The Journal of Nutrition, Health & Aging©
Volume 14, Number 3, 2010

JNHA: NUTRITION

TOWARDS AN INTEGRAL CONCEPTUAL MODEL OF FRAILTY

R.J.J. GOBBENS[1], K.G. LUIJKX[2], M.T. WIJNEN-SPONSELEE[3], J.M.G.A. SCHOLS[4]

1. Lecturer and member of the Gerontology teaching and research group, Avans University of Applied Sciences Breda; Tranzo Academic Centre for Transformation in Care and Welfare, Tilburg University, The Netherlands; 2. Social scientist, senior researcher & research manager, Tranzo Academic Centre for Transformation in Care and Welfare, Tilburg University, The Netherlands; 3. Lecturer in Gerontology, Avans University of Applied Sciences Breda, The Netherlands; 4. Professor of Chronic Care, Tranzo Academic Centre for Transformation in Care and Welfare, Tilburg University and Professor of Nursing Home Medicine, Caphri, Department of General Practice, Maastricht University, The Netherlands. Correspondence: R.J.J. Gobbens, Tilburg University, Tranzo, PO Box 90153, 5000 LE Tilburg, The Netherlands, E-mail: r.j.j.gobbens@uvt.nl, Fax: +31 13 4663637, Phone: +31 13 4662769

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.

Key words: Frailty, elderly, definition, integral model, expert meetings.

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:

Received November 10, 2008
Accepted for publication March 6, 2009

'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 relationships' 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.

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

Figure 1
A working framework in development (32)

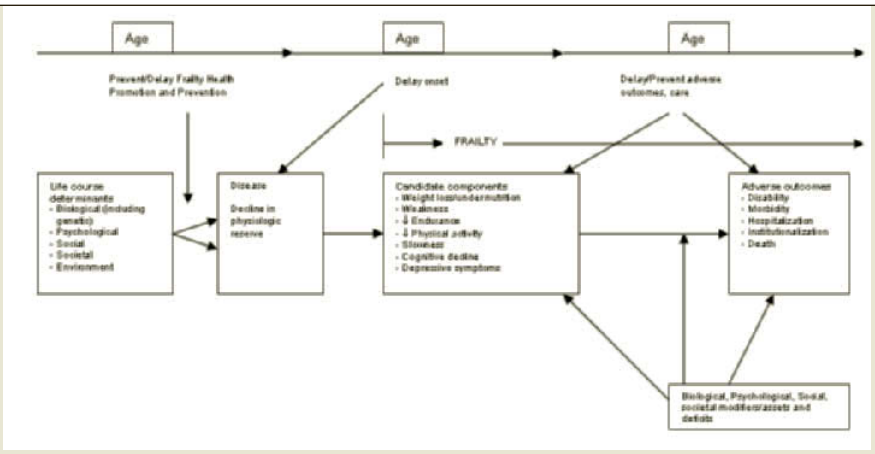
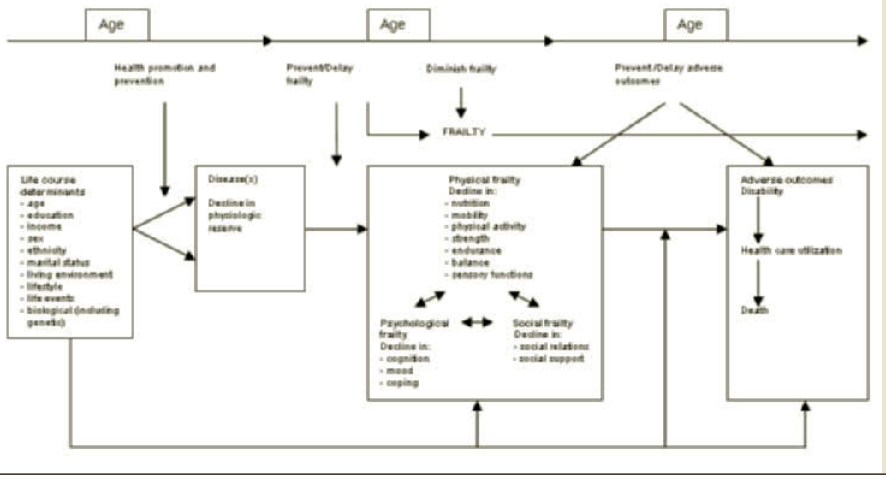


Figure 2
An integral conceptual model of frailty, based on 'a working framework in development' (32)



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).

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 institutionalization 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 utilization (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 relationships 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 relationships 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 utilization 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.

Acknowledgments: The authors would like to thank the following experts for their contribution to this study: Cochrane BB. University of Washington, Seattle, United States; Deeg DJH. VU University Medical Center, Amsterdam, The Netherlands; De Klerk MMY. Netherlands Institute for Social Research/SCP, The Hague, The Netherlands; Fried LP. The John Hopkins Medical Institutions, Baltimore, Maryland, United States; Guralnik JM. Epidemiology, Demography and Biometry, National Institute on Aging, Bethesda, Maryland, United States; Gussekloo J. Leiden University Medical Center. Leiden, The Netherlands; Kempen GIJM. Maastricht University, Maastricht, The Netherlands; Kwekkeboom MH. Avans University of Applied Sciences, Breda, The Netherlands; Mitnitski A. Departments of Medicine, Mathematics & Statistics, Dalhousie University, Halifax, Nova Scotia, Canada; Morley JE. Saint Louis University School of Medicine & Saint Louis VAMC, St. Louis, United States; Rockwood K. Dalhousie University, Halifax, Nova Scotia, Canada; Schuurmans MJ. University of Applied Sciences Utrecht, Utrecht, The Netherlands; Schuurmans H. Institute for Mental Health Care Breburg, Etten-Leur, The Netherlands; Slaets JPJ. University of Groningen, Groningen, The Netherlands; Sourial N. Jewish General Hospital. McGill University, Montreal, Quebec, Canada; van Rossum E. Maastricht University, Maastricht, The Netherlands; Que Q. The John Hopkins Medical Institutions, Baltimore, Maryland, United States.

Financial disclosure: None of the authors had any financial interest or support for this paper.

References

1. Slaets JP. Vulnerability in the elderly: frailty. Med Clin North Am. 2006 Jul;90(4):593-601.
2. Hogan DB, MacKnight C, Bergman H. Models, definitions, and criteria of frailty. Aging Clin Exp Res. 2003 Jun;15(3 Suppl):1-29.
3. van Iersel MB, Rikkert MG. Frailty criteria give heterogeneous results when applied in clinical practice. J Am Geriatr Soc. 2006 Apr;54(4):728-9.
4. Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs. 2003 Oct;44(1):58-68.
5. Rockwood K, Fox RA, Stolee P, Robertson D, Beattie BL. Frailty in elderly people: an evolving concept. Cmaj. 1994 Feb 15;150(4):489-95.
6. Buchner DM, Wagner EH. Preventing frail health. Clin Geriatr Med. 1992 Feb;8(1):1-17.
7. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing. 1997 Jul;26(4):315-8.
8. Walston J, Fried LP. Frailty and the older man. Med Clin North Am. 1999 Sep;83(5):1173-94.
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 Jan;53(1):40-7.
10. Rockwood K, Stadnyk K, MacKnight C, McDowell I, Hebert R, Hogan DB. A brief clinical instrument to classify frailty in elderly people. Lancet. 1999 Jan 16;353(9148):205-6.
11. Strawbridge WJ, Shema SJ, Balfour JL, Higby HR, Kaplan GA. Antecedents of frailty over three decades in an older cohort. J Gerontol B Psychol Sci Soc Sci. 1998 Jan;53(1):S9-16.
12. Rolfson DB, Majumdar SR, Tsuyuki RT, Tahir A, Rockwood K. Validity and reliability of the Edmonton Frail Scale. Age Ageing. 2006 Sep;35(5):526-9.
13. Ravaglia G, Forti P, Lucicesare A, Pisacane N, Rietti E, Patterson C. Development of an easy prognostic score for frailty outcomes in the aged. Age Ageing. 2008;37:161-6.
14. Bergman H, Ferrucci L, Guralnik J, Hogan DB, Hummel S, Karunananthan S, et al. Frailty: an emerging research and clinical paradigm--issues and controversies. J Gerontol A Biol Sci Med Sci. 2007 Jul;62(7):731-7.
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 Nov;56(3):282-91.
17. Fawcett. 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 Sep;34(5):432-4.
19. Ferrucci L, Guralnik JM, Studenski S, Fried LP, Cutler GB, Jr., Walston JD. 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 Apr;52(4):625-34.
20. Studenski S, Hayes RP, Leibowitz RQ, Bode R, Lavery L, Walston J, et al. Clinical Global Impression of Change in Physical Frailty: development of a measure based on clinical judgment. J Am Geriatr Soc. 2004 Sep;52(9):1560-6.
21. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001 Mar;56(3):M146-56.
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 Nov;58(11):1188-98.
23. Winograd CH, Gerety MB, Chung M, Goldstein MK, Dominguez F, Jr., Vallone R. Screening for frailty: criteria and predictors of outcomes. J Am Geriatr Soc. 1991 Aug;39(8):778-84.
24. Speechley M, Tinetti M. Falls and injuries in frail and vigorous community elderly persons. J Am Geriatr Soc. 1991 Jan;39(1):46-52.
25. Schuurmans H, Steverink N, Lindenberg S, Frieswijk N, Slaets JP. Old or frail: what tells us more? J Gerontol A Biol Sci Med Sci. 2004 Sep;59(9):M962-5.
26. Raphael D, Cava M, Brown I, Renwick R, Heathcote K, Weir N, et al. Frailty: a public health perspective. Can J Public Health. 1995 Jul-Aug;86(4):224-7.
27. Schulz R, Williamson GM. Psychosocial and behavioral dimensions of physical frailty. J Gerontol. 1993 Sep;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 Dec;13(6):443-53.
29. Morley JE, Perry HM, 3rd, Miller DK. Editorial: Something about frailty. J Gerontol A Biol Sci Med Sci. 2002 Nov;57(11):M698-704.
30. Woo J, Goggins W, Sham A, Ho SC. Social determinants of frailty. Gerontology. 2005 Nov-Dec;51(6):402-8.
31. Rockwood K, Mitnitski AB, MacKnight C. Some mathematical models of frailty and

their clinical implications. Rev Clin Gerontol. 2002;12:109-17.
32. Bergman H, Béland F, Karunananthan S, Hummel S, Hogan D, Wolfson C. 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 Apr;31(2):285-93.
34. Fried LP, Ferrucci L, Darer J, Williamson JD, Anderson G. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. J Gerontol A Biol Sci Med Sci. 2004 Mar;59(3):255-63.
35. Bortz WM, 2nd. A conceptual framework of frailty: a review. J Gerontol A Biol Sci Med Sci. 2002 May;57(5):M283-8.
36. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am. 2006 Sep;90(5):837-47.
37. Fries JF. Reducing disability in older age. Jama. 2002 Dec 25;288(24):3164-6.
38. Brown I, Renwick R, Raphael D. Frailty: constructing a common meaning, definition, and conceptual framework. Int J Rehabil Res. 1995 Jun;18(2):93-102.
39. Nourhashemi F, Andrieu S, Gillette-Guyonnet S, Vellas B, Albarede JL, Grandjean H. 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 Jul;56(7):M448-53.
40. Boyd CM, Xue QL, Simpson CF, Guralnik JM, Fried LP. Frailty, hospitalization, and progression of disability in a cohort of disabled older women. Am J Med. 2005 Nov;118(11):1225-31.
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 Feb;44(2):149-57.
42. Rockwood K, Mitnitski A, Song X, Steen B, Skoog I. Long-term risks of death and institutionalization of elderly people in relation to deficit accumulation at age 70. J Am Geriatr Soc. 2006 Jun;54(6):975-9.
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 Aug;14(4):223-5.
44. Abellan van Kan A, Rolland Y, Bergman H, Morley JE, Kritchevsky SB, Vellas B. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging. 2008 Jan;12(1):29-37.
45. Walston J, Hadley EC, Ferrucci L, Guralnik JM, Newman AB, Studenski SA, 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 Jun;54(6):991-1001.