated significantly with the Geriatrician's Clinical Impression of Frailty (GCIF) and the Barthel Index (mostly community-dwelling 65 years and older, N=158) |

**Table 2. Continued**

| Author | Operational definition | Validation |
|---|---|---|
| Abellan van Kan et al.[16] | Suggested to developed a FRAIL scale, a case finding tool, that should comprise the following five domains:<br>- fatigue<br>- resistance (the ability to climb stairs)<br>- ambulation (ability to walk certain number of meters)<br>- number of illnesses<br>- loss of weight (>5%) | - |

As Table 2 shows, there are also many different operational definitions of frailty. All five criteria of a successful definition of frailty will be discussed in the next section.

*Frailty as a multidimensional concept*. A widely cited operational definition is the 'phenotype of frailty', proposed by Fried et al.[7] Theou & Kloseck[17] found 12 studies (up to March 2007) that used the criteria proposed by Fried et al.[7] to assess frailty. Researchers who used the 'phenotype of frailty' approach were only interested in the physical domain of frailty. In fact this applies to most of the researchers.[16, 32, 42, 44] In the literature this is indicated using the term 'physical frailty'. The operational definitions by Strawbridge et al.,[8] Schuurmans et al.,[3] Jones et al.,[45] and Rolfson et al.[21] are definitions that refer to multiple domains of human functioning, such as the psychological or social domain.

*Frailty as a dynamic concept*. Table 2 presents operational definitions of frailty which distinguish a number of degrees or stages of frailty.[7, 19, 39, 42] According to Rockwood et al.,[27] a definition of frailty should identify clinically recognisable degrees of frailty. The operational definitions proposed by Fried et al.,[7] Rockwood et al.,[19] and Speechley & Tinetti[39] have been used frequently to assess stages of frailty.[17]

*Adverse outcomes*. The chances of success can increase if one operational definition has strong validity, and the basis of that validity can be understood.[27] However, there is no 'gold standard' against which these operational definitions can be compared, so predictive validity becomes the best standard.[27] The operational definitions by Chin A Paw et al.,[41] Fried et al.,[7] Mitnitski et al.,[43] Jones et al.,[45] and Rockwood et al.[46] have shown good predictive validity for adverse outcomes in groups of community-dwelling older people aged 65 years and older.

*Exclusion of disease, comorbidity and disability*. Table 2 presents operational definitions of frailty which contain disability as a measure of frailty.[19, 26, 35, 43, 45, 46] Functional independence and mobility, respectively used in the Edmonton Frail Scale[21] and the Groningen Frailty Indicator,[3] also refer to disability. In addition, quite a few operational definitions use disease or comorbidity as one of the measures of frailty.[3, 16, 28, 43, 45, 46] In conclusion, many operational definitions do not meet the criterion 'exclusion of disease, comorbidity and disability' for a successful definition of frailty.

*Practicability*. The phenotype of frailty[7] is typically rule-based: a person may be defined as frail if three or more symptoms are present. Rule-based definitions are often derived from multiple regression analyses, and can be superficially attractive in their precision, but require factors that might not be applicable in individual cases.[46] Adding together the number of impairments is another way of defining frailty.[43] This approach is however time-consuming and is not widely used clinically.[46] A third category of operational definitions consists of definitions which rely on clinical judgment[44, 46] The practicability of the Edmonton Frail Scale,[21] the Groningen Frailty Indicator,[3] and the operational definition by Strawbridge et al.[8] seems to be good. The measurement instruments based on these (multidimensional) operational definitions are user-friendly (self-report questionnaires) and the data collected with these instruments will provide relevant and specific information for health care providers to target their (preventive) interventions.

## DISCUSSION

This article aims to present a number of conceptual and operational definitions of frailty. At the beginning of the article it was acknowledged that there are numerous different definitions of frailty in circulation. The literature search made clear that five criteria should be used to determine the success of these definitions of frailty. A definition that meets these criteria contains a multidimensional approach, is dynamic, has predictive validity for adverse outcomes, does not include disease, comorbidity or disability, and is practicable. This overview of definitions also makes clear that at present there is no group of researchers with a broad view of frailty that has developed a conceptual definition, a conceptual model, as well as an operational definition of frailty.

The conceptual definitions by Strawbridge et al.,[8] Nourhashémi et al.[35] and Schuurmans et al.[3] are most appealing because they state that frailty consists of a combination of deficits in several functional domains of human functioning. On the other hand, a limitation of these three definitions is that they are not focused on adverse outcomes as a result of the pathway of frailty. Based on the results of the

literature search, we felt able to formulate a new, integral conceptual definition of frailty, that takes full account of the essential parts of existing conceptual definitions. The new definition is as follows: *'Frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social) that are caused by the influence of a range of variables and which increases the risk of adverse outcomes'*. The conceptual model 'A working framework of development'[2] fits in well with this proposed conceptual definition. It is a model that appeals because it advocates an integrative approach. The model describes the pathway from frailty to adverse outcomes, and draws a distinction between frailty, disability, and comorbidity. In addition, it offers opportunities for interventions, focused both on cure and on primary and secondary prevention.

For the concept of frailty to be of practical use, its theoretical conceptualisation must be capable of being translated into an operational definition.[27] It can be concluded that no current operational definition of frailty fulfils all the criteria that ought to be met by a successful definition of frailty. For many operational definitions, no validation of the definition has taken place. Moreover, many definitions of frailty are rendered out of date because they include references to disease, comorbidity or disability. The operational definition by Fried et al.,[7] the 'phenotype of frailty', has been used in numerous studies. The strength of this narrow definition is that it has been shown to predict adverse outcomes such as death, hospitalisation, and ADL disability. However, if frailty is defined in terms of physical losses alone this will be the sole focus when identifying frail older people.

In follow-up research an attempt will be made to arrive at an integral operational definition that fits in with our conceptual definition of frailty, based on consensus. To the authors of this article, it is self-evident that any operational definition of frailty must meet the criterion of 'practicability'. Thus the operational definition must include aspects on which (preventive) interventions can be focused. At the same time the definition must be capable of serving as a basis for the development of a measurement instrument, a frailty indicator. If a better operational definition of frailty can be successfully developed, it may be expected that a more complete and validated frailty indicator can also be developed, to enable the actual identification of frail community-dwelling older people.

## REFERENCES


1. Hogan DB, MacKnight C, Bergman H. Models, definitions, and criteria of frailty. Aging Clin Exp Res 2003;15:1-29.
2. Bergman H, Béland F, Karunananthan S, et al. English translation of article published in 'Gérontologie et société'. Dévelopment d'un cadre de travail pour comprendre et étudier la fragilité. Gérontologie et société 2004;109:15-29.
3. Schuurmans H, Steverink N, Lindenberg S, et al. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci 2004;59:M962-965.
4. Morley JE, Perry HM, 3rd, Miller DK. Editorial: Something about frailty. J Gerontol A Biol Sci Med Sci 2002;57:M698-704.
5. 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;347:1068-1074.
6. Kaethler Y, Molnar FJ, Mitchell SL, et al. Defining the concept of frailty: a survey of multi-disciplinary health professionals. Geriatrics Today: J Can Geriatr Soc 2003;6:26-31.
7. 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:M146-156.
8. Strawbridge WJ, Shema SJ, Balfour JL, et al. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci 1998;53:S9-16.
9. Gill TM, Gahbauer EA, Allore HG, Han L. Transitions between frailty states among community-living older persons. Arch Intern Med 2006;166:418-423.
10. Aminzadeh F, Dalziel WB, Molnar FJ. Targeting frail older adults for outpatient comprehensive geriatric assessment and management services: an overview of concepts and criteria. Rev Clin Gerontol 2002;12:82-92.
11. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003;44:58-68.
12. Van Iersel MB, Olde Rikkert MG. Frailty criteria give heterogeneous results when applied in clinical practice. J Am Geriatr Soc 2006;54:728-729.
13. Slaets JP. Vulnerability in the elderly: frailty. Med Clin North Am 2006;90:593-601.
14. 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;59:255-263.
15. Rockwood K, Fox RA, Stolee P, et al. Frailty in elderly people: an evolving concept. Cmaj 1994;150:489-495.
16. Abellan van Kan A, Rolland Y, Bergman H, et al. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging 2008;12:29-37.
17. Theou O, Kloseck M. Tools to identify community-dwelling older adults in different stages of frailty. Phys Occup Ther Geriatr 2008;26:1-21.
18. Lally F, Crome P. Understanding frailty. Postgrad Med J 2007;83:16-20.
19. Rockwood K, Stadnyk K, MacKnight C, McDowell I, Hebert R, Hogan DB. A brief clinical instrument to classify frailty in elderly people. Lancet 1999;353:205-206.
20. Puts MT, Lips P, Deeg DJ. Static and dynamic measures of frailty predicted decline in performance-based and self-reported physical functioning. J Clin Epidemiol 2005;58:1188-1198.
21. Rolfson DB, Majumdar SR, Tsuyuki RT, et al. Validity and reliability of the Edmonton Frail Scale. Age Ageing 2006;35:526-529.
22. 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 2007;62:731-737.

23. Bergman H, Beland F, Perrault A. The global challenge of understanding and meeting the needs of the frail older population. Aging Clin Exp Res 2002;14:223-225.
24. Rockwood K, Mitnitski A, Song X, et al. Long-term risks of death and institutionalization of elderly people in relation to deficit accumulation at age 70. J Am Geriatr Soc 2006;54:975-979.
25. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-847.
26. Raphael D, Cava M, Brown I, et al. Frailty: a public health perspective. Can J Public Health 1995;86:224-227.
27. Rockwood K. What would make a definition of frailty successful? Age Ageing 2005;34:432-434.
28. Winograd CH, Gerety MB, Chung M, et al. Screening for frailty: criteria and predictors of outcomes. J Am Geriatr Soc 1991;39:778-784.
29. Buchner DM, Wagner EH. Preventing frail health. Clin Geriatr Med 1992;8:1-17.
30. Bortz WM, 2nd. The physics of frailty. J Am Geriatr Soc 1993;41:1004-1008.
31. Kaufman SR. The social construction of frailty: an anthropological perspective. J Aging Stud 1994;8:45-58.
32. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing 1997;26:315-318.
33. Dayhoff NE, Suhrheinrich J, Wigglesworth J, et al. Balance and muscle strength as predictors of frailty among older adults. J Gerontol Nurs 1998;24:18-27; quiz 54-15.
34. Hamerman D. Toward an understanding of frailty. Ann Intern Med 1999;130:945-950.
35. Nourhashémi F, Andrieu S, Gillette-Guyonnet S, et al. Instrumental activities of daily living as a potential marker of frailty: a study of 7364 community-dwelling elderly women (the EPIDOS study). J Gerontol A Biol Sci Med Sci 2001;56:M448-453.
36. Bortz WM, 2nd. A conceptual framework of frailty: a review. J Gerontol A Biol Sci Med Sci 2002;57:M283-288.
37. Strandberg TE, Pitkala KH. Frailty in elderly people. Lancet 2007;369:1328-1329.
38. Fawcett J. Analysis and evaluation of conceptual models of nursing. 2nd edn. ed. Philadelphia, PA, USA: F.A. Davis Company, 1989.
39. Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. J Am Geriatr Soc 1991;39:46-52.
40. Ory MG, Schechtman KB, Miller JP, et al. Frailty and injuries in later life: the FICSIT trials. J Am Geriatr Soc 1993;41:283-296.
41. Chin APMJ, Dekker JM, Feskens EJ, et al. How to select a frail elderly population? A comparison of three working definitions. J Clin Epidemiol 1999;52:1015-1021.
42. Brown M, Sinacore DR, Binder EF, Kohrt WM. Physical and performance measures for the identification of mild to moderate frailty. J Gerontol A Biol Sci Med Sci 2000;55:M350-355.
43. Mitnitski AB, Graham JE, Mogilner AJ, Rockwood K. Frailty, fitness and late-life mortality in relation to chronological and biological age. BMC Geriatr 2002;2:1.
44. 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;52:1560-1566.
45. Jones DM, Song X, Rockwood K. Operationalizing a frailty index from a standardized comprehensive geriatric assessment. J Am Geriatr Soc 2004;52:1929-1933.
46. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. Cmaj 2005;173:489-495.

# Chapter 3

# In search of an integral conceptual definition of frailty Opinions of experts

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## ABSTRACT

*Introduction*

There are many different conceptual definitions of frailty in circulation. Most of these definitions focus mainly on physical problems affecting older people. Only a few also draw attention to other domains of human functioning such as the psychological domain. The authors of this article fear that this could lead to fragmentation of care for frail older people. The aim is to develop an integral conceptual definition of frailty which starts from the premise of a holistic view of the person.

*Methods*

In order to achieve this, a literature search was carried out. Thereafter a group of experts (N = 20) were consulted, both verbally during two expert meetings and via a written questionnaire. These experts were asked which existing conceptual definition of frailty places most stress on the integral functioning of older people.

*Results*

The experts expressed a clear preference for one of the conceptual definitions. The result of the literature search and the consultation with the experts led to a new integral conceptual definition of frailty.

*Conclusion*

The conceptual definition is intended to offer a framework for an operational definition of frailty for identifying frail older people.

## INTRODUCTION

The concept of 'frailty in older people' has developed over time into an increasingly relevant concept in gerontology and geriatrics. The concept is more and more being used in research into ageing[1] and in the clinical care of the elderly. Research has shown that the degree of frailty is a better predictor or selection criterion for treatment or intervention than age.[2-5] When deciding on the amount and type of care or treatment needed, it is important to look at the individual's frailty and the associated care need. This enables a good selection of older people to be made who should receive extra attention or care.[4] The clinical relevance of the concept of frailty has also been confirmed in research: 69% of a range of professional disciplines (such as nursing, medicine, psychology, social work) consider frailty to be a clinically useful concept.[6]

The prevalence of frailty in older people depends on the definition of frailty used, and in practice there are many differences between the various definitions. Fried et al. arrived at a prevalence of 7% among people aged 65 years and older;[7] the American Medical Association reported a prevalence of 20% for the same age group.[8]

A distinction can be made when defining a concept between a conceptual definition and an operational definition. In a conceptual definition, the concept is defined in terms of other concepts. An operational definition, also known as an empirical definition, defines a concept on the basis of criteria that must be applied in order to determine whether and to what extent that concept exists. In other words, an operational definition defines a concept in terms of observable data. A conceptual definition and an operational definition need to be well matched to each other; a conceptual definition must give direction to the operationalisation of the concept.

Researchers take very diverse views on frailty. This is evident from reviews containing conceptual definitions of frailty.[9-12] The majority of definitions home in strongly on physical diminution in the elderly person.[7, 13, 14] Some researchers have criticised these definitions.[1, 9, 10, 12, 15] According to these researchers, an integral approach is needed for the concept of frailty – an approach in which the focus is not exclusively on physical problems in older people, but which also incorporates psychological and social problems, and is thus based on the integral functioning of the individual. An overly narrow definition of frailty, focusing exclusively on physical problems in older people, can lead to fragmentation of care, jeopardising the attention for the whole person.[1, 9] The multidimensional nature of the concept of frailty demands a multidisciplinary approach. Results of evidence-based research suggest that integrated housing, welfare and care interventions for frail older people have a major impact on aspects such as health, quality of life, satisfaction, pattern of health care utilisation and cost.[16]

According to Rockwood, two approaches are possible in working towards a definition of frailty.[17] One approach is simply to accept that there are several definitions in circulation. Scientific research will then have to demonstrate which definition is most suitable for use by scientists and health care professionals. 'The Canadian Initiative on Frailty' has opted for this approach.[17] The other approach is to strive for consensus. Kaethler et al. believe that consensus-building is necessary for defining the concept. They regard it as unlikely that evidence-based research alone will lead to a general, clinically usable definition of frailty.[6]

In order to contribute to the consensus-building for a conceptual definition of frailty, experts in the field of frailty were consulted, both verbally (during two expert meetings), and in writing. Since the authors are convinced of the added value of an integral definition of frailty, the research question, was formulated as follows: Which existing conceptual definition of frailty places most emphasis on the integral functioning of older people?

## METHOD

*Literature search*

First, an extensive literature search was carried out in 2006 on conceptual definitions of frailty.[1] Since then, the researchers have kept abreast of the literature on this topic via the PubMed alert service. The literature search resulted in the development of a written questionnaire and also generated input for the content of two expert meetings.

*Selection of experts*

A total of 22 experts were approached with a request to make a contribution to this research project. Two experts did not respond to this request. Three experts were not able to attend one of the two expert meetings, but did complete the questionnaire. In total, therefore, 20 experts contributed to this study (11: both meeting and questionnaire; six: meeting only; three: questionnaire only).

A careful selection was made of experts in the field of frailty. Experts were invited if they had produced scientific publications on the target group of frail older people. In particular, experts were approached who had produced scientific publications on the definition of frailty. The experts selected included those working in America and Canada, where a great deal of research is being carried out on frailty. Experts from the Netherlands were also approached; this is explained by the nationality of the members of the research group. The multidimensional nature of frailty meant that the experts had to represent different disciplines. The distribution across the disciplines or focus areas was as follows: geriatric medicine (4), gerontology (3), nursing (3), (bio)statistics (3), general practice (2), psychology (2) and other disciplines (3) (see table 1).

*Written questionnaire*

The questionnaire was developed on the basis of a literature search and was distributed to the participating experts ahead of the expert meetings. The questionnaire contained one question on the two principles of this study: the multidimensional nature of frailty and positioning frailty on a continuum. The experts were asked whether they agreed with the formulated principles and whether they felt any essential principles were missing. Eleven existing conceptual definitions of frailty were submitted to the experts, who were then asked to assign a score to each definition. The experts were also invited to note down any comments about the list of proposed conceptual definitions.

Eleven of the 17 experts who were present at one of the two expert meetings returned the questionnaire at the end of the meeting. These were experts from America (3), Canada (2) and the Netherlands (6). The questionnaire was also sent to another three experts in the field of frailty. They were not able to participate in the meeting. All three completed and returned the questionnaire. One of these experts came from Canada, the other two from the Netherlands. In total, therefore, 14 experts (out of the total of 20) completed the questionnaire.

*Expert meetings*

The first expert meeting took place in November 2006 during the conference of The Gerontological Society of America in Dallas in the United States. Eleven experts took part in this meeting, from America (5), Canada (3) and the Netherlands (3). The second meeting was held in the Netherlands (Tilburg) in January 2007. A further six experts took part in this meeting, all from the Netherlands. In total, therefore, 17 experts took part in one of the two meetings. Reference is made to table 1 for an overview of the characteristics of the experts consulted in relation to the data gathering methods used.

The expert meeting in Dallas and in Tilburg both focused on answering the questions as formulated in the questionnaire. The researcher ensured that all experts were able to contribute. Contributors were regularly questioned further to obtain the maximum clarity possible about the views of the experts on the conceptual definition of frailty. The expert meeting in Dallas was recorded on a voice tracer and transcribed verbatim at a later date. Two people took minutes of the meeting in Tilburg; these were later amalgamated to create a single report. Each meeting lasted two hours.

The conclusions drawn in this study are based both on the results of the two expert meetings and on the outcome of the questionnaire and the literature search. In drawing these conclusions, the same weight was assigned to each of the data gathering methods used.

**Table 1.** Overview of experts consulted in relation to the data gathering methods used

| Discipline | Question-naire | Expert meeting Dallas | Expert meeting Tilburg | Working in | | |
|---|---|---|---|---|---|---|
| | | | | NL | U.S. | Can. |
| Geriatric medicine (4) | 3 | 3 | 1 | 1 | 2 | 1 |
| Gerontology (3) | 3 | 2 | | 1 | 1 | 1 |
| Nursing (3) | 3 | 1 | 1 | 2 | 1 | |
| (Bio)statistics (3) | 1 | 3 | | 1 | 1 | 1 |
| General practice (2) | 2 | | 1 | 2 | | |
| Psychology (2) | 2 | | 2 | 2 | | |
| Others (3) | | 2 | 1 | 2 | 1 | |
| Total (20) | 14 | 11 | 6 | 11 | 6 | 3 |

## RESULTS

*Principles*

Two principles were formulated on the basis of the literature search. The first principle concerns the multidimensional nature of the concept of frailty. This principle is receiving increasing support from researchers.[9, 18-20] These researchers interpret frailty as a combination of problems in different domains of human functioning, such as the physical, sensory, psychological and social domains. Nourhashémi et al. emphasise the influence of environmental factors in the onset of frailty.[21] For the authors of this article, the multidimensional nature of the concept of frailty demands an integral vision, based on a holistic view of the person. A unidimensional approach to frailty is not adequate; the concept is too complex for this, and its interpretation by each individual too different.[22, 23]

During the expert meetings it transpired that the first formulated principle was not endorsed by all experts. It was commented that it is essential to determine

in advance whether frailty should be seen as a unidimensional or multidimensional concept. According to the experts, this depends primarily on the envisaged goal; if the measurement of frailty is linked to interventions, a multidimensional approach is essential. A number of experts called explicitly for a unidimensional approach, arguing that frailty is a highly complex concept which is already complicated enough when interpreted solely as being unidimensional.

The second principle referred to a continuum on which frailty should be positioned. Raphael et al. propose that frailty should be placed on a 'frailty-hardiness continuum'.[24] The position on that continuum is determined by the complex interaction between personal and environmental factors. Bortz also places frailty on a continuum, but this time in opposition to vitality.[25] Frailty can be seen as a relative state, a state which can change over time.[9] It is a dynamic concept.[26, 27] The pathway of frailty is unique for each individual.[9] It must be possible to intervene in that pathway so that frailty is delayed, reduced or prevented from becoming worse.[2, 28] The authors of this article proposed the placing of frailty on a continuum between independence and dependence.

The meetings also considered this second principle. Placing frailty on a continuum was not so much an issue of debate. However, not everyone shared the opinion that the extremes of the continuum should be independence and dependence. It was suggested that 'non-frail' and 'completely frail' could be useful here, or that consideration could be given to the axis 'healthy-frail-needing care'.

In the discussions on the two formulated principles most experts, especially during the expert meeting in Dallas, expressed a wish to add a third principle, namely that frailty should be clearly distinguished from disability. In other words, disability should not be included in a definition of frailty. In the view of the experts, these are two different entities; not all older people with disabilities are frail, while similarly not all frail elderly people have disabilities. A few experts commented that frailty could be regarded as a form of predisability. For them, frailty could be seen as a risk factor for the onset of disability.

*Conceptual definitions*

Table 2 presents 11 definitions of frailty (column 1) based on a literature search.[1] In the written questionnaire, experts were asked to rank these definitions; each expert was asked to assign 11 points to the definition that matched the principles most closely, 10 points to the second best match, and so on. The definition which matched the two principles least well was assigned one point. Fourteen experts ranked the definitions in this way. Column 2 shows the total score, average, mode and range (with minimum and maximum), respectively, for each conceptual definition. The conceptual definition

with the highest total score is placed at the top of the table; the definition with the lowest total score is at the bottom.

The conceptual definition by Schuurmans et al. achieved the highest score (142 points). In addition, the range is small for this definition, with a minimum score of 8 and a maximum of 11. This definition is as follows: 'Frailty is a loss of resources in several domains of functioning, which leads to a declining reserve capacity for dealing with stressors'.[4] Analysis of the questionnaires revealed that five experts felt that this definition best matched the formulated principles. The comment was made in two questionnaires that the conceptual definition by Schuurmans et al. stresses loss of resources and is not so focused on adverse outcomes as a result of the pathway of frailty, as is the case with some other definitions.

The experts were also asked during the expert meetings to indicate which conceptual definition they felt best matched the principles described. The Tilburg meeting confirmed the findings from the completed questionnaires, with the definition by Schuurmans et al. being preferred by the majority. Four of the 6 experts felt this to be the best definition; two experts considered the definition by Strawbridge et al. to be the best. The situation in Dallas was distinctly different; more than half the experts present (six of the 11 experts) expressed a clear preference for the conceptual definition by Fried et al.,[7] which was regarded as the most accurate definition of frailty. Two experts in Dallas did make the qualifying comment that this definition refers only to the physical domain of frailty. They pointed out that a person can also be frail if there are also problems in other domains of human functioning, such as the psychological domain.

**Table 2.** Ranking of conceptual definitions of frailty

| Conceptual definitions of frailty | Sum | Mean | Mode | Range |
|---|---|---|---|---|
| Frailty is a loss of resources in several domains of functioning, which leads to a declining reserve capacity for dealing with stressors[4] | 142 | 10.1 | 10 | 3 (8 – 11) |
| A syndrome involving grouping of problems and losses of capacities in multiple domains which make the individual vulnerable to environmental challenge[18] | 123 | 8.8 | 9 | 5 (6 – 11) |
| A syndrome of multi-system reduction in reserve capacity as a result of which an older person's function may be severely compromised by minor environmental stresses, giving rise to the condition of 'unstable disability'[29] | 107 | 7.7 | 8 | 6 (4 – 10) |
| A biologic syndrome of decreased reserve and resistance to stressors, resulting from cumulative declines across multiple physiologic systems, causing vulnerability to adverse outcomes[7] | 104 | 7.4 | 9 and 11 | 9 (2 – 11) |
| A combination of biological, physiological, social and environmental changes that occur with advancing age and increase vulnerability to changes in the surroundings and to stress[21] | 104 | 7.4 | 9 and 10 | 9 (2 – 11) |
| A vulnerability state resulting from a precarious balance between the assets maintaining health and the deficits threatening it [30] | 87 | 6.7 | 5 | 9 (2 – 11) |
| A state of reduced physiological reserve associated with increased susceptibility to disability[13] | 74 | 5.3 | 4 | 9 (2 – 11) |
| A combination of aging, disease and other factors that make some people vulnerable[19] | 67 | 4.8 | 3 | 7 (2 – 9) |
| Complex and cumulative expression of altered homeostatic responses to multiple stresses resulting in metabolic imbalance[14] | 60 | 4.3 | 3 | 9 (1 – 10) |
| Frailty is diminished ability to carry out important practical and social activities of daily living[31] | 49 | 3.8 | 1 | 7 (1 – 8) |
| A state of being neither 'too independent' nor 'too impaired' that puts the person at risk for adverse health outcomes[32] | 40 | 3.1 | 1 and 2 | 8 (1 – 9) |

## DISCUSSION

Two principles are formulated in this article, based on a literature search, which must be met by an integral conceptual definition of frailty. One principle refers to the multidimensional nature of the concept, the other to the positioning of frailty on a continuum. The majority of the experts added one principle to these two; according to most of the experts consulted, frailty should be clearly distinguished from disability. This is confirmed by research by Fried et al.,[33] though that research does show that there is some overlap between these two concepts. Verbrugge and Jette have described a pathway of disability, which they call the disablement process.[34] Their model describes the pathway from pathology via impairments and functional limitations to disability. According to Verbrugge, frailty can be seen as a piling up of impairments.[35] It is then a preceding stage on the way to disability or, as Morley et al. put it, it is pre-disability.[36] This interpretation of frailty, in which a sequential process is described, is supported by many of the experts consulted, as is the difference between the two entities.

A recent study stated that frailty provides a conceptual basis for moving away from organ and disease-based approaches towards a health-based, integrative approach.[37] However, it emerged clearly from the expert meeting in Dallas that there is currently insufficient support for an integral definition of frailty. The experts present at the meeting saw frailty mainly as the presence of impairments in people's physical functioning. This is a unidimensional approach to frailty. The definition by Fried et al.,[7] which matches this interpretation most closely, was considered by most of the American experts to be the best conceptual definition of frailty. At the meeting in Tilburg in the Netherlands, the Dutch experts took a different view, with more support for an integral definition of frailty. This was evident from the strong preference for the definition by Schuurmans et al.[4] This definition ultimately achieved the highest total score (see table 2), followed by the conceptual definitions by Strawbridge et al,[18] Campbell and Buchner,[29] Fried et al.[7] and Nourhashémi et al.[21]

A number of differences and correspondences can be highlighted between the five conceptual definitions with the highest scores. In three of these five definitions, frailty refers to several domains of human functioning.[4, 18, 21] Nourhashémi et al. include specific domains in their definition, namely 'biological, physiological, social and environmental changes'.[21] Three of the five definitions refer to 'reserve capacity' and 'reserve'.[4, 7, 29] Reserve capacity can be defined as follows: 'The ability of an individual to withstand stressors from the environment. It is a function of their individual threshold limit or reserve capacity, beyond which an individual becomes frail'.[9] Two definitions make explicit reference to adverse outcomes.[7, 29] In the conceptual definition by Campbell and Buchner, that adverse outcome is 'unstable disability'.[29] Fried et al.[7] do

not describe the adverse outcomes in their conceptual definition.

A few qualifying comments can be made about the methodology followed in this study. A total of 20 experts contributed to the study; of those experts, 11 came from the Netherlands - i.e. more than half. This may have influenced the total score assigned to the definition by Schuurmans et al., which was formulated by Dutch researchers. A second qualifying comment relates to the composition of the expert panel in Dallas. During this meeting, two researchers were present whose conceptual definitions were the subject of discussion. Naturally, these researchers chose their own definition above the others. The presence of these two researchers may have had an impact on the selection of the best definition. On the other hand, the questionnaires were completed before the meetings started. It should also be noted that the geriatric medicine discipline was more explicitly represented in Dallas (three of the 11 experts) than in Tilburg (one of the 6 experts). This may explain the strong preference shown in Dallas for the definition by Fried et al.[7] Finally, it emerged when analysing the data from the questionnaires that five experts had probably not properly understood the question about ranking the 11 conceptual definitions; it may be that the instruction given was insufficiently clear. Four experts used the same score several times, and one expert did not assign a score to all definitions, leaving out the definitions by Rockwood et al.,[30] Brown et al.,[31] and Winograd et al.[32] These scores are however included in table 2, and taken together may have led to some distortion of the results. It can however be stated that the results from the questionnaires were congruent with the results from the expert meetings.

In spite of the aforementioned limitations we felt able, based on the results of the literature search, questionnaires and expert meetings, to formulate a new, integral conceptual working definition of frailty. It would be a definition which took full account of the principles formulated earlier and which combined essential components of existing conceptual definitions which were ranked highly by the experts. The new definition is as follows:

*'Frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social), which is caused by the influence of a range of variables and which increases the risk of adverse outcomes'.*

The total functioning of the person lies at the heart of this conceptual definition. It is proposed in this context that the concept be taken to include not only physical frailty,[38] but should also include psychological frailty and social frailty. Moreover, it should be noted that physical frailty, psychological frailty and social frailty cannot and must not be seen in isolation from each other; this conceptualisation of frailty is based on a holistic view of the person. It does however offer the possibility of enabling interventions among frail elderly people to be steered more effectively.

A frail elderly person is in a dynamic state, which can be positioned on a continuum between non-frail and very frail. Through curative and/or preventive interventions, it may be possible to influence the position of an elderly person on this continuum. The proposed integral conceptual definition does not explicitly describe the concept of reserve capacity; this is seen as one of the variables which, possibly in conjunction with one or more chronic diseases, leads to frailty.

As already highlighted in the introduction, the conceptual definition is intended to offer a framework for an operational definition of frailty. The concepts physical functioning, psychological functioning and social functioning need to be operationalised. Physical functioning can be operationalised using the frequently cited operational definition by Fried et al[7] or the recently produced FRAIL scale.[39, 40] The three concepts must form the heart of an integral conceptual working model of frailty. The other concepts from the proposed conceptual definition must also be operationalised and positioned within that model. This applies in particular for the determinant variables and the adverse outcomes. The integral vision of human functioning must be expressed explicitly in a conceptual model. Several researchers have called for such a model.[12] After formulating the operational definition of frailty and developing an integral model of frailty, the true value of the newly formulated conceptual definition of frailty will become apparent. Follow-up research will be then needed in order to demonstrate this value.

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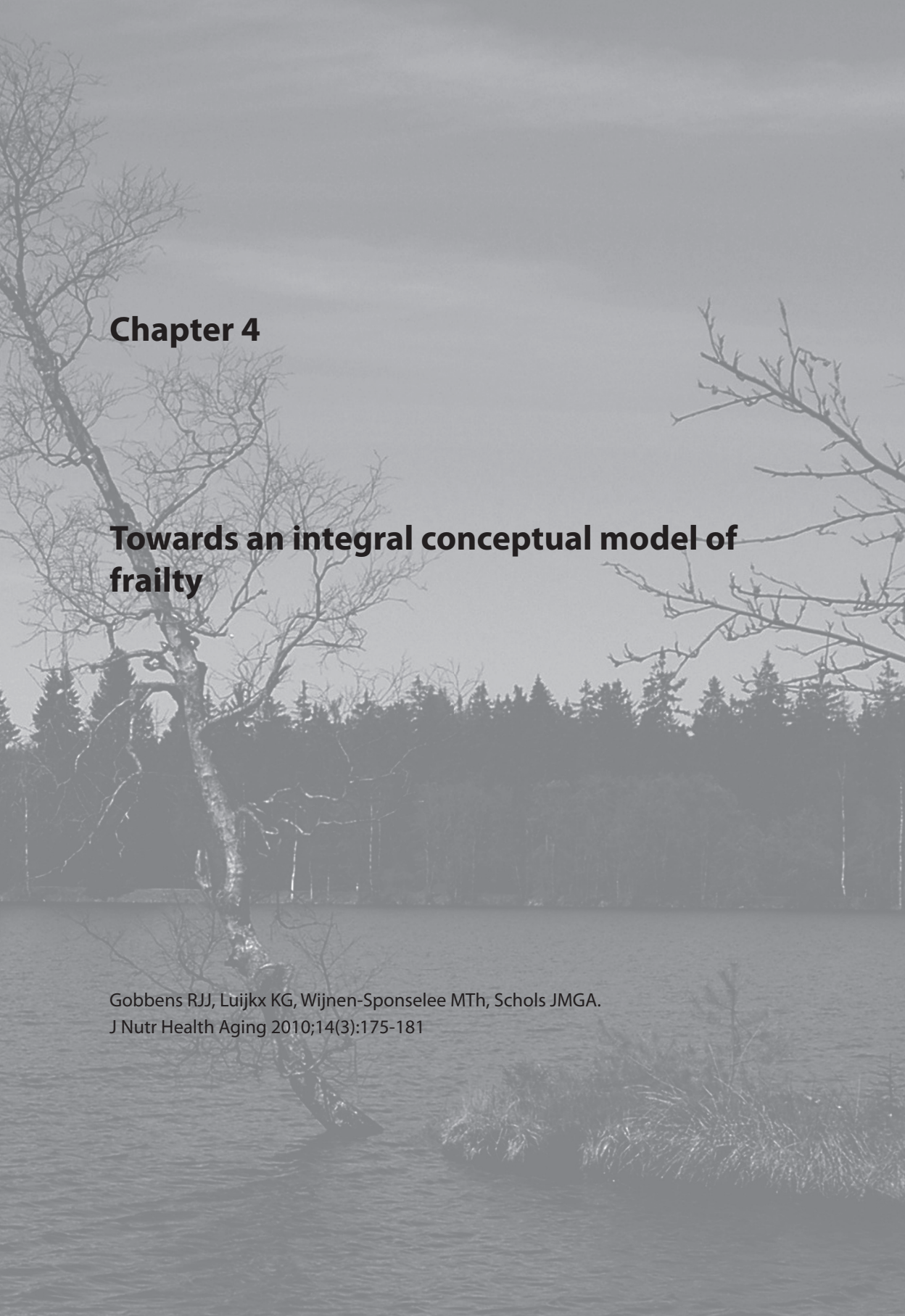
## REFERENCES


1. Gobbens RJ, Luijkx KG, Wijnen-Sponselee MT, Schols JM. [Frail elderly. Identification of a population at risk]. Tijdschr Gerontol Geriatr 2007;38:65-76.
2. Morley JE, Perry HM, 3rd, Miller DK. Editorial: Something about frailty. J Gerontol A Biol Sci Med Sci 2002;57:M698-704.
3. 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;347:1068-1074.
4. Schuurmans H, Steverink N, Lindenberg S, et al. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci 2004;59:M962-965.
5. Mitnitski AB, Mogilner AJ, MacKnight C, Rockwood K. The mortality rate as a function of accumulated deficits in a frailty index. Mech Ageing Dev 2002;123:1457-1460.
6. Kaethler Y, Molnar FJ, Mitchell SL, et al. Defining the concept of frailty: a survey of multi-disciplinary health professionals. Geriatrics Today: J Can Geriatr Soc 2003;6:26-31.
7. 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:M146-156.
8. American Medical Association white paper on elderly health. Report of the Council on Scientific Affairs. Arch Intern Med 1990;150:2459-2472.
9. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003;44:58-68.
10. Hogan DB, MacKnight C, Bergman H. Models, definitions, and criteria of frailty. Aging Clin Exp Res 2003;15:1-29.
11. Aminzadeh F, Dalziel WB, Molnar FJ. Targeting frail older adults for outpatient comprehensive geriatric assessment and management services: an overview of concepts and criteria. Rev Clin Gerontol 2002;12:82-92.
12. Levers MJ, Estabrooks CA, Ross Kerr JC. Factors contributing to frailty: literature review. J Adv Nurs 2006;56:282-291.
13. Buchner DM, Wagner EH. Preventing frail health. Clin Geriatr Med 1992;8:1-17.
14. Hamerman D. Toward an understanding of frailty. Ann Intern Med 1999;130:945-950.
15. Rockwood K, Hogan DB, MacKnight C. Conceptualisation and measurement of frailty in elderly people. Drugs Aging 2000;17:295-302.
16. Bergman H, Beland F, Perrault A. The global challenge of understanding and meeting the needs of the frail older population. Aging Clin Exp Res 2002;14:223-225.
17. Rockwood K. What would make a definition of frailty successful? Age Ageing 2005;34:432-434.
18. Strawbridge WJ, Shema SJ, Balfour JL, et al. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci 1998;53:S9-16.
19. Rockwood K, Stadnyk K, MacKnight C, et al. A brief clinical instrument to classify frailty in elderly people. Lancet 1999;353:205-206.
20. Puts MT, Lips P, Deeg DJ. Sex differences in the risk of frailty for mortality independent of disability and chronic diseases. J Am Geriatr Soc 2005;53:40-47.
21. Nourhashémi F, Andrieu S, Gillette-Guyonnet S, et al. Instrumental activities of daily living as a potential marker of frailty: a study of 7364 community-dwelling elderly women (the EPIDOS study). J Gerontol A Biol Sci Med Sci 2001;56:M448-453.
22. Becker G. The oldest old: autonomy in the face of frailty. J Aging Stud 1994;8:59-76.
23. Kaufman SR. The social construction of frailty: an anthropological perspective. J Aging Stud 1994;8:45-58.

24. Raphael D, Cava M, Brown I, et al. Frailty: a public health perspective. Can J Public Health 1995;86:224-227.
25. Bortz WM, 2nd. The physics of frailty. J Am Geriatr Soc 1993;41:1004-1008.
26. Puts MT, Lips P, Deeg DJ. Static and dynamic measures of frailty predicted decline in performance-based and self-reported physical functioning. J Clin Epidemiol 2005;58:1188-1198.
27. Slaets JP. [The importance of the 'frailty-concept' in geriatric assessment]. Tijdschr Gerontol Geriatr 1998;29:276-278.
28. Fries JF. Reducing disability in older age. Jama 2002;288:3164-3166.
29. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing 1997;26:315-318.
30. Rockwood K, Fox RA, Stolee P, et al. Frailty in elderly people: an evolving concept. Cmaj 1994;150:489-495.
31. Brown I, Renwick R, Raphael D. Frailty: constructing a common meaning, definition, and conceptual framework. Int J Rehabil Res 1995;18:93-102.
32. Winograd CH, Gerety MB, Brown E, Kolodny V. Targeting the hospitalized elderly for geriatric consultation. J Am Geriatr Soc 1988;36:1113-1119.
33. 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;59:255-263.
34. Verbrugge LM, Jette AM. The disablement process. Soc Sci Med 1994;38:1-14.
35. Verbrugge LM. Flies without wings. In: Carey R, Robine J-M, Michel J-P., Christen Y, eds. Longevity and frailty. Heidelberg: Springer-Verlag, 2005, pp. 67-81.
36. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-847.
37. 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 2007;62:731-737.
38. 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;52:1560-1566.
39. Abellan van Kan A, Rolland Y, Bergman H, et al. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging 2008;12:29-37.
40. Abellan van Kan G, Rolland YM, Morley JE, Vellas B. Frailty: toward a clinical definition. J Am Med Dir Assoc 2008;9:71-72.



# Chapter 4

# Towards an integral conceptual model of frailty

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## ABSTRACT

*Objectives*

Most conceptual and operational definitions of frailty place heavy emphasis on the physical problems encountered by older people. The accompanying models are based largely on a medical model. An integral approach is almost never adopted. This study aims to develop both an integral operational definition of frailty and an integral conceptual model of frailty.

*Design*

In order to achieve these aims, a thorough literature search was performed on components of operational definitions and models of frailty. In addition, experts (N=17) were consulted during two expert meetings.

*Results*

There was consensus among the experts on the inclusion of the following components in the operational definition of frailty: strength, balance, nutrition, endurance, mobility, physical activity and cognition. Some respondents indicated that they would wish to add components from the psychological or social domain. Supported by results from the literature search, a new integral operational definition of frailty was developed. This operational definition lies at the heart of an integral conceptual working model of frailty. This model expresses the relationships between three domains of frailty, adverse outcomes such as disability and the determinants.

*Conclusion*

The model should be able to serve as a basis for further scientific research on frailty. The model also provides a framework for the development of a measurement instrument which can be used for the identification of frail elderly persons.

## INTRODUCTION

The scientific and clinical relevance of the concept of frailty has been increasing considerably for several years. Frailty can be seen as a proxy for the severity of the ageing process in an individual, and is linked to, but distinct from, chronic diseases (comorbidity) and disability.[1] The number of publications on frailty has grown significantly since 1991.[2] However, there is as yet no uniform conceptual and operational definition of frailty, and as a result the prevalence figures for frailty among elderly are variable. Van Iersel et al. reported prevalence figures ranging from 33% to 88%, depending on the operational definition that was used.[3]

Most conceptual and operational definitions of frailty place heavy emphasis on physical losses in older people. The accompanying conceptual models are based chiefly on the medical sciences.[4] This is the case among others for 'the dynamic model of frailty',[5] 'frailty and disability',[6, 7] and 'the cycle of frailty',[8] all of which are based on the medical model. According to that model, people can be separated into their physical and mental elements: the notion of dualism. The object of the medical sciences is the human organism, the 'human machine'.

A degree of disquiet has arisen among a growing number of health care professionals about this exclusive focus on the medical model. According to these professionals, human beings should be seen as 'more than the sum of their parts'. This is a reference to an integral approach; an approach which in addition to physical aspects also devotes attention to the psychological and social aspects of humanity and to the relationships between those aspects. The authors of this article, together with other scientific researchers,[4] fear that if the definition and accompanying model of frailty home in exclusively on the physical components of frailty, attention for the individual as a whole will be jeopardised. This could potentially lead to fragmentation of care and subsequently to a reduction in the quality of care provided to frail elderly persons. Literature searches have shown that more and more researchers are becoming convinced of the multifactorial nature of the concept of frailty.[2, 4, 9-13] For example, according to Bergman et al., frailty provides a conceptual basis for moving away from organ and disease-based approaches towards a health-based, integrative approach.[14] Taking as a starting point the definition by the World Health Organization**,** which defines health as 'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity',[15] the authors of this article propose a new integral conceptual definition of frailty. This definition is as follows: 'Frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social), which is caused by the influence of a range of variables and which increases the risk of adverse outcomes'. The actual state

of a frail elderly person is a dynamic one. This state can be positioned on a continuum between non frail and frail.

In addition, there is currently no integral conceptual model of frailty;[16] a model which is multidimensional in nature. Following on from Fawcett, a conceptual model is defined as: 'a set of concepts and propositions which integrate the concepts to create a meaningful whole'.[17] The question posed in this article is therefore: 'What constitutes a scientifically sound and practically relevant integral conceptual model of frailty?' This model is intended to achieve a number of objectives. First, the model must be able to serve as a basis for further scientific research into the definition of frailty. Rockwood, too, stresses the importance of such research.[18] Several researchers feel it should be possible to influence the pathway of frailty;[4] the model of frailty should then contain aspects that can be influenced by health care professionals. It must provide a framework for effective (preventive) interventions, not just in the physical but also in the psychological and social domains of human functioning. And, given the multidimensional nature of the concept, it must open the way for a multidisciplinary approach to the complex problems facing frail elderly persons. Finally, it must be possible to develop a measurement instrument for frailty in elderly persons based on the conceptual model; an instrument which enables frailty to be measured in day-to-day health care practice.

The heart of the integral model of frailty incorporates the components of the operational definition of frailty. For this reason, this article first describes which components should form part of an integral operational definition of frailty. In order to make a contribution to the consensus-building for an operational definition of frailty, experts in the field of frailty were consulted. These experts were asked to make a verbal contribution during two expert meetings. The research question for these expert meetings was as follows: 'Which components of existing operational definitions of frailty should be included in an integral operational definition of frailty?'

## METHOD

### *Literature search*

Initially, a computerised search was performed in the databases PubMed, Web of Science and PsychInfo (up to December 2008). Combinations of the following subject headings and words were used: 'frail' (and the related words 'frail elderly' and 'frailty'), 'definition', 'conceptual framework', 'conceptual model', 'determinants', 'risk factors' and ' adverse outcomes'. In addition to this computerised search, the snowball method was used, involving a study of the references in the articles found in order to identify other relevant articles not thrown up by the initial search. A number of criteria were applied

in the selection of literature. The study had to relate to older adults (aged 65 years and over); the search was restricted to articles in English; there was no restriction on year of publication. The material selected by the authors for inclusion represented the most relevant work dealing with the topics (conceptual model of frailty, operational definition of frailty) covered in this article. Ultimately 43 articles were selected for the purpose of this review.

***Selection of experts***

A total of 22 scientific experts were approached with a request to contribute to this research project. Two experts did not respond to this request. Three experts were not able to attend one of the expert meetings. In total, therefore, 17 experts contributed to this study. A careful selection was made of experts in the field of frailty. Experts were invited if they had produced scientific publications on frail elderly. In particular, experts were approached who had produced scientific publications on the definition of frailty. Allowance was also made when selecting experts for the country where the experts worked; they also had to represent different disciplines. The distribution across the disciplines or focus areas was as follows: geriatric medicine (5), gerontology (2), nursing (2), (bio)statistics (3), psychology (2), general practice (1), health care (1) and social inclusion (1).

***Expert meetings***

Since the aim was to achieve a consensus on the operational definition of frailty, expert meetings were organised. A group interview was held during each expert meeting; this method is based on interaction within the group, which should ideally consist of between six and 12 participants. The first expert meeting took place in November 2006 during the conference of The Gerontological Society of America in Dallas in the United States. Eleven experts took part in this meeting, from America (5), Canada (3) and the Netherlands (3). The second meeting was held in the Netherlands (Tilburg) in January 2007. A further six experts took part in this meeting, all from the Netherlands. In total, therefore, 17 experts took part in one of the two meetings. The geriatric medicine discipline was more strongly represented in Dallas than in Tilburg: four of the 11 experts in Dallas were specialists in this discipline, compared with one of the six experts in Tilburg.

The experts at both the expert meeting in Dallas and the meeting in Tilburg were presented with nine components derived from operational definitions of frailty. They were each presented with the same two questions. The first question was: Do you think that these nine components should be included in an operational definition of frailty? The second question was: Would you like to add any components to the

proposed list, and if so, which? Contributors were regularly questioned to ensure the maximum possible clarity about their views on whether or not certain components should be included in an operational definition of frailty. The expert meeting in Dallas was recorded on a voice tracer and transcribed verbatim at a later date. Two authors of this article took minutes of the meeting in Tilburg; these were later amalgamated to create a single report. Each meeting lasted two hours.

The conclusions drawn in this study are based both on the results of the two expert meetings and the outcome of the literature search. In drawing these conclusions, the same weight was assigned to each of the data gathering methods used.

## RESULTS

### *An integral operational definition of frailty*

*Literature search*

In a consensus report, Ferrucci et al. report on eight components which form part of existing operational definitions of frailty.[19] These eight components are: mobility, strength, balance, motor processing, cognition, nutrition, endurance and physical activity. Panel discussions with doctors, patients and other experts show that they feel it is important that strength, balance, nutrition, stamina (fatigue, endurance), mobility, self-perceived health, life space, activities of daily living (ADL) and emotions should be included in an operational definition of frailty.[20] Both the components presented by Ferrucci et al. and those put forward by Studenski et al. include the five components which form part of the frequently cited operational definition by Fried et al., referred to as 'a phenotype of frailty'.[21] According to Fried et al., frailty can be said to exist if three or more of the following five criteria are present in the individual: unintentional weight loss or sarcopenia, weakness (decreased grip strength), poor self-reported endurance, walking slowness and low physical activity.[21]

Based on the foregoing, and in order to reflect the multidimensional nature of the concept of frailty as adequately as possible, the following components were selected: strength, balance, nutrition, endurance, mobility, physical activity, activities of daily living (ADL) and instrumental activities of daily living (IADL), cognition and emotions.

*Expert meetings*

These nine components mentioned above were then submitted to the experts. The experts were unanimous in their opinion that strength, balance, nutrition, endurance,

mobility and physical activity should be included in an operational definition of frailty. The same applied for cognition, though a few experts attending the panel discussion in Dallas commented that they would like to see this component limited to the aspect of multitasking. A majority of the experts also felt that (instrumental) activities of daily living should be left out of the definition; according to these experts, this component belongs to a different entity, namely disability. The opinions of the experts were divided with regard to the component 'emotions'; some of the experts who took part in the meeting in Dallas, in particular, felt that emotions did not belong to the entity of frailty. One of the experts at that meeting commented that emotions, like (instrumental) activities of daily living, should be seen as a (potential) consequence of frailty. Two experts, one of whom was present at the expert meeting in Dallas and the other in Tilburg, felt that a social component should be included in the operational definition of frailty. It was suggested that the component 'loneliness' be added. Other components which one or two experts felt should be included in the definition were coping, self-efficacy, sensory functions (hearing and visual acuity), social support and incontinence. One expert argued that incontinence should be included because it is one of the five 'geriatric giants'. Some of the experts felt that the components could not be seen in isolation from each other, arguing that the interaction between the components will influence the predictive value for the occurrence of adverse outcomes in frail elderly persons. As an example, one of those present outlined the relationship between strength, balance, endurance, mobility and (instrumental) activities of daily living.

*Integration of literature search and expert meetings*

After consulting the experts, a consensus was found on including the five Fried components in an integral operational definition of frailty. The same applied for the component 'balance'. All of these components belong to the physical domain of human functioning. The component 'sensory functions' is added to these here; this is supported by several publications.[11, 22, 23] Since the aim is to develop an integral definition which covers three domains (physical, psychological, social), components also need to be selected which belong to the psychological and social domains of frailty. The most likely candidates in the psychological domain are 'cognition', 'emotions' and 'coping'. There was consensus among the experts on including 'cognition' in the operational definition of frailty. The component 'emotions' refers to depression and anxiety. According to Winograd et al.,[23] Speechley & Tinetti,[24] Schuurmans et al.[25] and Puts et al.,[9] depressive symptoms are part of frailty. For Schuurmans et al.,[25] this also applies for anxiety. Coping, which refers to 'mastery', 'self-efficacy' and 'self-esteem' has hardly ever been included as a component in research on frailty; one exception to this

is the study by Puts et al.,[9] while Raphael et al.[26] include 'self-efficacy' in their operational definition of frailty. It is assumed that there is a relationship between coping and other components of frailty. This is supported by Schulz & Williamson.[27] There are virtually no operational definitions of frailty which incorporate components from the social domain of human functioning. In an integral model of frailty, however, this domain cannot be left out.[16] Imuta et al.[28] and Schulz & Williamson[27] endorse the importance of the social domain in relation to the occurrence of adverse outcomes. The authors of this article propose in this context that the components 'social relations' and 'social support' be included in the model. These components are seen by several researchers as determinants of frailty.[11, 29, 30] The selected components of frailty together constitute the proposed new definition of frailty. This definition will in turn form the core of the integral conceptual model of frailty.

### *An integral model of frailty*

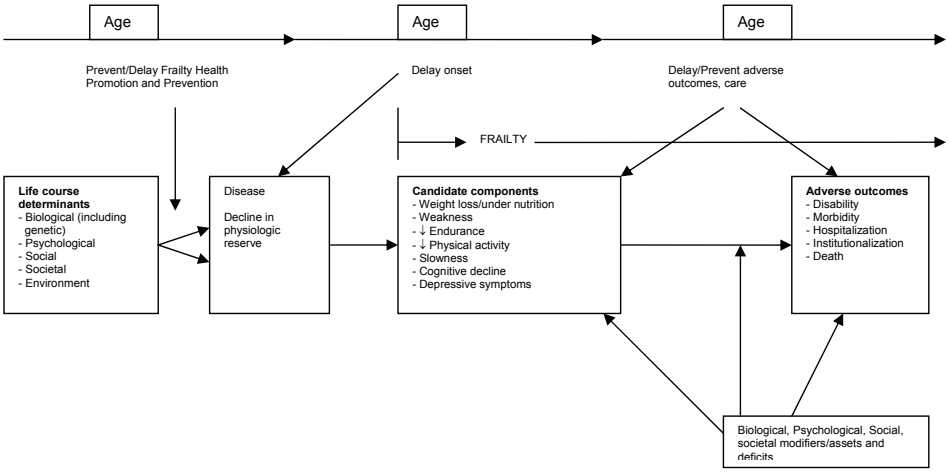
*Literature search*

The literature search revealed that there are several models of frailty in existence.[2, 4] There are mathematical models;[31] models in which dysfunction in various biological systems are the central consideration;[8, 29] biomedical/psychosocial models;[5] and models based on a life course approach.[32] The models are presented in various forms, such as an algorithm,[29, 32] a scale,[5] a circle[8, 21] and a plot.[8]

It was stated in the introduction that most models of frailty place heavy emphasis on physical components of frailty. The main exceptions to this are the models developed by Raphael et al.[26] and Bergman et al.[32] Raphael et al. do not provide a graphic representation of their model, unlike Bergman et al., who present their model as 'a working framework in development'[32] (see figure 1).

The model 'a working framework in development' is characterised by a life course approach.[33] It describes the pathway from frailty to adverse outcomes and shows that these can be influenced by a number of biological, psychological and social variables. These can be described as the competences, resources and deficits of an individual in his or her specific context. At the heart of this model is an operational definition of frailty. This is based on the five objective criteria described earlier as developed by Fried et al. to aid the diagnosis of frailty.[21, 34] Bergman et al.[32] add two components to this from the psychological domain, namely cognitive decline and depressive symptoms.

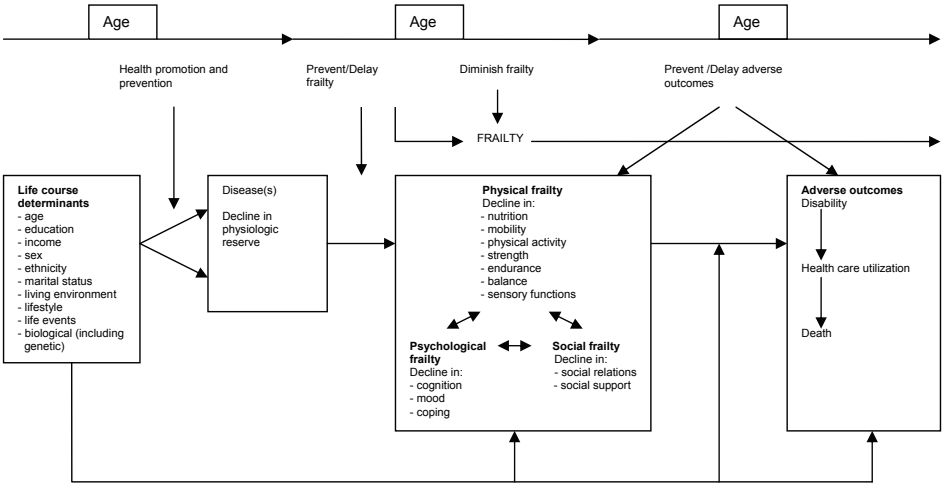
**Figure 1.** A working framework in development[32]




This is an appealing model for several reasons. It draws a distinction between frailty, disability and comorbidity. Earlier research by Fried et al. has shown that, while there is some overlap between these three concepts, they do need to be separated from each other.[34] The model also makes clear that there is a relationship between frailty and adverse outcomes. In addition, it offers opportunities for interventions, focused both on cure and on primary and secondary prevention. However, it does not yet fully reflect a complete integral approach to frailty. The emphasis is heavily on the physical domain of frailty, to which five of the seven components refer. Components from the social domain are absent from the operational definition of frailty developed by Bergman et al. If such an operational definition of frailty is used to identify frail elderly persons, this could potentially lead to fragmentation of care, with insufficient attention for the whole person.[4] In addition, the model does not specifically state which life course determinants influence frailty and the relationship between frailty and adverse outcomes.

Based on this model and the results of the expert meetings and literature search, a slightly modified integral conceptual model of frailty was developed (see figure 2).

**Figure 2.** An integral conceptual model of frailty, based on 'a working framework in development'[32]




The main differences between the model (figure 2) and the model developed by Bergman et al.[32] is that it is based on the integral conceptual definition of frailty described in the Introduction and the operational definition derived from it. It is proposed that reference be made not only to physical frailty, which refers exclusively to the physical domain of frailty, but also to psychological and social frailty.

In addition, this modified integral model of frailty (figure 2) specifies the life course determinants, which are assumed to influence (the degree of) frailty, the adverse outcomes and the relationship between frailty and adverse outcomes. According to several researchers, an unhealthy lifestyle, characterised by dietary problems, smoking and alcohol use, can lead to the onset of frailty.[35-37] This also applies for biological (genetic) factors.[21, 35] Numerous studies describe the relationship between socio-economic factors (such as education level and income) and socio-demographic factors (such as age, sex, civil status, ethnicity) and frailty.[5, 11, 21, 29, 38, 39] The living environment, including safety in the neighbourhood,[26] and the influence of life events[36] are also among the determinants in the model. Disease has a prominent place in the model. Research has shown that several diseases, such as heart failure, anaemia and diabetes mellitus, can lead to frailty.[6, 11, 21, 35, 36, 38] The review by Levers et al. also shows that having a disease is an important determinant for the onset of frailty.[16]

One of the adverse outcomes in this model is disability. A survey of geriatric specialists from seven university medical centres showed that 98% felt that frailty is a cause of disability.[8] Boyd et al.[40] also conclude that frailty is associated with the

development of dependence in the performance of activities of daily living (ADL). Boyd et al.[40] see ADL-dependence as a crucial health outcome for older people, since it bears a strong relationship to quality of life and has an association with future hospital admissions and death. Covinsky et al.[41] also argue that ADL-dependence is one of the strongest risk factors for the occurrence of other adverse outcomes, namely nursing home admission, high health care costs and death. Fried et al.[21] conclude in their study that the 'frailty-phenotype' is a predictor for the onset of disability, hospital admissions and death. According to Schuurmans et al.[25] and Rockwood et al.,[42] a measure of frailty that incorporates a diverse range of deficits (physical, psychological, social) is a better predictor of institutionalisation and death than chronological age.

## CONCLUSION

Based on the literature search and consultation of 17 experts during the expert meetings, a number of components were selected which should form part of an integral operational definition of frailty. These components are nutrition, mobility, physical activity, strength, endurance, balance, cognition, sensory functions, mood, coping, social relations and social support. There was consensus between the experts on the inclusion of the first seven components (up to and including 'cognition') in an operational definition of frailty. Starting from a health-based definition of frailty, the other five components were then added on the basis of the literature search and the expert meetings.

Currently there are several models of frailty in circulation; most of these models place heavy emphasis on the physical aspects of human functioning. What is called for here is an integral model of frailty;[16, 26] a model which devotes attention not just to the physical domain, but also to the psychological and social domains. Following an extensive exposition on the operationalisation of frailty, a conceptual working model is presented in this article in which a holistic view of the person is expressed. It is a model which is geared towards a multidisciplinary approach. Results of evidence-based research suggest that integrated housing, welfare and care interventions for frail elderly persons have a major effect on aspects such as health, quality of life, satisfaction, patterns of health care utilisation.[43] The model also offers a starting point for further scientific research on frailty. This is important, because many questions remain unanswered. Based on the literature search and consultation of experts, components were selected which together constitute an operational definition of frailty. However, the question remains of whether these are the correct components of frailty. The choice of particular components was probably influenced to some extent by the backgrounds of the experts consulted. The Geriatric Advisory Panel (GAP) of

the International Academy of Nutrition and Ageing, consisting mainly of medical specialists, recently produced the FRAIL scale. This scale contains the following physical components: fatigue, resistance, ambulation, number of illnesses and loss of weight.[44] The majority of the experts in the present study also had a medical background; this was because most of the work that has been published on frailty to date has come from this discipline. The dominance of geriatricians in the Dallas expert meeting meant that the components chosen there were limited to the physical domain. The experts at the Tilburg meeting were more open to components from the psychological and social domains. Follow-up research will above all need to demonstrate the added value of including social components in the operational definition of frailty. To date, this domain has been left out of definitions of frailty. This, too, raises a number of questions: What is the role of social components (social relations and social support) in the frailty concept? Are these really components of frailty or are they determinants of it? Is there a relationship between the social components referred to and the physical and psychological components of frailty? Are the components chosen (social relations and social support) the correct ones? And which is the dependent variable in those relationships, and which the independent variable? Walston et al.[45] and Bergman et al.[14, 32] also point out the importance of carrying out further research into the influence of social components on frailty.

The integral conceptual model of frailty incorporates ten determinants. These were selected after a thorough study of scientific research articles. Scientific research will then have to demonstrate to what extent these factors have predictive value for the onset of frailty in particular. The working model also describes an assumed relationship between the operational definition of frailty and adverse outcomes. The adverse outcomes included in the model are disability, health care utilisation and death. Earlier research has shown that that there is a relationship between these three adverse outcomes and frailty.[21, 25, 40, 41] Research results will need to expose the relationship between the operational definition of frailty employed – the sum of all components – and the individual adverse outcomes. At the same time, however, it will be necessary to investigate what contribution each domain (physical, psychological, social) and each individual component of frailty makes to the onset of those adverse outcomes. It may be that certain combinations of components within and between domains of frailty make the occurrence of adverse outcomes more likely.

The aim of the integral conceptual model of frailty presented here is to provide a conceptual framework which can serve among other things as a starting point for the development of a measurement instrument for frailty. Efforts need to be made to develop a user-friendly instrument which can be used for the identification of frail elderly persons. Following this identification, it may be possible through the

provision of integrated (preventive) interventions to prevent or diminish frailty. Use of the measurement instrument will enable those interventions to be properly directed.

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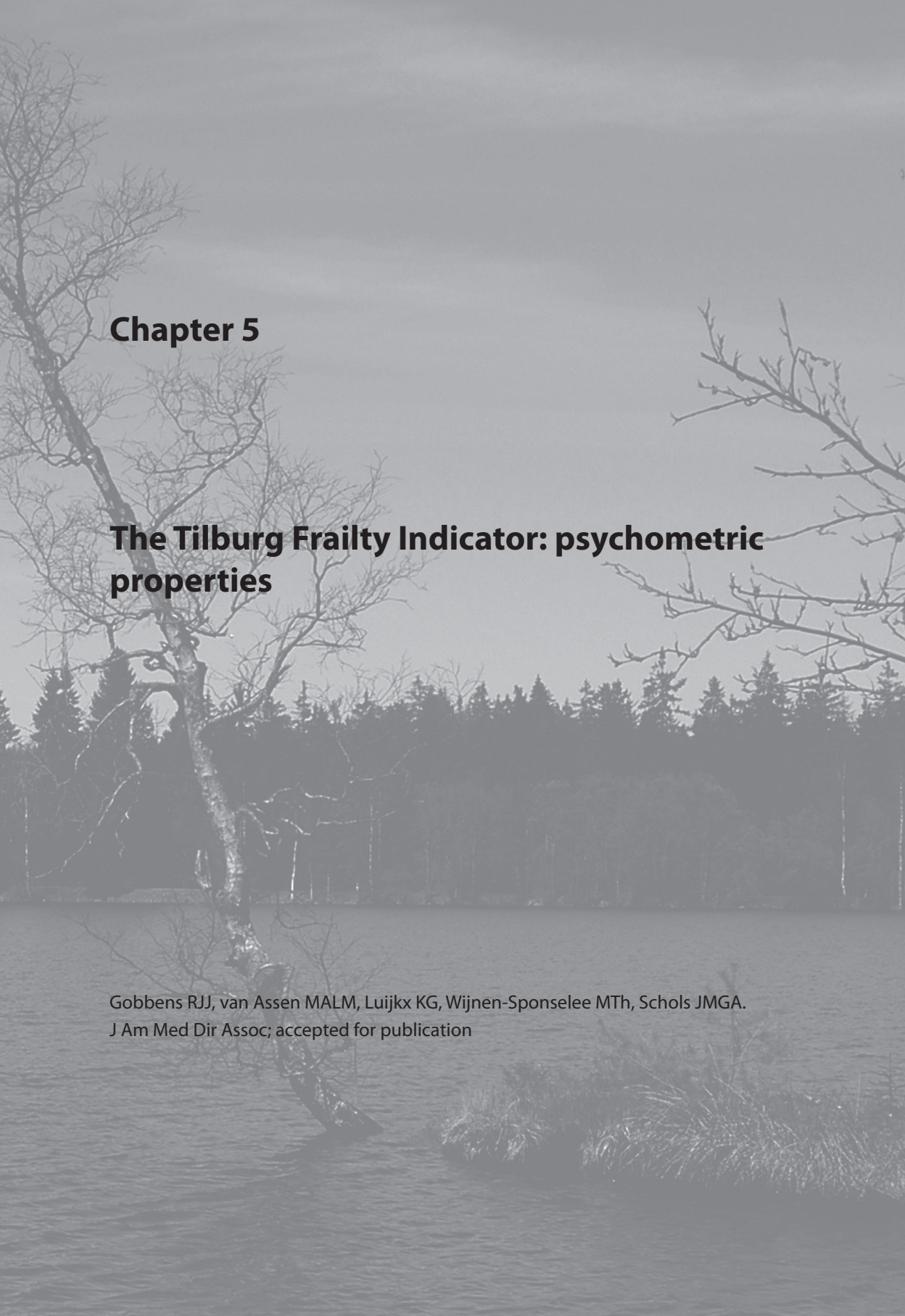
## REFERENCES


1. Slaets JP. Vulnerability in the elderly: frailty. Med Clin North Am 2006;90:593-601.
2. Hogan DB, MacKnight C, Bergman H. Models, definitions, and criteria of frailty. Aging Clin Exp Res 2003;15:1-29.
3. van Iersel MB, Olde Rikkert MG. Frailty criteria give heterogeneous results when applied in clinical practice. J Am Geriatr Soc 2006;54:728-729.
4. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003;44:58-68.
5. Rockwood K, Fox RA, Stolee P, et al. Frailty in elderly people: an evolving concept. Cmaj 1994;150:489-495.
6. Buchner DM, Wagner EH. Preventing frail health. Clin Geriatr Med 1992;8:1-17.
7. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing 1997;26:315-318.
8. Walston J, Fried LP. Frailty and the older man. Med Clin North Am 1999;83:1173-1194.
9. Puts MT, Lips P, Deeg DJ. Sex differences in the risk of frailty for mortality independent of disability and chronic diseases. J Am Geriatr Soc 2005;53:40-47.
10. Rockwood K, Stadnyk K, MacKnight C, et al. A brief clinical instrument to classify frailty in elderly people. Lancet 1999;353:205-206.
11. Strawbridge WJ, Shema SJ, Balfour JL, et al. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci 1998;53:S9-16.
12. Rolfson DB, Majumdar SR, Tsuyuki RT, et al. Validity and reliability of the Edmonton Frail Scale. Age Ageing 2006;35:526-529.
13. Ravaglia G, Forti P, Lucicesare A, et al. Development of an easy prognostic score for frailty outcomes in the aged. Age Ageing 2008;37:161-166.
14. 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 2007;62:731-737.
15. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.
16. Levers MJ, Estabrooks CA, Ross Kerr JC. Factors contributing to frailty: literature review. J Adv Nurs 2006;56:282-291.
17. Fawcett J. Analysis and evaluation of conceptual models of nursing. 2nd edn. ed. Philadelphia, PA, USA: F.A. Davis Company, 1989.
18. Rockwood K. What would make a definition of frailty successful? Age Ageing 2005;34:432-434.
19. Ferrucci L, Guralnik JM, Studenski S, et al. Designing randomized, controlled trials aimed at preventing or delaying functional decline and disability in frail, older persons: a consensus report. J Am Geriatr Soc 2004;52:625-634.
20. 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;52:1560-1566.
21. 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:M146-156.
22. Puts MT, Lips P, Deeg DJ. Static and dynamic measures of frailty predicted decline in performance-based and self-reported physical functioning. J Clin Epidemiol 2005;58:1188-1198.

23. Winograd CH, Gerety MB, Chung M, et al. Screening for frailty: criteria and predictors of outcomes. J Am Geriatr Soc 1991;39:778-784.
24. Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. J Am Geriatr Soc 1991;39:46-52.
25. Schuurmans H, Steverink N, Lindenberg S, et al. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci 2004;59:M962-965.
26. Raphael D, Cava M, Brown I, et al. Frailty: a public health perspective. Can J Public Health 1995;86:224-227.
27. Schulz R, Williamson GM. Psychosocial and behavioral dimensions of physical frailty. J Gerontol 1993;48 Spec No:39-43.
28. Imuta H, Yasumura S, Abe H, Fukao A. The prevalence and psychosocial characteristics of the frail elderly in Japan: a community-based study. Aging (Milano) 2001;13:443-453.
29. Morley JE, Perry HM, 3rd, Miller DK. Editorial: Something about frailty. J Gerontol A Biol Sci Med Sci 2002;57:M698-704.
30. Woo J, Goggins W, Sham A, Ho SC. Social determinants of frailty. Gerontology 2005;51:402-408.
31. Rockwood K, Mitnitski AB, MacKnight C. Some mathematical models of frailty and their clinical implications. Rev Clin Gerontol 2002;12:109-117.
32. Bergman H, Béland F, Karunananthan S, et al. English translation of article published in 'Gérontologie et société'. Dévelopment d'un cadre de travail pour comprendre et étudier la fragilité. Gérontologie et société 2004;109:15-29.
33. Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. Int J Epidemiol 2002;31:285-293.
34. 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;59:255-263.
35. Bortz WM, 2nd. A conceptual framework of frailty: a review. J Gerontol A Biol Sci Med Sci 2002;57:M283-288.
36. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-847.
37. Fries JF. Reducing disability in older age. Jama 2002;288:3164-3166.
38. Brown I, Renwick R, Raphael D. Frailty: constructing a common meaning, definition, and conceptual framework. Int J Rehabil Res 1995;18:93-102.
39. Nourhashémi F, Andrieu S, Gillette-Guyonnet S, et al. Instrumental activities of daily living as a potential marker of frailty: a study of 7364 community-dwelling elderly women (the EPIDOS study). J Gerontol A Biol Sci Med Sci 2001;56:M448-453.
40. 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;118:1225-1231.
41. Covinsky KE, Hilton J, Lindquist K, Dudley RA. Development and validation of an index to predict activity of daily living dependence in community-dwelling elders. Med Care 2006;44:149-157.
42. Rockwood K, Mitnitski A, Song X, et all. Long-term risks of death and institutionalization of elderly people in relation to deficit accumulation at age 70. J Am Geriatr Soc 2006;54:975-979.
43. Bergman H, Beland F, Perrault A. The global challenge of understanding and meeting the needs of the frail older population. Aging Clin Exp Res 2002;14:223-225.
44. Abellan van Kan A, Rolland Y, Bergman H, et al. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging 2008;12:29-37.

45. 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.



# Chapter 5

# The Tilburg Frailty Indicator: psychometric properties

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## ABSTRACT

*Objectives*
To assess the reliability, construct validity, and predictive (concurrent) validity of the Tilburg Frailty Indicator (TFI), a self-report questionnaire for measuring frailty in older persons.

*Design*
Cross-sectional

*Setting*
Community-based

*Participants*
Two representative samples of community-dwelling persons aged 75 years and older (N=245; N=234)

*Measurements*
The TFI was validated using the LASA Physical Activity Questionnaire, BMI, Timed Up & Go test, Four test balance scale, Grip strength test, Shortened Fatigue Questionnaire, Mini-Mental State Examination, Center for Epidemiologic Studies Depression Scale, Anxiety subscale of the Hospital Anxiety and Depression Scale, Mastery Scale, Loneliness Scale, and the Social Support List. Adverse outcomes were measured using the Groningen Activity Restriction Scale and questions regarding health care utilisation. Quality of life was measured using the WHOQOL-BREF.

*Results*
The test-retest reliability of the TFI was good: .79 for frailty, and from .67 to .78 for its domains for a one-year time interval. The fifteen single components, and the frailty domains (physical, psychological, social) of the TFI correlated as expected with validated measures, demonstrating both convergent and divergent construct validity of the TFI. The predictive validity of the TFI and its physical domain was good for quality of life and the adverse outcomes disability and receiving personal care, nursing and informal care.

*Conclusion*
This study demonstrates that the psychometric properties of the TFI are good, when performed in two samples of community-dwelling older people. The results regarding the TFI's validity provide strong evidence for an integral definition of frailty consisting of the physical, psychological, and social domain.

## INTRODUCTION

Frailty has developed over time into an increasingly relevant concept from both the standpoint of the clinical care of older persons and research on aging.[1] Frailty is considered to confer high risk of adverse outcomes, including hospitalisation, institutionalisation, and mortality.[2] However, how frailty should be defined remains controversial.[3] Frailty is not synonymous with either comorbidity or disability, since all three create specific care needs in older patients.[4] Frailty is considered a predisability state.[5-7] Most of the conceptual and operational definitions of frailty focus mainly on physical problems affecting older persons. Only a few definitions also focus attention on the psychological and social domain of human functioning. Some endorse the importance of the social domain in relation to the occurrence of adverse outcomes.[5, 6]

More and more researchers are becoming convinced of the multidimensional nature of frailty.[2, 8-10] Frailty provides a conceptual basis for moving away from organ and disease-based approaches towards a health-based, integrative approach.[11] Taking as a starting point the definition by the World Health Organization**,** which defines health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity",[12] we have defined frailty as "a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social), which is caused by the influence of a range of variables and which increases the risk of adverse outcomes".[13] We, together with other researchers,[8] fear that if the definition of frailty home in exclusively on the physical components of frailty, attention for the individual as a whole will be jeopardised. This could potentially lead to fragmentation of care and subsequently to a reduction in the quality of care provided to frail elderly.

There is a need for a practical and empirically validated screening instrument, [5] which can be particularly useful for identifying frail elderly persons in the community.[14] Following this identification, it may be possible through the provision of integrated interventions to prevent or diminish frailty and to prevent adverse outcomes such as disability, health care utilisation, and untimely death. At present there are several frailty measurement instruments based on different definitions of frailty, e.g., the frailty scale,[2] the Frailty Index from a Standardized Comprehensive Geriatric Assessment,[15] the Edmonton Frail Scale,[9] and the Groningen Frailty Indicator.[16] The inclusion of disability in the assessment of frailty renders all these measurement instruments out of date.[6] Some other instruments, e.g., the phenotype of frailty,[17] the Clinical Global Impression of Change in Physical Frailty scale,[18] and the FRAIL scale[5, 6] only focus on the physical domain of frailty.

An instrument to assess frailty is needed that excludes disability but includes

multiple domains of human functioning (physical, psychological, social). Since none of the aforementioned measurement instruments satisfied these two conditions we developed the Tilburg Frailty Indicator (TFI), a user-friendly questionnaire for screening frail community-dwelling older people, including only self-reported information. The TFI is based on an integral conceptual model of frailty,[19] based on 'A working framework in development'.[1] This integral model of frailty describes an assumed relationship between the operational definition of frailty, ten life course determinants, disease(s), and the adverse outcomes disability, health care utilisation, and death. The TFI consists of two parts. Part A contains ten questions on determinants of frailty and diseases (multimorbidity); part B contains three domains of frailty with a total of fifteen questions on components of frailty (see Appendix). In fact part B assesses the presence of frailty in concrete terms.

The present study examines the psychometric properties of the TFI, part B. The results of an evaluation of the reliability (test-retest reliability and internal consistency reliability) and validity (face validity, content validity, construct validity (convergent and divergent)), and predictive (concurrent) validity of the TFI part B relating to components of frailty are presented. We expected each of the fifteen frailty components and each of the three frailty domains to correlate strongly with corresponding measurement instruments (convergent validity), and to correlate less strong with more distantly related measurement instruments (divergent validity). Predictive validity of Part B of the TFI was examined using quality of life, disability and health care utilisation as criteria.

## METHODS

### Study Populations and Data Collection

Two samples of community-dwelling individuals aged 75 years and older were randomly drawn from a register of the municipality in Roosendaal (The Netherlands), a town of 78,000 inhabitants. In Sample 1 (N=245; 54% response rate) we investigated the construct validity of the TFI using additional measures of frailty, and in Sample 2 (N=234; 34% response rate) we examined the predictive validity of the TFI using questions on adverse outcomes and quality of life. The proportion of men (.46) and average age (80.7 years) of the non-respondents in Sample 1 were not significantly different from those of the respondents (.45 and 80.3 years). Although no systematic information is available on non-respondents of Sample 2, since the characteristics of the two samples do not differ (see below), the two samples are considered representative of the population.

In Sample 1 participants' frailty was assessed with several questions and measurement instruments. The participants were first interviewed and physical measurements were performed on them between November 2007 and June 2008. Approximately an equal number of respondents were interviewed each month. Trained interviewers conducted personal interviews using structured questionnaires at the subject's residence in order to collect information. Interview procedures and interviewers' attitudes were standardised through participation in an eight-hour training course. Completing the interview and physical measures took on average 75 minutes. Second, in June 2008, one week after the last interview, the TFI and the WHOQOL-BREF (a quality of life scale) was completed by the respondents from Sample 1.

To assess the predictive validity of Part B of the TFI, participants in Sample 2 completed a questionnaire containing the TFI, the WHOQOL-BREF on quality of life, and questions on adverse outcomes of frailty such as disability and health care utilisation.

A subset of all 479 respondents from both samples completed the TFI again one year later (N=343, 72%), and again two weeks later (N=226, 66%). The review board of the Faculty of Behavioural and Social Sciences at Tilburg University approved the study, and informed consent for the collection and use of the information was obtained from all respondents.

## Measures

### *Frailty: TFI*

Frailty was assessed using the TFI part B. The components of the TFI were selected on the basis of previous research on frailty.[19] Four of the eight components of the physical domain of frailty (physical frailty) correspond to questions in the phenotype of frailty.[17] These are: unexplained weight loss, difficulty in walking, strength in hands and physical tiredness. Physical health,[9, 20] balance,[21-23] vision problems and hearing problems[10, 24] were added to the physical domain (range 0-8).[19] The psychological domain of frailty (psychological frailty; range 0-4) in the TFI consists of four components: cognition,[2, 9, 22, 24] depressive symptoms,[9, 16, 25, 26] anxiety[16] and coping.[10, 27] The social domain of frailty (social frailty; range 0-3), includes living alone, social relations[16, 27] and social support.[9, 20, 25, 27] Eleven items from the TFI have two response categories "yes" and "no"; four items have three response categories: "yes", "sometimes", and "no"; these items were dichotomised (see Appendix). The score for frailty and the three domains of frailty are determined by adding the responses to the items belonging to each scale (see Appendix). The maximum score is 15 and represents the highest level of frailty.

***Other Measures of Frailty***

Various questionnaires and physical criteria were used to measure the components of frailty. Physical frailty components were assessed using the LASA Physical Activity Questionnaire (LAPAQ),[28] the Body Mass Index (BMI), the Timed Up & Go (TUG) test,[29] the Four-test balance scale,[30] one question to determine poor hearing, one question to determine poor vision, a hand grip strength test (Martin Vigorimeter; Elmed Inc., Addison, USA), and the Shortened Fatigue Questionnaire (SFQ)[31] on endurance. The LAPAQ asks respondents how often and for how long in the two weeks before the interview they had walked, cycled, and performed sporting activities, and light and heavy household activities. The *Timed Up & Go (TUG) test* of physical mobility measures the time the respondent takes to rise from an armchair, walk three meters, and return to the chair. The *Four-test balance scale* includes four timed static balance tasks. In this study participants performed three tasks (side-by-side, semi-tandem and tandem). Poor hearing and vision problems were ascertained by asking respondents how they assess their hearing (good, moderate, poor) and how often they encounter situations in which they find that their vision is poor (very often, sometimes, hardly ever). Hand grip strength was measured three times. The highest value was used. In the *Shortened Fatigue Questionnaire (SFQ)*[31] we used three response categories (yes that is correct, that is more or less correct, no that is not correct).

Psychological frailty was assessed using four scales: the *Mini-Mental State Examination (MMSE)* evaluates various dimensions of cognition (memory, calculation, orientation in space and time, language, and word recognition),[32] mood (feeling down) was assessed using the 20-item *Center for Epidemiologic Studies Depression Scale (CES-D*),[33] and mood (feeling nervous or anxious) was measured using the seven-item *Anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A)*.[34] Coping was assessed using a short five-item version of the *Pearlin and Schooler Mastery Scale (MAS)*.[35]

Finally, social frailty was measured using one question to determine whether respondents live alone or with others, the Loneliness Scale [36, 37] and the Social Support List (SSL).[38] Problems with social relations were assessed using the 11-item *Loneliness Scale*. The degree of social support that people experience was assessed by a short six-item version of the *Social Support List (SSL)* including items on everyday emotional support, emotional support with problems, self-esteem support, instrumental support, social companionship, and informative support.

***Quality of Life***

The WHOQOL-BREF is a 26-item, cross-cultural, self-administered scale, covering four domains of quality of life: psychological (six items), physical health (seven items), social

relations (three items), environmental (eight items), and includes one overall QOL and one general health item.[39, 40] We used only the 24 domain items. All items were rated on a 5-point scale with a higher score indicating a higher quality of life. Domain scores were calculated by multiplying the mean domain score by a factor of 4, and accordingly, resulting in a range from 4-20 for each domain.

***Adverse Outcomes***

Disability was assessed using the *Groningen Activity Restriction Scale (GARS)*.[41, 42] This is a non-disease-specific instrument to measure disability in activities of daily living and instrumental activities of daily living. The GARS scores range from 18 (no disability) to 72 (maximum disability). The cutpoint of 29 was chosen for the disabled group.[43]

Five indicators of health care utilisation were used: *Visit to a general practitioner* ("How frequently have you visited or been visited by a general practitioner during the last year?", using five categories from "never" to "seven times or more"); *Hospital admission* ("Were you admitted to a hospital in the last year?", yes/no); *Receiving personal care* ("Have you used professional support for your personal care in the last year?", yes/no); *receiving nursing care* ("Have you used professional nursing support in the last year, for example to care for wounds or give injections?", yes/no); *Receiving informal care* ("Have you received informal care during the past twelve months because of your health status?", yes/no).

**Analysis Strategies**

All statistical analyses were conducted using SPSS Statistics 17.0. After presenting the descriptive statistics, the results of reliability and validity analyses were reported. Both the test-retest reliability and internal consistency reliability of frailty and frailty domain scores in the TFI were reported. Test-retest reliability was calculated using the Pearson correlation coefficient. The test-retest reliability was assessed for two time intervals; one of twelve months and one of two weeks. The internal consistency reliability was assessed using Cronbach's $\alpha$. Evidence of the face and content validity was provided by describing the development of the TFI. Construct validity was checked through an examination of the Pearson correlations of the fifteen single TFI frailty components, using established measurement instruments that addressed the same construct. Positive and significant correlations were interpreted as evidence for construct validity. Construct validity of frailty was also assessed using convergent and divergent validity. It was expected that the TFI domain scores would show the highest correlations with their corresponding measures of frailty (convergent construct validity) and the lowest correlations with measures of the other domains (divergent construct validity) (See Table 3 for an overview of measures corresponding to each frailty domain). Finally,

the predictive validity for frailty was investigated by performing lineair regression and ROC analyses. The ROC analyses were applied to criteria of adverse outcomes: disability and health care utilisation. Sensitivity and specificity were estimated for each criterion at each cutpoint of the frailty score and the frailty physical domain score, and the AUC with 95% confidence intervals was reported. Multiple regression analyses were carried out with the subscales from the WHOQOL-BREF (physical, psychological, social, environmental) as dependent variables and all frailty domains as independent variables. Predictive validity of the frailty domains is supported if a frailty domain score is associated with a corresponding QOL subscale after controlling for the effect of the other frailty domains in the multiple regression.

## RESULTS

### Participant Characteristics

See Table 1 for an overview of descriptive statistics of Sample 1 and Sample 2. T-tests show no statistically significant differences between the two samples on determinants of frailty, components of frailty, and quality of life. The mean age was 80.3 and 80.2 years, 55 and 59% were female, 35 and 41% were widowed, respectively, for both samples.

**Table 1.** Characteristics of Respondents on Determinants of Frailty, Components of Frailty, Quality of Life (Sample 1 and Sample 2), Interview and Physical Measures (Sample 1), and Adverse Outcomes (Sample 2).

| Characteristic | Sample 1<br>n = 245 | Sample 2<br>n = 234 |
|---|---|---|
| **Part A of the TFI: Determinants of Frailty** | | |
| Age, mean ± SD | 80.3 ± 3.9 | 80.2 ± 3.7 |
| Sex, % of women | 134 (54.7) | 138 (59.0) |
| Marital status | | |
| Married or cohabiting | 123 (50.4) | 115 (49.1) |
| Not married | 29 (11.9) | 16 (6.8) |
| Divorced | 7 (2.9) | 8 (3.4) |
| Widow | 85 (34.8) | 95 (40.6) |
| Ethnicity | | |
| Dutch | 236 (96.3) | 225 (97.0) |
| Other | 9 (3.6) | 7 (3.0) |
| Education | | |
| No or primary | 92 (37.9) | 89 (38.4) |

**Table 1. Continued**

| Characteristic | Sample 1 n = 245 | Sample 2 n = 234 |
|---|---|---|
| Secondary | 110 (45.3) | 111 (47.8) |
| Higher | 41 (16.9) | 32 (13.8) |
| Monthly income | | |
| €600 or less | 8 (3.6) | 4 (1.9) |
| €601 - €900 | 30 (13.5) | 41 (19.1) |
| €901 - €1200 | 50 (22.4) | 56 (26.0) |
| €1201 - €1500 | 30 (13.5) | 27 (12.6) |
| €1501 - €1800 | 36 (16.1) | 31 (14.4) |
| €1801 - €2100 | 29 (13.0) | 19 (8.8) |
| €2101 or more | 40 (17.9) | 37 (17.2) |
| Lifestyle | | |
| Healthy | 182 (74.3) | 169 (72.8) |
| Not healthy, not unhealthy | 56 (22.9) | 58 (25.0) |
| Unhealthy | 7 (2.9) | 5 (2.2) |
| Comorbidity, % of Yes | 120 (49.2) | 110 (47.8) |
| Life events, % of Yes | | |
| Death loved one | 83 (34.0) | 74 (31.9) |
| Serious illness | 34 (14.0) | 33 (14.3) |
| Serious illness loved one | 88 (35.9) | 61 (26.4) |
| End of important relationship | 12 (4.9) | 11 (4.8) |
| Traffic accident | 6 (2.5) | 3 (1.3) |
| Crime | 2 (0.8) | 1 (0.4) |
| Satisfaction residence, % of Yes | 235 (95.9) | 223 (97.0) |
| **Part B of the TFI: Components of Frailty** | | |
| TFI, mean ± SD (range 0-15) | 232 4.7 ± 3.0 | 213 4.7 ± 3.0 |
| Physical domain, mean ± SD (range 0-8) | 237 2.6 ± 2.1 | 220 2.5 ± 2.0 |
| Poor physical health | 69 (28.5) | 69 (30.0) |
| Unexplained weight loss | 19 (7.8) | 17 (7.3) |
| Difficulty in walking | 120 (49.0) | 110 (47.2) |
| Strength in hands | 85 (34.7) | 79 (33.8) |
| Physical tiredness | 116 (47.3) | 101 (43.3) |

**Table 1. Continued**

| Characteristic | Sample 1 n = 245 | Sample 2 n = 234 |
|---|---|---|
| Difficulty maintaining balance | 89 (36.3) | 77 (33.6) |
| Poor hearing | 89 (36.5) | 85 (36.8) |
| Poor vision | 53 (21.9) | 48 (20.8) |
| Psychological domain, mean ± SD (range 0-4) | 241 0.9 ± 1.1 | 228 1.0 ± 1.1 |
| Problems with memory | 25 (10.2) | 21 (9.0) |
| Feeling down | 97 (39.6) | 95 (40.8) |
| Feeling nervous or anxious | 71 (29.1) | 77 (32.9) |
| Able to cope with problems | 32 (13.2) | 39 (17.0) |
| Social domain, mean ± SD (range 0-3) | 244 1.2 ± 0.9 | 231 1.3 ± 0.9 |
| Living alone | 117 (47.8) | 112 (47.9) |
| Social relations | 139 (57.0) | 143 (61.1) |
| Social support | 38 (15.5) | 40 (17.3) |
| **Quality of Life** | | |
| Physical | 243 15.0 ± 2.8 | 231 15.2 ± 3.0 |
| Psychological | 244 14.9 ± 1.9 | 233 15.0 ± 2.4 |
| Social | 242 15.7 ± 2.6 | 230 16.1 ± 2.8 |
| Environmental | 244 15.7 ± 2.1 | 228 15.6 ± 2.3 |
| **Interview and Physical Measures (Sample 1)** | | |
| Weight | | |
| Body Mass Index (BMI) | | |
| <18.5 (underweight) | 4 (1.7) | |
| 18.5-24.9 (normal) | 84 (34.9) | |
| 25-29.9 (overweight) | 106 (44.0) | |
| >30 (obese) | 47 (19.5) | |
| Walking | | |
| Timed Up & Go test, mean ± SD | 14.2 ± 8.9 | |
| time >10 seconds | 173 (72.1) | |
| Physical activity | | |
| LASA Physical Activity Questionnaire, mean ± SD | 118.9 ± 84.8 | |

**Table 1. Continued**

| Characteristic | Sample 1<br>n = 245 | Sample 2<br>n = 234 |
|---|---|---|
| <65 min/day | 71 (29.5) | |
| Strength | | |
| Hand grip strength | 72.8 ± 19.9 | |
| Physical tiredness, mean ± SD | 6.3 ± 2.6 | |
| Shortened fatigue questionnaire (range 4-12) | | |
| Balance | | |
| Four test balance scale | | |
| Poor balance | 99 (42.3) | |
| Hearing | | |
| Poor hearing | 102 (41.6) | |
| Vision | | |
| Poor vision | 77 (31.6) | |
| Cognition, mean ± SD | 27.9 ± 2.5 | |
| Mini Mental State Examination | | |
| <24 (range 0-30) | 12 (4.9) | |
| Depression, mean ± SD | 6.7 ± 7.6 | |
| Center for Epidemiologic Studies Depression Scale (CES-D) | | |
| ≥16 (range 0-60) | 26 (10.9) | |
| Anxiety, mean ± SD | 2.0 ± 3.2 | |
| Hospital Anxiety and Depression Scale – Anxiety subscale (HADS-A) | | |
| ≥8 (range 0-21) | 14 (5.7) | |
| Coping, mean ± SD | 17.2 ± 3.3 | |
| Mastery Scale (MAS) | | |
| <14 (range 5-25) | 29 (12.1) | |
| Living alone | 112 (45.7) | |
| Social relations, mean ± SD | 2.0 ± 2.6 | |
| Loneliness scale | | |
| ≥3 (range 0-11) | 69 (28.2) | |
| Social support, mean ± SD | 6.9 ± 1.9 | |
| Social Support List (SSL) (range 0-18) | | |

**Table 1. Continued**

| Characteristic | Sample 1<br>n = 245 | Sample 2<br>n = 234 |
|---|---|---|
| **Adverse Outcomes (Sample 2)** | | |
| Disability, mean ± SD | | |
| GARS* | | 27.7 ± 11.0 |
| ≥29 (range 0-72) | | 73 (34.8) |
| Health care utilisation | | |
| Visits general practitioner | | |
| 0 | | 19 (8.3) |
| 1-2 | | 59 (25.8) |
| 3-4 | | 83 (36.2) |
| 5-6 | | 35 (15.3) |
| ≥7 | | 33 (14.4) |
| Hospitalisation | | 49 (21.3) |
| Receiving personal care | | 35 (15.3) |
| Receiving nursing | | 31 (13.9) |
| Receiving informal care† | | 51 (26.6) |

*Note:* *24 cases were missing. † 42 cases were missing.
SD = standard deviation.

### Development of the TFI: Face Validity and Content Validity

The first draft of the TFI was developed on the basis of previous research on frailty.[19] This draft was presented to participants at two geriatrics meetings in 2008 (n=47 and n=44). These participants represented several disciplines such as medicine, nursing, care and social work. They were asked if they felt any essential components of frailty were missing from the first draft. Their responses resulted in several changes to the TFI. First, eight determinants and one component of frailty (coping) were added to the content. Second, response categories were changed, with six open questions being replaced by closed questions with yes/no categories; an extra response category 'sometimes' was added to four questions. Finally, the format of the questionnaire was changed by organising the determinants in part A and the components of frailty in part B.

The second TFI draft was presented to representatives of professional disciplines (n=10) and to people aged 75 years and older (n=33). No changes were made to the TFI since they indicated that the questions were clear and that no essential components were missing. Completing the TFI took on average 14 minutes.

**Reliability**

We combined both samples before computing the internal consistency reliabilities of the frailty (TFI) scales. The (unstandardised) Cronbach's alpha was .73 for frailty, .70 for the physical domain, .63 for the psychological domain, and .34 for the social domain. The test-retest reliability for the one-year period was .79 for frailty, .78 for the physical domain, .67 for the psychological domain, and .76 for the social domain. It was .90, .87, .77, .86, for frailty, the physical, psychological, and social domains, respectively, for the two-week interval.

**Table 2.** Construct Validity: Correlation between the TFI Questions and Other Frailty Measures

| Model Questions TFI | Other Frailty Measure | *r* | *P*-value* |
|---|---|---|---|
| **Physical domain** | | | |
| Physical activity | | | |
| Q11 Physical health | LASA Physical Activity Questionnaire (LAPAQ) | .19 | .001 |
| Nutrition | | | |
| Q12 Unexplained weight loss | Body Mass Index (BMI) | .03 | .316 |
| Mobility | | | |
| Q13 Difficulty in walking | Timed Up & Go test | .36 | <.001 |
| Balance | | | |
| Q14 Difficulty maintaining balance | Four test balance scale | .28 | <.001 |
| Sensory functions | | | |
| Q15 Poor hearing | "How do you assess your hearing?" | .62 | <.001 |
| Q16 Poor vision | "How often do you come in situations in which you find your vision is bad?" | -.43 | <.001 |
| Strength | | | |
| Q17 Strength in hands | Grip strength test (Martin Vigorimeter) | -.35 | <.001 |
| Endurance | | | |
| Q18 Physical tiredness | Shortened Fatigue Questionnaire (SFQ) | .58 | <.001 |
| **Psychological domain** | | | |
| Cognition | | | |
| Q19 Problems with memory | Mini-Mental State Examination (MMSE) | -.19 | .002 |

**Table 2. Continued**

| Model<br>Questions TFI | Other Frailty Measure | *r* | *P*-value* |
|---|---|---|---|
| Mood | | | |
| Q20 Feeling down | Center for Epidemiologic Studies Depression Scale (CES-D) | .44 | <.001 |
| Q21 Feeling nervous or anxious | Hospital Anxiety and Depression Scale – Anxiety subscale (HADS-A) | .46 | <.001 |
| Coping | | | |
| Q22 Able to cope with problems | Mastery Scale (MAS) | .35 | <.001 |
| **Social domain** | | | |
| Social relations | | | |
| Q23 Living alone | "Do you live alone at present or with others?" | .96 | <.001 |
| Q24 Social relations | Loneliness Scale | .29 | <.001 |
| Social support | | | |
| Q25 Social support | Social Support List (SSL) | .40 | <.001 |

* P-values are one-tailed

## Construct Validity

The significant correlations between the frailty domains were .42 between the physical and psychological, .19 between the physical and social, and .18 between the psychological and social domains (all $P < .001$). The results for the construct validity of the individual components of frailty are summarised in Table 2. With one exception the components of the TFI (first column) correlated as expected and significantly with related measures (second column). The only exception was the correlation between Q12 "Unexplained weight loss" and the BMI index. After concluding that the components were valid, we assessed the convergent and divergent validity of the TFI. Table 3 presents the correlations between the TFI domains and other scales related to frailty. The internal consistency reliability of these other scales is reported between brackets in the first column of Table 3. As shown in the second column, frailty correlated as expected and significantly with all other scales.

The convergent validity of the physical domain was good since it correlated as expected and significantly with the other physical measures. Divergent validity was also good, because these correlations were stronger than the correlations between

**Table 3.** Construct Validity (Convergent and Divergent Validity): Correlations of Frailty Domains with Other Frailty Measures

| | TFI | | TFI Ph | | TFI Ps | | TFI So | |
|---|---|---|---|---|---|---|---|---|
| | *r* | *P*-value* | *r* | *P*-value* | *r* | *P*-value* | *r* | *P*-value* |
| **Physical domain** | | | | | | | | |
| Body Mass Index (BMI) | .13 | .022 | .20 | .001 | -.10 | .067 | .08 | .125 |
| Timed Up & Go test | .27 | <.001 | .36 | <.001 | -.04 | .262 | .12 | .028 |
| LASA Physical Activity Questionnaire (LAPAQ) | -.23 | <.001 | -.28 | <.001 | -.09 | .091 | -.02 | .361 |
| Grip strength test | -.27 | <.001 | -.27 | <.001 | -.05 | .205 | -.20 | .001 |
| Shortened Fatigue Questionnaire (SFQ) (α = 0.84) | .52 | <.001 | .53 | <.001 | .22 | <.001 | .16 | .007 |
| Four test balance scale | .25 | <.001 | .30 | <.001 | -.02 | .407 | .12 | .036 |
| **Psychological domain** | | | | | | | | |
| Mini-Mental State Examination (MMSE) (α = 0.56) | -.24 | <.001 | -.24 | <.001 | -.09 | .076 | -.11 | .042 |
| Center for Epidemiologic Studies Depression Scale (CES-D) (α = 0.86) | .48 | <.001 | .31 | <.001 | .45 | <.001 | .34 | <.001 |
| Hospital Anxiety and Depression Scale–Anxiety subscale (HADS-A) (α = 0.83) | .34 | <.001 | .20 | .001 | .39 | <.001 | .20 | .001 |
| Mastery Scale (MAS) (α = 0.75) | .45 | <.001 | .32 | <.001 | .40 | <.001 | .24 | <.001 |
| **Social domain** | | | | | | | | |
| Loneliness scale (α = 0.83) | .39 | <.001 | .24 | <.001 | .24 | <.001 | .45 | <.001 |
| Social Support List (SSL) (α = 0.80) | .22 | <.001 | .11 | .042 | .14 | .012 | .31 | <.001 |

* One-tailed P-value

the other frailty domains and the physical measures. Evidence for the convergent validity of the psychological domain did not appear unequivocal. Although the psychological domain correlated as expected and significantly with three other psychological frailty measures, it did not correlate with the MMSE. Interestingly, the MMSE did correlate with the physical and social domains. The divergent validity of the psychological domain on the three other scales was good, since psychological frailty correlated more strongly with these three than the other two domains did. Finally, the social domain showed both good convergent and divergent validity, since social frailty correlated as expected and significantly with the two related scales, and correlated more strongly with these scales than the other two domains correlated with these two scales.

**Predictive Validity**

To demonstrate the predictive validity of frailty and physical frailty, measured by the TFI, the AUC with 95% confidence interval for adverse outcome measure GARS and five health care utilisation measures was calculated, as well as the sensitivity and specificity for one or two cutpoints that gave the best results. The predictive validity with respect to the GARS and reporting personal care was excellent, evidenced by AUCs larger than .8, whereas it was good (AUC between .7 and .8) for reporting nursing and informal care. The predictive validity was mediocre for reporting general practitioner visits and hospitalisation.

The predictive validity of frailty and all frailty domains was also demonstrated by correlating frailty with quality of life domains, and regressing quality of life domains on the three frailty domains (see Table 5). The reliabilities of the quality of life domains are shown in the first column of the table. The second and last columns reveal that frailty correlated strongly with quality of life. From 17.3% of the variance of social quality of life to 54.2% of the variance of physical quality of life was explained by the frailty score (TFI).

The third to fifth columns (Table 5) present the bivariate correlations and their significance (first row in cell), standardised regression coefficients (second row in cell), and the unique contributions to the explained variance by this frailty domain after controlling for the effect of the other two domains and their significance (third row in cell). In particular three results of the multiple regression analysis provide evidence for the validity of the TFI and its domains. First, each frailty domain was associated with its corresponding quality of life domain, as shown by their correlations. Second, they also correlated with each other after controlling for the effect of the two other domains, as shown by the unique contributions. Note that these first two results also demonstrate the construct validity of the frailty domains. Finally, with only one exception (effect of

social frailty on psychological quality of life), each frailty domain explained a unique part of the variance of each quality of life domain. For example, both the psychological and social domains explained part of physical quality of life that could not be explained by physical frailty alone.

**Table 4.** Predictive Validity of the TFI and TFI Physical Domain: Disability and Health Care Utilisation

| | Screening Cutpoint | Interview Instruments /Questions | Sensitivity | Specificity | AUC (95% CI) |
|---|---|---|---|---|---|
| TFI | ≥5 | GARS | 0.84 | 0.76 | 0.86 (0.81-0.92) |
| TFI Ph | ≥3 | | 0.86 | 0.79 | 0.86 (0.80-0.91) |
| TFI | ≥4 | Visit general practitioner | 0.60 | 0.59 | 0.64 (0.52-0.76) |
| | ≥5 | | 0.47 | 0.65 | |
| TFI Ph | ≥2 | | 0.64 | 0.67 | 0.68 (0.56-0.80) |
| | ≥3 | | 0.47 | 0.83 | |
| TFI | ≥5 | Hospital admission | 0.63 | 0.59 | 0.61 (0.51-0.71) |
| TFI Ph | ≥3 | | 0.62 | 0.61 | 0.63 (0.54-0.72) |
| TFI | ≥5 | Receiving personal care | 0.91 | 0.63 | 0.85 (0.78-0.92) |
| TFI | ≥6 | | 0.73 | 0.72 | |
| TFI Ph | ≥3 | | 0.83 | 0.65 | 0.81 (0.74-0.89) |
| TFI Ph | ≥4 | | 0.69 | 0.77 | |
| TFI | ≥5 | Receiving nursing | 0.87 | 0.61 | 0.77 (0.69-0.86) |
| TFI | ≥6 | | 0.63 | 0.69 | |
| TFI Ph | ≥3 | | 0.81 | 0.62 | 0.77 (0.69-0.86) |
| TFI Ph | ≥4 | | 0.72 | 0.76 | |
| TFI | ≥5 | Receiving informal care | 0.71 | 0.63 | 0.74 (0.67-0.81) |
| TFI | ≥6 | | 0.58 | 0.73 | |
| TFI Ph | ≥3 | | 0.67 | 0.64 | 0.72 (0.64-0.80) |
| TFI Ph | ≥4 | | 0.47 | 0.74 | |

AUC = area under the curve; CI = confidence interval; GARS = Groningen Activity Restriction Scale; TFI Ph = Tilburg Frailty Indicator physical domain.

**Table 5.** Predictive Validity of the TFI: Quality of Life

| QoL domains (α) | TFI | | TFI Ph | | TFI Ps | | TFI So | | $R^2$ | *P*-value† |
|---|---|---|---|---|---|---|---|---|---|---|
| | *r* | *P*-value* | *r* / Beta | *P*-value* / *P*-value‡ | *r* / Beta | *P*-value* / *P*-value‡ | *r* / Beta | *P*-value* / *P*-value‡ | | |
| Physical | -.71 | <.001 | -.71 | <.001 | -.47 | <.001 | -.21 | <.001 | | |
| (0.84) | | | -.61 | | -.21 | | -.06 | | | |
| | | | [.306] | <.001 | [.034] | <.001 | [.003] | .044 | .542 | <.001 |
| Psychological | -.68 | <.001 | -.60 | <.001 | -.58 | <.001 | -.20 | <.001 | | |
| (0.76) | | | -.43 | | -.39 | | -.04 | | | |
| | | | [.153] | <.001 | [.123] | <.001 | [.002] | .118 | .493 | <.001 |
| Social | -.40 | <.001 | -.29 | <.001 | -.36 | <.001 | -.22 | <.001 | | |
| (0.60) | | | -.16 | | -.26 | | -.14 | | | |
| | | | [.020] | <.001 | [.057] | <.001 | [.020] | <.001 | .173 | <.001 |
| Environmental | -.54 | <.001 | -.45 | <.001 | -.43 | <.001 | -.27 | <.001 | | |
| (0.79) | | | -.31 | | -.28 | | -.16 | | | |
| | | | [.078] | <.001 | [.062] | <.001 | [.023] | <.001 | .302 | <.001 |

* One-tailed P-value
† Two-tailed P-value
‡ One-tailed P-value of the unstandardised regression weight
TFI Ph = Tilburg Frailty Indicator physical domain; TFI Ps = Tilburg Frailty Indicator psychological domain; TFI So = Tilburg Frailty Indicator social domain; QoL = quality of life; Beta = standardised regression weight.

## DISCUSSION

We developed a measurement instrument, the Tilburg Frailty Indicator (TFI), for identifying frail community-dwelling older people. The TFI is based on an integral view of human functioning, based on a definition of frailty that excludes disability but includes physical, psychological and social components of frailty. In the present study the psychometric properties of the TFI were examined in representative samples of Dutch community-dwelling elderly persons.

This study shows that the TFI is a valid and reliable instrument for measuring frailty. Its test-retest reliability was good, its face and content validity satisfactory. Its construct validity was also good; the single components generally correlated as expected with established measures, and the frailty domains (physical, psychological, social) correlated as expected with other frailty measures, demonstrating both convergent and divergent validity of the domains. The predictive (concurrent) validity of the TFI and its physical domain was good to excellent for the adverse outcomes disability, receiving personal care, receiving nursing and informal care, and mediocre for hospitalisation and general practitioner visits. Finally, frailty and its domains correlated strongly with quality of life, which is evidence of good predictive as well as construct validity of frailty and its domains.

The internal consistency reliability was low for the social domain. We do not consider this a problem since we selected the components of frailty to cover the most important elements of frailty and its domains in as few questions as possible. We do not want to create a measure consisting of closely related components, i.e., a measure with high internal consistency. If desired, the internal consistency can be increased by adding other indicators of social frailty. However, for our purposes, test-retest reliability is more relevant than internal consistency reliability, and this was good for frailty and all its domains.

Four issues concerning the construct validity warrant some discussion. First, the component 'unexplained weight loss' did not correlate with the BMI. This merely shows that the BMI is an invalid measure to correlate with; the component should have been correlated to a change in the BMI or any other indicator of change in weight over time. Second, we doubted the validity of the question "Do you feel physically healthy?", for measuring physical activity. Therefore, we added one question at the end of the TFI when assessing its test-retest reliability, namely "Do you find that you can be sufficiently physically active?" Since there was a substantial correlation (.52) between the two questions we conclude that the original question was valid. Third, the component 'problems with memory' (Q19) did correlate with the MMSE, but unexpectedly, the MMSE did not correlate with the other three questions on the psychological domain.

The MMSE did correlate with the physical domain. In retrospect, this finding is no surprise since several studies have reported that physical frailty is associated with low cognitive performance.[24, 44] Finally, we note that the interview did not occur at the same time as the assessment of the TFI, but up to six months earlier. Since the substantial time interval between the two likely resulted in lower associations between the TFI and other measures, these associations would have been larger and our evidence on validity stronger if they had been assessed simultaneously.

The predictive validity of the TFI and its three domains was demonstrated by the strong correlations with quality of life, measured by the WHOQOL-BREF. In particular, regression analyses showed that it is not only physical frailty that is relevant for quality of life, but psychological frailty and social frailty as well, even after controlling for the effect of physical frailty. Additionally, the psychological and social domain explained part of physical quality of life that could not be explained by physical frailty. These results provide strong evidence for an integral definition of frailty.

We chose 5 as the cutpoint of the TFI, since at this point the sensitivity was good and specificity acceptable for most adverse outcomes. Using this cutpoint 47.1% of our respondents were identified as frail. This figure is comparable to other frailty prevalence data; for instance, the American Medical Association identified 40% of people aged 80 and over as frail,[45] the Groningen Frailty Indicator classified 32% of community-dwelling elderly (65 years and older) as frail.[16] Finally, we chose 3 as the cutpoint for physical frailty, which equals the cutpoint of the phenotype of frailty[17] that shares four of eight components with the physical part of the TFI. Using this cutpoint, 45.0% of the respondents were identified as having problems in the physical domain of frailty. The prevalence of frailty in a community-dwelling population measured with the phenotype of frailty was 6.9%.[17] However, this population was 65 years and older, with most people (67.3%) having an age from 65-74 years.

A limitation of our study was the response rates (Sample 1, 54%; Sample 2, 34%), which were lower than in other studies (between 60% and 89%),[46] probably because those studies used a second mailing and we did not. The response rate in the current study might have been increased considerably by a second mailing, or by recruiting elderly via intermediaries, e.g. general practitioners. Another cause of the low response rate was possibly the high age of the targeted population (75 years and older). The consequence of non-response is probably an underestimation of frailty in the community population.[47, 48]

Glass proposed that self-report questionnaires asking people what they can do ("hypothetical tense") do not measure the same as performance tests ("experimental tense").[49] However, our findings show that frailty as measured by the TFI questionnaire is consistent with other indicators of frailty like performance tests such as the Timed

Up & Go test, the Four test balance scale, the Grip strength test, and the Mini-Mental State Examination.

We suggest several directions for future research. First, the predictive validity of the TFI needs to be assessed in a longitudinal study, with an emphasis on how frailty and its domains affect adverse outcomes in the long term. This study should also include adverse outcomes related to the psychological and social domains of frailty, to determine optimal cutpoints for these two frailty domains as well. Second, though not yet validated for settings other than the community, the TFI may have potential applications in hospital or primary care settings. Hence we propose to examine its validity in these settings. Third, early detection of older people with frailty can lead to early interventions in the community. It will be important to determine whether specific interventions for frail people will be effective in reducing the frequency of adverse health outcomes. Fourth, for effective prevention and treatment 'at risk of frailty' and frailty must be recognised. Therefore it is important to examine which determinants (TFI part A) predict frailty (TFI part B).[50]

In conclusion, we offer general practitioners, nurses, social workers, and other health care workers a user-friendly measurement instrument including only self-reported information: the TFI, which embraces the complexity of frailty that will do justice to the possibly complex needs of community-dwelling older people.

## REFERENCES


1. Bergman H, Béland F, Karunananthan S, et al. English translation of article published in 'Gérontologie et société'. Dévelopment d'un cadre de travail pour comprendre et étudier la fragilité. Gérontologie et société 2004;109:15-29.
2. Rockwood K, Stadnyk K, MacKnight C, et al. A brief clinical instrument to classify frailty in elderly people. Lancet 1999;353:205-206.
3. Fisher AL. Just what defines frailty? J Am Geriatr Soc 2005;53:2229-2230.
4. 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;59:255-263.
5. Abellan van Kan G, Rolland YM, Morley JE, Vellas B. Frailty: toward a clinical definition. J Am Med Dir Assoc 2008;9:71-72.
6. Abellan van Kan A, Rolland Y, Bergman H, et al. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging 2008;12:29-37.
7. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-847.
8. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003;44:58-68.
9. Rolfson DB, Majumdar SR, Tsuyuki RT, et al. Validity and reliability of the Edmonton Frail Scale. Age Ageing 2006;35:526-529.
10. Puts MT, Lips P, Deeg DJ. Sex differences in the risk of frailty for mortality independent of disability and chronic diseases. J Am Geriatr Soc 2005;53:40-47.
11. 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 2007;62:731-737.
12. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948.
13. Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. In search of an integral conceptual definition of frailty: opinions of Experts. J Am Med Dir Assoc 2010;accepted for publication:000-000.
14. Aminzadeh F, Dalziel WB, Molnar FJ. Targeting frail older adults for outpatient comprehensive geriatric assessment and management services: an overview of concepts and criteria. Rev Clin Gerontol 2002;12:82-92.
15. Jones DM, Song X, Rockwood K. Operationalizing a frailty index from a standardized comprehensive geriatric assessment. J Am Geriatr Soc 2004;52:1929-1933.
16. Schuurmans H, Steverink N, Lindenberg S, et al. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci 2004;59:M962-965.
17. 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:M146-156.
18. 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;52:1560-1566.
19. Gobbens RJ, Luijkx KG, Wijnen-Sponselee MT, Schols JM. Towards an integral conceptual model of frailty. J Nutr Health Aging 2010;accepted for publication:000-000.
20. Rockwood K, Fox RA, Stolee P, et al. Frailty in elderly people: an evolving concept. Cmaj 1994;150:489-495.

21. Brown M, Sinacore DR, Binder EF, Kohrt WM. Physical and performance measures for the identification of mild to moderate frailty. J Gerontol A Biol Sci Med Sci 2000;55:M350-355.
22. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing 1997;26:315-318.
23. Ory MG, Schechtman KB, Miller JP, et al. Frailty and injuries in later life: the FICSIT trials. J Am Geriatr Soc 1993;41:283-296.
24. Strawbridge WJ, Shema SJ, Balfour JL, et al. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci 1998;53:S9-16.
25. Winograd CH, Gerety MB, Chung M, et al. Screening for frailty: criteria and predictors of outcomes. J Am Geriatr Soc 1991;39:778-784.
26. Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. J Am Geriatr Soc 1991;39:46-52.
27. Raphael D, Cava M, Brown I, et al. Frailty: a public health perspective. Can J Public Health 1995;86:224-227.
28. Stel VS, Smit JH, Pluijm SM, et al. Comparison of the LASA Physical Activity Questionnaire with a 7-day diary and pedometer. J Clin Epidemiol 2004;57:252-258.
29. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 1991;39:142-148.
30. Gardner MM, Buchner DM, Robertson MC, Campbell AJ. Practical implementation of an exercise-based falls prevention programme. Age Ageing 2001;30:77-83.
31. Alberts M, Smets EM, Vercoulen JH, et al. ['Abbreviated fatigue questionnaire': a practical tool in the classification of fatigue]. Ned Tijdschr Geneeskd 1997;141:1526-1530.
32. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-198.
33. Radloff LS. The CES-D Scale: a Self-Report Depression Scale for Research in the General Population. Appl Psychol Measure 1977;1:385-401.
34. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67:361-370.
35. Pearlin LI, Schooler C. The structure of coping. J Health Soc behav 1978;19:2-21.
36. de Jong-Gierveld J, Kamphuis FH. The Development of a Rasch-Type Loneliness Scale. Appl Psychol Measure 1985;9:289-299.
37. de Jong-Gierveld J, van Tilburg T. Manual of the Loneliness Scale Amsterdam: Department of Social Research Methodology Free University Amsterdam, 1999.
38. van Sonderen E. Het meten van sociale steun met de Sociale Steun Lijst Handleiding (Assessing social support with the Social Support List Manual), Groningen, The Netherlands: Noordelijk Centrum voor gezondheidsvraagstukken, 1993.
39. WHOQOL Group. Development of the World Health Organization WHOQOL-BREF quality of life assessment. . Psychol Med 1998;28:551-558.
40. Skevington SM, Lotfy M, O'Connell KA. The World Health Organization's WHOQOL-BREF quality of life assessment: psychometric properties and results of the international field trial. A report from the WHOQOL group. Qual Life Res 2004;13:299-310.
41. Kempen GI, Suurmeijer TP. The development of a hierarchical polychotomous ADL-IADL scale for noninstitutionalized elders. Gerontologist 1990;30:497-502.
42. Suurmeijer TP, Doeglas DM, Moum T, et al. The Groningen Activity Restriction Scale for measuring disability: its utility in international comparisons. Am J Public Health 1994;84:1270-1273.

43. Ormel J, Rijsdijk FV, Sullivan M, et al. Temporal and reciprocal relationship between IADL/ADL disability and depressive symptoms in late life. J Gerontol B Psychol Sci Soc Sci 2002;57:P338-347.
44. Gill TM, Williams CS, Richardson ED, Tinetti ME. Impairments in physical performance and cognitive status as predisposing factors for functional dependence among nondisabled older persons. J Gerontol A Biol Sci Med Sci 1996;51:M283-288.
45. American Medical Association white paper on elderly health. Report of the Council on Scientific Affairs. Arch Intern Med 1990;150:2459-2472.
46. Alessi CA, Josephson KR, Harker JO, et al. The yield, reliability, and validity of a postal survey for screening community-dwelling older people. J Am Geriatr Soc 2003;51:194-202.
47. Hebert R, Bravo G, Korner-Bitensky N, Voyer L. Predictive validity of a postal questionnaire for screening community-dwelling elderly individuals at risk of functional decline. Age Ageing 1996;25:159-167.
48. Brody KK, Johnson RE, Douglas Ried L. Evaluation of a self-report screening instrument to predict frailty outcomes in aging populations. Gerontologist 1997;37:182-191.
49. Glass TA. Conjugating the "tenses" of function: discordance among hypothetical, experimental, and enacted function in older adults. Gerontologist 1998;38:101-112.
50. Gobbens RJJ, Van Assen MALM, Luijkx KG, et al. Determinants of frailty. J Am Med Dir Assoc 2010;accepted for publication:000-000.

## **Appendix** The Tilburg Frailty Indicator (TFI)*

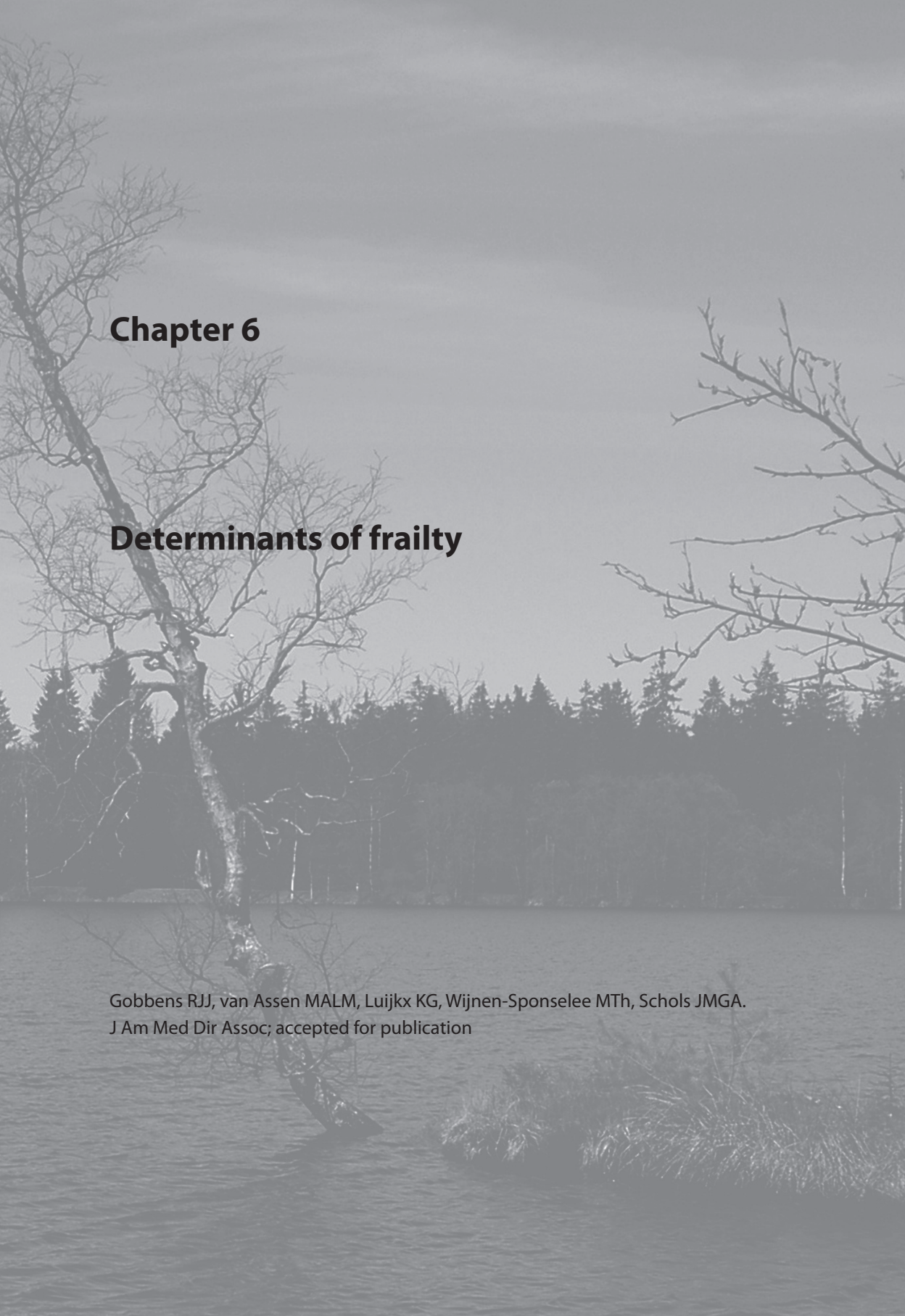
| **Part A Determinants of frailty** | |
|---|---|
| 1. Which sex are you? | 0 male 0 female |
| 2. What is your age? | ..... years |
| 3. What is your marital status? | 0 married/living with partner<br>0 unmarried<br>0 separated/divorced<br>0 widow/widower |
| 4. In which country were you born? | 0 The Netherlands<br>0 Former Dutch East Indies<br>0 Suriname<br>0 Netherlands Antilles<br>0 Turkey<br>0 Morocco<br>0 Other, namely..... |
| 5. What is the highest level of education you have completed? | 0 none or primary education<br>0 secondary education<br>0 higher professional or university education |
| 6. Which category indicates your net monthly household income? | 0 €600 or less<br>0 €601 - €900<br>0 €901 - €1200<br>0 €1201 - €1500<br>0 €1501 - €1800<br>0 €1801 - €2100<br>0 €2101 or more |
| 7. Overall, how healthy would you say your lifestyle is? | 0 healthy<br>0 not healthy, not unhealthy<br>0 unhealthy |
| 8. Do you have two or more diseases and/or chronic disorders? | 0 yes 0 no |
| 9. Have you experienced one or more of the following events during the past year? | |
| - the death of a loved one | 0 yes 0 no |
| - a serious illness yourself | 0 yes 0 no |
| - a serious illness in a loved one | 0 yes 0 no |
| - a divorce or ending of an important intimate relationship | 0 yes 0 no |
| - a traffic accident | 0 yes 0 no |
| - a crime | 0 yes 0 no |
| 10. Are you satisfied with your home living environment? | 0 yes 0 no |

| **Part B Components of frailty** | | | |
|---|---|---|---|
| **B1 Physical components** | | | |
| 11. Do you feel physically healthy? | 0 yes | | 0 no |
| 12. Have you lost a lot of weight recently without wishing to do so? *('a lot' is: 6 kg or more during the last six months, or 3 kg or more during the last month)* | 0 yes | | 0 no |
| Do you experience problems in your daily life due to: | | | |
| 13. .....difficulty in walking? | 0 yes | | 0 no |
| 14. .....difficulty maintaining your balance? | 0 yes | | 0 no |
| 15. .....poor hearing? | 0 yes | | 0 no |
| 16. .....poor vision? | 0 yes | | 0 no |
| 17. .....lack of strength in your hands? | 0 yes | | 0 no |
| 18. .....physical tiredness? | 0 yes | | 0 no |
| **B2 Psychological components** | | | |
| 19. Do you have problems with your memory? | 0 yes | 0 sometimes | 0 no |
| 20. Have you felt down during the last month? | 0 yes | 0 sometimes | 0 no |
| 21. Have you felt nervous or anxious during the last month? | 0 yes | 0 sometimes | 0 no |
| 22. Are you able to cope with problems well? | 0 yes | | 0 no |
| **B3 Social components** | | | |
| 23. Do you live alone? | 0 yes | | 0 no |
| 24. Do you sometimes miss having people around you? | 0 yes | 0 sometimes | 0 no |
| 25. Do you receive enough support from other people? | 0 yes | | 0 no |

* The TFI was translated into English using the method of back-translation.

## Scoring Part B Components of frailty (range: 0 – 15)

Question 11: yes = 0, no = 1
Question 12 – 18: no = 0, yes = 1
Question 19: no and sometimes = 0, yes = 1
Question 20 and 21: no = 0, yes and sometimes = 1
Question 22: yes = 0, no = 1
Question 23: no = 0, yes = 1
Question 24: no = 0, yes and sometimes = 1
Question 25: yes = 0, no = 1



# Chapter 6

# Determinants of frailty

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## ABSTRACT

*Objectives*
To determine which determinants predict frailty and domains of frailty (physical, psychological, social) in a community-dwelling sample of elderly persons.

*Design*
Cross-sectional

*Setting*
Community-based

*Participants*
A representative sample of 484 community-dwelling persons aged 75 years and older.

*Measurements*
The Tilburg Frailty Indicator (TFI), a self-report questionnaire, was used to collect information about determinants of frailty and to assess frailty and domains of frailty (physical, psychological, social).

*Results*
Results were obtained by regression and mediation analyses. The ten determinants explain about 35% of the variance of frailty. After controlling for other determinants, medium income, an unhealthy lifestyle and multimorbidity predicted frailty. The effects of other determinants differed across domains of frailty; age predicted physical frailty, life events predicted psychological frailty, whereas being a woman predicted social frailty since older women have a higher probability of living alone.

*Conclusion*
Our finding that the effect of the determinants of frailty differs across frailty domains suggests that it is essential to divide the concept of frailty into domains.

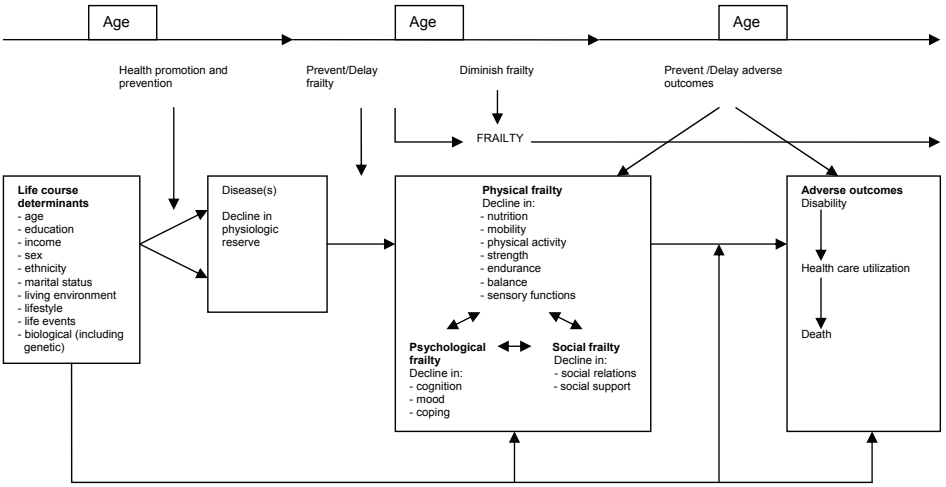
## INTRODUCTION

The scientific and clinical relevance of the concept of frailty has been increasing considerably for several years.[1] However, how frailty should be defined remains controversial.[2] Frailty is not synonymous with multimorbidity and disability; each confers specific care needs on older patients.[3] The concept of frailty provides a basis for moving away from organ and disease-based approaches towards a health-based, integrative approach.[4] Three recent reviews state that the social and psychological domains of frailty have been neglected.[5-7] To address this, the following integral conceptual definition of frailty is proposed: 'Frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social), which is caused by the influence of a range of variables and which increases the risk of adverse outcomes'.[8] Examples of adverse outcomes are hospitalisation, falls and mortality.[9]

Early stages of frailty are more common in community-dwelling older adults.[9, 10] For effective prevention and treatment of frailty in community-dwelling older people, frailty or 'at risk of frailty' must be recognised and interventions therefore need to start early.[11] Interventions can be used to delay the onset of frailty or reducing its adverse outcomes. The aim of this study was to determine which determinants predict frailty in a community-dwelling sample of older persons.

Numerous studies describe the relationship between frailty and life-course determinants such as socioeconomic and socio-demographic factors.[9, 12-17] Other influences on frailty are life events, such as death of a spouse,[18] and environmental factors, such as living environment.[15] Research has also shown that several diseases, such as heart failure, anaemia and diabetes, can lead to frailty.[9, 13, 18, 19] One recent review shows that having disease, whether measured as one specific disease or an accumulation of several diseases (multimorbidity), is an important determinant for the onset of frailty.[7] Another review concluded that very little work has been done on the causes of multimorbidity.[20] We assume that life-course determinants affect the occurrence of diseases. Consequently, an integral model of frailty[21] (see Figure 1) assumes that part of the effect of life course determinants on frailty is mediated by diseases. Mediation occurs if an independent variable (life-course determinants) has an effect on another independent variable (diseases), which in turn has an effect on the dependent variable (frailty).[22] Diseases is also called a mediator variable. These hypothesised relations are part of this integral model of frailty (see Figure 1). In this paper we only test that part of the model corresponding to the relationships between determinants of frailty, multimorbidity, and the three domains of frailty.

**Figure 1.** An Integral Conceptual Model of Frailty[21]




Many measurement instruments have been used to measure frailty in research. Some of these instruments focus exclusively on the physical domain of frailty, e.g. 'the phenotype of frailty',[9] the Clinical Global Impression of Change in Physical Frailty,[23] and the FRAIL scale.[24, 25] The Groningen Frailty Indicator (GFI),[26] the Edmonton Frail Scale (EFS),[27] and the Frailty Index from a Standardized Comprehensive Geriatric Assessment (FI-CGA)[28] also refer to the psychological and/or social domain of human functioning, but these instruments also refer to disability. Frailty and disability are two different but related concepts; according to the Geriatric Advisory Panel frailty is a state of predisability.[24, 25]

A user-friendly questionnaire for screening frail and 'at risk of frailty' community-dwelling older people, which includes only self-reported information, which explores the physical, psychological and social domain of human functioning and which does not refer to disability, did not exist. Therefore, such a measurement instrument, denoted as the Tilburg Frailty Indicator (TFI), was developed. The TFI is based on the integral model of frailty in Figure 1.[21] The TFI consists of two parts; part A on Determinants of frailty, and part B on Components of frailty. Previous research suggests that the TFI is a valid and reliable instrument for measuring frailty. The TFI has good test-retest reliability, good construct validity and good to excellent predictive validity for predicting the adverse outcomes disability, receiving personal care, receiving nursing and informal care, and mediocre validity for hospitalisation and general practitioner visits.[29]

## METHODS

### Study sample

In June 2008, the TFI was sent to a sample of 1,154 community-dwelling individuals aged 75 years and older, living in Roosendaal (the Netherlands), a town of 78,000 inhabitants. The sample was randomly drawn from the Roosendaal municipal register. A total of 42% of the addressees returned the questionnaire (n=484). The non-respondents did not differ from the respondents with respect to sex and average age. The review board of the Faculty of Behavioural and Social Sciences at Tilburg University approved the study, and informed consent for the collection and use of the information was obtained from all respondents.

### Measures

#### *Determinants*

Part A of the TFI includes one question on multimorbidity and nine questions on life-course determinants, namely sex, age, marital status, ethnicity, level of education, income, lifestyle, life events and living environment (see Appendix).

#### *Frailty*

Frailty was assessed using part B of the TFI (see Appendix). The components of the TFI were selected on the basis of previous research on frailty. Four of the eight components of the physical domain of frailty (physical frailty) refer to the phenotype of frailty.[9] These are: unexplained weight loss, difficulty in walking, strength in hands, and physical tiredness. Physical health,[12, 27] balance,[30-32] vision problems, and hearing problems[13, 33] were added to the physical domain.[21] The psychological domain of frailty (psychological frailty) consists of four components: cognition,[13, 27, 31, 34] depressive symptoms,[26, 27, 35, 36] anxiety,[26] and coping.[15, 33] Finally, the social domain of frailty (social frailty) includes living alone, social relations[15, 26] and social support.[12, 15, 27, 35] Several studies endorse the importance of the social domain in relation to the occurrence of adverse outcomes.[37, 38] Participation in social activities promotes successful aging and is associated with lower morbidity.[39] One study concluded that elderly people over age 75 who live alone are at great risk of losing not only their physical independence but also their lives.[40]

The score for frailty and the three domains of frailty were determined by adding the responses to the components belonging to each scale (see Appendix). The maximum score is 15 and represents the highest level of frailty.

### Analysis strategies

Some of the determinants overlap with a particular domain of frailty or with each other, and are therefore excluded from some analyses. The life event 'a serious illness yourself' is excluded because it overlaps with multimorbidity. Since 'living alone' is one of social frailty's constituent elements, 'marital status' is excluded in its prediction. Some other determinants are excluded because of their low frequency, as revealed by the initial descriptive statistical analysis.

Linear regression analyses are carried out to examine which determinants predict frailty scores, and scores on each of the frailty domains (physical, psychological, social) separately. We used two-tailed tests in all cases. The multiple regression analyses are hierarchical, consisting of two steps. In the first step multimorbidity is not included as a predictor, in the second it is. The first step enables us to estimate the effect of a life-course determinant on frailty, controlled for the effects of other life course determinants. The second step allows us to assess (i) whether multimorbidity contributes to the explanation of frailty, and (ii) to what extent the effect of other life-course determinants remains after controlling for the effect of multimorbidity. According to our model (see Figure 1), the effects of life-course determinants should decrease after controlling for multimorbidity.

Finally, logistic regression analysis is carried out to predict multimorbidity with the other life-course determinants, corresponding to the effect represented by the upper-left arrow in Figure 1. The combined results of the hierarchical and logistic regression analyses enable us to draw conclusions on which effect of life-course determinants on frailty is mediated by multimorbidity. An effect of a determinant on frailty is mediated if at the same time (i) the determinant affects frailty in the first step of the hierarchical regression analysis; (ii) this determinant affects multimorbidity in the logistic regression; and (iii) multimorbidity affects frailty in the second step of the hierarchical regression analysis.[22] The mediation is said to be complete if there is no effect of the determinant on frailty after controlling for multimorbidity in the second step of the hierarchical regression, and is said to be partial if the effect still exists.[22]

All statistical analyses were performed using SPSS version 17.0.

## RESULTS

### Participant characteristics

The participants' mean age was 80.3 years (SD = 3.8); 57.2% were women and 49.7% were married or cohabiting. Table 1 presents the descriptive statistics on all the determinants. Since the percentage of non-Dutch participants (3.3%) was very low, we excluded them from further analyses. Similarly, we excluded the life events 'end

of important relationship', 'traffic accident', 'crime', and dissatisfaction residence from further analyses because of low prevalence (5.0% or lower).

**Table 1.** Participant characteristics (N = 484), regarding part A of the TFI

| Characteristic | n (%) |
|---|---|
| Age, mean ± SD | 484 80.3 ± 3.8 |
| Sex, % of women | 277 (57.2) |
| Marital status | |
| Married or cohabiting | 240 (49.7) |
| Not married | 46 (9.5) |
| Divorced | 15 (3.1) |
| Widowed | 182 (37.7) |
| Ethnicity | |
| Dutch | 466 (96.7) |
| Other | 16 (3.3) |
| Education | |
| None or primary | 181 (37.7) |
| Secondary | 225 (46.9) |
| Higher | 74 (15.4) |
| Income | |
| €600 or less | 12 (2.7) |
| €601 - €900 | 71 (16.1) |
| €901 - €1200 | 107 (24.2) |
| €1201 - €1500 | 57 (12.9) |
| €1501 - €1800 | 68 (15.4) |
| €1801 - €2100 | 49 (11.1) |
| €2101 or more | 78 (17.6) |
| Lifestyle | |
| Healthy | 354 (73.4) |
| Not healthy, not unhealthy | 116 (24.1) |
| Unhealthy | 12 (2.5) |
| Multimorbidity, % Yes | 233 (48.7) |
| Life events, % Yes | |
| Death loved one | 158 (32.8) |
| Serious illness | 68 (14.2) |
| Serious illness loved one | 151 (31.4) |
| End of important relationship | 24 (5.0) |
| Traffic accident | 9 (1.9) |
| Crime | 3 (0.6) |
| Satisfaction residence, % Yes | 463 (96.5) |

Table 2 presents the frequencies of answers on the TFI frailty components, both in total and by sex. On the majority of components women scored higher on frailty. This is also reflected by significantly higher scores for women on the physical domain (2.25 vs. 2.68, $t(443) = -2.17$, $p = .03$), social domain (.96 vs. 1.44, $t(460) = -5.89$, $p < .001$), and frailty (3.99 vs. 4.92, $t(437) = -3.37$, $p < .001$). The difference on the psychological domain was not statistically significant for men and women (.75 vs. .82, $t(461) = -.82$, $p = .42$).

**Table 2.** Frequencies of the answers to TFI frailty components, in total and by sex, in relation to part B of the TFI

| | Reporting problem or difficulty | | | |
|---|---|---|---|---|
| **Frailty components** | **Males (n = 207) n (%)** | **Females (n = 277) n (%)** | **All (n = 484) n (%)** | ***P*-value*** |
| **Physical domain** | | | | |
| Physical health | 54 (26.3) | 86 (31.6) | 140 (29.4) | .210 |
| Unexplained weight loss | 13 ( 6.3) | 24 (8.7) | 37 (7.7) | .323 |
| Difficulty in walking | 85 (41.1) | 147 (53.3) | 232 (48.0) | .008 |
| Difficulty maintaining balance | 68 (33.3) | 100 (36.4) | 168 (35.1) | .492 |
| Poor hearing | 89 (43.2) | 85 (31.0) | 174 (36.3) | .006 |
| Poor vision | 41 (20.1) | 60 (21.9) | 101 (21.1) | .634 |
| Strength in hands | 48 (23.2) | 119 (43.0) | 167 (34.5) | <.001 |
| Physical tiredness | 74 (35.9) | 145 (52.3) | 219 (45.3) | <.001 |
| **Psychological domain** | | | | |
| Problems with memory | 27 (13.0) | 20 (7.2) | 47 (9.7) | .033 |
| Feeling down | 74 (35.8) | 121 (43.8) | 195 (40.4) | .073 |
| Feeling nervous or anxious | 53 (25.7) | 96 (34.7) | 149 (30.8) | .036 |
| Able to cope with problems | 27 (13.3) | 44 (16.1) | 71 (14.9) | .403 |
| **Social domain** | | | | |
| Living alone | 58 (28.0) | 174 (62.8) | 232 (47.9) | <.001 |
| Social relations | 106 (51.2) | 179 (64.9) | 285 (59.0) | .003 |
| Social support | 34 (16.6) | 45 (16.3) | 79 (16.4) | .934 |

* Two-tailed $\chi^2$ tests of independence

## Regression analyses

First bivariate regressions were run on frailty in order to decide how to incorporate the determinants of frailty in the multiple regression analyses. The effects of age, education

and lifestyle were linear, whereas the effect of income was both linear and quadratic. These determinants were accordingly entered as such in the analyses. The variable 'income' was centred by subtracting the average score on income for all participants. Since frailty for participants who were divorced, not married, or widowed was equal to but different from those who cohabited or were married, a dummy variable 'cohabit' was created ('1' married or cohabiting, '0' rest). The two life events 'death loved one' and 'serious illness loved one' were combined into one dummy 'life events' ('1' if both life events had occurred, '0' rest), since frailty was only negatively affected when both events occurred. Finally, a dummy 'sex' was created ('1' for women, '0' for men).

Table 3 presents the effects of the determinants on frailty and their significance in the two steps of the hierarchical regression analyses. The first step reveals that women were on average frailer than men, and that greater age and an unhealthier lifestyle were both associated with a higher degree of frailty, whereas income had both a negative linear and quadratic effect, after controlling for the effects of other life-course determinants. The effects of income imply that frailty was lowest for respondents with the highest monthly income (higher than €1,800), medium for those with the lowest income (smaller than €600) and income in interval €1,501-€1,800, and highest for those with a medium income, between €601 and €1,500. Education and life events had no effect. About 25% of frailty was explained by the determinants. Multimorbidity explained an additional 10.5% of the variance of frailty, which represents a medium effect size.[41] As expected, multimorbidity was associated with a greater degree of frailty. After adding multimorbidity as a predictor in the second step, the effects of sex and age on frailty were no longer significant, whereas the effects of income and lifestyle remained significant.

As regards physical frailty, age and unhealthy lifestyle were associated with greater frailty, whereas income had a negative linear effect on frailty. These effects persisted after controlling for multimorbidity. The model without the predictor 'multimorbidity' explained 22% of physical frailty. Multimorbidity explained an additional 12.6% of the variance, which represents a medium effect size.

Psychological frailty was associated with an unhealthy lifestyle and serious illness or death of a loved one, both before and after controlling for multimorbidity. The effects of income were similar to those on other domains of frailty, but were only marginally significant. Multimorbidity itself was also associated with a higher score on frailty. About 11% was explained by the life-course determinants. Multimorbidity explained an additional 2.4% of the variance of frailty, representing a small effect size.

Social frailty was lower for women, and associated with an unhealthy lifestyle, and nonlinearly associated with income. Table 2 reveals that the effect of sex was due to the fact that women lived alone more often than men (63% vs. 28%). Social frailty was highest for those having an income between €901 and €1,800, and lower for both the lowest and highest income categories. About 15% of social frailty was explained

**Table 3.** Results of hierarchical regression analyses on frailty*

| | Total Frailty | | Physical | | Psychological | | Social | |
|---|---|---|---|---|---|---|---|---|
| Determinant | Step 1 (*P*-value) | Step 2 (*P*-value) | Step 1 (*P*-value) | Step 2 (*P*-value) | Step 1 (*P*-value) | Step 2 (*P*-value) | Step 1 (*P*-value) | Step 2 (*P*-value) |
| Sex | .73 (.006) | .41 (.105) | .30 (.144) | .00 (.992) | .03 (.749) | -.02 (.823) | .46 (<.001) | .47 (<.001) |
| Age | .07 (.042) | .06 (.067) | .07 (.007) | .06 (.013) | -.02 (.193) | -.02 (.157) | .02 (.165) | .02 (.170) |
| Cohabit | | | -.06 (.758) | -.12 (.515) | .14 (.147) | .13 (.173) | | |
| Education | .18 (.397) | .00 (.988) | .18 (.254) | .03 (.840) | -.02 (.193) | -.07 (.367) | -.02 (.785) | -.02 (.746) |
| Income | | | | | | | | |
| linear | -.30 (<.001) | -.24 (.003) | -.19 (.002) | -.13 (.015) | -.05 (.057) | -.04 (.119) | -.04 (.119) | -.04 (.134) |
| quadratic | -.12 (.009) | -.12 (.007) | -.02 (.468) | -.02 (.546) | -.03 (.054) | -.03 (.059) | -.07 (<.001) | -.07 (<.001) |
| Lifestyle | 2.22 (< .001) | 1.77 (< .001) | 1.60 (<.001) | 1.21 (<.001) | .45 (<.001) | .38 (<.001) | .21 (.013) | .20 (.021) |
| Life events | .62 (.076) | .56 (.086) | .26 (.315) | .21 (.358) | .33 (.007) | .31 (.009) | .04 (.729) | .04 (.740) |
| Multimorbidity | | 1.97 (<.001) | | 1.64 (<.001) | | .30 (.001) | | .04 (.632) |
| R2† | .251 (< .001) | .356 (<.001) | .220 (< .001) | .361 (<.001) | .114 (<.001) | .138 (.001) | .150 (<.001) | .151 (<.001) |

* All reported *P*-values are two-tailed

† *P*-values are of omnibus test of hypothesis that the model does not explain variance of frailty.

by the life-course determinants. Adding multimorbidity to the model neither increased the fit of the model nor affected the estimates of the effects of the life-course determinants.

**Logistic regression analysis**

The model with all life-course determinants included significantly predicted multimorbidity ($\chi^2(8) = 46.4$, $p < .001$). After controlling for the other determinants, income had a negative linear effect (B = –.14, Wald $z = 4.02$, $p = .05$), women scored higher (B = .80, Wald $z = 11.66$, $p < .001$), and both education (B = .38, Wald $z = 4.56$, $p = .03$) and unhealthy lifestyle (B = 1.06, Wald $z = 22.49$, $p < .001$) had a positive effect on multimorbidity. Marital status, life events and age had no effect after controlling for the other variables.

**Mediation**

Mediation does not occur for social frailty since multimorbidity does not affect social frailty. Effects of life-course determinants on frailty (domains) that satisfy all three requirements of mediation are the effect of sex, income, and lifestyle on frailty, and the effect of income and lifestyle on the physical and psychological domain of frailty. All these effects became weaker after controlling for multimorbidity, meaning that part of their effects operate via multimorbidity (partial mediation). Specifically, women and elderly persons with an unhealthier lifestyle and low income scored higher on frailty, partly because these persons had more multimorbidity on average, and multimorbidity is associated with a higher degree of frailty.

## DISCUSSION

Previous research has concluded that there is a need for a broader conceptual and operational definition to studying frailty,[5-7] which excludes disability.[25] Based on an integral model of frailty, which incorporates life-course determinants, diseases (multimorbidity) and frailty, we developed an instrument, the Tilburg Frailty Indicator (TFI). In the present study, we used the TFI to assess frailty and to ascertain which determinants predict frailty in a representative sample of persons aged 75 years and older, living in a Dutch city.

In general the results corroborated our model as presented in Figure 1. The relationship between frailty and diseases is poorly understood.[4] We found that multimorbidity explains a substantial part of the variance of frailty, and the nine life-course determinants also explained a substantial part of the variance of frailty. Multimorbidity partly mediated the effects of life-course determinants on frailty,

physical frailty and psychological frailty, but not social frailty. Interestingly, the domains were uniquely affected by some determinants: age, life events and sex only affected physical, psychological and social frailty, respectively. Two other striking results were the nonlinear effect of income and the large effect of unhealthy lifestyle.

The present study showed that women are frailer than men. This finding is compatible with other studies reporting sex-based differences in frailty.[9, 17, 33] According to Walston and Fried, there is evidence that lower levels of activity and lower caloric intake in women as compared to men influence the higher prevalence of physical frailty in women.[42] These researchers also suggested that frailty is more frequent in women because men have higher baseline levels of muscle mass and higher levels of neuroendocrine and hormonal factors that may protect them from reaching physical frailty.[42] However, the results of our regression analyses suggest that the sex-based difference in physical frailty disappears after controlling for age. Interestingly, women are on average more frail than men, including after controlling for age, due to the higher social frailty of women. The finding of lower scores for women on social frailty is supported by other studies. In both the Canadian Study of Health and Aging and the National Population Health Survey, women had higher social vulnerability frailty scores than men.[43] The effect in our study was due to the fact that women lived alone more often than men, because men die earlier on average and women are on average younger than their partner.

The effect of income on frailty was nonlinear. The frailty score was highest for people with a medium income. This finding is supported by the Longitudinal Aging Study Amsterdam, which reported that physical functioning decreased more for people with a medium income than for people with a low or a high income.[44] Additional research is needed to explain this unexpected relationship between frailty and income.

We found a large effect of unhealthy lifestyle on all frailty domains. An explanation for this finding is a self-report or attribution bias by the respondents; if the respondent feels bad, (s)he might reason that this is because (s)he has a poor lifestyle, which inflates the 'effect' of unhealthy lifestyle on frailty. However, using our data we also found that the self-report question on unhealthy lifestyle showed the expected negative correlation with independent measures of lifestyle, such eating fruit and vegetables, and correlated positively with smoking. Moreover, our finding that lifestyle is a major contributor to frailty concurs with findings of other researchers.[18, 45]

The finding that the domains are differently and uniquely affected by the determinants and by multimorbidity exemplifies the importance of distinguishing between the three domains. Social frailty is the only domain not affected by multimorbidity. Age predicted physical frailty, which is in agreement with one study

that found that age correlates with functional impairment, and increasing health problems.[46] As expected, psychological frailty was affected by life events. Finally, as discussed above, sex predicts social frailty since women more often live alone than men.

In this study frailty was treated as a continuous variable in our analyses; we examined how differences in frailty were associated with life-course determinants and multimorbidity. We did not dichotomise frailty scores since this would have resulted in a loss of information on differences in frailty, and hence would have interfered with answering our research question. Nevertheless, a natural question to ask is how many elderly persons aged 75 years and older can be considered frail. In a previous study it was concluded that a cutpoint of 5 on the TFI total score was optimal in distinguishing frail elderly from those who are not frail.[29] Applying this cutpoint to the data in the present study led to 47,1% of the sample being identified as frail. Another frailty measurement instrument, The Groningen Frailty Indicator, which is also a self-report measure, classified 32% of community-dwelling elderly (65 years and older) as frail.[26]

Some limitations of our study must be noted. The response rate to the questionnaire was 42%. This is lower than in other studies,[47] probably because those studies used a second mailing and we did not. The non-respondents could potentially represent a higher score on the TFI, which may have caused an underrepresentation of severely frail respondents. An additional limitation is that the cross-sectional nature of this study does not allow strict cause-effect interpretations of the associations between life-course determinants, multimorbidity, and frailty. For instance, the effect of some life-course determinants on multimorbidity such as living environment and lifestyle, might be reciprocal. A longitudinal study of the change in the score on frailty in relation to the changes in life-course determinants and multimorbidity could be used to address this question. Another limitation is that the TFI is a self-report measure, and does not include performance-based tests. The frailty domain scores of the TFI, however, correlate as expected with these performance-based measures, which supports the construct validity of the frailty domains of the TFI.[29]

In summary, our finding that the effect of both life-course determinants and multimorbidity on frailty differs across domains of frailty suggests that it is worthwhile distinguishing three domains of frailty (physical, psychological, social). The TFI seems to be a suitable measurement instrument to achieve this aim.

## REFERENCES


1. Bergman H, Béland F, Karunananthan S, et al. English translation of article published in 'Gérontologie et société'. Dévelopment d'un cadre de travail pour comprendre et étudier la fragilité. Gérontologie et société 2004;109:15-29.
2. Fisher AL. Just what defines frailty? J Am Geriatr Soc 2005;53:2229-2230.
3. 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;59:255-263.
4. 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 2007;62:731-737.
5. Hogan DB, MacKnight C, Bergman H. Models, definitions, and criteria of frailty. Aging Clin Exp Res 2003;15:1-29.
6. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003;44:58-68.
7. Levers MJ, Estabrooks CA, Ross Kerr JC. Factors contributing to frailty: literature review. J Adv Nurs 2006;56:282-291.
8. Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. In search of an integral conceptual definition of frailty: opinions of Experts. J Am Med Dir Assoc 2010;accepted for publication:000-000.
9. 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:M146-156.
10. Gill TM, Gahbauer EA, Allore HG, Han L. Transitions between frailty states among community-living older persons. Arch Intern Med 2006;166:418-423.
11. Strandberg TE, Pitkala KH. Frailty in elderly people. Lancet 2007;369:1328-1329.
12. Rockwood K, Fox RA, Stolee P, et al. Frailty in elderly people: an evolving concept. Cmaj 1994;150:489-495.
13. Strawbridge WJ, Shema SJ, Balfour JL, et al. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci 1998;53:S9-16.
14. Morley JE, Perry HM, 3rd, Miller DK. Editorial: Something about frailty. J Gerontol A Biol Sci Med Sci 2002;57:M698-704.
15. Raphael D, Cava M, Brown I, et al. Frailty: a public health perspective. Can J Public Health 1995;86:224-227.
16. Nourhashémi F, Andrieu S, Gillette-Guyonnet S, et al. Instrumental activities of daily living as a potential marker of frailty: a study of 7364 community-dwelling elderly women (the EPIDOS study). J Gerontol A Biol Sci Med Sci 2001;56:M448-453.
17. Woo J, Goggins W, Sham A, Ho SC. Social determinants of frailty. Gerontology 2005;51:402-408.
18. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-847.
19. Buchner DM, Wagner EH. Preventing frail health. Clin Geriatr Med 1992;8:1-17.
20. Gijsen R, Hoeymans N, Schellevis FG, et al. Causes and consequences of comorbidity: a review. J Clin Epidemiol 2001;54:661-674.
21. Gobbens RJ, Luijkx KG, Wijnen-Sponselee MT, Schols JM. Towards an integral conceptual model of frailty. J Nutr Health Aging 2010;accepted for publication:000-000.
22. Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. Journal of Personality and Social Psychology 1986;51:1173-1182.

23. 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;52:1560-1566.
24. Abellan van Kan G, Rolland YM, Morley JE, Vellas B. Frailty: toward a clinical definition. J Am Med Dir Assoc 2008;9:71-72.
25. Abellan van Kan A, Rolland Y, Bergman H, et al. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging 2008;12:29-37.
26. Schuurmans H, Steverink N, Lindenberg S, et al. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci 2004;59:M962-965.
27. Rolfson DB, Majumdar SR, Tsuyuki RT, et al. Validity and reliability of the Edmonton Frail Scale. Age Ageing 2006;35:526-529.
28. Jones DM, Song X, Rockwood K. Operationalizing a frailty index from a standardized comprehensive geriatric assessment. J Am Geriatr Soc 2004;52:1929-1933.
29. Gobbens RJJ, van Assen MALM, Luijkx KG, et al. The Tilburg Frailty Indicator: psychometric properties. J Am Med Dir Assoc 2010;accepted for publication:000-000.
30. Brown M, Sinacore DR, Binder EF, Kohrt WM. Physical and performance measures for the identification of mild to moderate frailty. J Gerontol A Biol Sci Med Sci 2000;55:M350-355.
31. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing 1997;26:315-318.
32. Ory MG, Schechtman KB, Miller JP, et al. Frailty and injuries in later life: the FICSIT trials. J Am Geriatr Soc 1993;41:283-296.
33. Puts MT, Lips P, Deeg DJ. Sex differences in the risk of frailty for mortality independent of disability and chronic diseases. J Am Geriatr Soc 2005;53:40-47.
34. Rockwood K, Stadnyk K, MacKnight C, et al. A brief clinical instrument to classify frailty in elderly people. Lancet 1999;353:205-206.
35. Winograd CH, Gerety MB, Chung M, et al. Screening for frailty: criteria and predictors of outcomes. J Am Geriatr Soc 1991;39:778-784.
36. Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. J Am Geriatr Soc 1991;39:46-52.
37. Imuta H, Yasumura S, Abe H, Fukao A. The prevalence and psychosocial characteristics of the frail elderly in Japan: a community-based study. Aging (Milano) 2001;13:443-453.
38. Schulz R, Williamson GM. Psychosocial and behavioral dimensions of physical frailty. J Gerontol 1993;48 Spec No:39-43.
39. Strawbridge WJ, Cohen RD, Shema SJ, Kaplan GA. Successful aging: predictors and associated activities. Am J Epidemiol 1996;144:135-141.
40. Lichtenberg PA, MacNeill SE, Lysack CL, et al. Predicting discharge and long term outcome patterns for frail elders. Rehabilitation Psychology 2003;48:37-43.
41. Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd edition ed: Lawrence Erlbaum Assoc Inc, 1988.
42. Walston J, Fried LP. Frailty and the older man. Med Clin North Am 1999;83:1173-1194.
43. Andrew MK, Mitnitski AB, Rockwood K. Social vulnerability, frailty and mortality in elderly people. PLoS ONE 2008;3:e2232.
44. Koster A, Bosma H, Broese van Groenou MI, et al. Explanations of socioeconomic differences in changes in physical function in older adults: results from the Longitudinal Aging Study Amsterdam. BMC Public Health 2006;6:244.
45. Bortz WM, 2nd. A conceptual framework of frailty: a review. J Gerontol A Biol Sci Med Sci 2002;57:M283-288.

46. Brody KK, Johnson RE, Douglas Ried L. Evaluation of a self-report screening instrument to predict frailty outcomes in aging populations. Gerontologist 1997;37:182-191.
47. Alessi CA, Josephson KR, Harker JO, et al. The yield, reliability, and validity of a postal survey for screening community-dwelling older people. J Am Geriatr Soc 2003;51:194-202.

## **Appendix** The Tilburg Frailty Indicator (TFI)*

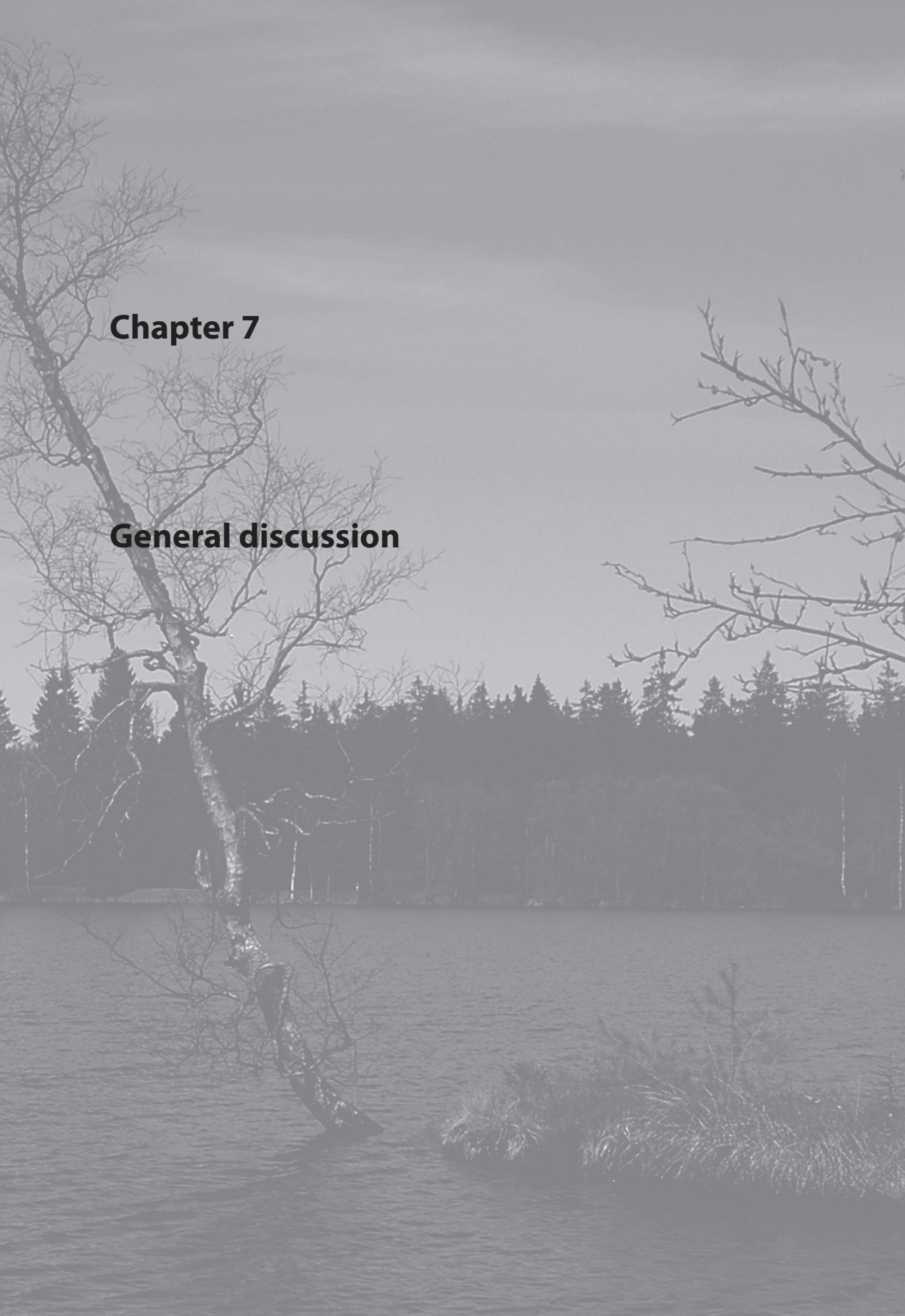
| **Part A Determinants of frailty** | |
|---|---|
| 1. Which sex are you? | 0 male 0 female |
| 2. What is your age? | ..... years |
| 3. What is your marital status? | 0 married/living with partner<br>0 unmarried<br>0 separated/divorced<br>0 widow/widower |
| 4. In which country were you born? | 0 The Netherlands<br>0 Former Dutch East Indies<br>0 Suriname<br>0 Netherlands Antilles<br>0 Turkey<br>0 Morocco<br>0 Other, namely..... |
| 5. What is the highest level of education you have completed? | 0 none or primary education<br>0 secondary education<br>0 higher professional or university education |
| 6. Which category indicates your net monthly household income? | 0 €600 or less<br>0 €601 - €900<br>0 €901 - €1200<br>0 €1201 - €1500<br>0 €1501 - €1800<br>0 €1801 - €2100<br>0 €2101 or more |
| 7. Overall, how healthy would you say your lifestyle is? | 0 healthy<br>0 not healthy, not unhealthy<br>0 unhealthy |
| 8. Do you have two or more diseases and/or chronic disorders? | 0 yes 0 no |
| 9. Have you experienced one or more of the following events during the past year? | |
| - the death of a loved one | 0 yes 0 no |
| - a serious illness yourself | 0 yes 0 no |
| - a serious illness in a loved one | 0 yes 0 no |
| - a divorce or ending of an important intimate relationship | 0 yes 0 no |
| - a traffic accident | 0 yes 0 no |
| - a crime | 0 yes 0 no |
| 10. Are you satisfied with your home living environment? | 0 yes 0 no |

| **Part B Components of frailty** | | | |
|---|---|---|---|
| **B1 Physical components** | | | |
| 11. Do you feel physically healthy? | 0 yes | | 0 no |
| 12. Have you lost a lot of weight recently without wishing to do so? *('a lot' is: 6 kg or more during the last six months, or 3 kg or more during the last month)* | 0 yes | | 0 no |
| Do you experience problems in your daily life due to: | | | |
| 13. .....difficulty in walking? | 0 yes | | 0 no |
| 14. .....difficulty maintaining your balance? | 0 yes | | 0 no |
| 15. .....poor hearing? | 0 yes | | 0 no |
| 16. .....poor vision? | 0 yes | | 0 no |
| 17. .....lack of strength in your hands? | 0 yes | | 0 no |
| 18. .....physical tiredness? | 0 yes | | 0 no |
| **B2 Psychological components** | | | |
| 19. Do you have problems with your memory? | 0 yes | 0 sometimes | 0 no |
| 20. Have you felt down during the last month? | 0 yes | 0 sometimes | 0 no |
| 21. Have you felt nervous or anxious during the last month? | 0 yes | 0 sometimes | 0 no |
| 22. Are you able to cope with problems well? | 0 yes | | 0 no |
| **B3 Social components** | | | |
| 23. Do you live alone? | 0 yes | | 0 no |
| 24. Do you sometimes miss having people around you? | 0 yes | 0 sometimes | 0 no |
| 25. Do you receive enough support from other people? | 0 yes | | 0 no |

* The TFI was translated into English using the method of back-translation.

## Scoring Part B Components of frailty (range: 0 – 15)

Question 11: yes = 0, no = 1
Question 12 – 18: no = 0, yes = 1
Question 19: no and sometimes = 0, yes = 1
Question 20 and 21: no = 0, yes and sometimes = 1
Question 22: yes = 0, no = 1
Question 23: no = 0, yes = 1
Question 24: no = 0, yes and sometimes = 1
Question 25: yes = 0, no = 1



# Chapter 7

# General discussion

## INTRODUCTION

Over the next forty years, an increasing number of people will grow old and see their life expectancy increase.[1] It is therefore likely that the number of frail elderly persons will also increase. Preventive strategies and targeted services for frail elderly people require identification of this risk group, preferably before the onset of adverse outcomes such as disability and health care utilisation (hospitalisation, institutionalisation).[2] (The risk of) frailty needs to be detected early so that (preventive) interventions can be employed to delay the onset of frailty or prevent its further progression. Interventions can even facilitate transition to a non-frail status.[3]

Community health care professionals, such as general practitioners, community nurses, nurse practitioners and social workers will be increasingly confronted with frail older people. They therefore need a better understanding of frailty, in terms of conceptual and operational definitions of frailty and the measurement of frailty, so that they are able to identify individuals who are in the early stages of frailty or who are already frail. Frailty provides a conceptual basis for moving away from organ and disease-based approaches towards an integral approach[4] that is focused on physical, psychological and social problems in older people, and the relationships between those problems.

The foregoing led to the following main research question that is addressed in this thesis: "How can frailty be defined and measured as a means of identifying frail community-dwelling older people with regard to integral human functioning?" The main research aim was to develop a measurement instrument which can be used for the identification of frail community-dwelling older people.

This chapter summarises the main findings and relates them to existing literature. In addition, the research limitations of our study are discussed, as well as the difficulties experienced in this study. Recommendations for future research on frailty are also presented. Finally, the practical implications are considered. In this regard, special attention is given to the way in which the TFI sets itself apart from other frailty measurement instruments.

## MAIN FINDINGS

*Literature search*

Chapter 2 dealt with the conceptualisation and operationalisation of the term 'frailty' by answering the following sub-questions: (1) Which conceptual and operational definitions of frailty have been used in the literature? and (2) Which definitions are most appropriate for identifying frail community-dwelling older people?

A literature search was performed on conceptual and operational definitions of frailty. This search showed that the majority of definitions are heavily focused on physical diminution in elderly persons. Together with other reseachers,[5] we fear that if a definition focuses only on physical components of frailty, there is a risk that attention for the individual as a whole will be jeopardised. This could potentially lead to fragmentation of care and consequently to a decrease in the quality of life of frail older people.

Our literature search also showed that five criteria should be taken into account to determine the success of a definition of frailty. A successful definition reflects a multidimensional view,[5, 6] makes clear the dynamic nature of the concept,[7] does not include disease, comorbidity or disability,[8] and meets the criterion of practicability.[9] Practicability refers to the inclusion of components at which (preventive) interventions can be targeted.[9] Furthermore, a successful definition predicts adverse outcomes such as health care utilisation (hospitalisation, institutionalisation) and death.[10] It should be emphasised that the criterion 'a multidimensional view' is very important, because the consequence for the identification of frail elderly is the greatest here. Ultimately, this criterion determines which older people are frail or non-frail. None of the current conceptual and operational definitions encountered in the literature met all these criteria.

In summary, the literature review made clear that no researchers have to date developed a conceptual and operational definition or a conceptual model of frailty which reflect an integral approach to human functioning. It was this discovery which prompted us to embark on the development of an integral conceptual definition of frailty, and subsequently of an operational definition and a conceptual model.

*Consultation of experts*

Chapter 3 and 4 deal with the consultation of experts, both during two expert meetings and via a written questionnaire. The following sub-questions were answered: (3) Which existing conceptual definition of frailty places most emphasis on the integral functioning of older people?; (4) Which components of existing operational definitions of frailty should be included in an operational definition of frailty?; (5) What constitutes a scientifically sound and practicably relevant integral model of frailty?

In Chapter 3 sub-question (3) was answered: Which existing conceptual definition of frailty places most emphasis on the integral functioning of older people? Consensus-building is one approach that can be used to arrive at a definition of a concept.[10, 11] In order to contribute to the consensus-building for a conceptual definition of frailty, experts in the field of frailty (N = 20) were consulted. The consultation started from two basic premises, namely the multidimensional nature of frailty[5, 6, 12, 13] and the

positioning of frailty on a continuum;[9, 14] highlighting frailty as a dynamic concept.[7, 15] Frailty can be seen as a relative state according to this view, which can change over time.[5] It must be possible to intervene so that frailty is delayed, reduced or prevented from becoming worse.[16] During one of the expert meetings (in Dallas in the United States) the experts added a third premise, namely that frailty should be distinguished from disability.

The experts were asked to rank eleven existing conceptual definitions of frailty in terms of the three premises formulated above. The conceptual definition by Schuurmans et al.[17] achieved the highest score. This definition is as follows: Frailty is a loss of resources in several domains of functioning, which leads to a declining reserve capacity for dealing with stressors'. This definition was followed in turn by the conceptual definitions by Strawbridge et al.,[12] Campbell and Buchner,[18] and Fried et al.[19] The definition by Schuurmans et al.[17] does not specifically state which domains of functioning are involved, and does not describe the relationship with a diversity of adverse outcomes. Using this approach, we formulated a new conceptual definition of frailty. The new definition is as follows: "Frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social), which is caused by the influence of a range of variables and which increases the risk of adverse outcomes".

In Chapter 4 the following sub-question was answered: (4) Which components of existing operational definitions of frailty should be included in an integral operational definition of frailty? For the concept of frailty to be of practical use, its theoretical conceptualisation must be capable of being translated into an operational definition.[10] In order to make a contribution to the consensus-building for a multidimensional operational definition of frailty, the consulted experts were also presented (during the two expert meetings) with components derived from operational definitions of frailty.

There was consensus among the experts on the inclusion of the following seven components in the operational definition of frailty: strength, balance, nutrition, endurance, mobility, physical activity and cognition. Additionally, supported by results from the literature search and the opinions of some experts, the component 'sensory functions' (hearing, vision) was added to the physical domain; four components belonging to the psychological and social domain were added, namely mood (depressive symptoms, anxiety), coping, social relations and social support.

Sub-question (5) was also answered in Chapter 4: What constitutes a scientifically sound and practicable relevant integral model of frailty? Based on our conceptual and operational definition of frailty, we developed an integral conceptual model of frailty. This model expresses the relationships between frailty and adverse outcomes (disability, health care utilisation and death). Disability increases the risk of

health care utilisation; the need for home help,[20] hospitalisation,[20,21] institutionalisation[22] and premature death.[23]

Our integral model of frailty is based on the model of Bergman et al. "A working framework of development",[24] which is characterised by a life-course approach. The first main difference between the two models is that the new operational definition of frailty lies at the heart of our integral model of frailty. It does not refer exclusively to physical frailty, but also takes in psychological frailty and social frailty. The second main difference between the two frailty models relates to the specification of the life-course determinants described in our new frailty model. These determinants, selected on the basis of a literature search, comprise socio-economic factors (such as education level and income), socio-demographic factors (such as age, sex, civil status, ethnicity),[12, 16, 19, 25] lifestyle,[26, 27] life events,[27] living environment[9] and genetic factors.[19, 26] Disease(s) has a prominent place in our model; a literature review suggested that having one or more diseases is an important determinant for the onset of frailty.[28]

*The Tilburg Frailty Indicator (TFI)*

In line with our integral conceptual model of frailty, a new instrument for measuring frailty was developed, the Tilburg Frailty Indicator (TFI). The TFI is a user-friendly questionnaire for screening frail community-dwelling older people, which includes only self-reported information. The TFI consists of two parts, part A and part B. Part A contains ten questions on determinants of frailty; one question on multimorbidity and nine questions on life-course determinants of frailty, namely sex, age, marital status, ethnicity, level of education, income, lifestyle, life events and living environment.

Part B contains fifteen questions on components of frailty. In fact part B assesses the presence of frailty. The components referring to physical frailty are: unexplained weight loss,[19] difficulty in walking,[19] strength in hands,[19] physical tiredness,[19] physical health,[25, 29] balance,[18, 30, 31] vision and hearing problems.[12, 13] Cognition,[6, 12, 18, 29] depressive symptoms,[17, 29, 32, 33] anxiety,[17] and coping[9, 13] refer to psychological frailty. Finally, social frailty includes the components living alone, social relations[9, 17] and social support.[9, 25, 29, 32]

Eleven items from the TFI have two response categories "yes" and "no"; four items have three response categories "yes", "sometimes", and "no"; these items were dichotomised (see Appendix). The score for frailty is determined by adding the responses to the items. The maximum score is 15; this score represents the highest level of frailty.

*Psychometric properties of the TFI*

The answer to sub-question (6) was presented in Chapter 5. This question was: What are the psychometric properties of the Tilburg Frailty Indicator (TFI), which is based upon an integral model of frailty? Our study was conducted on two representative samples of Dutch community-dwelling older people (N = 245; N = 234) and assessed the reliability and validity of part B of the TFI (components of frailty). The results showed that the TFI is a reliable and valid instrument for measuring frailty.

The test-retest reliability for a one-year period was good: .79 for frailty, .78 for the physical domain, .67 for the psychological domain and .76 for the social domain. The internal consistency reliability of the TFI was .73.

The face and content validity of the TFI were satisfactory. The construct validity was good; the fifteen single TFI components correlated as expected with established measures, and the three frailty domains (physical, psychological, social) correlated as expected with other scales used, demonstrating convergent and divergent validity of the domains. The predictive validity of the TFI was good for quality of life, measured by the WHOQOL-BREF, and for the adverse outcomes disability and receiving personal care, nursing and informal care. We chose 5 as the cutpoint of the TFI, since at this point the sensitivity was good and specificity was acceptable for the aforementioned adverse outcomes. Using this cutpoint, 47.1% of our respondents (community-dwelling persons aged 75 years and older) were identified as frail.

*Determinants of frailty*

Finally, Chapter 6 attempted to answer the last sub-question (7): What are the determinants of frailty in community-dwelling older people as measured using the TFI? We used the TFI to determine which life-course determinants predict frailty and domains of frailty (physical, psychological, social) in a community-dwelling sample of elderly persons (N = 484), and whether these effects were mediated by multimorbidity. This study showed that the nine life-course determinants explained 25% of the variance of frailty, while multimorbidity explained an additional 10.5%. Multimorbidity partly mediated the effects of life-course determinants on frailty, physical frailty and psychological frailty, but not social frailty. The frailty domains were also uniquely affected by some determinants: age predicted physical frailty, life events predicted psychological frailty, and sex predicted social frailty. Being a woman predicted social frailty since older women have a higher probability of living alone. Two other results were the nonlinear effect of income and the large effect of unhealthy lifestyle on frailty. Our finding that the effect of both life-course determinants and multimorbidity on frailty differs across domains of frailty suggests that it is worthwhile distinguishing three domains of frailty (physical, psychological, social).

## METHODOLOGICAL CONSIDERATIONS

The topics of this study, definitions of frailty and the measurement of frailty, were rather complex, especially as there is a lack of consensus on the definition of frailty.[34] The debate up to now has mainly focused on whether frailty should be defined purely in terms of biomedical factors or whether psychosocial factors should be included as well.[35] Our study started from the premise of a holistic view of the person, and consequently frailty was considered from a multidimensional perspective. This is rather controversial in a research field dominated by the medical sciences.

An important question is whether the composition of the expert panels has influenced the results of the study. Considering that more than half the experts (11 of the 20 experts) came from the Netherlands, this may have influenced the total score assigned to the conceptual definition of Schuurmans et al.,[17] which was formulated by Dutch researchers. In addition, some experts who have themselves defined frailty were present at the meetings; their presence may possibly have had an impact on the selection of the best definition during these meetings. On the other hand, the results from the expert meetings did not differ from the results from the questionnaires, and these were completed before the expert meetings started.

There was only consensus between the consulted experts on the inclusion of seven components in the operational definition of frailty, namely nutrition, mobility, physical activity, strength, endurance, balance, and cognition. All these components, except cognition, refer to physical frailty. Since the aim was to develop an integral operational definition of frailty, the other five components (sensory functions, mood, coping, social relations, social support) were added. The inclusion of these five components, which refer to psychological frailty and social frailty, was supported by some experts and especially by the results of our literature search. The choice of particular components was probably influenced to some extent by the background of the experts consulted. In this connection, it should be noted that the geriatric medical discipline was more explicitly represented during the expert meeting in the United States than that in the Netherlands. There are indications that health care professionals representing different disciplines do not have the same perception of the concept of frailty.[36] However, another study showed that individual disciplines did not preferentially report attributes to the concept of frailty that are most closely linked to their profession;[11] individual disciplines do not appear to have concepts of frailty that are unique to their discipline. According to Kaethler et al.,[11] this is probably a testament to the multidisciplinary nature of the health care provided to frail older persons.

A few comments can also be made about the methodology followed in the studies involving the Tilburg Frailty Indicator (TFI). Using the TFI we gathered self-reported data. However, the question remains as to whether all the respondents - people aged 75 years and older - completed the questionnaire themselves. The WHOQOL-BREF, which was also completed by all respondents at the same time, included an item "Did you get help filling out this form?" 15.7% of the respondents indicated that this was the case, so that the majority of responses were genuinely "self-reported". We presume that this also applies for the TFI. However, in more frail populations, the availability of a (formal or informal) caregiver to assist in completing and mailing back a postal survey could affect response rates and result in more proxy responses.[37]

The TFI is a self-report questionnaire and does not include performance-based tests. In some LASA-studies differences were found with respect to self-reports and performance tests.[38, 39] Also, Glass proposed that self-report questionnaires asking people what they can do ("the hypothetical tense") do not measure the same things as performance tests ("the experimental tense").[40] However, our findings (see Chapter 5) show that frailty as measured by the TFI correlated as expected and significantly with related measures of frailty such as performance tests, e.g. the Timed Up & Go test[41], the Four test balance scale,[42] and the Mini-Mental State Examination;[43] this supports the construct validity of the TFI.

In general, postal surveys have been well accepted by older persons.[37] In spite of this, the response rates in our study (54%; 34%) were lower than in other studies,[37] perhaps because we did not follow up our initial mailing with a reminder to non-respondents, for example with a second mailing or a telephone contact. In addition, Sample 1 completed a questionnaire containing the TFI and the WHOQOL-BREF, while Sample 2 completed questions on adverse outcomes of frailty as well. We can surmise that higher response rates could be achieved by sending only the TFI; completing only the TFI would take less time and would be less of a burden. Another fact that probably explains the low response rates is that many respondents were approached more than six months after being sampled. All respondents were sampled in October 2007; at least half the respondents in Sample 1 were interviewed before February 2008, an average of six months before they were approached to complete the questionnaire, while all respondents in Sample 2 were approached only in June 2008, which is eight months after being initially sampled.

Owing to the limited information available on non-respondents (only sex and age), it is difficult to eliminate the possibility of selection bias. A probable consequence of the high non-response is an underestimation of the number of frail community-dwelling persons.[44, 45] However, our prevalence figure (47.1%) is comparable to other

frailty prevalence data. Another self-report measurement instrument for frailty, The Groningen Frailty Indicator, classified 32% of community-dwelling elderly (65 years and older) as frail,[17] while The American Medical Association identified 20% of people aged 65 and over, and 40% of people aged 80 and over as frail.[46]

In our study we doubted about the validity of question 11 of the TFI "Do you feel physically healthy?" for measuring physical activity; health seems to be a different concept from activity. We therefore added the following question at the end of the TFI when assessing its test-retest reliability "Do you find that you can be sufficiently physically active?" Notwithstanding the substantial correlation between these two questions, we might suggest replacing the original question.

Finally, the psychometric evaluation of the TFI indicated good reliability. The only exception was the low internal consistency reliability for the social domain. The internal consistency might be increased by adding one or more indicators of social frailty. This will need to be demonstrated through research. If we decide to expand the concept of social frailty, we would in any event propose adding the following question to the TFI: "Do you have sufficient contacts with other people?" (contacts in whatever form: personally, by telephone, in writing or by email). Some researchers have used this component "quantity of social contacts" as a determinant of frailty in their studies.[12, 47] However, we would note that we do not yet know the psychometric properties of this question.

## RECOMMENDATIONS FOR FUTURE RESEARCH

*The integral conceptual model of frailty*

This study has produced several recommendations for future research. So far, most studies of frailty have opted primarily for a biomedical perspective, thereby neglecting the psychological and social domains of frailty, which are probably also very important domains for the quality of life of older people.[48] In this study we have developed both a conceptual definition and an operational definition of frailty; both of which are characterised by an integral approach to frailty. Naturally, our integral conceptual model of frailty also adopts this integral approach to human functioning.

This model offers a starting point for further scientific research on frailty. This is important, because many questions remain unanswered. For example, the question remains of what role the psychological and social domain in the operational definition of frailty play in the onset of adverse outcomes presented in the model (disability, health care utilisation, death). Future research will need to demonstrate the added value of including the selected psychological and social components in the operational definition of frailty.

Also, more research is needed to demonstrate to what extent life-course determinants or combinations of life-course determinants and multimorbidity are predictive for the onset of frailty, and for the onset of disability, health care utilisation and premature death. The cross-sectional nature of this study does not allow for strict cause-effect interpretations of the associations between the nine life-course determinants, multimorbidity and frailty. A longitudinal study of the change in the score on the TFI in relation to these aspects could be used to address this question.

The effect of income on frailty was nonlinear. More research is needed to explain this unexpected relationship. In addition, we found a large effect of an unhealthy lifestyle on frailty. We propose to examine more specifically which aspects of lifestyle influence frailty and the individual domains of frailty (physical, psychological, social).

Our integral conceptual model of frailty also offers opportunities for interventions focused both on cure and on primary and secondary prevention. We therefore suggest that the usefulness of our integral conceptual model of frailty be examined as a basis for intervention studies. In addition, the TFI can be used to determine the effectiveness of the intervention.

In summary, more research is needed to validate the whole integral conceptual model of frailty, with all relationships described in the model. It is suggested that validated scales be used for this purpose. The data collected on participants from the interviews and the physical measures (N = 505) will enable us to continue our research on frailty, and more specifically to validate the integral model.

*The psychometric properties of the TFI*

The second recommendation for future research concerns the validity and reliability of the TFI. Our study showed that the TFI is a valid and reliable instrument for measuring frailty. During the development of the TFI its face validity and content validity were assessed by considering the questions in the light of direct comments and suggestions by experts and older people belonging to the target population. In addition, the construct validity and predictive validity were assessed. We examined the effect of frailty and physical frailty, both measured using the TFI, on adverse outcomes such as disability and health care utilisation. However, we did not study the effect of combinations of frailty components within and between the three frailty domains (physical, psychological, social) on these adverse outcomes. It is possible that certain combinations of frailty components increase the risk of adverse outcomes more than other combinations.

Furthermore, the design of our study in Chapter 5 and 6 was cross-sectional. As a consequence, the predictive validity of the TFI also needs to be assessed in a

longitudinal study, with an emphasis on how frailty and its domains affect adverse outcomes in the long term. This study should also include adverse outcomes that are related more to the psychological and social domains of frailty, such as well-being, to determine optimal cutpoints for these two frailty domains as well.

Despite the fact that the TFI has not been validated for settings other than the community, the TFI may nevertheless have potential applications in hospital or primary care settings. Hence we propose to examine its validity in these settings as well.

Finally, we would note that the Dutch version of the TFI has been validated in the Netherlands. The TFI was translated into English using the back-translation method. It is recommended that the TFI also be validated in other countries using other languages.

## PRACTICAL IMPLICATIONS AND RECOMMENDATIONS

*Measuring frailty*

At present there are several instruments available for measuring frailty, based on different definitions of frailty. There are measurement instruments which are typically rule-based; for example, a person may be defined as frail if three or more symptoms (weight loss, weakness, slow walking speed, feeling exhausted and physical inactivity) are present.[19] The researchers who used this Fried et al. phenotype focused only on the physical domain of frailty.

Adding together the number of impairments is another way of defining frailty.[49] However, this approach is time-consuming and not widely used clinically;[50] these scores may be problematic to use in clinical practice because they include too many items. The Edmonton Frail Scale (EFS) uses this approach and needs less time.[29] The EFS is a brief and user-friendly screening interview for frailty which samples ten domains. Two domains (cognitive impairment, functional performance) are tested using performance-based items.

A third approach taken by operational definitions relies on clinical judgment to interpret the results of history-taking and clinical examination.[50] The Frailty Index from a Standardized Comprehensive Geriatric Assessment (FI-CGA) is an example of this third approach.[51] It is reasonably easy to use and requires no special instrumentation; however, it requires a clinical judgment to be made.[52] Such a scale might be better exploited where clinicians are available who have experience in the care of elderly people.[50] This also applies for the Clinical Global Impression of Change in Physical Frailty scale developed by Studenski et al., which addresses six intrinsic domains (strength, balance, nutrition, endurance, neuromotor performance and mobility).[53]

Table 1 presents an overview of validated measurements of frailty. All these instruments were cited many times and validated in samples of community-dwelling older persons.

**Table 1.** Measurement instruments of frailty

| | Domains | Characteristics | Validation |
|---|---|---|---|
| Phenotype of frailty[19] | *physical*: weight loss, weakness, slow walking speed, feeling exhausted and physical inactivity | clinical judgment and self-reported; a rule-based instrument (frail ≥ three criteria) | predictive of falls, decline in mobility or ADL disability and death[19] |
| Strawbridge questionnaire[12] | *physical*: physical health (four items), nutrition (loss of appetite, weight loss), sensory (visual and hearing problems)<br>*psychological*: cognition (three items) | self-reported; a rule-based instrument (frail ≥ two of the following domains: physical, nutritive, cognitive, sensory) | associated with reduced activity, poorer mental health and lower life-satisfaction[12] |
| Edmonton Frail Scale[29] | *physical*: functional independence, self-rated health, medication use, nutrition, continence, functional performance<br>*psychological*: cognition, mood<br>*social*: social support<br>*adverse outcome*: hospitalisation | self-reported and clinical judgment; counting of impairments | associated with the Geriatrician's Clinical Impression of Frailty and the Barthel Index[29] |
| Frailty Index (based on a comprehensive geriatric assessment)[51] | *physical*: mobility, balance, bowel function, bladder function, nutrition, ADL, comorbidity, communication<br>*psychological*: cognitive status, mood<br>*social*: social status | self-reported and clinical judgment; counting of impairments | predictive of institutionalisation and mortality[51] |
| Frailty markers[7] | *physical*: body weight, peak expiratory flow, vision, hearing, incontinence, physical activity<br>*psychological*: sense of mastery, depressive symptoms, cognition | self-reported and clinical judgment; rule-based (frail ≥ three markers) | static frailty: predictive of physical decline in men and women; dynamic frailty: predictive of physical decline in women only[7] |
| Tilburg Frailty Indicator | *physical*: nutrition, mobility, physical activity, strength, endurance, balance, vision, hearing<br>*psychological*: depressive symptoms, anxiety, cognition, coping<br>*social*: living alone, social relations, social support | self-reported (frail ≥ five items) | associated with validated measures of frailty; predictive of quality of life, disability and receiving personal care, nursing and informal care |

Our new integral model of frailty enabled us to develop the TFI. The final version of the TFI, as presented in Chapter 5 and 6 (English version) and the Appendix to this thesis (Dutch version), is the first instrument constructed for measuring frailty which includes only self-reported information, which explores the physical, psychological and social domains of human functioning and which does not refer to disability and multimorbidity. Of the current validated instruments, only the Edmonton Frail Scale[29] and the Frailty Index[51] measure three domains of human functioning (physical, psychological, social), but these instruments also measure disability (functional independence, ADL) and multimorbidity (medication use, comorbidity).

The TFI is a user-friendly instrument for screening frail and 'at risk of frailty' community-dwelling older people; people aged 75 years and older. It emerged in the current study that the questions in the TFI were clear and completing the TFI by representatives of the study population took on average only 14 minutes. The questions in the TFI relating to determinants and components of frailty are simple and feasible for inclusion in a screening programme conducted in the primary care setting. In addition, they are meaningful to health care professionals and social care professionals, and are important for policymakers for guiding health and social care policies.

The TFI differs from the Groningen Frailty Indicator (GFI), a measurement instrument which is used frequently in the Netherlands. The GFI is a rule-based frailty instrument and was also developed as a short and easy to administer 15-item screening instrument to determine a person's level of frailty.[17] However, as far as we are aware the GFI has not been validated in a sample of community-dwelling older people. In addition, the GFI also refers to morbidity (medication use) and mobility (ADL and IADL).

*Early identification of frail elderly*

Measuring frailty is an important step in creating a risk stratification; at one end of the continuum are active, non-frail older persons, with the very frail elderly at the other end.[54] All manner of frailty profiles can occur in between. Those profiles can be based on the TFI in two ways. First, they can be based on the three domains of the TFI; this gives rise to a physical, psychological or social profile. Second, profiles can be linked to the overall score on the TFI. Research will be needed to determine how many different profiles are possible, and which different cutpoints should be used for this. The profiles which emerge as a result will then help determine the choice of disciplines to be deployed and the interventions to be carried out in providing care to the elderly persons concerned.

Community care plays a crucial role in the prevention of frailty. Professional primary carers have the task of identifying health risks in frail elderly persons at an early stage; they must sound the alarm whenever there is the threat of a cascade of deterioration.[55] This study provides an instrument, the TFI, which can be used by these carers for identifying frail people who are at risk of adverse outcomes. General practitioners already use the concept of frailty to aid clinical decision-making, assess risk factors and complications, evaluate interventions and predict adverse outcomes, because frailty is a better measure than chronological age.[25, 29] Moreover, frailty fits in well with the biopsychosocial model of general practice;[56] especially when an integral definition of frailty is used.

In addition to general practitioners, nurses and nurse practitioners could also use the TFI for identifying frail elderly persons. The shift in tasks from doctors to non-doctors makes a positive contribution to safe, effective, client-centred and accessible care.[57] The literature provides no evidence of low client satisfaction with the care delivered by nurse practitioners, but evidence from a randomised controlled trial draws the opposite conclusion.[58] Studies show that nurses are capable of fulfilling extended roles.[59, 60] They can offer an appropriate solution to the difficulties faced by general practitioners in providing high-quality services to elderly persons;[61] such as an increasing workload and consequently limited consultation time.

Using the TFI as a screening instrument for frailty gives general practitioners the possibility of inviting frail elderly persons for a more comprehensive geriatric assessment (CGA).This assessment could perhaps be performed in close collaboration with a nurse practitioner. It can be concluded that comprehensive geriatric assessment (CGA), with follow-up assessments, has many potential benefits for frail elderly persons.[62, 63] The results of the CGA can indicate a need for complex care and will give rise to a multidisciplinary care plan, possibly involving social workers, physiotherapists, occupational therapists and dieticians. All these primary caregivers must be able to call on specialist advice from the secondary (hospitals) and tertiary (nursing homes and institutions for mental health services) care sectors.[55] Geriatricians and nursing home physicians have to present themselves more as (complementary) specialists in the domain of care for the elderly.[55]

In the Dutch health care system, ambulatory health screening centres for the elderly can also offer an opportunity for identifying frail elderly persons. These centres provide lifestyle advice with a view to maximising the ability of older persons to live in good health, and medical tests are performed to detect diseases. These centres give practical form to integral health promotion through early consultation.[67] However, the potential effect of these ambulatory health screening centres for the elderly has yet to be studied.[67] From the perspective of effectiveness and efficiency, it is recommended

that the TFI be used as a screening instrument; depending on the score in Part B of the TFI (cutpoint 5), older persons are then invited to take part in further screening at the ambulatory health screening centre.

Intervention research in the field of frail older people is relatively new.[64] Given the multidimensional nature of frailty, complex interventions that require the integration of multiple components are more likely to be effective than simple, one-off interventions. However, multi-component interventions are difficult to standardise, reproduce and test in Randomised Controlled Trials.[65] A meta-analysis of 18 trials found that (preventive) home visits were effective in persons in relatively good health, in particular, when the intervention included multiple domains of human functioning.[66] It will be important to determine which interventions for elderly persons who achieve a positive score on the TFI will be effective in reducing the frequency of adverse outcomes and their related costs.

*Health care system*

The results of this thesis emphasise the importance of looking at frailty from a multidimensional perspective. Such a perspective will better match the perception of successful ageing of older adults, incorporating views on physical, psychological and social health.[68] The multidimensional nature of frailty demands an integrated view of human beings and a multidisciplinary approach. Since frail elderly persons often come into contact with a whole series of different caregivers, there is a great risk that the care they receive will not be integrated. The danger then is one of fragmented care, which only addresses one problem at a time and has difficulty detecting important risk factors and spotting any deterioration in the frail elderly person's situation in time.[69, 70] In addition, current care is mainly focused on the treatment of single diseases,[71] and is insufficiently geared to older persons with multimorbidity.[55] The starting point for the content and organisation of the care for frail elderly should not be the different specialisms, but rather the integral needs of the client;[72] the TFI can help in achieving this. In practice, integrated care means offering a coherent and coordinated care package which is put together via a series of care and welfare organisations or collaborating professionals together with informal carers, and which is able to cover the entire spectrum of health care and social support.[73] The ultimate goal of integrated care is to ensure that those in need of care receive demand-led care and services at the right time and in the place preferred by the care recipient.[73]

Finally, professional carers have a major task in identifying frail elderly persons at an early stage. This is important in order to avoid unnecessary loss of quality of life and to make timely preventive or curative interventions possible. In addition to a proactive attitude, this demands a willingness on the part of professionals to look

beyond the borders of their own disciplines. Integral care also requires collaborative skills on the part of care professionals; this is an area that warrants a good deal more attention in occupational training programmes.[74]

## REFERENCES


1. CBS http://statline.cbs.nl).
2. Chin APMJ, Dekker JM, Feskens EJ, Schouten EG, Kromhout D. How to select a frail elderly population? A comparison of three working definitions. J Clin Epidemiol 1999;52:1015-1021.
3. Gill TM, Gahbauer EA, Allore HG, Han L. Transitions between frailty states among community-living older persons. Arch Intern Med 2006;166:418-423.
4. 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 2007;62:731-737.
5. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003;44:58-68.
6. Rockwood K, Stadnyk K, MacKnight C, et al. A brief clinical instrument to classify frailty in elderly people. Lancet 1999;353:205-206.
7. Puts MT, Lips P, Deeg DJ. Static and dynamic measures of frailty predicted decline in performance-based and self-reported physical functioning. J Clin Epidemiol 2005;58:1188-1198.
8. 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;59:255-263.
9. Raphael D, Cava M, Brown I, et al. Frailty: a public health perspective. Can J Public Health 1995;86:224-227.
10. Rockwood K. What would make a definition of frailty successful? Age Ageing 2005;34:432-434.
11. Kaethler Y, Molnar FJ, Mitchell SL, et al. Defining the concept of frailty: a survey of multidisciplinary health professionals. Geriatrics Today: J Can Geriatr Soc 2003;6:26-31.
12. Strawbridge WJ, Shema SJ, Balfour JL, et al. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci 1998;53:S9-16.
13. Puts MT, Lips P, Deeg DJ. Sex differences in the risk of frailty for mortality independent of disability and chronic diseases. J Am Geriatr Soc 2005;53:40-47.
14. Bortz WM, 2nd. The physics of frailty. J Am Geriatr Soc 1993;41:1004-1008.
15. Slaets JP. The importance of the 'frailty-concept' in geriatric assessment (In Dutch: Het belang van het 'frailty-concept' bij case-finding in de geriatrie). Tijdschr Gerontol Geriatr 1998;29:276-278.
16. Morley JE, Perry HM, 3rd, Miller DK. Editorial: Something about frailty. J Gerontol A Biol Sci Med Sci 2002;57:M698-704.
17. Schuurmans H, Steverink N, Lindenberg S, et al. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci 2004;59:M962-965.
18. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing 1997;26:315-318.
19. 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:M146-156.
20. Avlund K, Damsgaard MT, Schroll M. Tiredness as determinant of subsequent use of health and social services among nondisabled elderly people. J Aging Health 2001;13:267-286.
21. Wolinsky FD, Culler SD, Callahan CM, Johnson RJ. Hospital resource consumption among older adults: a prospective analysis of episodes, length of stay, and charges over a seven-year period. J Gerontol 1994;49:S240-252.

22. Laukkanen P, Leskinen E, Kauppinen M, et al. Health and functional capacity as predictors of community dwelling among elderly people. J Clin Epidemiol 2000;53:257-265.
23. Avlund K, Schultz-Larsen K, Davidsen M. Tiredness in daily activities at age 70 as a predictor of mortality during the next 10 years. J Clin Epidemiol 1998;51:323-333.
24. Bergman H, Béland F, Karunananthan S, et al. English translation of article published in 'Gérontologie et société'. Dévelopment d'un cadre de travail pour comprendre et étudier la fragilité. Gérontologie et société 2004;109:15-29.
25. Rockwood K, Fox RA, Stolee P, et al. Frailty in elderly people: an evolving concept. Cmaj 1994;150:489-495.
26. Bortz WM, 2nd. A conceptual framework of frailty: a review. J Gerontol A Biol Sci Med Sci 2002;57:M283-288.
27. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-847.
28. Levers MJ, Estabrooks CA, Ross Kerr JC. Factors contributing to frailty: literature review. J Adv Nurs 2006;56:282-291.
29. Rolfson DB, Majumdar SR, Tsuyuki RT, et al. Validity and reliability of the Edmonton Frail Scale. Age Ageing 2006;35:526-529.
30. Brown M, Sinacore DR, Binder EF, Kohrt WM. Physical and performance measures for the identification of mild to moderate frailty. J Gerontol A Biol Sci Med Sci 2000;55:M350-355.
31. Ory MG, Schechtman KB, Miller JP, et al. Frailty and injuries in later life: the FICSIT trials. J Am Geriatr Soc 1993;41:283-296.
32. Winograd CH, Gerety MB, Chung M, et al. Screening for frailty: criteria and predictors of outcomes. J Am Geriatr Soc 1991;39:778-784.
33. Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. J Am Geriatr Soc 1991;39:46-52.
34. Abellan van Kan A, Rolland Y, Bergman H, et al. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging 2008;12:29-37.
35. Lally F, Crome P. Understanding frailty. Postgrad Med J 2007;83:16-20.
36. Herrmann FR, Osiek A, Cos M, et al. Frailty judgment by hospital team members: degree of agreement and survival prediction. J Am Geriatr Soc 2005;53:916-917.
37. Alessi CA, Josephson KR, Harker JO, et al. The yield, reliability, and validity of a postal survey for screening community-dwelling older people. J Am Geriatr Soc 2003;51:194-202.
38. Stel VS, Pluijm SM, Deeg DJ, et al. Functional limitations and poor physical performance as independent risk factors for self-reported fractures in older persons. Osteoporos Int 2004;15:742-750.
39. Schalk BW, Visser M, Penninx BW, et al. Change in serum albumin and subsequent decline in functional status in older persons. Aging Clin Exp Res 2005;17:297-305.
40. Glass TA. Conjugating the "tenses" of function: discordance among hypothetical, experimental, and enacted function in older adults. Gerontologist 1998;38:101-112.
41. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 1991;39:142-148.
42. Gardner MM, Buchner DM, Robertson MC, Campbell AJ. Practical implementation of an exercise-based falls prevention programme. Age Ageing 2001;30:77-83.
43. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-198.
44. Hebert R, Bravo G, Korner-Bitensky N, Voyer L. Predictive validity of a postal questionnaire for screening community-dwelling elderly individuals at risk of functional decline. Age Ageing 1996;25:159-167.

45. Brody KK, Johnson RE, Douglas Ried L. Evaluation of a self-report screening instrument to predict frailty outcomes in aging populations. Gerontologist 1997;37:182-191.
46. American Medical Association white paper on elderly health. Report of the Council on Scientific Affairs. Arch Intern Med 1990;150:2459-2472.
47. Woo J, Goggins W, Sham A, Ho SC. Social determinants of frailty. Gerontology 2005;51:402-408.
48. Puts MTE. Frailty: biological risk factors, negative consequences and quality of life. Dissertation VU University Amsterdam: 2006.
49. Rockwood K, Mitnitski AB, MacKnight C. Some mathematical models of frailty and their clinical implications. Rev Clin Gerontol 2002;12:109-117.
50. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. Cmaj 2005;173:489-495.
51. Jones DM, Song X, Rockwood K. Operationalizing a frailty index from a standardized comprehensive geriatric assessment. J Am Geriatr Soc 2004;52:1929-1933.
52. Theou O, Kloseck M. Tools to Identify Community-Dwelling Older Adults in Different Stages of Frailty. Phys Occup Ther Geriatr 2008;26:1-21.
53. 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;52:1560-1566.
54. Health Council of the Netherlands. Ageing with ambition (In Dutch: Vergrijzen met ambitie), The Hague: 2005.
55. Health Council of the Netherlands. Health care for the elderly with multimorbidity (In Dutch: Ouderdom komt met gebreken. Geneeskunde en zorg bij ouderen met multimorbiditeit). The Hague: 2008.
56. De Lepeleire J, Iliffe S, Mann E, Degryse JM. Frailty: an emerging concept for general practice. Br J Gen Pract 2009;59:e177-182.
57. Dutch Health Care Inspectorate. State of Health Care report 2007. Reallocation of tasks is found to have a positive impact on quality of care (In Dutch: Staat van de gezondheidszorg 2007. Taakherschikking blijkt positief voor de kwaliteit van zorg). The Hague: 2007.
58. Kinnersley P, Anderson E, Parry K, et al. Randomised controlled trial of nurse practitioner versus general practitioner care for patients requesting "same day" consultations in primary care. BMJ 2000;320:1043-1048.
59. Fall M, Walters S, Read S, et al. An evaluation of a nurse-led ear care service in primary care: benefits and costs. Br J Gen Pract 1997;47:699-703.
60. Gallagher M, Huddart T, Henderson B. Telephone triage of acute illness by a practice nurse in general practice: outcomes of care. Br J Gen Pract 1998;48:1141-1145.
61. Wilson A, Pearson D, Hassey A. Barriers to developing the nurse practitioner role in primary care-the GP perspective. Fam Pract 2002;19:641-646.
62. Aminzadeh F, Byszewski A, Dalziel WB, et al. Papahariss-Wright S. Effectiveness of outpatient geriatric assessment programs: exploring caregiver needs, goals, and outcomes. J Gerontol Nurs 2005;31:19-25.
63. Stuck AE, Beck JC, Egger M. Preventing disability in elderly people. Lancet 2004;364:1641-1642.
64. Daniels R, van Rossum E, de Witte L, van den Heuvel W. Frailty in older Age: concepts and relevance for occupational and physical therapy. Physical and Occupational Therapy in Geriatrics 2008;27:81-95.
65. Burden of Disease Network Project. Disability in old age. Final report. Conclusions and recommendations. Jyväskylä: Jyväskylä University Press, 2004.

66. Stuck AE, Egger M, Hammer A, et al. Home visits to prevent nursing home admission and functional decline in elderly people: systematic review and meta-regression analysis. JAMA 2002;287:1022-1028.
67. Luijkx KG, van Weert CMC, van Oers JAM, Schols JMGA. Ambulatory Health Screening Centre for the elderly (In Dutch: Consultatiebureau voor ouderen). TSG 2007;85:392-398.
68. Phelan EA, Anderson LA, LaCroix AZ, Larson EB. Older adults' views of "successful aging"--how do they compare with researchers' definitions? J Am Geriatr Soc 2004;52:211-216.
69. Clarfield AM, Bergman H, Kane R. Fragmentation of care for frail older people--an international problem. Experience from three countries: Israel, Canada, and the United States. J Am Geriatr Soc 2001;49:1714-1721.
70. Lowenstein A. A case management demonstration project for the frail elderly in Israel. Care Manag J 2000;2:5-14.
71. Tinetti ME, Fried T. The end of the disease era. Am J Med 2004;116:179-185.
72. Health Council of the Netherlands. Prevention in the elderly: Focus on functioning in daily life (In Dutch: Preventie bij ouderen: focus op zelfredzaamheid). The Hague: 2009.
73. Schols JMGA. The future of chronic care,....should we care? On old structures, and things that pass...(In Dutch: De toekomst van de chronische zorg,...ons een zorg? Van oude structuren, de dingen, die voorbijgaan...). Inaugural lecture Tilburg University: 2004.
74. Schols JMGA. Nursing home medicine: officially acknowledged, but also recognised and known? (In Dutch: Verpleeghuisgeneeskunde al langer officieel erkend; maar ook herkend en gekend?). Inaugural lecture Maastricht University: 2008.

# Appendix

## The Tilburg Frailty Indicator (Dutch version)

| **Onderdeel A Determinanten van fragiliteit** | |
|---|---|
| 1. Wat is uw geslacht? | 0 man 0 vrouw |
| 2. Wat is uw leeftijd? | .....jaar |
| 3. Wat is uw burgerlijke staat? | 0 gehuwd of samenwonend<br>0 ongehuwd<br>0 gescheiden<br>0 weduwnaar/weduwe |
| 4. Wat is uw geboorteland? | 0 Nederland<br>0 Nederlands Indië<br>0 Suriname<br>0 Nederlandse Antillen<br>0 Turkije<br>0 Marokko<br>0 Anders,<br>namelijk..... |
| 5. Wat is de hoogste opleiding die u heeft afgemaakt? | 0 geen of lager onderwijs<br>0 middelbaar onderwijs<br>0 hoger beroepsonderwijs of universiteit |
| 6. In welke categorie valt het netto maandinkomen van uw huishouden? | 0 600,- of minder<br>0 601,- tot en met 900,-<br>0 901,- tot en met 1200,-<br>0 1201,- tot en met 1500,-<br>0 1501,- tot en met 1800,-<br>0 1801,- tot en met 2100,-<br>0 2101,- of meer |
| 7. Hoe gezond vindt u alles bij elkaar uw manier van leven? | 0 gezond<br>0 niet gezond, niet ongezond<br>0 ongezond |
| 8. Heeft u twee of meer ziekten en/of chronische aandoeningen? | 0 ja 0 nee |
| 9. Heeft u het afgelopen jaar één of meerdere van de volgende gebeurtenissen meegemaakt? | |
| - het overlijden van een dierbaar persoon | 0 ja 0 nee |
| - een ernstige ziekte van uzelf | 0 ja 0 nee |
| - een ernstige ziekte van een dierbaar persoon | 0 ja 0 nee |
| - een scheiding, verbreking duurzame, intieme relatie | 0 ja 0 nee |
| - een verkeersongeval | 0 ja 0 nee |
| - een misdrijf | 0 ja 0 nee |
| 10. Bent u tevreden met uw woonomgeving? | 0 ja 0 nee |

| **Onderdeel B Componenten van fragiliteit** | | | |
|---|---|---|---|
| **B1 Lichamelijke componenten** | | | |
| 11. Voelt u zich lichamelijk gezond? | 0 ja | | 0 nee |
| 12. Bent u de afgelopen periode veel afgevallen zonder dit zelf te willen? *(veel is: 6 kg of meer in de afgelopen 6 maanden of 3 kg of meer in de afgelopen maand)* | 0 ja | | 0 nee |
| Heeft u problemen in het dagelijks leven door | | | |
| 13. .....slecht lopen? | 0 ja | | 0 nee |
| 14. .....het slecht kunnen bewaren van uw evenwicht? | 0 ja | | 0 nee |
| 15. .....slecht horen? | 0 ja | | 0 nee |
| 16. .....slecht zien? | 0 ja | | 0 nee |
| 17. .....weinig kracht in uw handen? | 0 ja | | 0 nee |
| 18. .....lichamelijke moeheid? | 0 ja | | 0 nee |
| **B2 Psychische componenten** | | | |
| 19. Heeft u klachten over uw geheugen? | 0 ja | 0 soms | 0 nee |
| 20. Heeft u zich de afgelopen maand somber gevoeld? | 0 ja | 0 soms | 0 nee |
| 21. Heeft u zich de afgelopen maand nerveus of angstig gevoeld? | 0 ja | 0 soms | 0 nee |
| 22. Kunt u goed omgaan met problemen? | 0 ja | | 0 nee |
| **B3 Sociale componenten** | | | |
| 23. Woont u alleen? | 0 ja | | 0 nee |
| 24. Mist u wel eens mensen om u heen? | 0 ja | 0 soms | 0 nee |
| 25. Ontvangt u voldoende steun van andere mensen? | 0 ja | | 0 nee |

**Scoring onderdeel B: range van 0 tot 15**

| | |
|---|---|
| Vraag 11: | ja = 0, nee = 1 |
| Vraag 12: | nee = 0, ja = 1 |
| Vraag 13 t/m 18: | nee = 0, ja = 1 |
| Vraag 19: | nee/soms = 0, ja = 1 |
| Vraag 20 en 21: | nee = 0, ja/soms = 1 |
| Vraag 22: | ja = 0, nee = 1 |
| Vraag 23: | nee = 0, ja = 1 |
| Vraag 24: | nee = 0, ja/soms = 1 |
| Vraag 25: | ja = 0, nee = 1 |

# Summary

## INTRODUCTION

Forecasts suggest that there will be more older people in Dutch society in the coming decades than ever before. This is due among other things to the increased national prosperity and related factors such as better education, diet and health care. Many older people possess the capacities needed for successful ageing. Yet there are also older people who are affected by chronic illness, physical and/or psychological impairments. A combination of problems in older persons can be described using the term 'frailty'. The first definition of frailty dates from 1978, when the United States Federal Council on Aging (FCA) defined the frail elderly as 'persons usually, but not always, over the age of 75, who because of an accumulation of various continuing problems often require one or several supportive services in order to cope with daily life'.[1] There has been a significant increase since 1991 in the number of publications on frailty, and over the years frailty has developed into an increasingly relevant concept. Research has for example shown that the degree of frailty in older people is a better predictor for treatment or intervention than chronological age,[2] because frailty is related more directly to adverse outcomes such as hospital admissions, nursing home admissions and mortality.[3, 4]

The term 'frailty' refers to a process that is unique for every individual. A systematic review by Markle-Reid and Browne emphasises that this process is changeable and reversible.[5] Factors which can result in prevention or mitigation of frailty include exercises to improve balance, nutritional advice and control of blood pressure.[6] The first stages of frailty are found mainly in older persons living independently in the community. It is therefore important to identify such frail community-dwelling older persons at an early stage, so that (preventive) interventions can be initiated rapidly. This could perhaps reduce frailty or prevent it from getting worse.

There is however no consensus on the definition of frailty. The prevalence of frailty is determined by the definition that is used, and as there are different definitions in circulation, the figures diverge considerably. For example, the American Medical Association reported a prevalence of 20% among community-dwelling people aged 65 and older;[7] Fried et al. classified 7% of people living independently (aged 65 and older) as frail.[3]

Most definitions of frailty place great emphasis on physical problems, with little or no attention being given to problems in the psychological and social domains. If frailty is defined primarily in terms of physical loss, efforts to identify frail elderly persons will focus only on this aspect. This could potentially lead to fragmentation of care, with lack of attention for the whole person.

A definition of frailty, and in particular an operational definition, must be

suitable for use as a basis for the development of a measurement tool which can be used to identify frail elderly persons. An integral approach to frailty in both the definition and the measurement instrument, will encourage multidisciplinary care for older persons.

**Chapter 1** introduces the central question addressed in this thesis, namely: "How can frailty be defined and measured as a means of identifying frail community-dwelling older people with regard to integral human functioning?" The specific questions answered in this thesis are as follows:

(1) Which conceptual and operational definitions of frailty have been used in the literature?
(2) Which definitions are most appropriate for identifying frail community-dwelling older people?
(3) Which existing conceptual definition of frailty places most emphasis on the integral functioning of older people?
(4) Which components of existing operational definitions of frailty should be included in an integral operational definition of frailty?
(5) What constitutes a scientifically sound and practically relevant integral model of frailty?
(6) What are the psychometric properties of the Tilburg Frailty Indicator (TFI), which is based upon an integral model of frailty?
(7) What are the determinants of frailty in community-dwelling older people as measured using the TFI?

## LITERATURE SEARCH

**Chapter 2** answers the following sub-questions: (1) *Which conceptual and operational definitions of frailty have been used in the literature?* and (2) *Which definitions are most appropriate for identifying frail community-dwelling older people?* A literature search was performed in order to formulate answers to these questions.

Five criteria can be distilled from the scientific literature on frailty which must be met by a successful definition of frailty. The first criterion refers to the multidimensional nature of the concept; the definition must not only refer to the physical domain, but must also incorporate the psychological and social domains of human functioning. More and more researchers are becoming convinced that frailty requires a broad definition.[4, 5, 8] The second criterion relates to the fact that frailty is a dynamic concept. Frailty can be seen as a relative state, which can change over time.[8] Several authors place frailty on a continuum. Bortz, for example, places frailty at one end of a continuum with vitality at the opposite extreme;[9] Raphael et al. propose that

frailty be placed on a 'frailty-hardiness continuum',[10] with an individual's position on the continuum being determined by the complex interaction between personal and environmental factors. The third criterion refers to the predictive value of frailty for the onset of adverse outcomes such as hospital and nursing home admission and mortality. The fourth criterion relates to the need to draw a distinction between frailty, disability and comorbidity – though research by Fried et al. shows that there is some overlap between these three concepts.[11] The fifth and final criterion is that a successful definition of frailty must be usable in practice. An operational definition must be suitable to serve as a basis for an instrument that can be used to identify frail elderly persons. The definition must also incorporate aspects on which care professionals can target (preventive) interventions.

Based on the literature search, our conclusion was that none of the existing conceptual and operational definitions of frailty meet all five criteria. This prompted the development of a new conceptual and operational definition of frailty and an associated integral model of frailty.

## CONSULTATION OF EXPERTS

According to Rockwood, there are two possible approaches to defining frailty.[12] One approach is simply to accept that there are several definitions in existence. Scientific research will then have to show which definition is the most practicable for scientists and health care professionals. The other approach is to strive for consensus between experts in this field. In order to contribute to consensus-building with regard to a conceptual definition of frailty, a number of experts (N = 20) from the United States, Canada and the Netherlands were consulted for this study. This was done both through a written questionnaire and verbally during two expert meetings. This consultation with experts provided an answer to sub-question (3) *Which existing conceptual definition of frailty places most emphasis on the integral functioning of older people?* A total of eleven conceptual definitions of frailty were submitted to the experts, to which they were asked to assign scores. They could award 11 points to the definition which most closely met predetermined criteria (multidimensional nature of frailty, frailty as a dynamic concept), 10 points to the next best definition, and so on, so that the definition which matched the criteria least well received one point.

**Chapter 3** presents the scores for the conceptual definitions. The definition which received the highest score was that formulated by Schuurmans et al.,[2] who define frailty as 'a loss of resources in several domains of functioning that leads to reduced reserve capacity to deal with stress'. The definition by Schuurmans et al. was followed in turn by the conceptual definitions by Strawbridge et al.,[13] Campbell & Buchner[14]

and Fried et al.,[3] all of which received high scores. The definition by Schuurmans et al. does not specifically state which domains of functioning are involved, and also does not establish the relationship with adverse outcomes. This prompted us to formulate a new conceptual definition of frailty. The new definition is as follows: 'Frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social), which is caused by the influence of a range of variables and which increases the risk of adverse outcomes'. This new conceptual definition of frailty provided a framework for a new integral operational definition of frailty and for an integral conceptual model of frailty.

**Chapter 4** of this thesis first answers the following sub-question: (4) *Which components of existing operational definitions of frailty should be included in an integral operational definition of frailty?*

To answer this question, the same experts were consulted. There was consensus among the experts on the inclusion of the following components: strength, nutrition, endurance, mobility, physical activity, balance and cognition. The first five components are also included in a frequently cited operational definition, namely that put forward by Fried et al. in what they call 'a phenotype of frailty'.[3] Based on the input from the respondents and the literature search, the component 'sensory functions' (hearing, visual acuity) was subsequently added to the physical domain. Components were also added which belong to the psychological and social domains. In the psychological domains these were the components mood (depressive symptoms, anxiety) and coping, while the components in the social domain were social relationships and social support.

**Chapter 4** then answers sub-question (5) *What constitutes a scientifically sound and practically relevant integral model of frailty?* A conceptual model is defined as 'a set of concepts and propositions which integrate the concepts to a meaningful whole'.[15] A literature search revealed that most models of frailty are based on the medical model. That model is in turn based on the principle that a human being can be separated into mind and body: the dualistic principle. An exception is the model by Bergman et al., 'A working framework in development'.[16] This model is characterised by a life-course approach; it describes the pathway from frailty to adverse outcomes (such as disabilities, hospital admissions and mortality) and shows that this pathway can be influenced by a variety of biological, psychological, social and societal variables which can be described as the competences, resources and shortfalls of an individual in their specific context. We found the model particularly appealing because of its multidisciplinary character. In addition, the model distinguishes between frailty, disabilities and comorbidity, and also identifies the points in the development of

frailty when carers can intervene curatively or preventatively.

Based on the model by Bergman et al., we developed a new integral conceptual model of frailty; in reality, it is a modification of the model by Bergman et al. There are two main differences between the two models. The first relates to the specification of the life-course determinants. Based on a literature search, we selected the following determinants: socioeconomic factors (education followed, income), socio-demographic factors (age, sex, civil status, ethnicity), lifestyle, life events, living environment and genetic factors. The second difference relates to the operational definition of frailty. In the model by Bergman et al. this definition, in addition to the five components of 'a phenotype of frailty',[3] contains only two components from the psychological domain (depressive symptoms, cognitive decline); there are no components from the social domain. At the heart of our modified integral conceptual model of frailty lies our integral operational definition of frailty, in which three domains of frailty are distinguished: physical frailty, psychological frailty and social frailty.

The new model needs to be validated by scientific research; the predictive value of the determinants of the onset of frailty and the predictive value of frailty for the onset of adverse outcomes will have to be demonstrated.

**THE TILBURG FRAILTY INDICATOR (TFI)**

Based on the integral conceptual model of frailty, we developed a measurement instrument, the Tilburg Frailty Indicator (TFI). The TFI can be used to determine whether someone is frail, to what degree and in which domain. The TFI is a user-friendly self-report questionnaire for screening frail community-dwelling older persons. The questionnaire consists of two parts, part A and part B. Part A contains ten questions on determinants of frailty, while part B contains fifteen questions on components of frailty. Part B can be used to determine whether or not frailty is present and in which domain the problems are manifesting themselves: the physical, psychological and/or social domain. Components that refer to physical frailty are unintended weight loss, difficulty in walking, strength in the hands, physical tiredness, physical health, balance and hearing and vision problems. Cognition, depressive symptoms, anxiety and coping refer to psychological frailty. Components of social frailty are living alone, social relationships and social support.

Eleven items from the TFI have two response categories 'yes' and 'no'; four items have three response categories 'yes', 'sometimes', and 'no'; these four items were dichotomised. The score for frailty is determined by adding together the responses to the items. The maximum score is 15; this represents the highest level of frailty.

The answer to sub-question (6) *What are the psychometric properties of the*

*Tilburg Frailty Indicator (TFI), which is based upon an integral model of frailty?* is presented in **chapter 5**. This chapter presents the results of the evaluation of the reliability (test-retest and internal consistency) and the validity (construct validity, predictive validity) of the TFI. To do this, a cross-sectional study was carried out using two representative samples (N=245; N=234) of community-dwelling older persons aged 75 years and older living in the municipality of Roosendaal, in the Netherlands. The test-retest reliability of the TFI for a one-year period was good, at .79 for frailty, .78 for the physical domain, .67 for the psychological domain and .76 for the social domain. The internal consistency of the TFI was .73. The construct validity of the TFI was also good: the fifteen individual components correlated as expected with validated scales such as the Timed Up & Go Test, the Four-Test Balance Scale, the Shortened Fatigue Questionnaire, the Center for Epidemiologic Studies Depression Scale, the Hospital Anxiety and Depression Scale – Anxiety Subscale, the Mastery Scale and the Loneliness Scale. The predictive validity of the TFI was good for quality of life, measured by the WHOQOL-BREF, and for the adverse outcomes disability, measured using the Groningen Activity Restriction Scale, and receiving personal care, nursing and informal care.

We opted to categorise people with a score of 5 and above as frail. Sensitivity was good at this score and the specificity of the TFI was acceptable in relation to predicting the presence of adverse outcomes. At this cutpoint (≥ 5), 47.1% of the respondents (community-dwelling older persons aged 75 years and older) were found to be frail.

The study shows the TFI to be a reliable and valid instrument for measuring frailty.

**Chapter 6** focuses on answering sub-question (7) *What are the determinants of frailty in community-dwelling older people as measured using the TFI?* Part A of the TFI was used to measure the determinants, while part B was used to measure frailty. Our integral conceptual model of frailty served as the substantive starting point for this study. The model positions multimorbidity between the life-course determinants and frailty; it was assumed that multimorbidity mediates the effect of life-course determinants on frailty.

To ascertain what the determinants of frailty are, a cross-sectional study was carried out among 484 community-dwelling older persons aged 75 years and older. The study showed that the nine life-course determinants explain 25% of the frailty score on the TFI; multimorbidity explains a further 10.5%. Multimorbidity partly mediates the effect of the life-course determinants on frailty and on the physical and psychological domains of frailty, but not on the social domain of frailty.

The scores on the three domains of frailty are also found to be predicted

by different determinants: age predicts physical frailty; the occurrence of life events predicts psychological frailty; and sex predicts social frailty. Two other notable results are the non-linear effect of income on frailty (highest score on the TFI for people with an average income) and the large effect of an unhealthy lifestyle on frailty.

## GENERAL DISCUSSION

**Chapter 7**, the general discussion, summarises the main findings of the study. It then discusses a number of methodological considerations. The chapter concludes with recommendations for further research and sets out some of the practical implications and recommendations to emerge from the study.

Several instrument are currently available for measuring frailty in older persons, such as the Edmonton Frail Scale,[17] the Frailty Index[18] and the Groningen Frailty Indicator.[2] Although these instruments are also multidimensional in nature, the TFI is different in that the score on the TFI results entirely from self-reporting; moreover, the TFI contains no questions on disabilities and multimorbidity. The TFI is found to be a user-friendly instrument; the questions are clear for people aged 75 years and older, and completing the TFI questionnaire takes an average of 14 minutes.

Measuring frailty is an important step in arriving at a risk stratification; at one end of the continuum are active, non-frail older persons and at the other end are the very frail elderly. All manner of profiles can be identified between these two extremes. They may be based on the total score on the TFI or on the score on the three domains of the TFI. These profiles can then be used to guide the choice of disciplines to be deployed and interventions to be made.

The primary care system plays a crucial role in preventing frailty. The TFI can be used by primary carers (e.g. general practitioners, nurses, nurse practitioners) to identify frail older persons. This is important in order to avoid unnecessary loss of quality of life and to enable preventive or curative interventions to be effected in good time. In addition to having a proactive attitude, health care professionals must be capable of looking beyond the boundaries of their own discipline; frailty demands a multidisciplinary approach. The underlying principle for both the content and organisation of the care for frail older persons must be the integral needs of the frail individual themselves.

## REFERENCES


1. Hogan DB, MacKnight C, Bergman H. Models, definitions, and criteria of frailty. Aging Clin Exp Res 2003;15:1-29.
2. Schuurmans H, Steverink N, Lindenberg S, et al. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci 2004;59:M962-965.
3. 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:M146-156.
4. Rockwood K, Stadnyk K, MacKnight C, et al. A brief clinical instrument to classify frailty in elderly people. Lancet 1999;353:205-206.
5. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003;44:58-68.
6. Morley JE, Perry HM, 3rd, Miller DK. Editorial: Something about frailty. J Gerontol A Biol Sci Med Sci 2002;57:M698-704.
7. American Medical Association white paper on elderly health. Report of the Council on Scientific Affairs. Arch Intern Med 1990;150:2459-2472.
8. Puts MT, Lips P, Deeg DJ. Static and dynamic measures of frailty predicted decline in performance-based and self-reported physical functioning. J Clin Epidemiol 2005;58:1188-1198.
9. Bortz WM, 2nd. The physics of frailty. J Am Geriatr Soc 1993;41:1004-1008.
10. Raphael D, Cava M, Brown I, et al. Frailty: a public health perspective. Can J Public Health 1995;86:224-227.
11. 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;59:255-263.
12. Rockwood K. What would make a definition of frailty successful? Age Ageing 2005;34:432-434.
13. Strawbridge WJ, Shema SJ, Balfour JL, et al. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci 1998;53:S9-16.
14. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing 1997;26:315-318.
15. Fawcett J. Analysis and evaluation of conceptual models of nursing. 2nd edn. ed. Philadelphia, PA, USA: F.A. Davis Company, 1989.
16. Bergman H, Béland F, Karunananthan S, et al. English translation of article published in 'Gérontologie et société'. Dévelopment d'un cadre de travail pour comprendre et étudier la fragilité. Gérontologie et société 2004;109:15-29.
17. Rolfson DB, Majumdar SR, Tsuyuki RT, et al. Validity and reliability of the Edmonton Frail Scale. Age Ageing 2006;35:526-529.
18. Jones DM, Song X, Rockwood K. Operationalizing a frailty index from a standardized comprehensive geriatric assessment. J Am Geriatr Soc 2004;52:1929-1933.

# Samenvatting

## INLEIDING

Naar verwachting zal de Nederlandse samenleving de komende tientallen jaren meer oudere mensen kennen dan ooit tevoren. Dat is onder andere te danken aan de gestegen welvaart en daarmee samenhangende factoren als betere scholing, voeding en een betere gezondheidszorg. Veel ouderen beschikken over capaciteiten om succesvol oud te worden. Toch zijn er ook oudere mensen die kampen met chronische ziekten, lichamelijke en/of psychische beperkingen. Een combinatie van problemen bij oudere mensen kan worden aangeduid met de term fragiliteit, in het Engels 'frailty'. De eerste definitie van fragiliteit dateert van 1978. In dat jaar definieerde de Federal Council on Aging (FCA) fragiele ouderen als 'personen die meestal, maar niet altijd, een hogere leeftijd hebben dan 75 jaar en die vanwege een opeenstapeling van diverse voortdurende problemen frequent ondersteuning nodig hebben om het hoofd te kunnen bieden aan het dagelijkse leven'.[1] Sinds 1991 is er sprake van een significante toename van het aantal publicaties over fragiliteit en in de loop der jaren heeft fragiliteit zich ontwikkeld tot een in relevantie toenemend concept. Zo blijkt uit onderzoek dat de mate van fragiliteit bij oudere mensen een betere voorspeller voor behandeling of interventie is dan de chronologische leeftijd;[2] fragiliteit is namelijk meer direct gerelateerd aan ongewenste uitkomsten zoals ziekenhuisopnames, verpleeghuisopnames en mortaliteit.[3, 4]

Fragiliteit verwijst naar een proces dat voor elk individu uniek is. Een systematische review van Markle-Reid & Browne heeft benadrukt dat dit proces veranderbaar en omkeerbaar is.[5] Factoren die kunnen leiden tot preventie of een vermindering van fragiliteit zijn: oefeningen om het evenwicht te verbeteren, voedingsadviezen en controle van de bloeddruk.[6] De eerste stadia van fragiliteit worden vooral aangetroffen bij zelfstandig wonende ouderen. Het is dus van belang zelfstandig wonende fragiele ouderen vroegtijdig op te sporen, zodat (preventieve) interventies snel gestart kunnen worden. Hiermee kan mogelijkerwijs fragiliteit worden verminderd of kan erger worden voorkomen.

Over de definitie van fragiliteit bestaat echter geen consensus. De prevalentie van fragiliteit wordt bepaald door de definitie van fragiliteit en aangezien er verschillende definities worden gehanteerd lopen de cijfers erg uiteen. Zo rapporteerde de American Medical Association een prevalentie van 20% onder zelfstandig wonende mensen van 65 jaar en ouder;[7] Fried et al. classificeerden 7% van de zelfstandig wonende mensen (65 jaar en ouder) als fragiel.[3] De meeste definities van fragiliteit leggen sterk de nadruk op fysieke problemen bij ouderen; aan psychische en sociale problemen wordt nauwelijks aandacht besteed. Als fragiliteit vooral gedefinieerd wordt in termen van lichamelijke verliezen, dan zal bij de identificatie van fragiele

ouderen alleen worden gefocust op dat aspect. Dat kan leiden tot fragmentatie van zorg, met een gebrek aan aandacht voor de gehele persoon.

Een definitie van fragiliteit, en in het bijzonder een operationele definitie, moet kunnen dienen als basis voor het ontwikkelen van een meetinstrument, waarmee fragiele ouderen kunnen worden opgespoord. Het hanteren van een integrale benadering van fragiliteit in zowel de definitie als het instrument stimuleert multidisciplinaire zorg aan ouderen.

In **hoofdstuk 1** wordt de centrale vraagstelling van dit proefschrift ingeleid. Deze luidt als volgt: "Hoe kan fragiliteit integraal worden gedefinieerd en gemeten met als doel fragiele zelfstandig wonende ouderen te identificeren?" De specifieke vraagstellingen die in dit proefschrift worden beantwoord zijn:

(1) Welke conceptuele en operationele definities van fragiliteit komen voor de in de literatuur?
(2) Welke definities zijn het meest geschikt om fragiele nog zelfstandig wonende ouderen te kunnen identificeren?
(3) Welke bestaande conceptuele definitie van fragiliteit benadrukt het meest het integraal functioneren van oudere mensen?
(4) Welke componenten van bestaande operationele definities van fragiliteit leggen het meeste nadruk op het integraal functioneren van oudere mensen?
(5) Hoe ziet een wetenschappelijk onderbouwd en praktisch relevant integraal conceptueel model van fragiliteit eruit?
(6) Wat zijn de psychometrische eigenschappen van de Tilburg Frailty Indicator (TFI), een instrument dat gebaseerd is op een integraal model van fragiliteit?
(7) Wat zijn, gemeten met de TFI, determinanten van fragiliteit bij zelfstandig wonende ouderen?

## LITERATUURONDERZOEK

**Hoofdstuk 2** geeft het antwoord op de volgende subvragen: (1) *Welke conceptuele en operationele definities van fragiliteit komen voor in de literatuur?* en (2) *Welke definities zijn het meest geschikt om fragiele nog zelfstandig wonende ouderen te kunnen identificeren?* Om antwoorden op deze vragen te formuleren werd een literatuuronderzoek uitgevoerd.

Uit de wetenschappelijke literatuur over fragiliteit kunnen vijf criteria worden afgeleid waaraan een succesvolle definitie van fragiliteit dient te voldoen. Het eerste criterium verwijst naar de multidimensionele aard van het concept; de definitie moet niet alleen naar het lichamelijk domein verwijzen, maar eveneens naar het psychisch en sociaal domein van het menselijk functioneren. Steeds meer onderzoekers raken

ervan overtuigd dat fragiliteit breed gedefinieerd moet worden.[4, 5, 8] Het tweede criterium heeft betrekking op het gegeven dat fragiliteit een dynamisch concept is. Fragiliteit kan gezien worden als een relatieve toestand waarin iemand zich bevindt, een toestand die in de loop van de tijd kan veranderen.[8] Diverse auteurs plaatsen fragiliteit op een continuüm. Bortz plaatst fragiliteit op een continuüm tegenover vitaliteit;[9] Raphael et al. stellen fragiliteit voor op een 'frailty-hardiness continuüm'.[10] De positie op dat continuüm wordt bepaald door de complexe interactie tussen persoonlijke en omgevingsfactoren. Het derde criterium verwijst naar de voorspellende waarde van fragiliteit voor het optreden van ongewenste uitkomsten zoals ziekenhuis- en verpleeghuisopname en sterfte. Het vierde criterium duidt op het onderscheid dat gemaakt moet worden tussen fragiliteit en beperkingen (in het Engels 'disability') en comorbiditeit. Uit onderzoek van Fried et al. blijkt echter dat er wel sprake is van overlap tussen deze drie concepten.[11] Ten slotte geldt als vijfde criterium dat een succesvolle definitie van fragiliteit bruikbaar moet zijn. Een operationele definitie moet kunnen dienen als basis voor een instrument waarmee fragiele ouderen kunnen worden geïdentificeerd. Daarnaast moet de definitie aspecten bevatten waar hulpverleners (preventieve) interventies op kunnen richten.

Op basis van ons literatuuronderzoek werd geconcludeerd dat geen enkele van de bestaande conceptuele en operationele definities van fragiliteit voldoet aan de vijf criteria. Dit vormde de aanleiding om een nieuwe conceptuele en operationele definitie van fragiliteit, en een bijbehorend integraal model van fragiliteit, te ontwikkelen.

## CONSULTATIE VAN EXPERTS

Volgens Rockwood zijn er twee benaderingen mogelijk om fragiliteit te definiëren.[12] De ene benadering is accepteren dat er meerdere definities bestaan. Wetenschappelijk onderzoek zal vervolgens moeten aantonen welke definitie van fragiliteit het meest bruikbaar is voor wetenschappers en werkers in de gezondheidszorg. De andere benadering is het nastreven van consensus tussen experts op dit gebied. Om een bijdrage te leveren aan consensusontwikkeling met betrekking tot een conceptuele definitie van fragiliteit zijn experts (N = 20), afkomstig uit Amerika, Canada en Nederland, geraadpleegd. Dit gebeurde zowel schriftelijk door middel van een vragenlijst, als mondeling tijdens twee expertmeetings. Door het raadplegen van experts werd een antwoord gevonden op subvraag (3) *Welke bestaande conceptuele definitie van fragiliteit benadrukt het meest het integraal functioneren van oudere mensen?* De experts kregen elf conceptuele definities voorgelegd. Hieraan moesten zij punten toekennen. Aan de definitie die het meest voldeed aan vooraf geformuleerde

uitgangspunten (multidimensionele aard van fragiliteit, fragiliteit als een dynamisch concept) konden zij elf punten toekennen, aan de op één na beste tien punten etc. De definitie die het minst voldeed kreeg dus één punt.

**Hoofdstuk 3** presenteert de scores met betrekking tot de conceptuele definities. De definitie van Schuurmans et al.[2] behaalde de hoogste score. Zij definiëren fragiliteit als 'een verlies aan bronnen in verschillende domeinen van het functioneren, dat leidt tot een vermindering van reservecapaciteit voor het omgaan met stressoren'. Na de definitie van Schuurmans et al. behaalden achtereenvolgens de conceptuele definities van Strawbridge et al.,[13] Campbell and Buchner[14] en Fried et al.[3] hoge scores. De definitie van Schuurmans et al. beschrijft niet specifiek welke domeinen van het functioneren het betreft en ook wordt geen relatie gelegd met ongewenste uitkomsten. Dat waren voor ons redenen om vervolgens een nieuwe conceptuele definitie van fragiliteit te formuleren. Deze luidt als volgt: 'Fragiliteit is een dynamische toestand waarin een individu verkeert die tekorten heeft in één of meerdere domeinen van het menselijk functioneren (lichamelijk, psychisch, sociaal), die onder invloed van een diversiteit aan variabelen wordt veroorzaakt en die de kans op het optreden van ongewenste uitkomsten vergroot'. De nieuwe conceptuele definitie van fragiliteit verschafte een kader voor een nieuwe integrale operationele definitie van fragiliteit en voor een integraal conceptueel model van fragiliteit.

In **hoofdstuk 4** van dit proefschrift wordt allereerst de volgende subvraag beantwoord: (4) *Welke componenten van bestaande operationele definities van fragiliteit leggen het meeste nadruk op het integraal functioneren van oudere mensen?*

Voor het beantwoorden van deze vraag zijn dezelfde experts geraadpleegd. Er was sprake van consensus tussen de experts over het opnemen van de volgende componenten: kracht, voeding, uithoudingsvermogen, mobiliteit, lichamelijk actief zijn, evenwicht en cognitie. De eerste vijf componenten maken ook deel uit van een veelvuldig geciteerde operationele definitie, namelijk die van Fried et al. genoemd 'a phenotype of frailty'.[3] Op basis van de input van de respondenten en de literatuurstudie is vervolgens bij het lichamelijk domein de component zintuiglijke functies (gehoor, gezichtsvermogen) toegevoegd. Daarnaast zijn componenten toegevoegd die behoren tot het psychisch en sociaal domein. Met betrekking tot het psychisch domein betreft het de componenten stemming (depressieve symptomen, angst) en coping en met betrekking tot het sociale domein de componenten sociale relaties en sociale steun.

Vervolgens geeft **hoofdstuk 4** een antwoord op de subvraag (5) *Hoe ziet een wetenschappelijk onderbouwd en praktisch relevant integraal conceptueel model van fragiliteit eruit?* Een conceptueel model wordt gedefinieerd als 'een set van concepten

en proposities die de concepten integreren tot een betekenisvol geheel'.[15] Uit literatuuronderzoek bleek dat de meeste modellen van fragiliteit zijn gebaseerd op het medisch model. Volgens dat model kan de mens gescheiden worden in lichaam en geest, het dualisme. Een uitzondering hierop vormt het model van Bergman et al., 'A working framework in development'.[16] Dit model wordt gekenmerkt door een levensloopbenadering. Het model schetst de weg van fragiliteit naar ongewenste uitkomsten (zoals beperkingen ziekenhuisopnames en sterfte) en laat zien dat dit traject kan worden beïnvloed door een verscheidenheid aan biologische, psychologische, sociale en maatschappelijke variabelen die beschreven kunnen worden als de competenties, hulpbronnen en tekorten van een individu in zijn specifieke context. Het model sprak ons bijzonder aan omdat het multidisciplinair van aard is. Daarnaast maakt het een onderscheid tussen fragiliteit, beperkingen en comorbiditeit. Het laat bovendien zien op welke momenten in het traject van fragiliteit hulpverleners curatief dan wel preventief kunnen interveniëren.

Op basis van het model van Bergman et al. hebben we een nieuw integraal conceptueel model van fragiliteit ontwikkeld; in feite betreft het een modificatie van het model van Bergman et al. Er zijn twee grote verschillen tussen beide modellen aan te duiden. Het eerste verschil betreft het specificeren van de levensloopdeterminanten. op basis van literatuuronderzoek hebben we de volgende determinanten geselecteerd; socio-economische factoren (gevolgd onderwijs, inkomen), socio-demografische factoren (leeftijd, geslacht, burgerlijke staat, etniciteit), leefstijl, levensgebeurtenissen, leefomgeving en genetische factoren. Het tweede verschil heeft betrekking op de operationele definitie van fragiliteit. Deze bevat in het model van Bergman et al., naast de vijf componenten van 'a phenoype of frailty',[3] slechts twee componenten van het psychisch domein (depressieve symptomen, cognitieve achteruitgang); componenten van het sociaal domein ontbreken. In ons aangepaste integrale conceptuele model van fragiliteit wordt de kern gevormd door de door ons ontwikkelde integrale operationele definitie van fragiliteit. Daarin worden drie domeinen van fragiliteit onderscheiden: lichamelijke fragiliteit, psychische fragiliteit en sociale fragiliteit.

Het nieuwe model dient gevalideerd te worden door wetenschappelijk onderzoek. Zo zal de voorspellende waarde van de determinanten voor het ontstaan van fragiliteit en de voorspellende waarde van fragiliteit voor het optreden van ongewenste uitkomsten aangetoond moeten worden.

## DE TILBURG FRAILTY INDICATOR (TFI)

Op basis van het integrale conceptuele model van fragiliteit hebben we een meetinstrument ontwikkeld, de Tilburg Frailty Indicator (TFI). Met behulp van de TFI

kan worden bepaald of iemand fragiel is, in welke mate en op welk domein. De TFI is een gebruiksvriendelijke vragenlijst (zelfrapportage) voor het screenen van zelfstandig wonende fragiele ouderen. De vragenlijst bestaat uit twee delen, deel A en deel B. Deel A bevat tien vragen over determinanten van fragiliteit en deel B bevat vijftien vragen over componenten van fragiliteit. Aan de hand van deel B kan worden bepaald of er sprake is van fragiliteit en in welk domein de problemen zich manifesteren; het lichamelijk, psychisch en/of sociaal domein. Componenten die verwijzen naar lichamelijke fragiliteit zijn: onbedoeld gewichtsverlies, moeilijkheden met lopen, kracht in handen, lichamelijke moeheid, lichamelijke gezondheid, evenwicht en gehoor- en gezichtsproblemen. Cognitie, depressieve symptomen, angst en coping verwijzen naar psychische fragiliteit. Sociale fragiliteit omvat de componenten alleenwonend, sociale relaties en sociale steun.

Elf items van deel B van de TFI hebben twee antwoordcategorieën, namelijk 'ja' en 'nee'; vier items hebben drie antwoordcategorieën, namelijk 'ja', 'soms', en 'nee'; voor het berekenen van de score worden deze vier items gedichotomiseerd. De score voor fragiliteit wordt bepaald door het optellen van de antwoorden op de items. De maximale score is vijftien; dat geeft het hoogste niveau van fragiliteit weer.

Het antwoord op subvraag (6) *Wat zijn de psychometrische eigenschappen van de Tilburg Frailty Indicator (TFI), een instrument dat gebaseerd is op een integraal model van fragiliteit?* staat beschreven in **hoofdstuk 5**. De resultaten van de evaluatie van de betrouwbaarheid (test-hertest en interne consistentie) en validiteit (constructvaliditeit, predictieve validiteit) worden gepresenteerd. Daartoe werd een cross-sectioneel onderzoek uitgevoerd onder twee representatieve steekproeven (N=245; N=234) van zelfstandig wonende ouderen van 75 jaar en ouder, woonachtig in de Gemeente Roosendaal (Nederland). De test-hertest betrouwbaarheid van de TFI was goed (periode van 1 jaar): .79 voor fragiliteit, .78 voor het lichamelijk domein, .67 voor het psychisch domein en .76 voor het sociaal domein. De interne consistentie van de TFI was .73. Ook de constructvaliditeit van de TFI was goed; de vijftien afzonderlijke componenten correleerden zoals verwacht met gevalideerde schalen zoals de Timed Up & Go Test, de Four test balance scale, de Shortened Fatigue Questionnaire, de Center for Epidemiologic Studies Depression Scale, de Hospital Anxiety and Depression Scale – Anxiety Subscale, de Mastery Scale en de Loneliness Scale. De predictieve validiteit van de TFI was goed voor kwaliteit van leven, gemeten met de WHOQOL-BREF, en voor de ongewenste uitkomsten beperkingen, gemeten met de Groningen Activity Restriction Scale, en het ontvangen van verzorging, verpleging en mantelzorg.

We hebben ervoor gekozen om mensen fragiel te noemen bij een score van tenminste vijf. Bij deze score bleek de sensitiviteit goed en de specificiteit van de TFI acceptabel te zijn met betrekking tot het voorspellen van de aanwezigheid van

ongewenste uitkomsten. Bij dit afkappunt (≥ 5) bleek 47.1% van de respondenten (zelfstandig wonende ouderen van 75 jaar en ouder) fragiel te zijn.

Het onderzoek laat zien dat de TFI een betrouwbaar en valide instrument is om fragiliteit te meten.

In **hoofdstuk 6** staat het beantwoorden van de volgende subvraag centraal (7) *Wat zijn, gemeten met de TFI, determinanten van fragiliteit bij zelfstandig wonende ouderen?* Voor het meten van de determinanten is deel A en voor het meten van fragiliteit is deel B van de TFI gebruikt. Het door ons ontwikkelde integrale conceptuele model van fragiliteit heeft als inhoudelijk vertrekpunt voor dit onderzoek gefungeerd. In het model is multimorbiditeit tussen de levensloopdeterminanten en fragiliteit gepositioneerd; verondersteld werd dat multimorbiditeit het effect van de levensloopdeterminanten op fragiliteit medieert.

Om te bepalen wat determinanten van fragiliteit zijn werd een cross-sectioneel onderzoek uitgevoerd onder 484 zelfstandig wonende ouderen van 75 jaar en ouder. Het onderzoek laat zien dat de negen levensloopdeterminanten 25% van de fragiliteitscore op de TFI verklaren; multimorbiditeit verklaart een aanvullende 10.5%. Multimorbiditeit medieert deels het effect van de levensloopdeterminanten op fragiliteit en op het lichamelijk en het psychisch domein van fragiliteit, maar niet op het sociaal domein van fragiliteit.

Ook blijkt dat de scores op de drie domeinen van fragiliteit door verschillende determinanten worden voorspeld: leeftijd voorspelt lichamelijke fragiliteit, het voorkomen van levensgebeurtenissen voorspelt psychische fragiliteit en geslacht voorspelt sociale fragiliteit. Twee andere opvallende resultaten zijn: het niet-lineaire effect van inkomen op fragiliteit (hoogste score op de TFI voor mensen met een gemiddeld inkomen) en het grote effect van een ongezonde leefstijl op fragiliteit.

## ALGEMENE DISCUSSIE

In **hoofdstuk 7**, de algemene discussie, wordt een samenvatting gegeven van de belangrijkste resultaten van het onderzoek. Daarna worden een aantal methodologische overwegingen bediscussieerd. Het hoofdstuk eindigt met aanbevelingen voor verder onderzoek en met implicaties en aanbevelingen voor de praktijk.

Momenteel zijn er meerdere instrumenten waarmee fragiliteit bij ouderen kan worden vastgesteld zoals de Edmonton Frail Scale,[17] de Frailty Index,[18] en de Groningen Frailty Indicator.[2] Hoewel ook deze instrumenten multidimensioneel van aard zijn, onderscheidt de TFI zich van deze meetinstrumenten doordat de score op de TFI uitsluitend tot stand komt via zelfrapportage; bovendien bevat de TFI geen vragen

over beperkingen en multimorbiditeit. De TFI blijkt een gebruiksvriendelijk instrument te zijn; de vragen zijn duidelijk voor mensen van 75 jaar en ouder en het invullen van de TFI duurt gemiddeld 14 minuten.

Het meten van fragiliteit is een belangrijke stap om te komen tot een risicostratificatie; aan de ene kant van het continuüm bevinden zich de actieve, niet fragiele ouderen en aan de andere kant de erg fragiele ouderen. Daar tussenin kunnen allerlei profielen worden onderscheiden. Ze kunnen worden gebaseerd op de hoogte van de totaalscore op de TFI of op de score op de drie domeinen van de TFI. Van de profielen kan dan vervolgens een sturende werking uitgaan op de keuze voor de inzet van de disciplines en de uit te voeren interventies.

De eerstelijnszorg speelt een cruciale rol in de preventie van fragiliteit. De TFI kan in de eerste lijn door zorgverleners (zoals huisartsen, verpleegkundigen, nurse practitioners) worden gehanteerd om fragiele ouderen op te sporen. Dit is van belang om onnodig verlies van kwaliteit van leven te voorkomen en tijdig preventief dan wel curatief te kunnen interveniëren. Naast een pro-actieve houding moeten professionals in staat zijn over de grenzen van de eigen discipline heen te kijken; fragiliteit vraagt om een multidisciplinaire benadering. Het uitgangspunt voor zowel de inhoud als de organisatie van de zorg ten behoeve van fragiele ouderen moeten de integrale behoeften van de individuele zorgvrager zijn.

## LITERATUUR


1. Hogan DB, MacKnight C, Bergman H. Models, definitions, and criteria of frailty. Aging Clin Exp Res 2003;15:1-29.
2. Schuurmans H, Steverink N, Lindenberg S, et al. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci 2004;59:M962-965.
3. 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:M146-156.
4. Rockwood K, Stadnyk K, MacKnight C, et al. A brief clinical instrument to classify frailty in elderly people. Lancet 1999;353:205-206.
5. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs 2003;44:58-68.
6. Morley JE, Perry HM, 3rd, Miller DK. Editorial: Something about frailty. J Gerontol A Biol Sci Med Sci 2002;57:M698-704.
7. American Medical Association white paper on elderly health. Report of the Council on Scientific Affairs. Arch Intern Med 1990;150:2459-2472.
8. Puts MT, Lips P, Deeg DJ. Static and dynamic measures of frailty predicted decline in performance-based and self-reported physical functioning. J Clin Epidemiol 2005;58:1188-1198.
9. Bortz WM, 2nd. The physics of frailty. J Am Geriatr Soc 1993;41:1004-1008.
10. Raphael D, Cava M, Brown I, et al. Frailty: a public health perspective. Can J Public Health 1995;86:224-227.
11. 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;59:255-263.
12. Rockwood K. What would make a definition of frailty successful? Age Ageing 2005;34:432-434.
13. Strawbridge WJ, Shema SJ, Balfour JL, et al. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci 1998;53:S9-16.
14. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing 1997;26:315-318.
15. Fawcett J. Analysis and evaluation of conceptual models of nursing. 2nd edn. ed. Philadelphia, PA, USA: F.A. Davis Company, 1989.
16. Bergman H, Béland F, Karunananthan S, et al. English translation of article published in 'Gérontologie et société'. Dévelopment d'un cadre de travail pour comprendre et étudier la fragilité. Gérontologie et société 2004;109:15-29.
17. Rolfson DB, Majumdar SR, Tsuyuki RT, et al. Validity and reliability of the Edmonton Frail Scale. Age Ageing 2006;35:526-529.
18. Jones DM, Song X, Rockwood K. Operationalizing a frailty index from a standardized comprehensive geriatric assessment. J Am Geriatr Soc 2004;52:1929-1933.

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Bijzonder dat is het eerste woord waaraan ik denk als mij gevraagd wordt mijn promotieonderzoek kort te typeren; het was een bijzonder promotieonderzoek.

Kort nadat ik, in februari 2005, een lezing getiteld 'Empowerment van ouderen met een chronische ziekte' had verzorgd kwam lector Ria Wijnen met een vraag: Robbert heb jij zin om een promotieonderzoek te doen? Ik had niet veel tijd nodig om een besluit te nemen. Spijt dat ik toen 'ja' heb gezegd heb ik geen moment gehad. Het contact met de beoogd promotor Jos Schols was snel gelegd. Vervolgens vroeg Jos zijn collega Katrien Luijkx erbij. Op 8 maart 2005 vond het eerste overleg plaats en het voelde meteen goed. Met deze drie mensen wilde ik het traject, waarvan ik wist dat het veel van me zou gaan vergen, graag ingaan. En nu, ruim vijf jaar later, is aan dit traject een einde gekomen. Er ligt een proefschrift.

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Robbert Gobbens
Etten-Leur, mei 2010

# List of publications

Gobbens RJJ, van Assen MALM, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. Determinants of frailty. J Am Med Dir Assoc 2010; accepted for publication.

Gobbens RJJ, van Assen MALM, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. The Tilburg Frailty Indicator: Psychometric Properties. J Am Med Dir Assoc 2010; accepted for publication.

Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. In search of an integral conceptual definition of frailty. Opinions of experts. J Am Med Dir Assoc 2010; accepted for publication.

Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. Toward a conceptual definition of frail community-dwelling older people. Nurs Outlook 2010;58(2):76-86.

Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. Towards an integral conceptual model of frailty. J Nutr Health Aging 2010;14(3):175-181.

Gobbens R, Luijkx K, Wijnen-Sponselee R, Schols J. Fragiele thuiswonende ouderen. Tijdschrift voor verpleegkundigen 2009;119(3):44-46.

Gobbens RJJ, Luijkx KG, van Assen MALM, Wijnen-Sponselee MT, Schols JMGA. Measuring frailty: the Tilburg Frailty Indicator (TFI). A tool to identify frail community-dwelling older people. J Nutr Health Aging 2009;13(suppl 1):S273.

Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. Validity of an operational definition of frailty. The Gerontologist 2008;48(suppl):99.

Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. Een integrale operationele definitie van fragiliteit. Tijdschr Gerontol Geriatr 2008;39(4):19.

Gobbens R, Luijkx K, Wijnen-Sponselee R, Schols J. Fragiliteit bij ouderen: voorkomen is beter dan genezen! Tijdschrift voor Gezondheidswetenschappen 2007;85(4):187.

Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MTh, Schols JMGA. Fragiele ouderen: de identificatie van een risicovolle populatie. Tijdschr Gerontol Geriatr 2007;38(2):65-76.

Gobbens RJJ, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. Frailty in the elderly: viewed from a nursing perspective. The Gerontologist 2007;47(special issue 1):404.

# Curriculum vitae

Robbert Gobbens was born on 29 January 1963 in Goirle, the Netherlands, and grew up in the Dutch town of Etten-Leur. In 1981 he obtained his senior general secondary (HAVO) diploma at the Katholieke Scholengemeenschap in Etten-Leur. From 1981 to 1985 he studied nursing at Eindhoven University of Professional Education. After completing his military service as a nurse in the rehabilitation centre in Doorn, he began working as a district nurse for the Kruisvereniging home nursing association in Breda in 1986. During this time he came into contact with the target group of this thesis, namely frail older persons. In 1990 he began a part-time course in Health Sciences at Maastricht University, graduating in Nursing Sciences in 1993 with a dissertation entitled 'First steps towards a management information system for quality of care for the Breda home nursing association'. Later, after obtaining a grade-one teaching qualification in health care, he made the switch from health care to education. In 1997 he began teaching on the nursing degree programme at Brabant University of Professional Education. Whilst there, he followed a Senior Management Programme between 2001 and 2003. In addition to teaching and course development, he also founded a Regional Professional Practice Training Bureau. In addition, he led a project for the introduction of a competence-based curriculum and was chairman of the examinations and curriculum committee. In 2004 he joined the Gerontology teaching and research group, and shortly afterwards he began his doctoral research project focusing on frail elderly. From September 2005 to December 2009 he worked on his doctoral thesis at Tranzo (Tilburg University). Since September 2009 he has worked at Rotterdam University of Applied Sciences, where he teaches on the Master of Advanced Nursing Practice programme and performs research in the Center of expertise Integrated care for the elderly. Robbert is married to Marianne van Rooden, who is a nurse. They have four children together, Isabella, Charlotte, Rebecca and Benjamin.

Robbert Gobbens werd geboren op 29 januari 1963 te Goirle en groeide op in Etten-Leur. In 1981 behaalde hij zijn HAVO-diploma aan de Katholieke Scholengemeenschap Etten-Leur. Van 1981 tot 1985 studeerde hij verpleegkunde aan de HBO-V te Eindhoven. Nadat hij zijn militaire diensttijd als verpleegkundige had doorgebracht in het revalidatiecentrum te Doorn, begon hij in 1986 als wijkverpleegkundige bij de Kruisvereniging Breda. Daar kwam hij in contact met de doelgroep van dit proefschrift, fragiele oudere mensen. In 1990 startte hij, in deeltijd, met de opleiding Gezondheidswetenschappen aan de Rijksuniversiteit Limburg te Maastricht. In 1993 studeerde hij af in de richting Verplegingswetenschap. Zijn afstudeerscriptie was getiteld 'Een eerste aanzet tot een managementinformatiesysteem van zorgkwaliteit voor de Kruisvereniging Breda'. Vervolgens maakte hij, na het behalen van het diploma

van de Eerstegraads Lerarenopleidingen Gezondheidszorg, de overstap van de zorg naar het onderwijs. In 1997 startte hij als docent bij de HBO-V van de Hogeschool Brabant. Daar volgde hij van 2001 tot 2003 de Hoger Management Opleiding. Naast het geven en ontwikkelen van onderwijs richtte hij een Regionaal Bureau Beroepspraktijkvorming op. Daarnaast was hij projectleider voor het invoeren van een competentiegericht curriculum en voorzitter van de examen- en curriculumcommissie. In 2004 trad hij toe tot de kenniskring van het lectoraat Gerontologie. Kort daarna startte hij met zijn promotieonderzoek gericht op fragiele ouderen. Van september 2005 tot en met december 2009 werkte hij bij Tranzo (Universiteit van Tilburg) aan zijn proefschrift. Sinds september 2009 is hij in dienst van de Hogeschool Rotterdam. Daar verzorgt hij onderwijs aan studenten van de opleiding Master of Advanced Nursing Practice en verricht onderzoek vanuit het lectoraat Samenhang in de ouderenzorg. Robbert is getrouwd met Marianne van Rooden, die ziekenverzorgende is. Samen hebben zij vier kinderen, Isabella, Charlotte, Rebecca en Benjamin.