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Frailty in the Elderly

Understanding and Managing Complexity

Edited by Sara Palermo

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Published in London, United Kingdom







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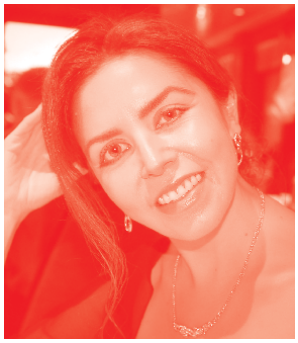

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http://dx.doi.org/10.5772/intechopen.83157
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First published in London, United Kingdom, 2021 by IntechOpen
IntechOpen is the global imprint of INTECHOPEN LIMITED, registered in England and Wales, registration number: 11086078, 5 Princes Gate Court, London, SW7 2QJ, United Kingdom
Printed in Croatia

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Additional hard and PDF copies can be obtained from orders@intechopen.com

Frailty in the Elderly – Understanding and Managing Complexity
Edited by Sara Palermo
p. cm.
Print ISBN 978-1-83968-218-6
Online ISBN 978-1-83968-219-3
eBook (PDF) ISBN 978-1-83968-220-9

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Meet the editor

Sara Palermo has an MSc in Clinical Psychology and a Ph.D. in Experimental Neuroscience. She is Specialty Chief Editor for Frontiers in Psychology – Neuropsychology and Scientific Director of the Italian National Institute of Philanthropy – Filantropolis, for which she carries out research on the psychology of giving and health. She is an ordinary member of the Italian Society of Neuropsychology (SINP), Italian Association of Psychogeriatrics (AIP), Italian Society of Neurology for Dementia (SiNdem), and International Society for Interdisciplinary Placebo Studies (SIPS). Importantly, she is a member of the European Innovation Partnership on Active and Healthy Aging (EIP on AHA), for which she is involved in the Action Group A3 for the Prevention of Functional Decline and Frailty.

Contents

Preface

The progressive and persistent growth in the number of elderly people worldwide has led to a modification of the current care scenario and a parallel increase in the use of the health resources (human, structural, economic, etc.) of this age group. These changes in combination with the lack of evidence-based data on the elderly population, and the need to rationalize limited public health resources, have contributed to discriminatory attitudes towards the elderly. Indeed, ageing is instinctively associated with the inevitable presence of pathologies and a reduction in health status. However, there is no single way of ageing, but different types of ageotypes have been identified. In view of the progressive increase in the number of elderly people with maintained cognitive abilities and functional autonomy, we now finally speak of successful ageing ("healthy ageing" or "ageing well"). This consideration creates the conditions for implementing modern ageing management strategies in both physiological and pathological forms.

However, complex clinical pictures arise in old age, due to the simultaneous presence of several diseases in the same individual of several diseases that are often chronic and not necessarily disabling. Frailty is the most problematic expression of the ageing population. It has also been used to measure degrees of interaction in a single system or to describe non-linear increases in vulnerability in relation to the number of physiological systems involved.

Chapter 1 deals with a lifespan and multisystemic perspective on frailty and proposes that clinical management must qualify itself as a "customized multidimensional approach" according to the principle of "taking care of the patient and not only of the disease." Chapter 2 discusses the concepts of frailty, operationalization strategies, and assessment tools and clarifies some ideas from the debate on what frailty is. Chapter 3 elaborates further and contributes towards reliability and validity aspects of currently applied frailty scales and indicators across different populations. It also mentions the emerging field of geropsychology. Chapter 4 discusses the existing simple, performance-based frailty screening tools that can be conducted effectively in clinical as well as home environments on the initiative of an older adult themselves or their personal physician.

Chapter 5 shifts the emphasis to the evidence that physiological and cognitive changes interfere with drug pharmacodynamics and pharmacokinetics, contributing to drug-related problems. Attention is therefore given to strategies and tools developed to assess the appropriateness of medication use in the elderly. The next two chapters focus on non-pharmacological monitoring and treatment. Chapter 6 describes exercise-based interventions as the best alternative methods for treating frailty syndrome. The focus is on presenting strategies for designing exercise programs for this type of population, considering their practical application in the field. Chapter 7 provides an overview of how the psychological environment may affect frailty, suggesting a possible role of new technology solutions and physical activity as therapeutic interventions.

The final chapter turns the spotlight on the topic of social frailty: the vulnerability of the elderly to acts of violence. This contribution analyzes the emblematic case of crimes against an elderly woman in India with the twofold aim of understanding the nature of crimes against elderly women and examining the impact of crime on the physical and emotional well-being of elderly women.

This book presents all the essential elements for identifying and managing frailty in the elderly to prevent loss of functional autonomy and the consequent deterioration of quality of life. To carry out such interventions, it is necessary to have a deep psychogeriatric culture able to contrast every insidious form of ageism. Thanks to a modern multidimensional perspective, experts dedicated to older people are increasing in number and competence, forming a stronger movement to fight ageism and protect human rights at all ages.

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Chapter 1

Frailty, Vulnerability, and Plasticity: Towards a New Medicine of Complexity

Sara Palermo

Abstract

There is no single way of ageing, but different types of ageotypes have been identified. Frailty is the most problematic expression of the ageing population. The understanding of the route linking ageing, frailty and 2nd order criticalities open new and intriguing operational perspectives. Indeed, frailty might be reversible or attenuated by interventions put in place to avoid its evolution over time. This is most true when traditional therapeutic approaches are combined with the promotion of healthy lifestyles. Not only the European Innovation Partnership on Active and Healthy (EIP-AHA) is actively involved in the promotion of healthy and active ageing, but a more aware geriatric culture toward a new medicine of complexity is spreading. The fight against frailty takes place in a lifespan and multisystemic perspective. Indeed, every individual is a dynamic, interacting, adaptable system in which the disease triggers a cause-and-effect model that cannot be considered linear. Frailty in the elderly requires therefore a customized multidimensional approach according to the principle of "taking care of the patient and not only of the disease". A bio-psycho-social model can help us to define the most appropriate interventions to promote health in terms of the best possible quality of life.

Keywords: ageing, ageotype, frailty, vulnerability, plasticity, prevention, comprehensive geriatric evaluation, medicine of complexity

1. Introduction

Ageing - whatever the age that characterizes it - cannot therefore be identified with a state of illness but must be considered a natural phenomenon that goes hand in hand with a progressive physiological and psychological transformation of the organism and that can determine - through an accentuated biological vulnerability - a greater propensity to illness [1].

Physical frailty is a condition of marked vulnerability to negative events caused by the reduction of functional reserves of multiple systems of the organism because of the ageing process and chronic polypathology. It is a condition that represents a risk factor of disability, hospitalization, institutionalization, and death [1]. But what determines frailty - not necessarily physical, but also cognitive or interpersonal - in an elderly person?

Biomedical sciences, neuroscience and epigenetics have increasingly analyzed the mechanisms that regulate structural-functional changes in the body in relation

to environmental influences. Each person has his/her own biography; each body and nervous system has its own development and use. Frailty and strength emerge in the course and within an individual story, according to a life-span perspective.

Frailty and strength constitute an oxymoron that often originates from the same semantic source. Paradoxically, it is the frailty condition that allows the discovery or rediscovery of resources and potentialities.

Frailty and strength are recognized, interwoven with affections, their formation and realization. It is the affective experiences that contribute in a decisive way to structuring an individual's personality, the feeling of security or precariousness, or the prevalence of one over the other.

Quintus Horatius Flaccus (Odi: IV, 4, v.65) argued that «*Merses profundo: pulchrior evenit*». It is frequent to observe how certain negative events allow the re-emergence of an inner strength, of a resilience, physical and motivating, which opens to new developments and opportunities. As an elderly person it is always possible, even in adverse conditions, to regain the ability to recover, to compensate, even for those who are less fortunate.

Frailty and strength interact, alternate and are continually shaped throughout life. Affectivity often represents its seismograph, but vulnerability can at the same time constitute the metronome of one's emotional instances, especially the deepest ones. The notions of "frailty" and "affectivity" recalls an ontological condition, as intrinsic to the human dimension, and offer original perspectives of investigation for multiple issues affecting the elderly. These perspectives are well highlighted by the analyses of numerous themes of both frailty-vulnerability and affectivity-emotivity in ageing developed by different disciplines (anthropology, sociology, philosophy, biology, psychology, neuroscience, medicine). It becomes relevant to understand how frailty and affectivity interact in the course of ageing, depending on what has been experienced and learned, and on what existence and life in society continue to offer.

The importance of a multidimensional assessment of the elderly to define their state of health and well-being has long been recognised. Indeed, cognitive, affective, behavioural and functional factors interact closely with somatic and socio-environmental ones.

A l bio-psycho-social model can help us to define the most appropriate interventions to promote health in terms of the best possible quality of life. This approach attributes health to the intricate and variable interaction of biological, psychological, and social factors [1, 2].

2. There is not a single ageing: from successful ageing to frailty

There is no single way of ageing, but there are as many different ageing processes as there are humans [2]. Indeed, ageing is a gradual and continuous process of natural mutation for which many bodily functions begin a gradual decline [2]. The life-span perspective recognizes changes in the functional state as characteristic of the human being ageing process [3] and are considered characteristic of the *pure ageing* [4].

Considering the continuum that goes from pure ageing to pathological ageing, one can define *successful ageing* as the situation in which the postponement or reduction of the unwanted effects related to advancing age occurs [2, 3]. The main features of successful ageing are the maintenance of physical health, an active and autonomous life; a full and satisfying emotional-relational life; prevention of ailments and disabilities. This perspective also applies to the neuropsychological domain: the label *successful cognitive ageing* can be used to refer to people whose physical health may or

may not be good, but whose cognitive profile remains exceptional [2]; at the same time, the label *typical cognitive ageing* can be used to refer to people who experience a slow loss of cognitive efficiency that does not result in a neurocognitive disorder and whose distinctive feature is the reduction of mental processing speed [3].

Different types of ageing patterns (*ageotypes*) have been identified, based on the molecular pathways that changed over time [5]: (1) metabolic (relating to the build-up and breakdown of substances in the body); (2) immune (relating to immune responses); (3) hepatic (relating to liver function); and (4) nephrotic (relating to kidney function) [5].

This type of classification provides a molecular assessment of individual ageing, reflective of personal lifestyle and medical history; indeed, ageotypes highlight the potential health risk factors and may ultimately be useful in monitoring the ageing process [2, 5]. Multimorbidity and polypharmacotherapy weakens the body and can predispose to accelerated ageing, resulting in frailty.

Frailty is certainly the most problematic expression of the ageing population [1, 2]. It is an integrated [6] and multidimensional [7] condition in which biological, functional, psychological, and social variables interact with each other. It may be relevant in identifying older people at risk of deteriorating mental health [8] and cognitive decline [9]. *Cognitive frailty* specifically refers to the co-occurrence of mild cognitive impairment and physical frailty in the absence of a major neurocognitive disorder diagnosis [10]. The presence of physical and/or cognitive frailty in the elderly increases the risk of negative outcomes and leads to greater use of health and care services [1, 2].

In the face of such a complex picture, there is yet no unambiguous operational definition of frailty that would make it possible to define a gold standard of evaluation. Experts belonging to the European Innovation Partnership on Active and Healthy (EIP-AHA) have identified two main approaches: the first concerns physical determinants (biomedical approach), while the second considers biological, cognitive, psychological, and socio-economic factors (bio-psycho-social approach). Indeed, a reliable assessment cannot be separated from the analysis of the affective, cognitive, and relational components [1].

3. From vulnerability to plasticity

Vulnerability should be considered as a predisposition of an individual exposed to a critical situation to slip into a more severe critical situation. Vulnerability and criticality define respectively a property of a process and a state within that process [11]. In this sense the definition of frailty proposed by Rozzini and Zanetti is explanatory [12]: «frailty is a condition of risk and vulnerability in the face of noxae of various kinds, which challenge the homeostatic balance of an organism. Frailty is predisposition to breakage, to damage when subjected to pressure».

Considering the above:

- *Criticality* is the condition experienced by an individual along a scale of severity and a scale of probability of occurrence. This concept is borrowed from the risk assessment process, a process from which all prevention and protection interventions for the individual are derived.

- *Vulnerability* is the degree of propensity of an individual, who experiences a less severe criticality (definable as *1st order criticality*: e.g., a bereavement, an acute illness), to slide towards a higher order of criticality (definable as *2nd order criticality*: e.g., dependence, chronicity, disability).

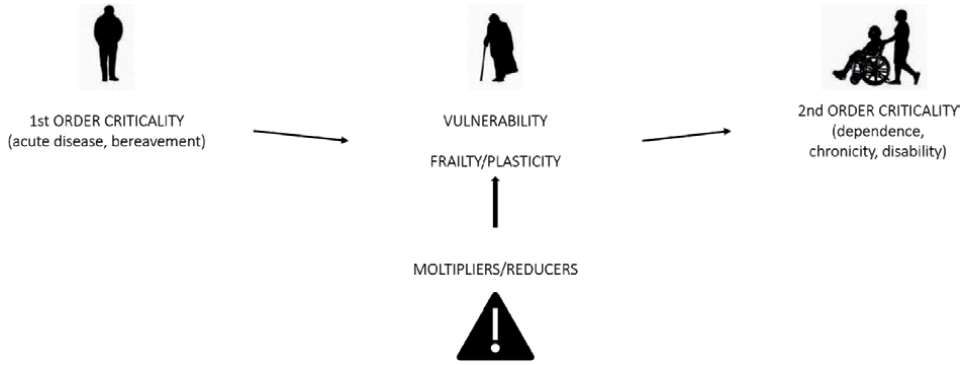

Figure 1.
Logical concatenations between the concepts of criticality and vulnerability. Adapted by Micheli [11].

The shift towards higher order critical issues is the recurring scenario in the problems of the elderly population [11]. Indeed, chronicity can be considered the final state of a path of depletion of plastic capacity (**Figure 1**). According to a *life-span perspective*, the individual shows a substantial plasticity at any given time. This *developmental reserve capacity* is specific and variable for each age and for each functional domain [11].

The understanding of the route linking ageing, frailty and 2nd order criticalities and the distinction between frailty and 2nd order criticalities have not only a pathophysiological significance. They open operational perspectives. It has been demonstrated that the route from pure ageing to 2nd order criticalities is not a one-way street, and that a regression from frailty to pre-frailty and from the latter to a "non-frailty condition" is possible [13]. Indeed, frailty might be reversible or attenuated by interventions put in place to avoid its evolution over time [14]. Many conditions of (pre)frailty can reverse their direction, so that they can move in the direction of successful ageing. This is most true when traditional therapeutic approaches are combined with the promotion of healthy lifestyles. In old age, the potential and limits of plasticity are often monitored in the neurocognitive and rehabilitative fields. The prestigious Nature has dedicated a special issue to these themes. In the cover article "Prevention: activity is the best medicine" [15] you can see two people dancing. The evidence in favor of the protective role of healthy lifestyles for the maintenance of cognitive functions is well established.

The task now is to move from lifestyle factors to interventions to find out how what kind and much exercise, what kind of intellectual activity, what kind of diet, what kind of social support and engagement (and at what stage each of them) could influence the directions of ageing.

The question of how to promote healthy lifestyles in the adult and elderly population as a prevention intervention no longer arises only at a scientific level but at a social and political level.

4. Promotion of healthy and active ageing

Recent studies have underlined the existence of a significant association between lifestyle and frailty [16, 17]. All older people are at risk of developing frailty, although risk levels are substantially higher among people with comorbidities, poor socio-economic status, poor nutrition and sedentary lifestyles [16]. However, inappropriate lifestyles and some clinical risk factors are potentially counteracted by specific interventions and preventive actions [16].

The EIP-AHA Action Group A3 has developed several multidimensional tools capable of predicting short-term negative outcomes [18]. Several factors have been highlighted as useful for proper health planning: malnutrition, polypharmacotherapy, impairment of physical function and social isolation have been identified as those on which to act to mitigate fragility and its consequences [18].

Data from a recently published study [19] also point in this direction. The Barcelona Brain Health Initiative is a longitudinal cohort study initiated in 2017 that aims to understand and characterize the determinants of brain health and intellectual efficiency in middle-aged adults. A cohort of 4686 individuals aged between 40 and 65 has been established, with no history of neurological and/or psychiatric illness. The researchers collected demographic, socio-economic, clinical and health data, associating them with assessments of perceived health status and lifestyles (general health, physical activity, cognitive activity, socialization, sleep, diet and so on). The results underline the importance of healthy lifestyles to support brain health and intellectual efficiency [19].

Consistently with the above, it is believed that the prevention and treatment of frailty can only be based on:

- promotion of healthy lifestyles.
- promotion of social inclusion and social engagement
- promotion of emotional relationships.
- timely identification of clinical-functional fluctuations and "sentinel events" (falls, urinary incontinence, sensory deficit, delirium, ...), which must be considered potential 1st order criticalities
- diagnosis and treatment of all pathologies that can be responsible for asthenia, weight loss, reduced tolerance to effort, reduced physical strength and physical activity
- intensive and frequent clinical monitoring of the elderly at risk
- adaptation of daily living environments
- reduced exposure of the frail elderly to environmental stresses (including hospitalization and unnecessary medical procedures)

5. Monitoring health in the elderly: the Active Aging Index

Active and healthy ageing is a multidimensional concept referring to a situation where the elderly persists to participate in the formal labour market, engage in voluntary activities, and live healthy, independent, and safe lives as they get older.

Active ageing policies therefore require addressing several factors: encourage healthy lifestyles, ensure social involvement, provide opportunities for independent living, and enable possibilities for longer working life. Monitoring such policy implementation requires a comprehensive tool that encompasses the multitude of aspects of active and healthy ageing. The European Commission has made the Active Aging Index (AAI) available precisely to meet this need.

The AAI captures various facets of active ageing by measuring 22 indicators grouped into 4 domains: employment, participation in society, independent

Figure 2.
The AAI has been developed within the framework of the 2012 European Year for Active Ageing and Solidarity between Generations (EY2012). The index is made up by four domains each of which reflects a different aspect of active ageing.

health and secure living, and capacity and enabling environment for active ageing (**Figure 2**). The AAI also provides a breakdown of results by gender to highlight potential differences in ageing between men and women. The index values range from 0 to 100. Higher values indicate a greater capacity to realize the unexpressed potential in old age. AAI offers a flexible framework that can be applied to different countries and at national as well as regional/local levels. It depicts the current situation and highlights the areas where future gains can be made. If computed on a regular basis, AAI allows to measure progress over time and helps to identify effective policy actions. The 2018 Active Ageing Index Analytical report reveals that since 2008 most European countries have improved their overall AAI scores [20]. This progress is probably due to increased attention to the elderly by society and politics and to the spread of a multidimensional and bio-psycho-social approach to the fight against frailty.

6. Towards a new medicine of complexity

The implementation of a bio-psycho-social approach to frailty allows an active and proactive management of a condition strongly related to chronicity, disability, and mortality. Frailty early identification can prevent or slow down the evolution towards negative outcomes, with a significant positive impact on the quality of life of the ageing population and on the health system and society as a whole [1].

The question is what the best screening protocols are and what types of intervention to carry out given the uniqueness of everyone's ageing and the type of ageotype associated with it. Indeed, the lack of effectiveness of a purely pharmacological management of frailty should be analyzed in the light of its pathophysiology.

A progressive alteration of several physiological systems induced by the interaction between the ageing process (pure ageing) with several morbid processes and multiple psycho-social and environmental conditions are involved [2, 6, 7]. After all, if the pathogenesis of frailty is multifactorial, intervention on a single physiological system will not in itself resolve frailty or even prevent it [21]. The probability of becoming frail older people increases non-linearly in relation to the number of abnormal physiological systems, and the number of abnormal systems would seem to be more predictive than the individual abnormal system involved [21]. Notably, the non-linear relationship of accelerating likelihood of frailty as the number of abnormal systems escalates suggests that there could be a threshold beyond which

there is an adverse downward spiraling nature to frailty etiology and progression. Implications are that a threshold loss of complexity, as indicated by number of systems abnormal, may undermine homeostatic adaptive capacity, leading to the development of frailty and its associated risk for subsequent adverse outcomes [21]. It also indicates that the replacement of any defective system may not be sufficient to prevent or ameliorate the whole health condition [21].

What has been indicated refers to the importance of a multidimensional approach to the elderly - and especially to the frail elderly - both in the evaluation and in taking charge of the individuals. To date, the comprehensive geriatric evaluation (CGA) is the most fruitful process to assess elderly people to optimize their subsequent management. Indeed, CGA has consistently shown its significant benefits for over 30 years [22].

However, the high speed with which the world's population ages and is affected by chronic diseases, polypathology and functional impairment is unfortunately not yet accompanied by a strong, competent, and aware geriatric culture. This unfulfilled need contributes to the further exponential increase in adverse outcomes (2° order criticalities) and to the loss of psychophysical well-being and health (which means complete happiness, as we have previously defined it) in older people.

It is increasingly evident that there is a dual need to put existing applied health research knowledge into practice (the "*know-do gap*") and the need to improve the evidence base (the "*know gap*") with respect to CGA [23].

Gladman et al. [23] discussed several barriers to the implementation of the GCA, including guiding factors, professional factors, patient factors, professional interactions, incentives, resources, capacity for organizational change, as well as social, political, and legal factors. There is little point in not actively working on *research co-production*, *practice communities* and *knowledge brokers* to overcome the main obstacles to the implementation of a multidimensional integrated approach that can bring its effectiveness in modern and novel settings. Applied health research and service innovation and development need to take place in parallel [22, 23]. These three action-domains are already inherent in the mindset of professionals as they reflect the method of academic medicine: research, clinical activity, and teaching [22]. Moreover, not only they could be realized in concerted actions of independent players/stakeholders, but they could be also greatly promoted by focusing on education and training, not only at the medical level (medical students and trainees) but also on the side of healthcare providers (multi-professional representatives of the geriatric team) [22].

Everything discussed urges geriatrics - nowadays a true medicine of complexity - to refine its cultural and operational tools and to make them available to a health system grappling with the growing problems posed by a progressively aging population.

The medicine of complexity suggests a model in which psychophysical well-being and disease are the result of complex, dynamic and unique interactions in the individual under examination: i.e., interactions between different components of the entire system. The human body is made up of interconnected, inter-reacting physiological systems, while the individual maintains a behaviour determined by experience and on the ability to adapt and interact with the environment.

The individual is therefore a dynamic, interacting, adaptable system in which the disease - and even more the polypathology - triggers a cause-and-effect model that cannot be considered linear. To this follows a situation of complexity that requires a new type of taking charge of the elderly patient. This approach to the patient accepts unpredictability and proposes solutions based on elements that are sometimes imperceptible but emerging to the clinical sensitivity of the health professional. Considering the above, two elements become substantial for a successful

CGA: to conceive the individual frail elderly person as unique and complex; to put the clinical methodology at the heart of the patient approach. These concepts are having profound consequences, introducing working methodologies based on multidisciplinary, integration, implementation, contextualized work.

To make this a concrete reality, it is essential that geriatrics share with other professionals involved in the field the cultural values that belong to them, promoting multidisciplinary confrontation and integration, so that it is possible to build a vision of intent common to all specialists and operators of the multidisciplinary team that acts around the frail elderly.

7. Conclusions

Ageing has always affected and often frightened humans, which since ancient times has been well aware that the biological changes connected with the passing of the years induce a progressive weakening of functional capacities, a decay of physical or mental conditions, an increasing difficulty in carrying out tasks that were once easy to perform.

Publio Terenzio Afro (160 B.C.) referred to the physical ailments and privations that usually accompany senescence with the well-known sentence «*Senectus ipsa est morbus*» (Phormio: IV, v.575). This vision of old age is refuted by Cicero, who in the Cato Maior de senectute (40 B.C.) affirms: «each part of life has its own character, so that the weakness of children, the boldness of young people, the seriousness of manhood and the maturity of old age bear their own natural fruit which must be harvested in time». Cato begins his calm argument: he examines the criticism commonly levelled at old age and disproves it, with examples taken from Greek and Roman history. The accusations examined are physical weakness and decadence; the weakening of intellectual capacity; the impossibility of enjoying the pleasures of the senses; the bizarreness of character and avarice. Cicero explicitly extols the advantages of old age, which he calls not an involution but an evolution of the individual's biological capacities. Cicero emphasizes through the mouth of Cato the Censor the ability of the elderly to make a positive contribution to society and future generations, reassessing their social role and placing them in a position worthy of respect and consideration.

Health should be considered as the ability to identify and realize one's aspirations, to satisfy one's needs and to positively modify the surrounding environment. The elderly is in good health if they maintain a condition of self-sufficiency as much as possible, psychophysical well-being, and positive thinking about the future.

Frailty in the elderly requires a customized multidimensional approach that cannot be segmented into isolated interventions for each pathology, taking into account individual differences - not only clinical but also socio-relational and environmental differences - according to the principle of "taking care of the patient and not only of the disease".

There are many health problems in the elderly, and one wonders whether it is appropriate to take action not only as health professionals but also individually to counter them or to stem the consequences: if each of us adopted healthy habits and made ourselves the bearer of them we would have done something - perhaps modest on an individual level but important on a collective level to counter the "silver tsunami" which could jeopardize our old age and the stability of our society.

The fight against frailty takes place in a life-span perspective. A bio-psycho-social model can help us to define the most appropriate interventions to promote the best quality of life. This approach attributes health to the intricate and variable interaction of biological, psychological, and social factors.

Such a multidimensional approach is fundamental when it comes to the elderly and the promotion of healthy and active ageing.

Acknowledgements

No funding was available to the author.

Conflict of interest

The authors declare that the manuscript was written in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Thanks

There are many ways to age and grow old can be frightening: all sorts of losses to deal with, a body and mind less vigorous and brilliant than it once was, sometimes memory becomes clouded, self-awareness diminishes and loved ones disappear. However, there are older people who make you want to grow old. They have not been spared by life, but for them growing old is like continuing their adventure. They seem to keep in the form of inner riches those outer ones they have lost and discover new possibilities and freedom. I thank the senior students at the University of the Third Age of Turin for being a source of inspiration and teachers of life. To them, who taught me what it means to have a soul that is always young, every effort I make is dedicated.

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References

[1] Morese R, Palermo S, Defedele M, Nervo J, Borraccino A. Vulnerability and Social Exclusion: Risk in Adolescence and Old Age. In: Morese R, Palermo S, editors. The New Forms of Social Exclusion. London: IntechOpen Limited; 2019. p. 1-16. DOI: 10.5772/intechopen.85463

[2] Palermo S. Covid-19 pandemic: Maximising future vaccination treatments considering ageing and frailty. Front. Med. 2020; 7:558835. DOI: 10.3389/fmed.2020.558835

[3] Smith GE, Bondi MW. Mild Cognitive Impairment and Dementia: Definitions, Diagnosis, and Treatment. Oxford: OUP USA; 2013. 416 p. ISBN: 0199764182

[4] Wise DA. Analyses in the Economics of Aging. Chicago: University of Chicago Press; 2005. 416 p. ISBN: 0-226-90286-2

[5] Ahadi S, Zhou W, Schüssler-Fiorenza Rose SM, et al. Personal aging markers and ageotypes revealed by deep longitudinal profiling. Nat Med. 2020; 26(1):83-90. DOI: 10.1038/s41591-019-0719-5

[6] Gobbens RJ, Luijkx KG, Wijnen-Sponselee MT, Schols JM. In search of an integral conceptual definition of frailty: opinions of experts. J Am Med Dir Assoc. 2010; 11(5):338-343. DOI: 10.1016/j.jamda.2009.09.015

[7] Sourial N, Wolfson C, Bergman H, et al. A correspondence analysis revealed frailty deficits aggregate and are multidimensional. J Clin Epidemiol. 2010; 63(6):647-654. DOI: 10.1016/j.jclinepi.2009.08.007

[8] Ní Mhaoláin AM, Fan CW, Romero-Ortuno R, et al. Frailty, depression, and anxiety in later life. Int Psychogeriatr. 2012; 24(8):1265-1274. DOI: 10.1017/S1041610211002110

[9] Nishiguchi S, Yamada M, Fukutani N, et al. Differential association of frailty with cognitive decline and sarcopenia in community-dwelling older adults. J Am Med Dir Assoc. 2015; 16(2):120-124. DOI: 10.1016/j.jamda.2014.07.010

[10] Kelaiditi E, Cesari M, Canevelli M, et al. Cognitive frailty: rational and definition from an (I.A.N.A./I.A.G.G.) international consensus group. J Nutr Health Aging. 2013; 17(9):726-734. DOI: 10.1007/s12603-013-0367-2

[11] Micheli GA. Vulnerabilità e radicamento. In: Cristini A, Cesa-Bianchi M, Porro A, Cipolli C, editors. Fragilità e affettività nell'anziano. Milano: Francoangeli; 2015. p. 79-96. ISBN: 978-88-917-1457-2

[12] Rozzini R, Zanetti O. Fragilità e malattie. In: Rozzini R, Morandi A, Trabucchi M, editors. Persona, salute, fragilità. Milano: Vita e pensiero; 2006. p. 35-56. EAN: 9788834313862

[13] Gill TM, Gahbauer EA, Allore HG, Han L. Transitions between frailty states among community-living older persons. Arch Intern Med. 2006;166(4):418-423. DOI: 10.1001/archinte.166.4.418

[14] Chen X, Mao G, Leng SX. Frailty syndrome: an overview. Clin Interv Aging. 2014; 9:433-441. DOI:10.2147/CIA.S45300

[15] DeWeerdt S. Prevention: Activity is the best medicine. Nature 2011; 475: S16–S17. DOI: 10.1038/475S16a

[16] Hoogendijk EO, Afilalo J, Ensrud KE, Kowal P, Onder G, Fried LP. Frailty: implications for clinical practice and public health. Lancet. 2019; 394(10206):1365-1375. DOI: 10.1016/S0140-6736(19)31786-6

[17] Wang X, Lu Y, Li C, et al. Associations of lifestyle activities and

a heathy diet with frailty in old age: a community-based study in Singapore. Aging (Albany NY). 2020; 12(1):288-308. DOI: 10.18632/aging.102615

[18] Liotta G, Ussai S, Illario M, et al. Frailty as the Future Core Business of Public Health: Report of the Activities of the A3 Action Group of the European Innovation Partnership on Active and Healthy Ageing (EIP on AHA). Int J Environ Res Public Health. 2018;15(12):2843. DOi: 10.3390/ijerph15122843

[19] Cattaneo G, Bartrés-Faz D, Morris TP, et al. The Barcelona Brain Health Initiative: Cohort description and first follow-up. PLoS One. 2020; 15(2): e0228754. DOI: 10.1371/journal.pone.0228754

[20] EU Commission. Active Ageing Index Analytical report 2018 [internet]. Available from: https://www.unece.org/population/aai.html

[21] Fried LP, Xue QL, Cappola AR, et al. Nonlinear multisystem physiological dysregulation associated with frailty in older women: implications for etiology and treatment. J Gerontol A Biol Sci Med Sci. 2009;64(10):1049-1057. DOI: 10.1093/gerona/glp076

[22] Polidori MC, Roller-Wirnsberger R. Chances and challenges of comprehensive geriatric assessment training for healthcare providers. Geriatric Care 2018; 4(4):79-83 DOI: 10.4081/gc.2018.7853.

[23] Gladman JR, Conroy SP, Ranhoff AH, Gordon AL. New horizons in the implementation and research of comprehensive geriatric assessment: knowing, doing and the 'know-do' gap. Age Ageing. 2016;45(2):194-200. DOI: 10.1093/ageing/afw012

Chapter 2

Current Perspectives on Frailty in the Elderly, Evaluation Tools and Care Pathways

Wilson Abreu and Margarida Abreu

Abstract

The concept of frailty is frequently mentioned in studies related to the elderly population. Frailty in the elderly is considered a relevant dimension of quality of life. The concept of frailty has grown in importance because of a need to evaluate the health status of older persons and a need to prevent or at least delay late-life disability and total dependence on self-care. There is to date no clear consensus regarding the definition of frailty; some definitions have been proposed, each with their own strengths and weaknesses. Just as conceptual disagreements arise about what frailty means, there are also disagreements about how to assess it. However, as researchers deepen the concept of frailty and the way to operationalize it, scales and inventories appear that allow us to have a more precise idea of the state of frailty. This aspect is extremely important because assistance strategies may depend on it. One of the most cited aspects is the assessment of the need to provide palliative care. In this chapter, we intend to review the concepts of frailty, operationalization strategies and assessment tools and clarify some ideas from the debate on what frailty is.

Keywords: cognition, dependence, elderly, frailty, functionality

1. Introduction

The concept of frailty is frequently mentioned in studies related to the elderly population—health status, self-care dependence, healthcare resources or even the configuration of the wards where care is provided. Looking at the scientific knowledge and clinical practice, frailty in the elderly is considered a relevant dimension of quality of life. Moreover, there is a tendency to accept that individuals with severe frailty have to be considered vulnerable and should be protected.

Frailty has been viewed as a cornerstone of geriatric medicine and a platform of biological vulnerability to a host of other geriatric syndromes and adverse health outcomes [1], such as long-term nursing home stay, injurious falls and death, in community-dwelling older adults independent of medical comorbidities and age. The expression "frailty elderly" was used for the first time in 1970, by researchers from the Federal Council on Aging (FCA) of the United States, with the purpose of describing elderly people who lived in unfavourable socioeconomic conditions and presented physical weakness and cognitive deficit that, with advancing age, began to demand more care; in the 1980s, frailty in the elderly people was understood

mainly as synonymous of disability or the presence of a disease, chronic or extreme condition linked with ageing [2]. In 1990, the expression "frailty elderly" was referred for the first time on the *Journal of the American Geriatrics Society* index [2].

The term "frailty" started to be used frequently in terms of diagnosis, clinical decisions and provision of care. Frailty and cognitive and functional decline are relatively common in older dependent people with health problems. One of the challenges for researchers today has been to study the physical characteristics and psychological symptoms of frailty and to relate them to adverse health outcomes. In this chapter, we intend to analyse the matters that have most attracted the attention of researchers and health professionals who deal with people in situations of frailty.

Understanding frailty has become crucial for caring for the elderly. In older people with dementia, the assessment of frailty is more important than determining the degree of dementia, since it is crucial to develop appropriate care people need; there are old people with moderate dementia but with a severe level of frailty.

In this chapter, we intend to review the concepts of frailty, operationalization strategies and assessment tools and clarify some ideas from the debate on what frailty is.

2. Concept of frailty

The concept of frailty has grown in importance because of a need to evaluate the health status of older persons and a need to prevent or at least delay the onset of late-life disability and its adverse consequences [3]. There is to date no clear consensus regarding the definition of frailty; some definitions have been proposed, each with their own strengths and weaknesses [3].

Frailty is a multidimensional concept and can be defined as a dynamic state that affects an individual with declines in one or more domains, such as physical, cognitive, social, attention or senses [4]. There is usually a dependence on self-care and need of support from others. Elderly does not mean frailty, but the ageing process led to frailty, which means that there are changes that reflect ageing-related alterations and involve intrinsic and extrinsic factors which are typical of ageing.

The occurrence of frailty is mainly a state of vulnerability resulting from comorbidities and the overall decline in organ functions. The progression to later stages of dementia often signals a loss of autonomy, dependence and reduction in physical and cognitive function. Frailty of people is positively related with their caregiver burden and associated with higher levels of depression on the caregiver. A lack of understanding about frailty has been identified as a barrier to providing optimal care to elderly people, for example, people with advanced dementia [4].

Frailty is an emerging concept used in the field of geriatrics and gerontology, to make reference to the clinical condition of the elderly. There is a deficit of information regarding the incidence and prevalence of frailty in the elderly, mainly due to the lack of consensus definition that can be used as reference in different populations. There is usually a "clinical sense" about what is frailty and what a frail elderly person is, but there is no agreement, a standard definition regarding this concept, that can assist in the diagnosis of frailty condition. As mentioned above, frailty is often considered an inherent condition of ageing, an attitude that can cause late interventions with minimal potential for prevention or reversing the consequences and adverse effects from the problem.

The concept of frailty, widely used in the recent years, focuses primarily on the physical dimensions. That is why it is understood that the criteria for assessing presence/absence are the physical signs and symptoms, sedentary behaviour, weight loss, exhaustion, slowed gait, decreased muscle strength, with three or more

of these five criteria we are facing physical frailty and the presence of one or two criteria indicates pre-physical frailty [5].

The diagnosis of frailty relies currently on the assessment of a small subset of easily measurable clinical markers. Just as conceptual disagreements arise about what frailty means, there are also disagreements about how to evaluate it. While recognizing the multifactorial nature of frailty, it is important to develop an "operational definition" of frailty that is simple enough to be used clinically and to guide prevention and care [3].

Frailty among older persons appears in the investigation as a dynamic process, characterized by frequent changes over time. The evolution of frailty incorporates quantitative and qualitative data, which motivated researchers to invest in modelling. Recent studies have highlighted age, medical factors and higher socioeconomic status to be protective [6]. In the study carried out by the *Canadian Study of Health and Aging* (CSHA) [6], it was concluded that cognitive status and frailty are associated. Functional decline contributes to increase costs in caring for people with dementia. Despite all the research related to Alzheimer's disease, very little has been indicated as effective therapies to deal with the disease, although it is known that cognitive decline is one of the first symptoms to appear and that interventions at this level can delay the evolution of the disease [6].

Andrade et al. [2] state that currently, two research groups have distinguished in the pursuit of consensus on the definition of frailty in the elderly: one of them in the United States, at the Johns Hopkins University, and the other one in Canada, the Canadian Initiative on Frailty and Aging (CIF-A). The group of researchers from the Johns Hopkins University produced an operational definition of frailty in the elderly and proposed measurable and objective criteria to the phenomenon. This operational definition starts from the hypothesis that the term is a geriatric syndrome and it can be identified by means of a phenotype that includes five measurable components: (a) unintentional weight loss, greater than 4.5 kg or more than 5% of body weight in the last year; (b) signs of fatigue; (c) reduction of handgrip strength, assessed with a specific instrument and adjusted to the person's sex and body mass; (d) little physical activity assessed by calorie consumption (measured in kcal), adjusted by sex; and (e) reduction of march activity in seconds, distance of 4.5 m adjusted by gender and height [2].

A second definition was formulated by researchers from the CIF-A, indicated above. This is based on a multidimensional construct—frailty was defined using a more holistic approach, which emphasizes the complex aetiology of the phenomenon, understood as a not optimal condition in elderly, multifactorial and dynamic in nature, relating it to its history or trajectory of life [2]. The indicated trajectory can be shaped by biological, psychological and social, whose interactions result in resources and/or individual deficits in a given context. A tool was developed to measure frailty in the elderly—the Edmonton Frail Scale (EFS)—contemplating nine domains: (I) cognition, (II) general state of (III) functional independence, (IV) support, (V) medication use, (VI) nutrition, (VII) humour, (VIII) continence and (IX) functional performance. These authors consider this scale more comprehensive, especially considering aspects of cognition, humour and social support [2].

3. Types and dimensions of frailty

Some definitions of frailty promote a multidimensional approach based on an evaluation according to "frailty indexes", which are calculated considering the accumulation of possible deficits, such as the presence of diseases, abnormal laboratory values, signs and symptoms or disabilities [7, 8].

It is difficult to establish a typology of frailty, given its multidimensional nature. On the one hand, frailty results from an articulation of factors of a physical and psychological nature. On the other hand, it is possible to assess frailty to highlight one or another aspect. Also, the investigation indicates that emotional management strategies can interfere with the signs and symptoms of frailty and with the ability to adjust to different disabilities.

Given the definitive trends in frailty, and although the creation of a typology is sometimes an academic task, we will try to describe four types of frailty in the elderly, on the assumption that they intersect and present common dimensions: physical, cognitive, social and emotional.

Frailty is a clinical situation known for the great vulnerability of the person in terms of the different physiological systems. In addition to the physical dimension, frailty is characterized by problems at the social, emotional and cognitive levels, despite the possibility of delaying its evolution in early stages [3, 9]. Fried et al. [10] proposed a clinical phenotype of frailty, defining it as a situation of increased vulnerability in the person for homeostatic resolution after pronounced distress. This growing vulnerability increases the risk of adverse outcomes, such as falls, fractures, hospitalization and ultimately mortality in elderly people living in organizations in the community or in their own homes.

Four main mechanisms can be identified in the progression of frailty: atherosclerosis, sarcopenia, cognitive deterioration and malnutrition [11]. It has been proven that malnutrition can be the cause of cognitive and functional decline and that the lack of some nutrients can cause cognitive frailty and vascular dementia [11].

There is an evident relationship between functionality and cognition, as evidenced by research evidence and some assessment tools (e.g., Clinical Dementia Rating). Many cross-sectional studies demonstrated the relationship between general cognitive function, emotions and physical frailty [12]. However, it is important to keep in mind that the decline in cognition and capacity of emotional management, given its functions and nature, evokes so many limitations to functionality that it becomes relevant to consider a cognitive frailty as a specific type.

Many studies have focused on the proposed entity of "cognitive frailty" to describe a clinical condition that is characterized by simultaneous occurrence of physical frailty and cognitive impairment in the absence of overt dementia [13]. Alzheimer's disease is characterized by an association between physical and cognitive decline, but in the opposite direction, people with physical limitations are more predisposed to suffer emotional and cognitive problems. However, it should be noted that in recent years studies are more focused on physical frailty, with a relative paucity of data available for concomitant transitions in cognitive status [6].

An International Consensus Group studied the "cognitive frailty" condition. "Cognitive frailty", although so defined, implies the presence of physical and cognitive decline. The key symptoms to characterize cognitive frailty are as follows: (1) presence of physical frailty and cognitive impairment and (2) exclusion from the concomitant presence of any type of dementia [14]. At the same time, the group indicated that "cognitive frailty" implies a rigorous diagnosis in terms of memory performance but also of other cognitive functions [14].

"Cognitive frailty" could represent a cognitive entity with specific neuropsychological patterns (executive and selective attention) [14]. The mechanisms in action and how deterioration occurs are not yet fully understood.

The loss of emotional management capacities and of establishing social interactions generates potential situations of frailty. It is also evident that any types of frailty (physical or psychological) also interfere with the emotional and social spheres. Usually, people with frailty (with cognitive impairment) experienced high

levels of emotional discomfort and behavioural changes. Even without significant cognitive changes, symptoms usually emerge that emphasize the importance of emotions and social interactions: sadness, loneliness, nervousness, concern for oneself, self-concept, self-care and sense of hope.

The relationship between emotions, behaviour and frailty emerges in studies that explore this association. Emotion, which can be considered positive or negative, interferes with the perception of self-efficacy and the subjective sense of well-being. Furthermore, studies conducted in older adults found that positive emotions were associated with lower disability in the execution of daily living activities, higher levels of mobility, less physical dependence and major likelihood of survival, as well as higher level of adjustment to chronic health problems; on the other hand, negative emotions are correlated with stress sensations and poor coping abilities [15].

Clark and Watson [16] emphasize the relationship between emotions and functionality, which is understood by the well-known association between emotions and behaviour. They concluded, in a study carried out with older adults, that positive emotions may be associated with lower disability in the execution of daily living activities, better mobility, good functional status and major likelihood of survival; on the contrary, negative emotions can be correlated with distress and poor coping abilities. Mulasso et al. [15] provide empirical evidence to the multidimensional theorization and definition of frailty, hypothesizing that a reduced level of positive emotions and high level of negative emotions may contribute to increases in the severity of frailty condition; on the other hand, they highlighted the role of emotion experience in interventions for the prevention of frailty, such as interventions of physical exercise or cognitive training associated with frequent experience of positive emotions.

Simultaneously, studies emphasize also the need to identify risks for frailty [4, 6, 9]. All dimensions that constitute limitations on functionality, carrying out activities of daily living, cognitive impairment and social isolation can and should be considered risks for frailty [4]. There are currently models, mathematical equations and Bayesian networks that allow identifying these risks and even predicting them, conjugating certain variables. Usually, these models take into account demographic, social and clinical variables. These models can have good performance, isolated or conjugated with other evaluation tools. Moreover, they can predict frailty evolution and enable dependent persons to be identified for further specific assessment or interventions.

4. Frailty: evidences from research

There are many studies that explore frailty, types of frailty and predictors of frailty every year. The relationship between frailty and functionality and the psychological sphere and relationship between the frailty of the recipient of care and burden on the caregiver are increasingly studied.

Armstrong et al. [17] used of a large database (n = 23,952) with comprehensive health information on home care clients (aged 65+) of eight Community Care Access Centres (CCACs) in Ontario, Canada. In this large cohort of older home care clients, they found that greater evidence of frailty as defined by each of the three measures was associated with greater risk of adverse outcomes. This result additionally confirmed the potential utility of a frailty concept for identifying vulnerable individuals within the home healthcare sector. They concluded that mathematical models can utilize data collected during clinical assessments to provide a quantitative indicator of a client's level of frailty.

Dudzińska-Griszek, Szuster and Szewieczek [18] developed a study whose aim was to assess conditions that influence grip strength in geriatric inpatients. A comprehensive geriatric assessment was complemented with assessment for the frailty phenotype. Functional assessment included Barthel Index of Activities of Daily Living (Barthel Index), Instrumental Activities of Daily Living Scale and Mini-Mental State Examination. The conclusion was that cognitive function, somatic comorbidity and medical treatment affect grip strength as a measure of physical frailty in geriatric inpatients.

A retrospective cohort study on 18,341 Medicare Advantage enrollees aged 65+ was conducted by Anzaldi et al. [19] in Massachusetts. When analysing the clinical information systems, they identified the presence of 10 syndromes commonly found in the elderly (falls, malnutrition, dementia, severe urinary incontinence, absence of faecal control, visual impairment, walking impairment, pressure ulcers, lack of social support and weight loss), as well as references to the presence of frailty identified in the natural language processing (NLP) algorithm. The main conclusion was that patients identified as "frail" by providers in clinical notes have higher rates of healthcare utilization and more geriatric syndromes than other patients. Certain geriatric syndromes were more highly correlated with descriptions of frailty than others.

Shimada et al. [20] studied the cognitive frailty in 4570 older adults. The aim of the study was to analyse the extent to which a new perspective of cognitive frailty could be considered as a predictor of dementia. There are 2326 women and the average age was 71.9 ± 5.5 years. Physical frailty was defined as the presence of more than one of these symptoms: slow walking speed and muscle weakness. Cognitive frailty was defined as comorbid physical frailty and cognitive impairment. They concluded that cognitive impairment and cognitive frailty could be considered risk factors for dementia. Findings showed clearly that individuals with comorbid physical frailty and cognitive impairment could have a higher risk of dementia than healthy older adults or older adults with either physical frailty or cognitive impairment alone.

The estimation of the prevalence of frailty in patients admitted to intensive care unit (ICU) and its impact on intra-ICU mortality, at 1 month and at 6 months, was developed by Cuenca et al. [21]. A prospective cohort study was conducted. Frailty was present in 35% of patients admitted to the ICU, associated with higher rates of mortality.

Ma et al. [22] carried out a study to determine social frailty status via developing a simple self-reported screening tool, termed the HALFT scale, and to examine the association between social frailty and physical functioning, cognition, depression and mortality among community-dwelling older adults. They state that social frailty is related to adverse health-related outcomes. Moreover, they added that research into the relationship between social frailty and physical functioning remains limited. A prospective cohort study was carried out, with 1697 community-dwelling adults aged ≥60 years from Beijing. The scale developed was based on five items: unhelpful to others, limited social participation, loneliness, financial difficulty and not having anyone to talk to.

The prevalence of social frailty in the participants was 7.7%. Social frailty was positively associated with physical frailty, low levels of physical activity and poor physical functioning. Researchers also found that social frailty was associated with dementia, memory decline, depression and cognitive impairment. Having experienced a negative or traumatic event was also associated with social frailty. Additionally, social frailty was associated with physical functioning, cognition and depression and predicts mortality; they emphasize that interventions aimed at preventing or delaying social frailty are warranted.

In a cross-sectional study carried out by Mulasso et al. [15] the association between frailty and emotional experience was studied in a sample of Italian

community-dwelling older adults. Participants consisted of 104 older adults (age 76 ± 8 years; 59.6% women) living in Italy. Frailty and emotion perception were measured with appropriate and valid tools. The Mini-Mental State Examination was used as a screening tool for cognitive functions (people with a score ≤ 20 points were excluded). The researchers stated that frailty increases individual vulnerability to external stressors and involves high risk for adverse geriatric outcomes [15]; findings demonstrate that emotion perception may influence frailty, which is really relevant for the evaluation and prevention of frailty in older adults.

A theoretical study based on research studies that equate the role of nutrition and nutrients in cognitive and functional decline was developed by Gomez-Gomez and Sapico [23]. They state that one of the most important factors to consider in the development of cognitive deterioration is oxidative stress. Consequently, they added that increasing antioxidants in the diet may be one of the therapeutic strategies in the management of these patients.

Some studies were analysed, mainly those that showed the effectiveness of antioxidants in the adjustment of oxidative stress, given their function as free radical scavengers, or factors that potentiate the antioxidant effect. Anyway, the studies emphasized that the inappropriate use of antioxidants could have side effects and become toxic at high doses. Given the multiplicity and some divergence in the results, additional studies are required as well as clinical trials to increase the clinical effectiveness [23].

Several studies were analysed, namely, those that have shown the effectiveness of antioxidants in the adjustment of oxidative stress, either by their function as free radical scavengers or potentiating the antioxidant effect. Studies showed that the inappropriate use of antioxidants could have side effects and toxicity at high doses. However, it was indicated that additional studies are required as well as clinical trials to increase the clinical effectiveness [23].

Abreu et al. [4] examined the healthcare needs of community-dwelling older people, trying to understand the relationship between frailty, functional dependence and healthcare needs among community-dwelling people with moderate to severe dementia. A sample of 83 participants was recruited. The Edmonton Frail Scale was used to evaluate frailty, in addition to tools that were chosen to collect data on other variables. A set of 26 healthcare needs was defined to support the assessment. There was a significant association between "severe frailty" and "severe dementia" and "fully dependent" and "severely or fully dependent in the activities of daily living". The most prevalent healthcare needs in the sample were food preparation, medication/taking pills, looking after their home, toilet use, sensory problems, communication/interaction, bladder, bowels, eating and drinking, memory, sleeping and fall prevention. In particular, the study shows a set of needs that are present simultaneously in both frailty and dementia stages, according to their severity. They found in the study that 16.7% of people with moderate dementia were also diagnosed with severe frailty. Concerning the needs assessment, the authors state that the concept of "severe dementia" is clearly a limiter in the matter of frailty. As an alternative, they suggest the expression of "advanced dementia", encompassing people with severe dementia and people with moderate dementia but who also have severe frailty.

5. Evaluation and measures of frailty

Usually, scales assess some domains of frailty in old people (cognition, general health status, functional independence, social support, medication usage, nutrition, mood, continence and functional performance). These tools are important on clinical point of view, for research and decision-making. Several tools that evaluate

functionality and cognition also evaluate several dimensions that we are traditionally including in frailty.

Armstrong et al. [17] indicate, in the scope of their study, three conceptually different approaches to the measurement of frailty: (1) Changes in Health, End-Stage Disease and Signs and Symptoms (CHESS) scale, (2) Edmonton Frail Scale (EFS), (3) the frailty index (FI) and the Tilburg Frailty Indicator (TFI).

The CHESS scale is a tool that uses information from the person's clinical assessment, which is used to calculate the person's level of decline. The tool was developed using statistical methods, based on the items available in the inter-RAI instruments. It is not a tool for objectively assessing frailty, but it allows assessing the "instability" of health status, which is also a predictor of mortality [17]. The scores ranging from 0 (meaning no instability) to 5 (for the highest level of instability) have been demonstrated to be a strong predictor of mortality ($P < 0.0001$) in continuing care patients [24].

The EFS is a brief multidimensional clinical measure, widely used and designed to use in both inpatient and outpatient settings [25]. The scale assesses nine domains of frailty in old people (cognition, general health status, functional independence, social support, medication usage, nutrition, mood, continence and functional performance) [25]. Total score can vary from 0 to 17. The participants were classified into categories, and a higher score represents a higher degree of frailty. Severe frail and non-frail participants were defined according of the EFS score from not frail (0–5), vulnerable (6–7), mild frailty (8–9), moderate frailty (10–11) and severe frailty (12–17). The EFS is a measure of frailty compared to the clinical impression of specialists after their more comprehensive assessment. A larger part of the assessment tools is focused primarily on determining the person's level of functioning in terms of managing activities of daily living and instrumental activities of daily living. In post-operative older adults, high scores on the EFS have been shown to be associated with increased complications and a lower chance of being discharged home after surgery [17].

The FI was developed by Rockwood and Mitnitski based on an idea of "accumulation of deficits" [17]. The FI is based on the view that frailty is a non-specific multifactorial state, best characterized by the quantity, rather than the quality, of the health deficits that the person accumulates during the course of life [26]. The FI is thus calculated as the proportion of potential deficits present in the person and can be calculated from the information present in most previous systems of clinical data (databases) [17].

The TFI is a tool widely used to assess 3 frailty domains and their 15 components. It is a user-friendly questionnaire and has good psychometric properties assessed in the initial validation process, constituting a good strategy for multidimensional assessment of frailty in community settings [27]. The instrument consists of two parts. Part A includes life-course determinants of frailty (sex, age and marital status), and part B assesses 15 components of frailty. The score on total frailty has a range of 0–15; people with a score ≥ 5 are considered frail; for physical, psychological and social frailty, the score ranges are 0–8, 0–4 and 0–3, respectively [28].

Studies carried out in different countries have demonstrated that these tools have in general good psychometric properties and are reliable and valid instruments for assessing frailty in community-dwelling older people [4, 17, 24–27, 29, 30].

6. Healthcare interventions in older frailty persons

Frailty's assessment is inseparable from an objective and competent evaluation of healthcare needs. Frailty is a multidimensional concept and can be defined as a dynamic state that affects an individual with declines in one or more domains,

such as physical, cognitive, social, attention or senses. The assessment of frailty is of limited interest if healthcare professionals do not invest in assessing the needs of frailty people in healthcare. This assessment must be multidimensional, multifactorial, longitudinal and comprehensive, covering all activities of life.

There are many debates on what are health needs assessment and problem identification. What is important to note is that care needs assessment is a systematic and sequential process, conducted by a care professional, which begins with the assessment of dependency focus, accounts for the presence and efficacy of current help, recognizes perceived need and finally determines the type of intervention needed to meet those needs [31].

It has been recognized that needs in the elderly should be patient-centred; holistic; analysed on by dependent people, caregivers and professionals; communicated to other professionals; and met in order to achieve better coordination between leading disciplines; needs assessment enhances the patient and carers experience and leads to more accurate information, but the level of reassessment by other professionals and the incidence of service duplication should also be reduced [31].

Care needs assessment has to promote an objective, competent evaluation of the self-care deficits. A self-care deficit is an inability to perform certain daily activities dependent on health and well-being. Common activities of daily living are the following: eating, bathing, getting dressed, toileting, transferring and continence. Self-care deficits can arise from physical or mental impairments. In elderly people, some of these problems accumulate and comorbidities appear. Health professionals play an important role when it comes to addressing self-care deficits through assessment and intervention. For assessment, evaluation of needs and identification of focuses of attention are necessary. Intervention can include, but is not limited to, helping patients to manage signs and symptoms, adhere to the therapeutic regime, adjust to deficits and strive to preserve, as far as possible, their self-care capacity.

With the ageing of the population and increased longevity, the need to provide palliative care is emphasized. However, this increased need is not usually accompanied by the availability of beds, which requires the use of indicators to manage the availability of palliative care provision. When to begin palliative care is a troublesome question for patients, families and healthcare providers [32]. Severe frailty is a relevant marker, along with functional dependence, cognitive impairment, symptom distress and family support for beginning palliative care. Frailty, independent of specific diseases, can be associated with a limited life expectancy and therefore is an important indication for palliative care [32]. Frailty is an essential model for palliative care in older adults as optimal medical treatment for the frail patient typically includes preventive, life-prolonging, rehabilitative and palliative measures in varying proportion and intensity based on the individual patient's needs and preferences [33].

7. Conclusion

Frailty elderly usually have dependence on self-care and need of support from others. Elderly does not mean frailty, but the ageing process led to frailty, which means that there are changes that reflect ageing-related alterations and involve intrinsic and extrinsic factors which are typical of ageing [4]. Usually, scales assess some domains of frailty in old people (cognition, general health status, functional independence, social support, medication usage, nutrition, mood, continence and functional performance). The occurrence of frailty is mainly a state of vulnerability resulting from comorbidities and the overall decline in organ functions. The progression to later stages of frailty often signals a loss of autonomy, dependence and reduction in physical and cognitive function.

Frailty is commonly positively related with caregiver burden and associated with higher levels of depression on the caregiver. A lack of understanding about frailty has been identified as a barrier to providing optimal care to elderly people. Self-care deficit theories suggest people are better able to recover when they maintain some independence over their own self-care. The evaluation of frailty is closely linked to the identification of dependencies in self-care. The use of frailty and self-care dependence assessment helps to determine the focus of attention, to respect vulnerability, to limit dependence as much as possible and to provide quality, safety and competent care.

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References

[1] Fried L, Walston J. Frailty and failure to thrive. In: Hazzard WR et al, editors. Principles of Geriatric Medicine and Gerontology. Vol. 4. New York: McGraw Hill; 1998. pp. 1387-1402

[2] Andrade A, Fernandes MG, Nóbrega MM, Garcia T, Costa K. Análise do conceito fragilidade em idosos. Texto Contexto Enferm, Florianópolis. 2012;**21**(4):748-756

[3] Rodríguez-Mañas L, Féart C, Mann G, Viña J, Chatterji S, Chodzko-Zajko W, et al. Searching for an operational definition of frailty: A delphi method based consensus statement: The frailty operative definition-consensus conference project. Journal of Gerontology Series A: Biological Sciences and Medical Sciences. 2013;**68**(1):62-67

[4] Abreu W, Tolson D, Jackson GA, Staines H, Costa N. The relationship between frailty, functional dependence, and healthcare needs among community-dwelling people with moderate to severe dementia. Health & Social Care in the Community. 2019;**11**:3-18. DOI: 10.1111/hsc.12678

[5] Theou O, Cann L, Blodgett J, Wallace L, Brothers T, Rockwood K. Modifications to the frailty phenotype criteria: Systematic review of the current literature and investigation of 262 frailty phenotypes in the survey of health, ageing, and retirement in Europe. Ageing Research Reviews. 2015;**21**:78-94

[6] Chong MS, Tay L, Chan M, Lim WS, Ye R, Wong WC, et al. Stage-specific relationship between frailty and cognitive impairment. Journal of Frailty & Aging. 2014;**3**(2):113-119

[7] Rockwood K, Howlett S, MacKnight C, Beattie B, Bergman H, Hebert R, et al. Prevalence, attributes, and outcomes of fitness and frailty in community-dwelling older adults: Report from the Canadian study of health and aging. Journal of Gerontology Series A: Biological Sciences and Medical Sciences. 2004;**59**:1310-1317

[8] Panza F, Solfrizzi V, Giannini M, Seripa D, Pilotto A, Logroscino G. Nutrition, frailty, and Alzheimer's disease. Frontiers in Aging Neuroscience. 2014;**6**:221

[9] Clegg A, Young J, Ili S, Rikkert M, Rockwood K. Frailty in elderly people. Lancet. 2013;**381**:752-762

[10] Fried L, Tangen C, Walston J, Newman A, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. Journal of Gerontology Series A: Biological Sciences and Medical Sciences. 2001;**56**(3):146-154

[11] Morley J. Frailty and sarcopenia: The new geriatric giants. Revista de Investigación Clínica. 2016;**68**:59-67

[12] Robertson D, Savva G, Kenny R. Frailty and cognitive impairment—A review of the evidence and causal mechanisms. Ageing Research Reviews. 2013;**12**:840-851

[13] Canevelli M, Cesari M, van Kan G. Frailty and cognitive decline: How do they relate? Current Opinion in Clinical Nutrition and Metabolic Care. 2015;**18**(1):43-50

[14] Delrieu J, Andrieu S, Pahor M, Cantet C, Cesari M, Ousset P, et al. Neuropsychological profile of "Cognitive Frailty" subjects in MAPT study. Journal of Prevention of Alzheimer's Disease. 2016;**3**(3):51-159. DOI: 10.14283/jpad.2016.94

[15] Mulasso A, Argiolu L, Roppolo M, Azucar D, Rabaglietti E. Emotion

experience and frailty in a sample of Italian community-dwelling older adults. Clinical Interventions in Aging. 2017;**12**:2017-2024. DOI: 10.2147/CIA.S147121

[16] Clark L, Watson D. Diurnal variation in mood: Interaction with daily events and personality. In: Meeting of the American Psychological Association. Washington, DC; 1986

[17] Armstrong J, Mitnitski A, Andrew M, Launer L, White L, Rockwood K. Cumulative impact of health deficits, social vulnerabilities, and protective factors on cognitive dynamics in late life: A multistate modelling approach. Alzheimer's Research & Therapy. 2015;**7**:38. DOI: 10.1186/s13195-015-0120-7

[18] Dudzinska-Griszek J, Szuster K, Szewieczek J. Grip strength as a frailty diagnostic component in geriatric inpatients. Clinical Interventions in Aging. 12, 2017:1151-1157. DOI: 10.2147/CIA.S140192

[19] Anzaldi L, Davison A, Boyd C, Leff B, Kharrazi H. Comparing clinician descriptions of frailty and geriatric syndromes using electronic health records: A retrospective cohort study. BMC Geriatrics. 2017;**17**(1):248

[20] Shimada H, Makizako H, Tsutsumimoto K, Doi T, Lee S, Suzuki T. Cognitive frailty and incidence of dementia in older persons. Journal of Prevention of Alzheimer's Disease. 2018;**5**(1):42-48

[21] Cuenca L, Lopez S, Martin L, Jaimes N, Villamayor I, Artigas M, et al. Frailty in patients over 65 years of age admitted to Intensive Care Units (FRAIL-ICU). Medicina Intensiva. 2019;**43**(7):395-401

[22] Ma L, Sun F, Tang Z. Social frailty is associated with physical functioning, cognition, and depression, and predicts mortality. Journal of Nutrition, Health and Aging. 2018;**22**(8):989-995

[23] Gomez-Gomez M, Zapico S. Frailty, cognitive decline, neurodegenerative diseases and nutrition interventions. International Journal of Molecular Sciences. 2019;**20**(11):1-18

[24] Hirdes J, Frijters D, Teare G. The MDS-CHESS scale: A new measure to predict mortality in institutionalized older people. Journal of the American Geriatrics Society. 2003;**51**:96-100

[25] Rolfson D, Majumdar S, Tsuyuki R, Tahir A, Rockwood K. Validity and reliability of the Edmonton Frail Scale. Age Ageing. 2006;**35**:526-529

[26] Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. Journal of Gerontology. Series A, Biological Sciences and Medical Sciences. 2007;**62A**:722-727

[27] Gobbens R, Schols J, van Assen MA. Exploring the efficiency of the Tilburg Frailty Indicator: A review. Clinical Interventions in Aging. 2017;**12**:1739-1752. DOI: 10.2147/cia.s130686

[28] Gobbens RJ, van Assen MA, Luijkx KG, Schols JM. The predictive validity of the Tilburg Frailty Indicator: Disability, health care utilization, and quality of life in a population at risk. Gerontologist. 2012;**52**(5):619-631. DOI: 10.1093/geront/gnr135

[29] Santiago L, Luz L, Mattos IE, Goddens R. Adaptação transcultural do instrumento Tilburg Frailty Indicator (TFI) para a população brasileira. Cadernos de Saúde Pública. 2012;**28**(9):1795-1801. DOI: 10.1590/S0102-311X2012000900018

[30] Uchmanowicz I, Jankowska-Polanska B, Uchmanowicz B, Kowalczuk K, Gobbens RJ. Validity and reliability of the Polish version of the

Tilburg Frailty Indicator (TFI). Journal of Frailty & Aging. 2016;**5**(1):27-32. DOI: 10.14283/jfa.2015.66

[31] Meaney AM, Croke M, Kirby M. Needs assessment in dementia. International Journal of Geriatric Psychiatry. 2005;**20**(4):322-329

[32] Raudonis B, Daniel R. Frailty: An indication for palliative care. Geriatric Nursing. 2010;**31**(5):379-384

[33] Morrison R, Meir D, editors. Geriatric Palliative Ccare. New York: Oxford University Press; 2003

Chapter 3

Reliability and Validity of Clinicopathological Features Associated with Frailty Syndrome in Elderly Population

Kelvin Leshabari

Abstract

Geriatrics is an applied science as its practice is an art of medicine. As a scientific discipline, there exists a potential race for measurements. Frailty stands as among poorly defined concepts in geriatric medicine. There are philosophical, circumstantial, and practical justifications behind this rather seemingly *clinical tragedy*. This chapter contributes toward reliability and validity aspects of currently applied frailty scales and indicators across different population base. It acknowledges the contribution of Fried's frailty scale. It also describes different frailty scales and indicators tested in America, Europe, and Asia. Lastly, the chapter contrasts the popular belief behind applications of Cronbach's α coefficient of test scores for reliability assessment in clinical research. Other research gaps are also highlighted including merging clinical research findings in geriatrics with psychosocial aspects under the emerging field of geropsychology. It also proposes a solution for usage in future studies that aim at assessing reliability of test scores in clinical and biomedical sciences.

Keywords: frailty, reliability, validity, multimorbidity, index, scale

1. Introduction

Geriatric medicine is a relatively younger sub-specialty of medicine. Unlike fields like general internal medicine or surgery, that are known to have existed since antiquity, geriatrics has gained significant popularity, in orthodox medical practice, around the second half of the twentieth century. Geriatrics is *an applied science* just as its practice is *an art* of medicine. For that matter, there exists a potential race for measurements. It follows logic therefore that for geriatric medical conditions and practice to be acceptable among scientists, it needs unified codes that are measurable. This chapter will provide basic aspects associated with measuring variables that are customarily prevalent in geriatric wards and corridors throughout the world. Specifically, it analyzes the reliability and validity of different scales of the commonest concept of *frailty* among senior citizens the world over.

The clinical characterization, of modern geriatric medicine, owes much to the pioneering work, of Professor Bernard Isaacs back in the 1960s. It was Isaacs who is credited in public literature, to have coined the term "*geriatric giants*," in common usage, to geriatricians the world over to date [1]. Simply stated, he referred "geriatric

giants" to conditions of *immobility*, *instability*, *incontinence*, and *impaired memory/intellect* that are relatively common, on statistical grounds, among senior citizens of any human society [1]. From 1960s onward, the conditions characterizing *geriatric giants* have changed several times, and currently used mainly among scholars and clinicians alike, in its modified form, as per Professor Mary Tinetti's keynote address of *Geriatric 5Ms,* at the Canadian Geriatric Society conference, back in April 2017 [2]. She addressed the Geriatric 5Ms to comprise the *Mobility*, *Mind*, *Medications*, *Multi-complexity*, and *Matters* most [2]. It must be understood that most of this characterization refers to measurable constructs that defines core aspects of geriatric medical research and practice, initially coined as *geriatric giants* by Isaacs in 1965.

There exists a lot of confusion in geriatric medicine to date, regarding the measurable construct of *geriatric giants* [3–7]. Part of this confusion has basis from failure to achieve standard definitions from its components. This is because, in almost all cases, disease conditions among senior citizens, unlike other groups in the population pyramid, tend to present *atypically* on clinical grounds. Whereas the exact cause of this trend among senior citizens is still ill understood, there exists evidence for a common pathway, originating from different organ systems, in etiopathogenesis of diseases in the elderly. Moreover, quite often there is also a disconnect between the original site of *malice* and the clinical presentations for symptoms and signs of pathologic conditions thereafter. The immediate effect of this rather anomalous conundrum is the rather *bizarre presentations* of most common clinical conditions, seen among senior citizens, as well as recorded in their morbidity and mortality statistics throughout the world.

Atypical presentation in the elderly can be exemplified, say by a Nonagenarian lady, presenting to the emergency department of a typical hospital, with symptoms and signs suggestive of acute confusional state like delirium, caused by *Escherichia coli* infection in her urinary tract. As it is commonly the case, once her bladder cystitis/urethritis is treated, using relatively simple treatment pathways, the acute confusional state disappears. The observation given, justifies not only the atypical nature of presentation, to most geriatric illnesses, but also the multiple organo-systemic involvement, in their pathogenesis. Besides, growing characterization of emotional, social, and cognitive aspects of aging is paramount in modern clinical practice. There are several theories and postulates that endeavor to link the interplay of the mind (and the central nervous system) in multisystemic etiopathogenesis of Geriatric 5Ms. The theories and postulates have evolved into a new sub-specialty named geropsychology. The details of which will be discussed further in the discussion section. However, to the betterment of science, there exists palpable evidence that probably the so-called *Geriatric 5Ms* has achieved a unified goal of standardizing the measurable construct of *geriatric giants*. It is on this basis that this chapter finds its pivot, on the attributable last aspect of *Matters most*, referred to as *Frailty*.

Frailty is a poorly defined syndrome almost exclusively confined to the elderly population. There are dozens of descriptions given for frailty [8–15]. All of them were made for specified frameworks of interest by their original authors. On pedagogic sense, none could be used systematically, without a pinch of doubt, to any destitute clinician/researcher. However, out of dozens of frailty definitions available, the one proposed by Fried and colleagues in Cardiovascular Health Study Collaborative Research Group back in 2001 [13] is the most widely applied framework by clinicians/researchers in bio-gerontologists the world over. The underlying scientific framework for applying frailty syndrome to be discussed in this chapter has taken into account the famous fact derived by Sir George Box's seminal paper back in 1978 that *all models are wrong but some are useful* [16] in its philosophical sense. It is neither the intention of this chapter nor anywhere in the mind of its author to market the Cardiovascular Health Study Collaborative Research Group's

frailty postulate. Rather, and I do believe it to be safe, the plan is to sparingly appreciate strengths and weaknesses of some of these useful concepts, via estimation of their internal consistency and content validity in each of them. Thus, this chapter will guide the reader through reliability and validity aspects of clinicopathological features associated with frailty syndrome in senior citizens.

2. Reliability of frailty models in elderly population studies

Geriatrics, as a branch of clinical sciences, is a scientific discipline as physics or chemistry is to natural sciences. To that end, measurements are the core aspect for its sustainability. It is under this framework that most frailty scales are available the world over to date, and in future shall be assessed. Technically, assessing the quality aspects of the scale takes mainly two domains, namely, *reliability* and *validity*. Taken simply, reliability assessment refers to the process of determining the extent to which a measurement of a phenomenon provides stable and consistent results [17]. This definition, though adopted from Carmine and Zeller's publication of 1979 [17], who worked in the field of psychometrics, is as applicable, in its entirety to frailty scale assessment, as it was intended in assessing psychometric scales. Thus, whereas the intention here is to adopt quantifiable and logically consistent manner for reliability assessment of frailty scales, it is by no means the intention of the author to *sales pitch* the methods discussed nor should it be conclusive that the method described in this chapter is the only mechanism of achieving reliability assessment. To ensure clarity in this endeavor, the end of the chapter will also contain some vivid shortcomings and a potential solution to the reliability assessment method described in this chapter.

2.1 Internal consistency assessment of frailty scales used in elderly population

There are various ways of assessing reliability index of any given phenomenon/scale in nature. Some are well known in literature, and there are probably many others in production pipelines for usage in future. However, the most popular methods include test-retest reliability, split-half reliability, and internal consistency reliability tests. Out of these, this chapter will deal with internal consistency reliability. The decision to do so is derived from its conceptual meaning as opposed to the rest. Simply stated, internal consistency refers to the extent to which a measurement of a scale provides stable and consistent results across a specified condition [17]. One rule is important to be mentioned here, in that all accounts of assessing reliability of any given scale, the reliability score to be obtained is not reflective of a constancy but rather a mere statistic for a given test result. This translates to the fact that a given scale may end up with different scores, under different elderly population conditions, dependent on a number of factors, some known (e.g., test settings and gender) and others unknown even to the test itself. Thus, caution to the interpretation of the test scores is highly warranted.

2.1.1 Clinical Frailty Scale

Clinical Frailty Scale (CFS) is a clinical judgment-based tool (originally designed as an epidemiological tool) to screen for frailty and other adverse health events in opposition to fitness in older aged population. It is a direct replica of a frailty index that was part of the original design aspect of the first part of Canadian Study on Health and Aging (CSAH), with the aim of characterizing cognitive impairment and other important health issues, designed as a prospective 5-year follow-up of 10,263 people aged at least 65 years back in 1991 [18, 19]. At the time of going to

press, the Clinical Frailty Scale is composed of a 9-point scale, that was made public in 2007, an improvement from the original scale of a 5-point scale originally published in 2005 [20]. It was originally developed in the second half of the Canadian Study of Health and Aging (CSHA) as a quick means to assess frailty and other senile physical and mental challenges past clinical assessment [20]. The conceptual framework of the Clinical Frailty Scale relies on the "fitness and frailty" model, and the scale was designed by adopting the mechanism from Streiner and Norman [21]. It is for all practical purposes, not a questionnaire but a quantified summary write-up of an elderly overall health status in relation to mortality risks. Internal consistency scores for Clinical Frailty Scale among elderly population across different geographical areas are provided in **Table 1**.

2.1.2 Edmonton Frail Scale (EFS)

Edmonton Frail Scale, an effort first conceptualized by Darryl Rolfson while at the University of Alberta, Canada back in 1999, was presented for the first time to peer review at the Canadian Geriatric Society in Edmonton, Canada, in 2000 [25]. Ever since its first time in press, the scale has been applied in research, educational and clinical settings for quantitative frailty assessment among senior citizens [15, 26–33]. Edmonton Frail Scale consists of nine domains and 11 items. The initial scale devised by Rolfson at Edmonton had 10 domains [25]. Each component may have a score of 0, 1, or 2 signifying normal health, mild/moderate impairment, or severe impairment, respectively. Domains include general health status; cognitive status; medication use; presence of social support; incontinence; nutrition and mood; functional dependency; and functional performance test [25]. The total scores are also classified into no frailty (0–3 points); pre-frailty (4–5 points); frailty (6–8 points), and severe frailty (9–17) [26]. The internal consistency scores of Edmonton Frail Scale for senior citizens across different geographical settings are as reported here in **Table 2**.

2.1.3 Groningen Frailty Indicator

Groningen Frailty Indicator (GFI) is a 15-item indicator for assessment of frailty developed by Professor Steverink and his colleagues at the University of Groningen, The Netherlands, first published in 2001 [34]. The internal consistency findings of GFI are as summarized in **Table 3**.

2.1.4 Tilburg Frailty Indicator

Tilburg Frailty Indicator (TFI) is a questionnaire for screening frail community dwelling older people that includes self-reported information, originally tested and validated from an elderly community of Roosendaal in The Netherlands, based on

Country/region	Cronbach's α-reliability score (95% C.I.)	Settings
1. Australia [22]	0.76 (0.7–0.81)	Perioperative (hospital-based)
2. Canada [20]	0.97 (not given)	Community-based
3. Singapore [23]	0.91 (0.86–0.95)	Hospital-based
4. Turkey [24]	0.811 (not given)*	Outpatient clinic (hospital-based)

** p-value cited as <0.001.*

Table 1.
Internal consistency scores for Clinical Frailty Scale across elderly population from different geographical areas.

Country/region	Cronbach's α-reliability score (95% C.I.)	Settings
1. Canada [25]	0.62	Hospital/clinic based
2. Ireland [31]	0.41	Hospital based
3. Italy [26]	0.98	Hospital based
4. Poland [28]	0.709	Hospital based
5. China [33]	0.95	Hospital based
6. Canada [20]	0.97	Hospital based

Table 2.
Internal consistency scores for Edmonton Frail Scale across senior citizens from different geographical areas.

Country/region	Construct validity index	Settings
1. The Netherlands [35]	0–1: disorder (median, range): 2, 1–4 2: (median, range): 4, 3–6 3: (median, range): 6, 4–8	Community-based
2. The Netherlands [36]	GFI ≥ 4	Community-based
3. Romania [37]	GFI score = 0.746	Physician-based

Table 3.
Construct validity scores for Groningen Frailty Indicator across senior citizens in different geographical areas.

Country/region	Construct validity index	Settings
1. China [39]	Physical domain: r = −0.39–0.57 (P < 0.001) Psychological domain: r = −0.47–0.49 (P < 0.001)	Community-based
2. The Netherlands [38]	Social domain: r = −0.35–0.71 (P < 0.001) Physical domain: r = −0.43–0.62 (P < 0.001) Psychological domain: r = −0.19–0.46 (P < 0.001) Social domain: r = 0.29–0.96 (P < 0.001) Physical domain: r = 0.31 (P < 0.001) Psychological domain: r = 0.24 (P < 0.001)	Community-based
3. Italy [40]	Social domain: r = 0.25 (P < 0.001)	Community-based

Table 4.
Construct validity scores of Tilburg Frailty Indicator across senior citizens in different geographical areas.

a working framework in development, developed by a team of Dutch scientist first published in 2009 [38]. Tilburg Frailty Indicator is unique among frailty indicators, in that it includes multiple domains of human functions but selectively excludes disability [38]. TFI consists of two parts, namely, multimorbidity and frailty domains. The first part (designated as part A) contains 10 questions on determinants of frailty in relation to disease states, while the second part is solely on frailty aspects [38]. The internal consistency score ratings of TFI across studies from different geographical areas are given in **Table 4**.

3. Validity aspects of frailty scales and indicators used in elderly population

Much as reliability may be loosely assumed to be synonymous to precision in measurements, it follows a natural pattern then to ensure validity by the assumption

of accuracy. It must be understood that geriatrics, just as other branches of clinical medicine, is essentially an applied science field. To this end, the reader is cautioned against making substantial error in reasoning, that of assuming measurement exactness of constructs made in its clinical measurements, just as natural scientists make, in say reaction time in subjects like physics or chemistry. It is on this basis, that all aspects of validity, discussed in this chapter, constitute a number of assumptions, some of them may be hard to prove, even when considered useful in the stated models. For instance, since most validation processes in constructing frailty scales and indicators consisted of a number of items, the assumptions made are such that those items, when taken collectively, refer to a construct of frailty, and that when applied to humans in their contextual nature, can distinguish those who are frail from those who are not. This section will deal with one important form of validity measurement, that of construct validity at most [41].

Construct validity is a way of measuring a disposition/character/trait/belief such that its accuracy can be estimated with quantifiable degrees of confidence. In simplistic fashion, it is a way of measuring a test for what it claims to quantify. Construct validity differs from other forms of validity in applied sciences, namely, criterion and content validity, since in construct validation, there is an aspect of quantifying the quality of a measuring instrument toward what it claims to measure. Thus, for all practical purposes, this chapter will endeavor to quantify aspects hypothesized to assess frailty, as applied to the community of senior citizens living in different geographical communities. This notion, inter alia, follows the appreciable level of acceptance in reliability indices prior to its undertaking, lest of that, it may be deemed invalid in practice. In this sub-section, an analysis of different frailty scales/indicators in construct validity will be determined here underneath.

4. The triumph and controversies surrounding reliability and validity of frailty scales/indicators in elderly population

It is important to underscore the importance of association between what is characterized as *frailty* and increased susceptibility to ill health among humans of advanced age. From the earlier sections of this chapter, an account of the term *frailty* has been made. However, it is important to analyze those numbers, in a bid to express not only what they suggest but also not to overexpress their usefulness in science. One important caution needs special attention here in that myself as a clinical researcher, positively influenced by biased affection to make judgment using numbers and experimental findings, maybe at risk of committing a *self-fulfilling prophecy*, a typical form of rather known *pygamalion effect,* quite common among scientists dealing with quantitative research methods and applications. Therefore, this section will be dealt with not only interpretation of reliability and validity of different frailty scales/indicators shown before but also the challenges of assuming the score results to individuals as *sin qua non* in frailty assessment to prospective readers be it practicing geriatricians, bio-gerontologists and/or policy makers, and other decision makers in aging field.

First, on reliability aspects, it is important for geriatricians, other clinicians handling senior citizens, clinician-scientists, policy makers as well as other readers alike to be aware of the fact that frailty scales/indicators scores derived from cited studies above do not in actual sense measure reliability at best. There is no doubt that no other statistic in published literature has been a subject of wide confusion than *coefficient* α for reliability test scores. Specifically, *Cronbach's* α coefficient that at best displays homogeneity of test scores has been incorrectly associated with a quality indicator of internal stability score, a direct reflection of a reliability

estimate. This rather subtle cognitive error has been in existence in science for at least 60 years. It was formerly described by Cronbach via a seminal paper published in 1951 [42]. To simply describe the extent of the spread of the flaw, as well as the confusion therein, until the time this line you read was first typed by the author, at the peak of a COVID19 pandemic, the Cronbach's paper published in Psychometrika back in 1951, had been cited more than 45,000 times in published literature worldwide. Details about the flaws (as well as the resulting confusion) of *Cronbach's* α as an index measure of reliability of test scores are beyond the scope of this book. However, just to give a glimpse to readers, I have decided to provide a narrative account of the fallacy behind usage of Cronbach's α coefficient as a measure of reliability of test results.

Cronbach's α coefficient as a test statistic in principle is consistently and incorrectly taken as a measure of internal stability of test scores, and therefore an estimate of internal consistency. It has been shown that Cronbach's α coefficient cannot provide investigators that sort of information [43]. Cronbach's α coefficient is at best the *greatest lower bound* to reliability estimate, and therefore almost always an underestimate of a reliability coefficient α for internal consistency of test scores [43]. At this juncture, it is important to remind readers on what exactly is internal consistency of test scores results. Simply written, internal consistency of test score results refer to interrelatedness of a set of items, be it test scores results or any other of non-singular matrix scores [44]. It therefore follows that much of the confusion surrounding Cronbach's α coefficient dates back to Cronbach's paper of 1951 [42] in that Cronbach used internal consistency and homogeneity synonymously [44]. It is clear nowadays, therefore, that Cronbach's α coefficient may attain values that are outside the scope of possible reliability scores from a single test result. I would like just to mention a solution to this challenge, just sparingly to include standard measurement errors in the form of the following equation:

$$\sigma_y = \sigma_x \left(1 - \rho_x + x'_+\right)^{1/2} \tag{1}$$

where $\rho_{x+}x'_+$—test score reliability in a population, σ_x—standard deviation of a population of interest, and σy—standard measurement error of a sample of interest.

It is important to remind readers that application of standard measurement error as a measure of internal consistency of test scores assumes each individual score results originated from a test with the same accuracy [43]. Details of this method of assessing internal consistency, and therefore inherent reliability of any given test scores, are given in other published findings of the past [43–47].

In this chapter, I have hesitated myself from committing a rather common statistical crime. It is well known that meta-analysis of findings from individual studies, customarily using forest plots, is an efficacious way of deriving effect size as well as identifying small and insignificant statistical results. However, I must admit there have been strong attempts to pool reliability and validity estimates from different studies here. The decision at the end, of not to include forest plots, from meta-analysis in this chapter, is based on the same philosophy, behind the chapter, namely, *reliability and validity* for test scores of sample estimates. On a frank note, there is profound heterogeneity reported from the study sample used for assessment of reliability and validity of frailty scales and indicators in publication database. This made all attempts toward "*forest plotting*" a futile exercise on philosophical grounds. It is quite obvious that given wealthy of statistical tests available to date, there were remedial measures to account for heterogeneity of those referred studies. However, given the fact that data were different from how they were conceptualized, and

not only in the way they were analyzed, made all those statistical tests available for estimating heterogeneity, a *non-starter* in this endeavor.

At large, these studies differ significantly on the basis of their designs. For instance, whereas findings in **Table 1** reflected assessment of Cronbach's alpha coefficient, for what was referred to as internal consistency, out of studies targeting Clinical Frailty Scale, the study by Rockwood and colleagues in Canada was conceived as a prospective observational study [20]. Moreover, Chong and colleagues' study conducted in Singapore was designed in a retrospective fashion [23]. It therefore comes out automatic that *total population at risk* was a distinguishing feature between these two studies. Clearly, with prospective data, one can quantify *population at risk*, whereas in retrospective data, such a count is not possible. The difference in probability counts of risk between those two studies does not end in risk estimates. It blows out in any calculation involving probabilistic appointments, including the early stages of obtaining Cronbach's α coefficient. Pooling out estimates from these two study designs (prospective vs. retrospective) is no difference from mixing oranges and mangoes together. Whereas the idea may seem useful in gastronomy, it is *a statistical crime*, equivalent to a third-degree murder in jurisprudence [48]. Details about the flaws in pooling estimates of retrospective and prospective designs together are described in length in mathematical statistical literature [49–52].

Apart from the design differences between studies whose estimates were pooled as means to assess reliability and validity in this chapter, heterogeneity is also suspected to be present from publication bias. Quite commonly in biomedical research and databases, studies are only published if they attain positive outcomes as per research questions designed by investigators. Whereas the message here is not to support the idea, as I personally believe in learning from findings with negative results from their hypothesized questions, I found it an important message to remind readers. It is quite possible that there were other studies left behind simply because they either failed to appear in press for what so ever reasons or they were left behind merely out of ignorance by the author during retrieval of information used to pool these data. At this point, it should be clear that there are quantitative mechanisms of assessing heterogeneity in statistical data [39, 40, 52–61]. However, those techniques are far behind abilities to correct what went wrong during design stage. It was therefore futile to justify application of those techniques to data that was conceived in either retrospective fashion or out of publication bias.

On a positive note, however, the findings from these studies do probably highlight an important construct that is related to diminished ability of various body systems, currently coined as *frailty*. This is because in most of these studies, all of their domains (physical, psychological, or social) do reflect some deficiencies that are commonly associated with those of advanced age, who we may safely assume, to reflect a true concept of frailty. Until now, it must be born to the minds of readers that the lack of gold standard decision rule for assessing frailty forces scholars to make comparisons to available tools. It is therefore a call to action for future researchers in aging research to consider design and development of more innovative concepts and tools in assessment of frailty [62–64].

Lastly, and as a matter of urgent priority, geriatricians, aging research scientists as well as other practitioners and decision makers in health need to consider different population base in their future research on frailty. At present, there appears to be palpable evidence that demographic transition has started, and likely to mature soon, in parts of sub-Saharan Africa [65]. For instance, it is quite evident that Tanzania, just like other sub-Saharan African countries, has its population undergoing *demographic transition* [65], perhaps at a faster rate than what was

seen in Europe in the nineteenth century and early parts of twentieth century. It is clear that part of what may be termed as *residual effects*, in ascertaining factors associated with frailty and other aging-related concepts, to be better explained by environmental milieu found in sub-Saharan Africa, rather than the developed North. It is therefore a matter of intellectual maturity that future studies on quality indicators in frailty assessment will also be tested and validated in population found in the South.

Likewise, on a pioneering scale, global efforts in the interplay of *mind* and *organosystemic degeneration*s in later life need a critical eye among aging researchers. At present, there is a lot of confusion not only among geropsychologists but even among clinician-scientists caring for the senior citizens across nations. For instance, there is a clear gap in research evidence on inability to characterize the cognitive domain in the illustration of the concept of frailty, in addition to clear discrepancies in how best to handle cognitive abnormalities in the oldest old. It also follows the logic that the current interventions and strategies in psychosocial interventions the world over to be *porous* at best and segregate the senior citizens at worst. To this end, I propose that psychosocial challenges arising directly or indirectly from the aging process to be handled using data-based findings. Moreover, there is a desperate call for inductive research to deductive thinking in the science of geropsychology the world over. Short of that, most scales/indicators of frailty will have a *lack-of-fit* on the basis of their missing domain of the psyche.

Acknowledgements

I wish to convey my sincere vote of thanks to my fellow trustees of **Ultimate Family Health Care**, namely, *Drs Godfrey Swai* and *Mathew Mwanjali*, whose inspiration and courage during the chapter preparation, notwithstanding their tolerance and experts' opinion, to review the chapter manuscript, is highly appreciated. Special thanks goes to these two personalities for their inception of the concept of "*family health*" in Tanzania, including their time-to-time "*free mentorship*," both in clinical practice and clinical research works, I have been making with them, out of which my current practice in Tanzania follows and grows. It is from this group interaction, the Dar es Salaam Longitudinal Ageing Study has been conceptualized.

I also wholeheartedly thank all patients and other clients in geriatric/endocrinology clinics at Moyo Safi Hospital, Alshifa Medical and Dialysis Centre as well as AB hospitals in Dar es Salaam, Tanzania, for their openness and very welcoming ground to work and appreciate my geriatric practice. Special vote of thanks goes to Dr Chuor Garang de Alier for his tireless efforts in tracing some of the full text documents used as references in this chapter. His helping hand, out of his tight schedule, at times via midnight calls, as a student at St. Hugh's College in Oxford, aiming at ensuring all references cited, have been read in context, is highly appreciated.

Conflict of interest

No conflict of interest declared in the preparation of this manuscript.

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References

[1] A giant of geriatric medicine – Professor Bernard Isaacs (1924-1995) British Geriatrics Society. Available from: https://www.bgs.org.uk/geriatricmedicinearchive/bgsarchive/biographies/a-giant-of-geriatric-medicine-professor-bernard-isaacs-1924-1995 [Accessed: March 10, 2020]

[2] Morley J. The new geriatric giants. Clinics in Geriatric Medicine. 2017;**33**(3):xi-xii

[3] Emmet K. Nonspecific and atypical presentation of disease in the older patient. Geriatrics. 1998;**53**(2):50-60

[4] Jarrett P, Rockwood K, Carver D, Stolee P, Cosway S. Illness presentation in elderly patients. Archives of Internal Medicine. 1995;**155**(10):1060-1064

[5] Gavazzi G, Krause K. Ageing and infection. The Lancet Infectious Diseases. 2002;**2**(11):659-666

[6] Schattner A, Klein Y, Herskovitz P. An atypical presentation of a common disease. QJM. 2012;**105**(9):891-893

[7] Hughes L, McMurdo M, Guthrie B. Guidelines for people not for diseases: The challenges of applying UK clinical guidelines to older people with multiple co-morbidities. Age and Ageing. 2013;**42**(1):62-69

[8] Bortz W II. A conceptual framework of frailty: A review. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences. 2002;**57**:M283-M288

[9] Fried L, Tangen C, Walston J, Newman A, Hirsch C, Gottdiener J, et al. Frailty in older adults: Evidence for a phenotype. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences. 2001;**56**(3):M146-M156

[10] Rockwood K, Andrew M, Mitniski A. A comparison of two approaches to measuring frailty in elderly people. Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2007;**62**(7):738-743

[11] Rockwood K, Mitniski A. Frailty in relation to the accumulated deficits. Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2007;**62**(7):722-727

[12] Soong J. Functional assessment in older people. BMJ. 2011;**343**:d4681

[13] Fried L, Xue Q, Cappola A, Ferrucci L, Chaves P, Varadhan R, et al. Nonlinear multisystem physiological dysregulation associated with frailty in older women: Implications for etiology and treatment. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences. 2009;**64A**(10):1049-1057

[14] Rumero-Ortuno R, Walsh C, Lawlor B, Kenny R. A frailty instrument for primary care: Findings from the survey of health, ageing and retirement in Europe (SHARE). BMC Geriatrics. 2010;**10**(1):57. DOI: 10.1186/1471-2381-10-57

[15] Rolfson D, Majumdar S, Tsuyuki R, Tahir A, Rockwood K. Validity and reliability of the Edmonton Frail Scale. Age and Ageing. 2006;**35**(5):526-529

[16] Box G. Robustness in the strategy of scientific model building. In: Launer R, Wilkinson G, editors. Robustness in Statistics. Academic Press; 1979. pp. 201-236

[17] Carmines E, Zeller R. Reliability and Validity Assessment. SAGE Publications; 1979. DOI: 10.4135/9781412985642

[18] CSHA Working Group. Canadian Study of Health and Aging: Study

methods and prevalence of dementia. CMAJ. 1994;**150**(6):899-913

[19] Rockwood K, Wolfson C, McDowell I. The Canadian Study of Health and Aging: Organizational lessons from a national, multicenter, epidemiologic study. International Psychogeriatrics. 2001;**13**(suppl 1):233-237

[20] Rockwood K, Song X, MacKnight C, Bergman H, Hogan D, McDowell I, et al. A global clinical measure of frailty in elderly people. CMAJ. 2005;**173**(5):489-495

[21] Streiner D, Norman G. Health Measurement Scales: A Practical Guide to their Development and Use. 3rd ed. Oxford: Oxford University Press; 2003. pp. 4-13

[22] Darvall J, Loth J, Bose T, Braat S, de Silva A, Story D, et al. Accuracy of the Clinical Frailty Scale for perioperative frailty screening: A prospective observational study. Canadian Journal of Anesthesia. 2020;**67**:694-705. DOI: 10.1007/s.12630-020-01610-x

[23] Chong E, Chia J, Law F, Chew J, Chan M, Lim W. Validating a standardized approach in administration of the Clinical Frailty Scale in hospitalized older adults. Annals of the Academy of Medicine, Singapore. 2019;**48**:115-124

[24] Ozsurekci C, Balci C, Kizilarslanoglu C, Caliskan H, Dogrul R, Aycicek G, et al. An important problem in an aging country: Identifying the frailty via a 9 point Clinical Frailty Scale. Acta Clinica Belgica. 2019;**75**:200-204. DOI: 10.1080/17843286.2019.1597457

[25] Rolfson D, Majumdar S, Tahir A, Tsuyuki R. Development and validation of a new instrument for frailty. Clinical and Investigative Medicine. 2000;**23**:336

[26] Perna S, Francis M, Bologna C, Moncaglieri F, Riva A, Morazzoni P, et al. Performance of Edmonton Frail Scale on frailty assessment: Its association with multi-dimensional geriatric conditions assessed with specific screening tools. BMC Geriatrics. 2017;**17**:2. DOI: 10.1186/s 12877-016-0382-3

[27] Fabricio-Wehbe S, Schiaveto F, Vendrusculo T, Haas V, Dantas R, Rodriguez R. Cross-cultural adaptation and validity of 'Edmonton Frail Scale – EFS' in a Brazilian elderly sample. Revista Latino-Americana de Enfermagem. 2009;**17**(6):1043-1049

[28] Polanska B, Uchmanowicz B, Kujawska-Danecka H, Nowicka-Sauer K, Chudiak A, Dudek K, et al. Assessment of frailty syndrome using Edmonton Frailty Scale in Polish elderly sample. The Aging Male. 2018;**22**:177-186. DOI: 10.1080/13685538.2018.1450376

[29] Aygor H, Fadiloglu C, Sahin S, Aykar F, Akcicek F. Validation of Edmonton Frail Scale into elderly Turkish population. Archives of Gerontology and Geriatrics. 2018;**76**:133-137. DOI: 10.1016/j. archger.2018.02.003

[30] Hilmer S, Perera V, Mitchell S, Murnion B, Dent J, Bajorek B, et al. The assessment of frailty in older people in acute care. Australasian Journal on Ageing. 2009;**28**(4):182-188

[31] O'Brien M, Mallett V, Coghlan M, Yen D, Doran E, Williams D, et al. Edmonton Frail Scale as a predictor of adverse events in older patients undergoing systemic cancer therapy in Ireland. Age and Ageing. 2016;**45**:i13-i56

[32] Ramirez R, Cadena S, Ochoa M. Edmonton Frail Scale in Colombian older people: Comparison with the Fried criteria. Archives of Gerontology and Geriatrics. 2017;**75**:91-95

[33] Zhang X, Yang Y, Zhang C, Luo R, Liu Y. Development of a frailty scale

for elderly people in China. Chinese Nursing Research. 2017;**4**(2):64-70. DOI: 10.1016/j.cnre.2017.06.003

[34] Steverink N, Slaets J, Schuurmans H, Lis M. Measuring frailty: Developing and testing the GFI (Groningen Frailty Indicator). The Gerontologist. 2001;**41**:236

[35] Peters L, Boter H, Buskens E, Slaets J. Measurement properties of the Groningen Frailty Indicator in home dwelling and institutionalized elderly people. JAMDA. 2012;**13**:546-551

[36] Bielderman A, Schans C, Lieshout M, Greef M, Boersma F, Krijnen W, et al. Multidimensional structure of the Groningen Frailty Indicator in community-dwelling older people. BMC Geriatrics. 2013;**13**:86. DOI: 10.1186/1471-2381-13-86

[37] Olaroiu M, Ghinescu M, Naumov V, Brinza I, Heuvel W. The psychometric qualities of the Groningen Frailty Indicator in Romanian community-dwelling older citizens. Family Practice. 2014;**31**(4):490-495

[38] Gobbens R, van Assens M, Luijkx K, Wijnen-Sponselee M, Schols M. The Tilburg Frailty Indicator: Psychometric properties. JAMDA. 2009;**11**:344-355. DOI: 10.1016/j.jamda.2009.11.003

[39] Dong L, Liu N, Tian X, Qiao X, Gobbens R, Kane R, et al. Reliability and validity of the Tilburg Frailty Indicator (TFI) among Chinese community-dwelling older people. Archives of Gerontology and Geriatrics. 2017;**73**:21-28

[40] Mulasso M, Roppolo M, Gobbens R, Rabaglietti E. The Italian version of Tilburg Frailty Indicator: Analysis of psychometric properties. Research on Aging. 2015;**38**(8):842-863

[41] Bouillon K, Kivimaki M, Hamer M, Sabia S, Fransson E, Singh-Manoux A, et al. Measures of frailty in a population-based studies: An overview. BMC Geriatrics. 2013;**13**:64. DOI: 10.1186/1471-2381-13-64

[42] Cronbach L. Coefficient alpha and the internal structure of tests. Psychometrika. 1951;**16**:297-334

[43] Sijtsma K. On the use, misuse and very limited use of Cronbach's alpha. Psychometrika. 2009;**74**(1):107-120

[44] Schmitt N. Uses and abuses of coefficient alpha. Psychological Assessment. 1996;**8**:350-353

[45] Lord F. An empirical study of the normality and independence of errors of measurement in test scores. Psychometrika. 1960;**25**:91-104

[46] Lord F, Novick M. Statistical Theory of Mental Test Scores. Reading: Addison-Wesley; 1968

[47] Cortina J. What is coefficient alpha? An examination of theory and practice. Journal of Applied Psychology. 1993;**78**:98-104

[48] Moreau D, Kirk I, Waldie K. Seven pervasive statistical flaws in cognitive training interventions. Frontiers in Human Neuroscience. 2016;**10**:153

[49] Sedgwick P. Relative risks versus odds ratio. BMJ. 2014;**348**:g1407

[50] Ranganathan P, Aggarwal R, Pramesh C. Common pitfalls in statistical analysis: Odds versus risk. Perspectives in Clinical Research. 2015;**6**(4):222-224

[51] Sackett D, Deeks J, Altman D. Down with odds ratio! Evidence-Based Medicine. 1996;**1**(6):164-166

[52] Streiner D. Risky business: Making sense of estimates of risk. Canadian Journal of Psychiatry. 1998;**43**(4):411-415

[53] Anselmi P, Colledani D, Robusto E. A comparison of classical and modern measures of internal consistency. Frontiers in Psychology. 2019;**10**:2714. DOI: 10.3389/fpsyg.2019.02714

[54] Peters L, Boter H, Burgerhof J, Slaets J, Buskens E. Construct validity of the Groningen Frailty Indicator established in a large sample of home-dwelling elderly persons: Evidence of stability across age and gender. Experimental Gerontology. 2015;**69**:129-141

[55] Strauss M, Smith G. Construct validity: Advances in theory and methodology. Annual Review of Clinical Psychology. 2009;**5**:1-25

[56] Sechrest L. Validity of measures is no simple matter. Health Services Research. 2005;**40**(5Pt 2):1584-1604

[57] Kelly P, O'Malley K, Kallen M, Ford M. Integrating validity theory with use of measurement instruments in clinical settings. Health Services Research. 2005;**40**(5 Pt 2):1605-1619

[58] Westen D, Rosenthal R. Quantifying construct validity: Two simple measures. Journal of Personality and Social Psychology. 2003;**84**(3):608-618

[59] Elasy T, Gaddy G. Measuring subjective outcomes: Rethinking reliability and validity. Journal of General Internal Medicine. 1998;**13**(11):757-761

[60] Snow A, Cook K, Lin P, Morgan R, Magaziner J. Proxies and other external raters: methodological considerations. Health Services Research. 2005;**40**(5Pt2):1676-1693

[61] Ioannidis J, Patsopoulos N, Rothstein H. Reasons or excuses for avoiding meta-analysis in forest plots. BMJ. 2008;**336**(7658):1413-1415

[62] Edwardes M. Meta-analysis and the reversed theorem of the means. Research Synthesis Methods. 2014;**5**(4):313-321

[63] Pettiti D. Meta-analysis, Decision Analysis and Cost-effectiveness Analysis. 2nd ed. Oxford University Press; 1999

[64] Esterhuizen T, Thabane L. Meta-analysis: Some key limitations and potential solutions. Nephrology, Dialysis, Transplantation. 2016;**31**:882-885

[65] Leshabari K, Biswas A, Gebuis E, Leshabari S, Ohnishi M. Challenges in morbidity and mortality statistics of the elderly population in Tanzania: A call to action. Quality in Ageing and Older Adults. 2017;**18**(3):171-174

Chapter 4

Performance-Based Screening Tools for Physical Frailty in Community Settings

Tina Levec and Miroljub Jakovljević

Abstract

Frailty is one of the leading causes of morbidity and premature mortality in older people. It is a multidimensional syndrome characterized by a reduced ability to deal with acute, physical, mental, socio-economic and spiritual stressors, and/or to perform daily living activities. Physical frailty is a complex condition deriving from multiple causes and contributors. It is characterized by the decline of physiological systems, leading to a loss of strength and endurance, and reduced physical ability. Frailty presents an increased risk of vulnerability to disease, dependency and/or death. Frail individuals are also prone to falls and are at greater risk of hospitalization and admission to long-term care. Consequently, there is a need for an effective tool or tools that can easily identify frail community-living individuals at an early stage of physical decline. Screening tools can be performance-based tests, questionnaires or a combination of both. The aim of the present narrative literature review is to describe the existing simple performance-based frailty screening tools.

Keywords: physical frailty, performance-based tests, community

1. Introduction

In recent years, specific importance has been placed on defining frailty in order to better understand the health, functional abilities of older adults, and to prevent or delay the onset of disability and its consequences [1]. It is widely recognized that frailty is associated with an increased risk of adverse health outcomes [2, 3], such as functional impairment and hospitalization [4, 5], loss of autonomy [6] and death [4, 7–9]. Globally, frailty can affect everyone at all stages of life, with a prevalence rate of 4.0% to 59.1%. This wide range of the established prevalence is probably due to various definitions of frailty used in scientific sources and professional literature [10].

Broader definitions of frailty, looking beyond physical functioning, have been put forward [11–13]. Frailty is a multidimensional syndrome characterized by a reduced ability to cope with acute, physical, psychological and socioeconomic stressors, and/or to perform activities of daily living [14, 15]. According to Gobbens and co-workers [16 , p. 342], frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social) caused by the influence of a range of variables and which increases the risk of adverse outcomes. However, frailty should rather be defined

as a process and not as a state. A multidimensional approach to frailty is congruent with the interdisciplinary diagnostic process used in the Comprehensive Geriatric Assessment for frail older people, which also examines physical, mental [including both psychological and cognitive functioning], and social functioning [17, 18].

Human health is determined by the health in different biological (physical), psychological (mental), social, and spiritual domains. Performance and interaction of these four dimensions determine the behaviors and abilities of human beings [19]. Teo and colleagues [20] identified three dimensions of frailty in their research, namely, physical frailty [21], emotional [mental] frailty [22] and social frailty [23, 24], to which spiritual frailty can be added [25] (**Figure 1**). With aging, changes occur in physical, mental (psychological), social and spiritual functioning. Accumulation of problems in one or more of these domains of functioning is characteristic of frail people. Consequently, the age group most affected is the older adults. For example, the prevalence of frailty averages 10.7% of community dwelling adults aged 65 years or more and this percentage rises to 15.7% and 26.1% respectively in the 80–84 and >85 age groups [26]. The prevalence of frailty in community dwelling older adults is even higher in studies involving the use of multidimensional tools, which recorded a 13.9% of frail and 7.6% of very frail older adults living in the community [27].

Originally, frailty was primarily focused on the physical problems that older people encounter, as defined in the popular Fried's 'phenotype of frailty' [21]. Physical frailty is a medical syndrome with multiple causes and contributors that is characterized by diminished strength and endurance as well as reduced physiological function resulting in individuals' vulnerability, increased dependency and/or death [30]. Physical frailty is discrete from disease and disability and it may be reversible [1]. Physical frailty is the result of a sub-threshold reduction in the capacity of many physiological systems due to aging and disease. Consequent to the reduced ability to maintain homeostasis, this is a high-risk condition for adverse

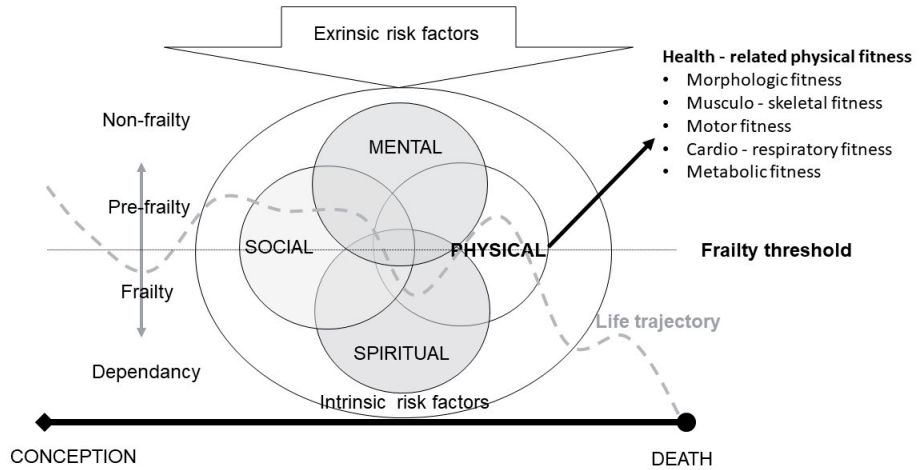

Figure 1.
Like life, frailty is dynamic, complex process, which is going on from the conception until the end of life, which oscillates between non-frailty [complete independency] and complete dependency. All components (of frailty) influence each other. The incidence of frailty is influenced by extrinsic and intrinsic (mental, physical, social, spiritual) factors. Physical frailty is closely connected with health-related physical fitness, since majority of frailty tests contain at least one of the components of health-related physical fitness. Physical fitness is a set of characteristics that individuals already have or achieve and relate to their ability to perform physical activity [28]. It is also is a state of well-being with a low risk of developing premature health problems and sufficient energy to participate in a variety of physical activities [29]. Health-related physical fitness is a more complex construct and includes the functional fitness needed to perform daily tasks.

health outcomes, including inability, dependence, falls, fractures, loneliness, poor quality of life, depression, cognitive decline, dementia, long-term care and death [31]. The risk of developing physical frailty increases with age and many older adults are frail, even though they do not have any life-threatening illness [32]. A systematic review of the literature on physical frailty in people aged 65 and over [26] shows that the prevalence of physical frailty ranges from 4.0–17% (average 9.9%). In women (9.6%), it is almost twice as high as in men (5.2%) and increases with advancing age, and very markedly after the age of 80 years. On the basis of the five Fried phenotype frailty criteria, the prevalence of prefrailty and frailty in community dwelling population (aged 65 and older) ranges from 4.9% to 27.3% and 34.6% to 50.9%, respectively [33]. It is important to note that the Survey of Health, Aging and Retirement in Europe evidences important differences among countries as regards the prevalence of frailty, varying from 5.8% in Switzerland to 27.3% in Spain. The prevalence is especially high in some southern European countries, including Spain, Italy, France, and Greece [34].

The prevalence of physical frailty increases with age, but 5.3% of the population is already fragile between the ages of 18 and 34 [35].

1.1 Screening

Physical frailty secondary prevention embodies the earliest possible detection of physical frailty or changes mostly leading to this syndrome. Screening is a strategy designed to diagnose frailty syndrome in elderly adults with subtle or no clinical manifestations of frailty by employing the most simple tests possible. This strategy is defined as the process of identifying individuals at higher risk for adverse outcomes, functional impairment and mortality. Management of frail seniors includes counseling, additional tests and appropriate treatment to mitigate the risks and possible subsequent complications of this condition [36]. The goal of screening is to reduce frailty incidence, which can be achieved by regularly examining selected groups of the population. In order to attain this goal, the participation of the target population should be adequately high. The selection of diseases which warrant screening is based on the revised criteria set by Andermann and co-workers [37 , p. 318], namely:

- The screening program should respond to the identified need.
- The objectives of the review should be defined at the outset.
- The target population must be defined.
- There should be scientific evidence on the effectiveness of the screening program.
- The program should integrate education, testing, clinical services, and program management.
- There must be a quality assurance system, with mechanisms to reduce potential screening risks.
- The program must ensure informed choice, confidentiality and respect for autonomy.
- The program should promote equal access to screening for the entire target population.

- Program evaluation should be planned from the outset.
- The overall benefits of screening should outweigh the harms.

Bowling and Dieppe [38] suggest that a forward-looking policy for older age would be a program to promote successful aging from middle age onwards, rather than simply aiming to support elderly people with chronic conditions.

1.2 Performance screening tests for community dwelling older adults

Prevention of frailty is therefore necessary as it may eventually lead to prevention or postponement of hospitalization and institutionalization of elderly people. It should be directed at both delaying the onset of frailty and slowing down the frailty process. Insight into the factors that are associated with the presence of frailty is the first step to assist the identification of potentially vulnerable groups.

Tools for the detection of frailty syndrome in older adults can be divided into self-report, performance-based screening instruments [39] and a combination of both. Performance-based instruments have several advantages, including the following:

- greater sensitivity to non-response, changes in time and differences in the execution of activities [40];
- greater precision and validity of answers [41, 42];
- reduced risk of bias associated with perceptions and mood [43–45];
- increased reliability across measurements by standardized administration and scoring [43–45];
- greater sensitivity to clinical changes as compared to self-report [43–45].

On the other hand, performance-based measures and tests also have several limitations. Some of these instruments are less user-friendly and may be time-consuming [41, 42, 46]. Sometimes they require sophisticated equipment, space, or trained personnel. They may sometimes be difficult to score or interpret rendering them impractical in most clinical settings. Experts warn of one major limitation of performance-based measures when used in a simulated environment. Due to the structure or context of the test, the results of these measures may mislead to overestimation or underestimation of the seniors' physical and functional capabilities.

2. Single performance-based tests

Although the phenotype elaborated by Fried and co-workers [21] is frequently used in research internationally, some researchers have proposed a more simplified index to detect physical frailty, with the objective of facilitating clinical practice and identifying individuals at risk [47, 48]. Measurements of physical performance, such as gait speed, five-time sit-to-stand test and grip strength can identify frailty [48] and may be suitable for frailty screening in primary care or population health survey [49].

2.1 Gait speed

Normal gait is defined as a highly controlled, coordinated and evenly repetitive movement of the lower limbs, the purpose of which is to reach a certain place at a certain time with the least possible energy consumption [50]. The combination of joint mobility, muscle capacity and nerve function, and energy expenditure affect stride length and relaxed walking speed. In the absence of impairment, walking is effective and easy, while disease processes or injuries can affect the accuracy, coordination, speed, and versatility that define normal walking [51]. Gait ability tests are clinically useful in screening older individuals at high risk of frailty [52]. To date, a large variety of methods [e.g. habitual and maximal gait speed] and distances [from 2.4 m to ten or more meters] have been used to measure gait speed [53]. Without regard to the exact measurement protocol, walking speed is a valid and reliable measure appropriate to assess the overall mobility function and health. This indicator is often associated with institutionalization and mortality [54].

Habitual gait speed (GS) has been recognized as a safe and simple measure with which adverse outcomes in community dwelling older people can be predicted [53]. It correlates with all indicators of health, functioning, and overall activity regardless of whether it was assessed at home over a 3-meter distance or in the research centre over a 10-m distance [55]. Differences in measuring devices [stopwatch vs. photocell] or distance should not affect the reliability of the measures [56].

The GS is valid [57, 58], reliable [56, 57], and sensitive [59, 60] measure. For gait speed of <0.8 m/s, the sensitivity is 0.99 and specificity 0.64 [60]. However, limited specificity implies many false-positive results indicating that these instruments cannot be used as accurate single tests to identify frailty [61]. Due to the measure's extensive predictive capabilities, as well as ease of administration, the GS is considered the "sixth vital sign" [62–66].

In future, it will certainly be necessary to unify the performance of the gait speed test for screening purposes with all the requirements for performing the test, with regard to the start of the test, the length of the track, the method of time measuring, client encouragement, the use of walking aids and the selection of appropriate footwear.

2.2 Handgrip isometric dynamometry

The unique composition of the hand provides the ability to perform important functions such as drinking, perceiving, or communicating [67]. Most daily activities involve human hand-object interaction. As one of the requirements for the handgrip is its strength, physical frailty phenotype criteria also include weakness based on the isometric handgrip strength (IHGS) measurement [21]. Of the five frailty indicators, the IHGS deserves attention as a simple and objective measure of the frailty syndrome [68, 69]. The test produces a measure of the isometric force of intrinsic and extrinsic hand muscles expressed in kilograms or Newtons and can be normalized allometrically [70, 71]. The IHGS has been recommended as a basic measure in the determination of musculoskeletal function as well as of weakness and disability [72–74]. It is a good general indicator of health and functioning regardless of whether it is assessed in the home setting or in more formal research centre settings [75, 76]. It is associated with a variety of aging outcomes [43, 77] and forms a key component of sarcopenia [78] and frailty [21, 79] phenotypes.

The IHGS is a simple, quick and inexpensive means of stratifying an individual's frailty. However, the methods used to characterize the IHGS vary considerably, both with regard to the choice of dynamometer and the measurement protocol used, which

makes comparison between studies difficult [80]. The Jamar dynamometer is considered the "gold standard" in handgrip dynamometers [81, 82] at the handle position two [83]. When handgrip strength was assessed with similar devices at home and in the research centre the results correlated highly and were not affected by the participants' health, functioning and overall activity [55]. It seems that IHGS was least prone to measurement error related to different assessment tools and protocols [55, 75].

Weak handgrip strength in later life is a risk factor for disability, morbidity, and mortality and is central to the definitions of sarcopenia and frailty [75, 84]. Evidence indicates that low IHGS is significantly associated with physical frailty, also when the effects of body mass index and arm muscle circumference are ignored [85]. Several studies have suggested that hand dynamometry can be used to measure the manner in which muscles are used, which is a predictor of frailty and disability in the advanced age [85].

Grip strength thresholds for men ranged from 23.2 kg to 39.0 kg, and for women from 15.9 kg to 22.0 kg [86–89]. The British grip strength centiles [90] and their associated cut points accord with the definitions for sarcopenia and frailty across developed regions, but highlight the need for different cut points in developing regions [75].

The test–retest reliability of the IHGS in older adults is good to excellent [intraclass correlation coefficient ≥ 0.80] [91, 92] when using the mean value, the best value, or the first of the 2 measurements [92].

2.3 Sit-to-stand tests

The sit-to-stand (STS) movement is considered a fundamental prerequisite for mobility and functional independence since the movement is part of the various Activities of Daily Living [ADL] [93]. The STS maneuver is a common activity of daily living [94] and is partly dependent on lower limb muscle strength and performance [91, 95, 96], and balance [95, 97]. It seems, however, that the STS performance is also dependent, at least in part, on the factors other than muscular strength [e.g. motivation, pain] [97, 98].

Variations of the STS maneuver have been adapted as functional performance measures, including the time to perform a given number of the STS maneuvers [99] or the maximum number of the STS maneuvers in a given time period, usually 30 or 60 s [100, 101]. The STS tests correlate well with other objective physical performance measures such as Timed Up and Go test, gait speed [102] and the 6MWT [100] in healthy older community-living populations.

Regardless of all variations of the STS test, the same equipment is required; standard (folding) chair without arms, with seat height of 43.2 cm and a chronometer.

2.3.1 Five-time sit to stand test

The five-time STS test (FTSST) is the most frequently employed [99] and the best described STS test in older adults. The test measures the time taken to stand five times from a sitting position as rapidly as possible. It less likely reflects endurance than a ten repetition [103] or 30 second test [101]. Normative values [99] and data on reliability [104] and validity [96] have been well described in healthy older community dwelling individuals.

2.3.2 30-second sit to stand test

The 30-second sit to stand test (30STST) aimed to test leg strength and endurance in older adults. The 30STST involves recording the number of stands a person

can complete in 30 seconds. It is part of the Fullerton Functional Fitness Test Battery. This test was developed to overcome the floor effect of the five or ten repetition sit to stand test in older adults [105]. It is possible to assess a wide variety of ability levels with scores ranging from 0 for those who cannot complete 1 stand to greater than 20 for more fit individuals [106]. The 30STST provides a reasonably reliable and valid indicator of lower body strength in generally active, community dwelling older adults [101]. Older adult persons were inferior in force production and quickness of movement, which decreased as elderly stood up from a chair of a lower height [107]. It is worth noting that chair seat height's relation to the lower leg length should be considered when interpreting the 30STST scores [108].

2.4 Transfer tests

Depending on the social and living environment, sitting down on and rising from the floor is essential for independent daily living. Irrespective of the culture, the ability to return to an upright position after the fall is of vital importance [109]. The inability to return to upright position is viewed as an indicator of frailty in older adults [110]. Tinetti et al. [110] report that 47% of their older adult study participants were unable to get up without assistance after falls without injury.

2.4.1 Timed floor transfer test

In order to assess the functional ability of seniors to sit down on and rise from the floor, Murphy and colleagues [111], designed the so-called timed floor transfer test (TFTT), which measures the time one needs to sit on the floor and return back to the standing position in any preferred manner. The test is also used to detect individuals with greater risk of falling [111].

The TFTT is a simple, cheap, easy and short performance-based assessment tool, which does not require additional training. It can be administered quickly and easily in both the clinical and home settings. Furthermore, it may reduce the need for extensive assessment via other instruments. For test execution, a chronometer, a matt and a chair for possible support is needed. In the cross-sectional study by Ardali and co-workers [112], one practice trial was performed for familiarization purposes, followed by three timed trials for each subject. The mean of the three timed trials was used for data analysis. Usually, a two-minute rest is allowed between trials in order to minimize fatigue. The TFTT is applied to identify older adults with physical disabilities and/or functional dependence and may be useful in assessing readiness for independent living [112].

The TFTT test has been shown to have good test–retest reliability ($ICC(3,1) = 0.79$, $p \leq 0.0001$) [111]. In the same study, the TFTT times showed also significant correlation with the completion times of the 5-Step Test ($r = -0.57$), functional reach distance ($r = -0.49$), 50-ft (15.24 m) walk test times ($r = -0.52$), and scores on the Performance-oriented Mobility Assessment for Balance ($r = 0.44$). In addition, the ability to complete the TFTT was shown to be a significant predictor of falls among community dwelling older adults. It could correctly classify 95% of fallers and non-fallers among 50 community dwelling older adults, with 81.8% correct prediction of falls and 100% correct prediction of no-falls [111]. Inclusion of the TFTT test at initial evaluation may reveal the presence of these conditions and address the safety of older adults in the community [112]. The study of FT ability by Tinetti and co-workers [110] reported that those who had a history of falls and were unable to get up without help were more likely to suffer functional decline than those without the history of falls, or those who had a history of falls and who were able to get up without assistance. Similarly, Alexander and co-workers [109] noted

that 4 out of 9 congregate older adults [mean age = 80 years] who were unable to rise from the floor without support could complete the FT task with support, leaving 5 subjects who could not rise under any condition. In their work Bergland and Laake [113] concluded that the test "get up from lying on the floor" is a marker of failing health and function in older adults and a significant predictor of serious fall injuries. Murphy and co-workers [111] reported that the timed FT test predicted falls in independently functioning community dwelling adults older than 60 years, correctly classifying 95.5% of the participants.

2.4.2 Supine to stand test

The ability to rise from the floor to a standing position is a basic human motor skill [114], which is essential for maintaining independence and mobility through adulthood [114, 115]. For that reason, the assessment of supine to standing position has become an increasingly popular screening instrument to determine functional performance [115, 116]. The supine-to-stand (STS) test has been designed as a combined assessment of flexibility [117], strength [118], locomotion and balance [115], and overall motor competence [116].

Subsequent research by Ulbrich and co-workers [119] has demonstrated that older adults have more difficulty in rising from the floor than young adults. The congregate housing residents took more than three times as long as the healthy older adults to rise successfully from the floor, and the healthy older adults took twice as long as the young adults to rise. The most advanced movement pattern seems to be symmetrical (e.g., where both sides of the body move together in the same pattern), most often occurring in older adolescents and young adults [120–122].

Green and Williams [114] and Ng et al. [123] presented the sequence of procedures used in the assessment of supine-to-stand performance. The study participants were required to assume a supine position on a padded mat on the floor. They were instructed to stand up as fast as possible after a 'go' command. No prior demonstration was given so as to avoid influence on their moving patterns [114]. The participants were allowed a practice trial before conducting two trials for the purposes of data collection [123]. Two metrics of scoring supine-to-stand performance were used. Firstly, the time to complete the supine to stand movement was taken as a product measure of this motor performance. In the subsequent analysis the fastest time from the two trials was used. Timing started at the beginning of the movement after the 'go' command and stopped when the subjects were standing erect with both feet on the mat and with no compensatory movement or sway [114, 123].

2.5 Balance tests

The peripheral sensory systems that are responsible for maintaining posture control also deteriorate with aging [124, 125], while the ability to maintain control of posture is important for the successful performance of most daily activities [125]. Balance involves the reception and integration of sensory stimuli, and the planning and execution of movements to control the centre of gravity on the base support, carried out by the postural control system that integrates information from the vestibular and somatosensory system and visual receptors [126, 127]. Evidence shows that postural instability is related to frailty [128–131] and pre-frailty [132]. Accordingly, the presence of postural instability determines a greater chance of the elderly being frail or pre-frail [133].

2.5.1 Timed up and go test

Weaknesses of Up and Go Test (UGT) triggered the design and development of a modified version of the UGT, where the time in seconds required by the subject to perform the test is measured [134]. The authors named the test Timed Get Up and Go Test (TUGT). This test is an objective single continuous measure that is quick and easy to apply in all settings and requires no specialized equipment [e.g. chronometer, standard [folded] chair and masking tape or cone]. Individuals rise from a chair of standardized height, walk a fixed distance of 3 m, turn, return to the chair, and sit down again. The final test result expressed in seconds proved to be a more reliable criterion compared to the ranking scale of the original version [134].

The TUGT is a sensitive and specific measure of frailty that offers advantages in its measurement in cases when full application or interpretation of Fried's criteria is impracticable [135]. The TUGT can identify frail members of the population well but is less able to discriminate the non-frail from the prefrail or frail populations [135, 136]. For ordinal values, the TUGT times were categorized into fast ($\leq$ 10 seconds), intermediate (11–14 seconds), and slow ($\geq$15 seconds) groups, which correspond to non-frail, prefrail, and frail categories, respectively [135, 137]. The link between the impaired functional mobility and dynamic balance with frailty can be explained by the age-related physiological changes that occur in the body with frailty, such as sarcopenia resulting in loss of muscle mass and function [138].

The TUGT is an appropriate measure of functional mobility as well as dynamic balance among frail older adults [134]. The TUGT has good intra- and inter-rater reliability [139, 140]. It is correlated to regular physical activity [141], global health decline [142], disability in activities of daily living [142–144], and falls [143–145]. Less than optimal functional mobility and dynamic balance result in susceptibility to being frail [146].

2.5.2 Functional reach test

Functional Reach Test (FRT) is an assessment tool for ascertaining dynamic balance in one simple task. Duncan and co-workers [147] define functional reach as the maximal distance one can reach forward beyond arm's length, while maintaining a fixed base of support in the standing position. The only equipment required for the FRT is a yardstick or paper measuring tape fixed to the wall at shoulder height. Testing procedure is short and lasts less than five minutes. It was developed to predict fall in elderly people; being unable to reach more than 15 centimeters depicts a high fall risk and frailty [148]. The FRT is a practical instrument that correlates with physical frailty even more than with age [148].

There is evidence for excellent reliability for adults aged 20–87 years [147] and its concurrent [148], predictive [147, 149] and known groups validity [147, 150] among older adults. The FRT correlates with walking speed, tandem walk, and unipedal stance in community dwelling older adults [148].

2.5.3 Unipedal stance test

The Unipedal Stance Test (UPST) is a method of quantifying mostly static balance ability [151]. Individuals are tested with eyes open and they are asked to stand on either their left or right leg. They are instructed to keep their legs from touching and to maintain single-leg stance for as long as possible. A digital stopwatch is used for timing as this approach has previously been shown to exhibit

near perfect inter-rater reliability [152 , p. 9]. The UPST and timing begin once the subjects have lifted their foot off the floor, and end when placing the lifted foot on the floor or with arm movement of placing the hand on a chair that is positioned beside them for support if needed. The test is terminated after a maximum of 60s. Each leg is tested three times unless subjects perform perfectly on the first two trials. Subjects typically alternate between legs and are allowed to rest between trials if needed. The best trial score is used for analysis which is typically used clinically [152].

Normative data for the eyes open and closed conditions have been established with which to compare the tested values [153–155]. Performance is age-specific and not related to gender [152]. The UPST is a valid measure [99] and is correlated with frailty and self-sufficiency in activities of daily living [156, 157], gait performance [158] and fall status [157]. The UPST with the eyes open, but not closed, is also reliable for testing health-related fitness [155].

2.6 Joint range of motion and flexibility tests

Along with strength, balance, and endurance, flexibility is considered an important physical dimension for active and healthy aging. Upper-extremity joint impairments, including pain, limitations in range of motion (ROM), and joint deformity are related to self-reported loss of independence in basic ADL tasks [159, 160]. Lower-extremity ROM is associated with self-reported difficulty in functional mobility, such as rising from a chair, stair climbing, and the need for assistive devices during ambulation [161]. Independent of demographics and non-musculoskeletal conditions, joint impairment is associated with diminished walking ability in older adults [162].

2.6.1 Back scratch test

The back-scratch test (BST) is a part of Senior Fitness Test Manual [163], which assesses upper limb and shoulder flexibility. The participants stand with one hand reaching over shoulder and reach for another palm behind the back as far as possible and the distance between the extended middle fingers is recorded. The test is performed twice, and the best trial is noted to one decimal point. The BST provides an indication of the general shoulder range of motion, and the upper body and shoulder flexibility. It is associated with lifestyle activities such as getting dressed, reaching for objects and putting on a car seat belt. The BS is reported to have a good intraclass test–retest reliability (ICC = 0.98) [164] and is regarded as a valid instrument for measuring the upper-body flexibility of older adults [165].

2.6.2 Chair sit and reach test

The chair sit-and-reach test (CSRT) of the Senior Fitness Test Manual [163] measures flexibility of the posterior muscle chain, more specifically in the lower back and hamstrings. It is a modification of the Sit and Reach test. The participants reach forward in an attempt to touch their toes from a sitting position on the edge of a chair. The distance between the extended middle finger and the big toe is recorded while in a static position for a couple of seconds at the point of greatest reach [166]. The test is performed twice. The best trial in centimeters to one decimal point is noted.

The CSRT provides good validity and intraclass test–retest reliability (ICC = 0.92 for men; ICC = 0.96 for women), and it better correlates to hamstring flexibility in elderly people than the floor sit-and-reach test [167]. Further studies indicate that the CSRT produces reasonably accurate and stable measures of hamstring flexibility [168].

2.7 Cardiorespiratory tests

Maximal aerobic capacity, as measured by maximal oxygen consumption ($\dot{V}O_{2max}$), declines progressively with adult aging [169]. Although $\dot{V}O_{2max}$ may not provide an optimal measure of functional capacity [170], the decline in $\dot{V}O_{2max}$ with age contributes importantly to the age-related reduction in physical functional capacity [171–173]. A $\dot{V}O_{2max}$ of 15–18 ml kg^{-1} min^{-1} must be maintained for independent function [172, 174], maintaining maximal aerobic capacity is therefore an important component of successful aging.

Direct (maximal exercise) and indirect (submaximal exercise) laboratory measurement of $\dot{V}O_{2max}$, which have been defined as indicators of cardiorespiratory fitness, result in considerable expense to the healthcare system [equipment, medical personnel]. In addition, such kind of testing may in older adults provoke dyspnoea, muscle pain and fatigue. All submaximal methods of predicting the $\dot{V}O_{2max}$ are based on linear relationship between HR and $\dot{V}O_{2max}$. Furthermore, the majority of the equations used to estimate $\dot{V}O_{2max}$ were developed on the basis of tests performed in young and middle age individuals. HR can be affected by many extrinsic (environmental temperature and humidity) and intrinsic (state of health, medication) factors [175]. In older adults and especially in frail older people, multimorbidity and polypharmacy are common, which adds to the difficulty to properly assess cardiopulmonary fitness. Because of all mentioned problems, submaximal field exercise tests are useful alternatives to measurement of the $\dot{V}O_{2max}$ [176, 177]. Submaximal field exercise tests provide a feasible, safe, easy-to-administer, and inexpensive technique for the prediction of $\dot{V}O_{2max}$ [177].

2.7.1 Six minute walk test

Among field walking tests, the 6-minute walk test (6MWT) is used by reason of its ease of administration [178]. The 6MWT was first introduced as a functional exercise test by Lipkin [179]. The 6MWT measures the maximal distance that a person can walk in 6 minutes [180]. The European Respiratory Society and the American Thoracic Society [181] published the detailed 6MWT procedure guidelines. The 6MWT may be conducted in different environments, indoors or outdoors, with different track length.

Determining factors of the 6MWD in healthy adults are age [106, 182, 183], gender [106, 183, 184], height and weight [183], body mass index, ankle-arm blood pressure index, 1-second forced expiratory volume [184], health status [182, 184] and smoking [184].

The reliability of the test in healthy elderly persons is high (ICC = 0.93) [185]. The test results are highly correlated with those of the 12-minute walk test [186] and with cycle ergometer or treadmill based exercise tests [187]. The 6MWT performance correlates with both aerobic capacity and muscle fitness [188]. Several authors propose either reference equations or normative data for the 6MWT outcome [106, 183, 184].

2.7.2 Two minute step test

If the 6MWT is not feasible [space limitation], it can be replaced by the Two Minute Step test (TMST) [106]. Protocol involves determining the number of times within a period of 2 minutes that a person can step in place, raising the knee to a height halfway between patella and iliac crest. Performance on the test is defined as the number of right-side steps of the criterion height completed in 2 minutes. A chronometer and adhesive tape of a clearly visible color are the necessities needed to perform the test.

Rikli and Jones [106] found the TMST to demonstrate good interday test–retest reliability (ICC = 0.90). They also reported convergent validity relative to 1-mile walk treadmill performance time (r = 0.73) and known group validity [106]. It detects performance differences across different age groups and levels of physical activity [106, 165, 189] and proposes exercise intervention in various community-residing population [190, 191]. Rikli and Jones [192] also published normative reference values for adults 60 to 94 years old.

2.8 Functional fitness test batteries

The concept of fitness encompasses beneficial health outcomes, including aerobic conditioning, muscle strength and feelings of vigor [193], as well as increased physiological and cognitive functioning [194, 195] leading to a reduced mortality rate [196] and fewer years of disability before death [197]. Functional fitness has been defined as having the physiological capacity to perform normal everyday activities safely and independently without undue fatigue. Therefore, the test batteries must assess the physiological attributes that support the behavioral functions necessary to perform activities of daily living [106]. The frail older adults tend to depend on others due to limitations of physical functions compared to the normal elderly, and the maintenance of function is more important to the elderly than healing from diseases [198, 199]. Unlike frailty, maintenance of functional fitness is associated with successful aging [200, 201]. Slow gait speed and low physical activity/exercise seem to be the most powerful predictors followed by weight loss, lower extremity function, balance, muscle strength, and other indicators of frailty [202]. Functional fitness is typically assessed using batteries that include a combination of health- and performance-related tests, including measurements of aerobic capacity, muscular strength and endurance, body weight and composition, flexibility, balance, and coordination [203]. Physical performance factors are strongly associated with decreased frailty, suggesting that physical performance improvements play an important role in preventing or reducing the frailty [204].

Physical fitness in community dwelling older adults declines early in frailty and manifests differentially in both genders [205]. However, a decline in physical fitness [represented by agility, endurance, flexibility and strength] may begin as early as in middle life. After the age of 50, the annual decline of 1–2% in muscle mass is matched by a progressive loss of 1.5–3% in muscle strength every year [206]. A significant drop in aerobic capacity is observed after the age of 40 and this loss may reach as much as 30% by the age of 65 [207].

By convention, weakness in frailty criteria has included only grip strength and it is the most salient feature [208, 209] even though loss of muscle strength in the lower limbs is typically greater than in upper limbs [201, 210]. It is also interesting to note that physical exhaustion is observed much later in the frailty cycle despite the loss of nearly 10% of aerobic ability after every decade [209, 211]. Since deterioration in physical fitness typically precedes functional dependence [212], a comprehensive physical fitness assessment can be included in conventional measures of frailty to facilitate early detection and prevention of frailty.

2.8.1 Short performance physical battery

The Short Physical Performance Battery (SPPB) test [213] is designed to measure functional status and physical performance. It has primarily been used to assess elderly patients in the hospital, clinical and community settings. The SPPB test might be also used as a screening tool to detect frailty syndrome in community dwelling older adults [214, 215].

The SPPB test consists of three assessments: repeated chair stands, balance tests (side-by-side, semi-tandem and tandem balance tests) and eight-foot walk (2.44 m) test [213]. In terms of equipment, it requires only the use of a standard chair with arms, chronometer, tape measure and two cones to mark the distance. Categories of performance is created for each set of performance measures to permit analyses that includes those unable to perform a task. Those completing the task are assigned scores of 1 to 4, corresponding to the quartiles of time needed to complete the task, with the fastest times scored as 4. The three tests of standing balance are considered as hierarchical in difficulty in assigning a single score of 0 to 4 for standing balance. A summary performance scale is created by summing the category scores for the walking, chair stand, and balance tests [213]. The time taken to perform the test is around 10 minutes and the test is reasonably quick. The data can also be analyzed using the lower extremity continuous summary performance score [0 to 3], where each subscale has a maximum score out of 1 [216].

Regarding the threshold score for frailty, community dwelling older adults who score ≤ 9 points on the SPPB test are most likely to be classified as frail [217] and are at risk of losing the ability to walk 400 m [218]. In order to classify participants as frail, pre-frail and non-frail, the following cut-offs are used [6]: 0–6 points (frail), 7–9 points (pre-frail), 10–12 points (non-frail) [6].

The SPPB has been shown to have a high level of validity, reliability and responsiveness in measuring physical function within an older community dwelling population [219]. Test–retest reliability for community dwelling older adults ranges from 0.81 to 0.91 [220–222]. The SPPB test has satisfactory short (1 week) and long-term (6 months) reliability [222, 223].

The SPPB test has good concurrent validity when compared to other measures of frailty [217, 224] and internal consistency [213]. In the study of Pritchard and co-workers [225], there was fair ($R = 0.488$, $p < 0.001$) to moderate ($R = 0.272$, $p = 0.002$) agreement between Fried's phenotype method and the SPPB determining which participants were frail and pre-frail. The SPPB test score of ≤9 has the most desirable sensitivity (92%), specificity (80%) and greatest area under the curve (AUC =0.81) for identifying frail adults [224]. The SPPB better discriminated frailty in elderly with higher socioeconomic conditions [224]. Standard error of measurement for community dwelling older adults is between 0.68 and 1.42 points [220, 226, 227] and minimal detectable change is from 0.54 to 2.9 points [225, 226].

2.8.2 Physical performance test

Originally described in 1990, the Physical Performance Test (PPT) was developed by Reuben and co-workers [228] as an assessment tool to monitor and describe the multiple domains of physical function in frail and non-frail community dwelling elderly people through several performance tasks. These tasks simulate activities of daily living using various degrees of difficulty. The two versions presented [228] encompass a nine-item scale that includes writing a sentence, simulated eating, turning 360°, putting on and removing a jacket, lifting a book and putting it on a shelf, picking up a penny from the floor, a 50 ft. (15.24 m) walk test, and climbing stairs (scored as two items), and a seven-item scale that does not include stairs. Both versions demonstrate concurrent validity where high correlation is shown in comparison with basic daily activities and Performance Oriented Mobility Assessment [228] and the 7-item version showed high correlation with lower extremity muscle force and lower extremity joint range of motion as well [229]. The majority of PPT items are scored based on the time taken to finish the task. Scores vary from 0 to 28 and from 0 to 36 for the 7-item and 9-item PPTs, respectively, with higher scores showing better performance. The PPT involves few instruments and minimal instructions and takes about 10 minutes to complete [228].

2.8.3 Senior fitness test

Rikli and Jones [106] developed the Senior Fitness Test (SFT) which may be used to assess six underlying functional fitness parameters for older adults. These parameters include lower and upper body strength, aerobic endurance, lower and upper body flexibility, and agility/dynamic balance. The test components of the SFT have been singled out for their high content validity, criterion validity, construct validity, and reliability [230, 231]. The SFT is usually performed in a fitness facility or large community facility. However, Rikli and Jones [232] intentionally selected testing procedures that require very little equipment, and therefore could theoretically be easily adapted to other locations (even at home).

3. Discussion

Frailty is difficult to diagnose, particularly within primary care settings, due to its coexistence with other age-related conditions and lack of a universally accepted clinical definition [233, 234]. There is also a debate about frailty screening, especially in relation to screening eligibility as well as the place and time of its administration [235].

All single screening performance based instruments are less time-consuming than the two reference standard, most frequently used frailty indicators. Self-assessment questionnaires seem to be even faster to implement, they are simple and inexpensive. However, their weakness resides in lower rates of completion compared to instruments administered by health workers [236].

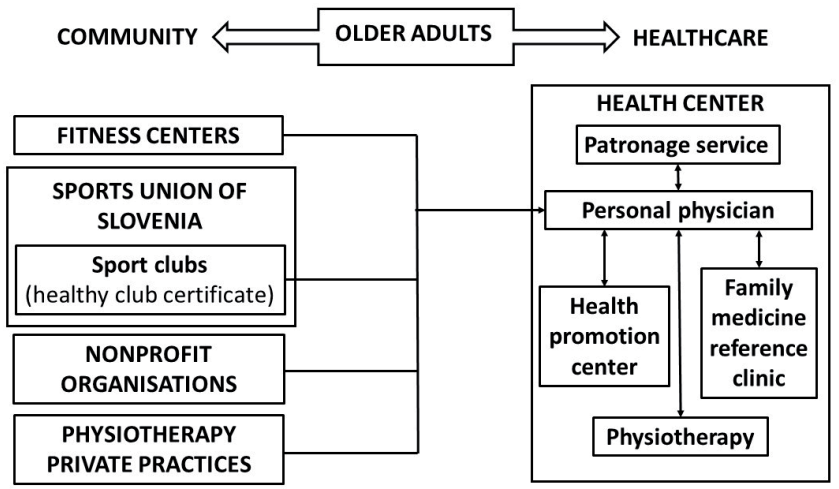

Figure 2.
The proposed screening scheme for frailty in the elderly in Slovenia. The two tests which proved to be most efficacious as regards the consumption of time for its performance, their good metric properties and costs are the handgrip isometric dynamometry and especially the five-time sit to stand test. The older adults can voluntarily commit to frailty testing or are referred for screening by their personal physician. Within the health centres, they can be advised to participate in frailty screening by their personal physician and can receive it within community nursing services, centres for health promotion, reference outpatient clinics or physiotherapy clinics. If participation in testing is voluntary, there are several possibilities. Numerous non-profit organizations (patients' associations, red cross, older people's associations, etc.) can organize the screening for frailty of the elderly once or several times a year either autonomously or in collaboration with sports associations, private physiotherapy outpatient clinics or fitness centres. It is of great importance to inform the participants' personal physician about the screening results on the basis of which they can perform a complete geriatric assessment. The elderly can be advised to undertake one of the available programmes within a health Centre or their community (e.g. ABC of physical activity for health monitored by certified sports clubs).

Individual performance tests can be conducted in all environments (**Figure 2**), including the subjects' home. Test batteries, however, require more organization, professional staff, and space. Such test batteries may be conducted in gyms or outdoors in collaboration with public health organizations, sports associations, fitness centres, and other interested non-profit organizations (**Figure 2**). Due to their simplicity, the tests can also be performed by non-medical professionals. The only requirement is strict observance of the test protocols and providing data to a personal physician.

For most performance tests, there are normative values for individual age groups and for each country or geographical area. Therefore, the evaluation of deviations from the expected results makes it difficult to classify the subjects into individual frailty stages. For that reason, the researchers frequently opt for the Z-score system which expresses the value as a number of standard deviations or Z-scores below or above the reference mean or median value. For population-based uses, a major advantage is that a group of Z-scores can be subjected to summary statistics, such as the mean and standard deviation [237]. For population-based assessment, the Z-score is widely recognized as the best system for analysis and presentation of health-related data because of its advantages compared to the other methods [237].

Physical fitness declines early in frailty and manifests differentially in both genders [205]. Prefrail/frail individuals have significantly poorer performance in upper limb dexterity, lower limb power, tandem and dynamic balance and endurance [205]. Except for balance and flexibility, all fitness measures usually differentiate prefrail/frail from robust women. In men, only lower body strength is significantly associated with frailty [205].

4. Conclusions

In screening for the condition of frailty, the latter should be first recognized as being a significant public health problem. The treatment should be successful, and the sufficient equipment and staff must be available for diagnosis and treatment. The examination must be reliable, inexpensive and simple to perform, and as mild as possible for the subjects. Given that physical frailty is correlated with other forms of frailty, any adverse outcome of an individual performance test or test batteries is a base for continuing a comprehensive geriatric assessment.

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References

[1] Rodríguez-Mañas L, Féart C, Mann G, et al. Searching for an operational definition of frailty: a Delphi method based consensus statement: the frailty operative definition-consensus conference project. J Gerontol A Biol Sci Med Sci. 2013;68(1):62-67. doi:10.1093/gerona/gls119

[2] Malaguarnera M, Vacante M, Frazzetto PM, Motta M. What is the frailty in elderly? Value and significance of the multidimensional assessments. Arch Gerontol Geriatr. 2013;56(1):23-26. doi:10.1016/j.archger.2011.09.017

[3] McMillan GJ, Hubbard RE. Frailty in older inpatients: what physicians need to know. QJM. 2012;105(11):1059-1065. doi:10.1093/qjmed/hcs125

[4] Kahlon S, Pederson J, Majumdar SR, et al. Association between frailty and 30-day outcomes after discharge from hospital. CMAJ. 2015;187(11):799-804. doi:10.1503/cmaj.150100

[5] Shamliyan T, Talley KM, Ramakrishnan R, Kane RL. Association of frailty with survival: a systematic literature review. Ageing Res Rev. 2013;12(2):719-736. doi:10.1016/j.arr.2012.03.001

[6] Subra J, Gillette-Guyonnet S, Cesari M, Oustric S, Vellas B, Platform T. The integration of frailty into clinical practice: preliminary results from the Gerontopole. J Nutr Health Ageing. 2012;16(8):714-720. doi:10.1007/s12603-012-0391-7.

[7] At J, Bryce R, Prina M, et al. Frailty and the prediction of dependence and mortality in low- and middle-income countries: a 10/66 population-based cohort study. BMC Med. 2015;13:138. Published 2015 Jun 10. doi:10.1186/s12916-015-0378-4

[8] Aguilar-Navarro SG, Amieva H, Gutiérrez-Robledo LM, Avila-Funes JA. Frailty among Mexican community-dwelling elderly: a story told 11 years later. The Mexican Health and Aging Study. Salud Publica Mex. 2015;57 Suppl 1(0 1):S62-S69. doi:10.21149/spm.v57s1.7591

[9] Tabue-Teguo M, Kelaiditi E, Demougeot L, Dartigues JF, Vellas B, Cesari M. Frailty Index and mortality in nursing home residents in France: results from the INCUR study. J Am Med Dir Assoc. 2015;16(7):603-606. doi:10.1016/j.jamda.2015.02.002

[10] Sieliwonczyk E, Perkisas S, Vandewoude M. Frailty indexes, screening instruments and their application in Belgian primary care. Acta Clin Belg. 2014;69(4):233-239. doi:10.1179/2295333714Y.0000000027

[11] Levers MJ, Estabrooks CA, Ross Kerr JC. Factors contributing to frailty: literature review. J Adv Nurs. 2006;56(3):282-291. doi:10.1111/j.1365-2648.2006.04021.x

[12] Hogan DB, MacKnight C, Bergman H; Steering Committee, Canadian Initiative on Frailty and Aging. Models, definitions, and criteria of frailty. Aging Clin Exp Res. 2003;15(3 Suppl):1-29.

[13] Markle-Reid M, Browne G. Conceptualizations of frailty in relation to older adults. J Adv Nurs. 2003;44(1):58-68. doi:10.1046/j.1365-2648.2003.02767.x

[14] Xue QL. The frailty syndrome: definition and natural history. Clin Geriatr Med. 2011;27(1):1-15. doi:10.1016/j.cger.2010.08.009

[15] Brown I, Renwick R, Raphael D. Frailty: constructing a common meaning,

definition, and conceptual framework. Int J Rehabil Res. 1995;18(2):93-102.

[16] Gobbens RJ, Luijkx KG, Wijnen-Sponselee MT, Schols JM. In search of an integral conceptual definition of frailty: opinions of experts. J Am Med Dir Assoc. 2010;11(5):338-343. doi:10.1016/j.jamda.2009.09.015

[17] Pilotto A, Cella A, Pilotto A, et al. Three decades of comprehensive geriatric assessment: evidence coming from different healthcare settings and specific clinical conditions. J Am Med Dir Assoc. 2017;18(2):192.e1-192.e11. doi:10.1016/j.jamda.2016.11.004

[18] Welsh TJ, Gordon AL, Gladman JR. Comprehensive geriatric assessment--a guide for the non-specialist. Int J Clin Pract. 2014;68(3):290-293. doi: 10.1111/ijcp.12313.

[19] Mohammadi M, Alavi M, Bahrami M, Zandieh Z. Assessment of the Relationship between Spiritual and Social Health and the Self-Care Ability of Elderly People Referred to Community Health Centers. Iran J Nurs Midwifery Res. 2017;22(6):471-475. doi:10.4103/ijnmr.IJNMR_171_16

[20] Teo N, Yeo PS, Gao Q, et al. A bio-psycho-social approach for frailty amongst Singaporean Chinese community-dwelling older adults - evidence from the Singapore Longitudinal Aging Study. BMC Geriatr. 2019;19(1):350. Published 2019 Dec 12. doi:10.1186/s12877-019-1367-9

[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(3):M146-M156. doi:10.1093/gerona/56.3.m146

[22] Fitten LJ. Psychological frailty in the aging patient. In: Fielding RA, Sieber C, Vellas B (eds): Frailty: pathophysiology, phenotype and patient care. Nestlé Nutr Inst Workshop Ser. 2015 83: 45-53. doi: 10.1159/000382060.

[23] Bunt S, Steverink N, Olthof J, van der Schans CP, Hobbelen JSM. Social frailty in older adults: a scoping review. Eur J Ageing. 2017;14(3):323-334. Published 2017 Jan 31. doi:10.1007/s10433-017-0414-7

[24] Teo N, Gao Q, Nyunt MSZ, Wee SL, Ng TP. Social Frailty and Functional Disability: Findings From the Singapore Longitudinal Ageing Studies. J Am Med Dir Assoc. 2017;18(7):637.e13-637.e19. doi:10.1016/j.jamda.2017.04.015

[25] Zimowski Z. The Dimensions of frailty. Annual Medicine, Bioethics and Spirituality Conference. College of the Holy Cross, Worcester, Massachusetts, 2015. Available from: https://www.thedivinemercy.org/articles/dimensions-frailty [Accessed: 2020-07-18]

[26] Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: a systematic review. J Am Geriatr Soc. 2012;60(8):1487-1492. doi:10.1111/j.1532-5415.2012.04054.x

[27] Liotta G, O'Caoimh R, Gilardi F, et al. Assessment of frailty in community-dwelling older adults residents in the Lazio region (Italy): A model to plan regional community-based services. Arch Gerontol Geriatr. 2017;68:1-7. doi:10.1016/j.archger.2016.08.004

[28] Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126-131.

[29] Howley ET, Franks BD. Health fitness instructor's handbook. 3rd ed. Champaign, IL: Human Kinetics, 1997.

[30] Morley JE, Vellas B, van Kan GA, et al. Frailty consensus: a call to action. J Am Med Dir Assoc. 2013;14(6):392-397. doi:10.1016/j.jamda.2013.03.022

[31] Hoogendijk EO, Afilalo J, Ensrud KE, Kowal P, Onder G, Fried LP. Frailty: implications for clinical practice and public health. Lancet. 2019;394(10206):1365-1375. doi:10.1016/S0140-6736(19)31786-6

[32] Rockwood K, Mitnitski A. Frailty in relation to the accumulation of deficits. J Gerontol A Biol Sci Med Sci. 2007;62(7):722-727. doi:10.1093/gerona/62.7.722

[33] Choi J, Ahn A, Kim S, Won CW. Global prevalence of physical frailty by Fried's criteria in community-dwelling elderly with national population-based surveys. J Am Med Dir Assoc. 2015;16(7):548-550. doi:10.1016/j.jamda.2015.02.004

[34] Santos-Eggimann B, Cuénoud P, Spagnoli J, Junod J. Prevalence of frailty in middle-aged and older community-dwelling Europeans living in 10 countries. J Gerontol A Biol Sci Med Sci. 2009;64(6):675-681. doi:10.1093/gerona/glp012

[35] Kehler DS, Ferguson T, Stammers AN, et al. Prevalence of frailty in Canadians 18-79 years old in the Canadian Health Measures Survey. BMC Geriatr. 2017;17(1):28. Published 2017 Jan 21. doi:10.1186/s12877-017-0423-6

[36] WHO. Cancer control: Early detection. WHO guide for effective programmes. Available from: https://www.who.int/cancer/publications/cancer_control_detection/en/ [Accessed: 2020-07-14]

[37] Andermann A, Blancquaert I, Beauchamp S, Déry V. Revisiting Wilson and Jungner in the genomic age: a review of screening criteria over the past 40 years. Geneva: WHO; 2008. Available from: http://www.who.int/bulletin/volumes/86/4/07-050112/en/index.html [Accessed: 2020-07-13]

[38] Bowling A, Dieppe P. What is successful ageing and who should define it? BMJ. 2005;331(7531):1548-1551. doi:10.1136/bmj.331.7531.1548.

[39] Daniels R, Van Rossum HIJ, De Witte LP, Heuvel Van den WJA. Frailty in older age: concepts and relevance for occupational and physical therapy. Phys Occup Ther Geriatrics. 2008, 27 (2): 81-95. doi: 10.1080/02703180802206181

[40] Metzelthin SF, Daniëls R, van Rossum E, de Witte L, van den Heuvel WJ, Kempen GI. The psychometric properties of three self-report screening instruments for identifying frail older people in the community. BMC Public Health. 2010;10:176. Published 2010 Mar 31. doi:10.1186/1471-2458-10-176

[41] Kempen GI, van Heuvelen MJ, van den Brink RH, et al. Factors affecting contrasting results between self-reported and performance-based levels of physical limitation. Age Ageing. 1996;25(6):458-464. doi:10.1093/ageing/25.6.458

[42] Guralnik JM, Branch LG, Cummings SR, Curb JD. Physical performance measures in aging research. J Gerontol. 1989;44(5):M141-M146. doi:10.1093/geronj/44.5.m141

[43] Cooper R, Kuh D, Hardy R; Mortality Review Group; FALCon and HALCyon Study Teams. Objectively measured physical capability levels and mortality: systematic review and meta-analysis. BMJ. 2010;341:c4467. Published 2010 Sep 9. doi:10.1136/bmj.c4467

[44] Pahor M, Manini T, Cesari M. Sarcopenia: clinical evaluation,

biological markers and other evaluation tools. J Nutr Health Aging. 2009;13(8):724-728. doi:10.1007/s12603-009-0204-9

[45] Studenski S, Perera S, Wallace D, et al. Physical performance measures in the clinical setting. J Am Geriatr Soc. 2003;51(3):314-322. doi:10.1046/j.1532-5415.2003.51104.x

[46] Martin FC, Brighton P. Frailty: different tools for different purposes? Age Ageing. 2008;37(2):129-131. doi:10.1093/ageing/afn011

[47] Ensrud KE, Ewing SK, Taylor BC, et al. Comparison of 2 frailty indexes for prediction of falls, disability, fractures, and death in older women. Arch Intern Med. 2008;168(4):382-389. doi:10.1001/archinternmed.2007.113

[48] Purser JL, Kuchibhatla MN, Fillenbaum GG, Harding T, Peterson ED, Alexander KP. Identifying frailty in hospitalized older adults with significant coronary artery disease. J Am Geriatr Soc. 2006;54(11):1674-1681. doi:10.1111/j.1532-5415.2006.00914.x

[49] Auyeung TW, Lee JS, Leung J, Kwok T, Woo J. The selection of a screening test for frailty identification in community-dwelling older adults. J Nutr Health Aging. 2014;18(2):199-203. doi:10.1007/s12603-013-0365-4

[50] Gage JR, Deluca PA, Renshaw TS. Gait analysis: principles and applications. J Bone Joint Surg. 1995 77(10): 1607-1623.

[51] Perry J, Burnfield MJ. Gait analysis: normal and pathological function. 2nd ed. New York: Slack Incorporated, 2010.

[52] Kim MJ, Yabushita N, Kim MK, Nemoto M, Seino S, Tanaka K. Mobility performance tests for discriminating high risk of frailty in community-dwelling older women. Arch Gerontol Geriatr. 2010;51(2):192-198. doi:10.1016/j.archger.2009.10.007

[53] Abellan van Kan G, Rolland Y, Andrieu Set al. Gait speed at usual pace as a predictor of adverse outcomes in community-dwelling older people an international academy on nutrition and ageing (IANA) task force. J Nutr Health Ageing. 2009;13:881-889. doi: 10.1007/s12603-009-0246-z.

[54] Studenski S, Perera S, Patel K, et al. Gait speed and survival in older adults. JAMA. 2011;305(1):50-58. doi:10.1001/jama.2010.1923

[55] Portegijs E, Karavirta L, Saajanaho M, Rantalainen T, Rantanen T. Assessing physical performance and physical activity in large population-based ageing studies: home-based assessments or visits to the research center? BMC Public Health. 2019;19(1):1570. Published 2019 Nov 27. doi:10.1186/s12889-019-7869-8

[56] Peters DM, Fritz SL, Krotish DE. Assessing the reliability and validity of a shorter walk test compared with the 10-meter walk test for measurements of gait speed in healthy, older adults. J Geriatr Phys Ther. 2013;36:24-30. doi: 10.1519/JPT.0b013e318248e20d.

[57] Rydwik E, Bergland A, Forsén L, Frändin K. Investigation into the reliability and validity of the measurement of elderly people's clinical walking speed: a systematic review. Physiother Theory Pract. 2012;28(3):238-256. doi:10.3109/09593985.2011.601804

[58] Verghese J, Wang C, Holtzer R. Relationship of clinic-based gait speed measurement to limitations in community-based activities in older adults. Arch Phys Med Rehabil. 2011;92(5):844-846. doi: 10.1016/j.apmr.2010.12.030.

[59] Goldberg A, Schepens S. Measurement error and minimum

detectable change in 4-meter gait speed in older adults. Aging Clin Exp Res. 2011;23(5-6):406-412. doi:10.1007/BF03325236

[60] van Iersel MB, Munneke M, Esselink RA, Benraad CE, Olde Rikkert MG. Gait velocity and the Timed-Up-and-Go test were sensitive to changes in mobility in frail elderly patients. J Clin Epidemiol. 2008;61(2):186-191. doi: 10.1016/j.jclinepi.2007.04.016.

[61] Clegg A, Rogers L, Young J. Diagnostic test accuracy of simple instruments for identifying frailty in community-dwelling older people: a systematic review. Age Ageing. 2015;44(1):148-152. doi:10.1093/ageing/afu157

[62] Afilalo J, Eisenberg MJ, Morin JF, Bergman H, Monette J, Noiseux N, Boivin JF. Gait speed as an incremental predictor of mortality and major morbidity in elderly patients undergoing cardiac surgery. J Am Coll Cardiol. 2010;56(20):1668-1676. doi: 10.1016/j.jacc.2010.06.039.

[63] Castell MV, Sanchez M, Julian R, Queipo R, Martin S, Otero A. Frailty prevalence and slow walking speed in persons age 65 and older: implications for primary care. BMC Fam Pract. 2013;14(1):86. doi: 10.1186/1471-2296-14-86.

[64] Elbaz A, Sabia S, Brunner E, Shipley M, Marmot M, Kivimaki M, Singh-Manoux A. Association of walking speed in late midlife with mortality: results from the Whitehall II cohort study. Age (Dordr) 2013;35(3):943-952. doi: 10.1007/s11357-012-9387-9.

[65] Matsuzawa Y, Konishi M, Akiyama E, Suzuki H, Nakayama N, Kiyokuni M, Kimura K. Association between gait speed as a measure of frailty and risk of cardiovascular events after myocardial infarction. J Am Coll Cardiol. 2013;61(19):1964-1972. doi: 10.1016/j.jacc.2013.02.020.

[66] Studenski S, Perera S, Patel K, Rosano C, Faulkner K, Inzitari M, Guralnik J. Gait speed and survival in older adults. JAMA. 2011;305(1):50-58. doi: 10.1001/jama.2010.1923.

[67] Schieber MH, Santello M. Hand function: peripheral and central constraints on performance. J Appl Physiol (1985). 2004;96(6):2293-2300. doi:10.1152/japplphysiol.01063.2003

[68] Chainani V, Shaharyar S, Dave K, et al. Objective measures of the frailty syndrome (hand grip strength and gait speed) and cardiovascular mortality: A systematic review. Int J Cardiol. 2016;215:487-493. doi:10.1016/j.ijcard.2016.04.068

[69] Mijnarends DM, Schols JM, Meijers JM, et al. Instruments to assess sarcopenia and physical frailty in older people living in a community (care) setting: similarities and discrepancies. J Am Med Dir Assoc. 2015;16(4):301-308. doi:10.1016/j.jamda.2014.11.011

[70] Jaric S, Mirkov D, Markovic G. Normalizing physical performance tests for body size: a proposal for standardization. J Strength Cond Res. 2005;19(2):467-474. doi:10.1519/R-15064.1

[71] Maranhao Neto GA, Oliveira AJ, Pedreiro RC, et al. Normalizing handgrip strength in older adults: An allometric approach. Arch Gerontol Geriatr. 2017;70:230-234. doi:10.1016/j.archger.2017.02.007

[72] Bohannon RW, Magasi S. Identification of dynapenia in older adults through the use of grip strength t-scores. Muscle Nerve. 2015;51(1):102-105. doi:10.1002/mus.24264

[73] Bohannon RW. Are hand-grip and knee extension strength reflective of a

common construct? Percept Mot Skills. 2012;114(2):514-518. doi:10.2466/03.26.PMS.114.2.514-518

[74] Bragagnolo R, Caporossi FS, Dock-Nascimento DB, de Aguilar-Nascimento JE. Espessura do músculo adutor do polegar: um método rápido e confiável na avaliação nutricional de pacientes cirúrgicos [Adductor pollicis muscle thickness: a fast and reliable method for nutritional assessment in surgical patients]. Rev Col Bras Cir. 2009;36(5):371-76. doi:10.1590/s0100-69912009000500003

[75] Dodds RM, Syddall HE, Cooper R, Kuh D, Cooper C, Sayer AA. Global variation in grip strength: a systematic review and meta-analysis of normative data. Age Ageing. 2016;45(2):209-216. doi:10.1093/ageing/afv192

[76] Rijk JM, Roos PR, Deckx L, van den Akker M, Buntinx F. Prognostic value of handgrip strength in people aged 60 years and older: a systematic review and meta-analysis. Geriatr Gerontol Int. 2016;16:5-20. doi: 10.1111/ggi.12508.

[77] Cooper R, Kuh D, Cooper C, et al. Objective measures of physical capability and subsequent health: a systematic review. Age Ageing. 2011;40(1):14-23. doi:10.1093/ageing/afq117

[78] Sayer AA, Robinson SM, Patel HP, Shavlakadze T, Cooper C, Grounds MD. New horizons in the pathogenesis, diagnosis and management of sarcopenia. Age Ageing. 2013;42(2):145-150. doi:10.1093/ageing/afs191

[79] Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people [published correction appears in Lancet. 2013 Oct 19;382(9901):1328]. Lancet. 2013;381(9868):752-762. doi:10.1016/S0140-6736(12)62167-9

[80] Roberts HC, Denison HJ, Martin HJ, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age Ageing. 2011;40(4):423-429. doi:10.1093/ageing/afr051

[81] Svens B, Lee H. Intra- and inter-instrument reliability of grip-strength measurements: GripTrack™ and Jamar® hand dynamometers. Brit J Hand Ther. 2005; 10(2): 47-55.

[82] Bellace JV, Healy D, Besser MP, Byron T, Hohman L. Validity of the Dexter Evaluation System's Jamar dynamometer attachment for assessment of hand grip strength in a normal population. J Hand Ther. 2000;13(1):46-51. doi:10.1016/s0894-1130(00)80052-6

[83] Trampisch US, Franke J, Jedamzik N, Hinrichs T, Platen P. Optimal Jamar dynamometer handle position to assess maximal isometric hand grip strength in epidemiological studies. J Hand Surg Am. 2012;37(11):2368-2373. doi:10.1016/j.jhsa.2012.08.014

[84] Syddall HE, Westbury LD, Dodds R, Dennison E, Cooper C, Sayer AA. Mortality in the Hertfordshire Ageing Study: association with level and loss of hand grip strength in later life. Age Ageing. 2017;46(3):407-412. doi:10.1093/ageing/afw222

[85] Syddall H, Cooper C, Martin F, Briggs B, Saye A. Is grip strength a useful single marker of frailty? Age and ageing. 2003;32(6):650-6. doi: 10.1093/ageing/afg111.

[86] Duchowny KA, Peterson MD, Clarke PJ. Cut points for clinical muscle weakness among older Americans. Am J Prev Med. 2017;53(1):63-69. doi:10.1016/j.amepre.2016.12.022

[87] Bahat G, Tufan A, Tufan F, et al. Cut-off points to identify sarcopenia according to the European Working

Group on Sarcopenia in Older People (EWGSOP). Clin Nutr. 2016;35(6):1557-1563. doi:10.1016/j.clnu.2016.02.002

[88] De Souza Barbosa JF, Zepeda MUP, Béland F, Guralnik JM, Zunzunegul MV, Guerra RO. Clinically relevant weakness in diverse populations of older adults participating in the International Mobility in Ageing Study. Age. 2016;38(1):25. doi:10.1007/s11357-016-9919-9

[89] DeSouza Vasconcelos KS, Domingues Dias JM, De Carvalho Bastone A, et al. Handgrip strength cutoff points to identify mobility limitation in community-dwelling older people and associated factors. J Nutr Health Ageing. 2016;20(3):306-315. doi:10.1007/s12603-015-0584-y

[90] Dodds RM, Syddall HE, Cooper R, et al. Grip strength across the life course: normative data from twelve British studies. PLoS One. 2014;9(12):e113637. Published 2014 Dec 4. doi:10.1371/journal.pone.0113637

[91] Bohannon RW, Bubela DJ, Magasi SR, Wang YC, Gershon RC. Sit-to-stand test: Performance and determinants across the age-span. Isokinet Exerc Sci. 2010;18(4):235-240. doi:10.3233/IES-2010-0389

[92] Wang CY, Chen LY. Grip strength in older adults: test-retest reliability and cutoff for subjective weakness of using the hands in heavy tasks. Arch Phys Med Rehabil. 2010;91(11):1747-1751. doi:10.1016/j.apmr.2010.07.225

[93] Pollock A, Gray C, Culham E, Durward BR, Langhorne P. Interventions for improving sit-to-stand ability following stroke. Cochrane Database Syst Rev. 2014;2014(5):CD007232. Published 2014 May 26. doi:10.1002/14651858.CD007232.pub4

[94] Dall PM, Kerr A. Frequency of the sit to stand task: An observational study of free-living adults. Appl Ergon. 2010;41(1):58-61. doi:10.1016/j.apergo.2009.04.005

[95] Bohannon RW. Body weight-normalized knee extension strength explains sit-to-stand independence: a validation study. J Strength Cond Res. 2009;23(1):309-311. doi:10.1519/JSC.0b013e31818eff0b

[96] McCarthy EK, Horvat MA, Holtsberg PA, Wisenbaker JM. Repeated chair stands as a measure of lower limb strength in sexagenarian women. J Gerontol A Biol Sci Med Sci. 2004;59(11):1207-1212. doi:10.1093/gerona/59.11.1207

[97] Lord SR, Murray SM, Chapman K, Munro B, Tiedemann A. Sit-to-stand performance depends on sensation, speed, balance, and psychological status in addition to strength in older people. J Gerontol A Biol Sci Med Sci. 2002;57(8):M539-M543. doi:10.1093/gerona/57.8.m539

[98] Schenkman M, Hughes MA, Samsa G, Studenski S. The relative importance of strength and balance in chair rise by functionally impaired older individuals. J Am Geriatr Soc. 1996;44(12):1441-1446. doi:10.1111/j.1532-5415.1996.tb04068.x

[99] Bohannon R. Single limb stance times. A descriptive meta-analysis of data from individuals at least 60 years of age. Topics in Geriatric Rehabil. 2006;22:70-77. doi:10.1097/00013614-200601000-00010

[100] Ozalevli S, Ozden A, Itil O, Akkoclu A. Comparison of the Sit-to-Stand Test with 6 min walk test in patients with chronic obstructive pulmonary disease. Respir Med. 2007;101(2):286-293. doi:10.1016/j.rmed.2006.05.007

[101] Jones CJ, Rikli RE, Beam WC. A 30-s chair-stand test as a measure of

lower body strength in community-residing older adults. Res Q Exerc Sport. 1999;70(2):113-119. doi:10.1080/02701367.1999.10608028

[102] Schaubert KL, Bohannon RW. Reliability and validity of three strength measures obtained from community-dwelling elderly persons. J Strength Cond Res. 2005;19(3):717-720. doi:10.1519/R-15954.1

[103] Csuka M, McCarty DJ. Simple method for measurement of lower extremity muscle strength. Am J Med. 1985;78(1):77-81. doi:10.1016/0002-9343(85)90465-6

[104] Bohannon RW. Test-retest reliability of the five-repetition sit-to-stand test: a systematic review of the literature involving adults. J Strength Cond Res. 2011;25(11):3205-3207. doi:10.1519/JSC.0b013e318234e59f

[105] Rehabilitation measures database. 30 second sit to stand test. Available from: https://www.sralab.org/rehabilitation-measures/30-second-sit-stand-test [Accessed: 2020-07-22]

[106] Rikli RE, Jones CJ. Development and validation of criterion-referenced clinically relevant fitness standards for maintaining physical independence in later years. Gerontologist. 2013;53(2):255-267. doi:10.1093/geront/gns071

[107] Demura S, Yamada T. Height of chair seat and movement characteristics in sit-to-stand by young and elderly adults. Percept Mot Skills. 2007;104(1):21-31. doi:10.2466/pms.104.1.21-31

[108] Kuo YL. The influence of chair seat height on the performance of community-dwelling older adults' 30-second chair stand test. Ageing Clin Exp Res. 2013;25(3):305-309. doi:10.1007/s40520-013-0041-x

[109] Alexander NB, Ulbrich J, Raheja A, Channer D. Rising from the floor in older adults. J Am Geriatr Soc. 1997;45(5):564-569. doi:10.1111/j.1532-5415.1997.tb03088.x

[110] Tinetti ME, Liu WL, Claus EB. Predictors and prognosis of inability to get up after falls among elderly persons. JAMA. 1993;269(1):65-70.

[111] Murphy MA, Olson SL, Protas EJ, Overby AR. Screening for falls in community-dwelling elderly. J Aging Phys Act. 2003;11(1): 64-78. doi: org/10.1123/japa.11.1.66

[112] Ardali G, Brody LT, States RA, Godwin EM. Reliability and Validity of the Floor Transfer Test as a Measure of Readiness for Independent Living Among Older Adults. J Geriatr Phys Ther. 2019;42(3):136-147. doi:10.1519/JPT.0000000000000142

[113] Bergland A, Laake K. Concurrent and predictive validity of "getting up from lying on the floor". Aging Clin Exp Res. 2005;17(3):181-185. doi:10.1007/BF03324594

[114] Green LN, Williams K. Differences in developmental movement patterns used by active versus sedentary middle-aged older adults coming from a supine position to erect stance. Phys Ther. 1992;72:560-568. doi: 10.1093/ptj/72.8.560.

[115] Klima D.W., Anderson C., Samrah D., Patel D., Chui K., Newton R. Standing from the floor in community dwelling older adults. J. Ageing Phys. Act. 2016;24:207-213. doi: 10.1123/japa.2015-0081.

[116] Nesbitt DR, Molina S, Cattuzzo MT, Phillips DS, Robinson L, Stodden DF. Assessment of a Supine-to-Stand (STS) task in early childhood: A measure of functional motor competence. J. Mot. Learn. Devel. 2017 doi: 10.1123/jmld.2016-0049.

[117] Brito L.B., de Araujo D.S., de Araujo C.G. Does flexibility influence

the ability to sit and rise from the floor? Am. J. Phys. Med. Rehabil. 2013;92(3):241-247. doi: 10.1097/PHM.0b013e3182744203.

[118] Bohannon RM, Lusardi MM. Getting up from the floor. Determinants and techniques among healthy older adults. Physiother. Theory Prac. 2004;20(4):233-241. doi: 10.1080/09593980490887993.

[119] Ulbrich J, Raheja A, Alexander NB. Body positions used by healthy and frail older adults to rise from the floor. J Am Geriatr Soc. 2000;48:1626-1632. doi: 10.1111/j.1532-5415.2000.tb03874.x.

[120] VanSant AF. Life-span development in functional tasks. Phys Ther. 1990;70(12):788-798. doi:10.1093/ptj/70.12.788

[121] VanSant AF. Rising from a supine position to erect stance. Description of adult movement and a developmental hypothesis. Phys Ther. 1988;68(2):185-192. doi:10.1093/ptj/68.2.185

[122] VanSant AF. Age differences in movement patterns used by children to rise from a supine position to erect stance. Phys Ther. 1988;68(9):1330-1339. doi:10.1093/ptj/68.9.1330

[123] Ng J, Conaway MR, Rigby AS, Priestman A, Baxter PS. Methods of standing from supine and percentiles for time to stand and to run 10 meters in young children. J Pediatr. 2013;162(3):552-556. doi:10.1016/j.jpeds.2012.08.030

[124] Fried LP, Bandeen-Roche K, Chaves PH, Johnson BA. Preclinical mobility disability predicts incident mobility disability in older women. J Gerontol A Biol Sci Med Sci. 2000;55(1):M43-M52. doi:10.1093/gerona/55.1.m43

[125] Daubney ME, Culham EG. Lower-extremity muscle force and balance performance in adults aged 65 years and older. Phys Ther. 1999;79(12):1177-1185.

[126] Misiaszek JE. Neural control of walking balance: if falling then react else continue. Exerc Sport Sci Rev. 2006;34(3):128-134. doi:10.1249/00003677-200607000-00007

[127] Horak FB. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls?. Age Ageing. 2006;35(Suppl 2):ii7-ii11. doi:10.1093/ageing/afl077

[128] Chkeir A, Safieddine D, Bera D, Collart M, Novella JL, Drame M, Hewson DJ, Duchene J. Balance quality assessment as an early indicator of physical frailty in older people. Conf Proc IEEE Eng Med Biol Soc. 2016:5368-5371. doi: 10.1109/EMBC.2016.7591940.

[129] Toosizadeh N, Mohler J, Wendel C, Najafi B. Influences of frailty syndrome on open-loop and closed-loop postural control strategy. Gerontology. 2015;61(1):51-60. doi: 10.1159/000362549

[130] Kubicki A, Bonnetblanc F, Petrement G, Ballay Y, Mourey F. Delayed postural control during self-generated perturbations in the frail older adults. Clin Interv Aging. 2012;(7):65-75. doi: 10.2147/CIA.S28352.

[131] Martínez-Ramírez A, Lecumberri P, Gómez M, Rodriguez-Mañas L, García FJ, Izquierdo M. Frailty assessment based on wavelet analysis during quiet standing balance test. J Biomech. 2011;44(12):2213-2220. doi: 10.1016/j.jbiomech.2011.06.007.

[132] Schwenk M, Mohler J, Wendel C, D'Huyvetter K, Fain M, Taylor-Piliae R, et al. Wearable sensor-based in-home assessment of gait, balance, and physical activity for discrimination of frailty status: baseline results of

the Arizona frailty cohort study. Gerontology. 2015;61(3):258-267. doi: 10.1159/000369095.

[133] Moraes DC, Lenardt MH, Seima MD, Mello BH, Setoguchi LS, Setlik CM. Postural instability and the condition of physical frailty in the elderly. Instabilidade postural e a condição de fragilidade física em idosos. Rev Lat Am Enfermagem. 2019;27:e3146. Published 2019 Apr 29. doi:10.1590/1518-8345.2655-3146

[134] Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991;39(2):142-148. doi:10.1111/j.1532-5415.1991.tb01616.x

[135] Savva GM, Donoghue OA, Horgan F, O'Regan C, Cronin H, Kenny RA. Using timed up-and-go to identify frail members of the older population. J Gerontol A Biol Sci Med Sci. 2013;68(4):441-446. doi:10.1093/gerona/gls190

[136] Kim MJ, Yabushita N, Kim MK, Nemoto M, Seino S, Tanaka K. Mobility performance tests for discriminating high risk of frailty in community-dwelling older women. Arch Gerontol Geriatr. 2010; 51(2): 192-198. doi: 10.1016/j.archger.2009.10.007.

[137] Robinson TN, Wu DS, Sauaia A, et al. Slower walking speed forecasts increased postoperative morbidity and 1-year mortality across surgical specialties. Ann Surg. 2013;258(4):582-590. doi:10.1097/SLA.0b013e3182a4e96c

[138] Vereckei E, Ildiko AG, Hodinka L. Sarcopenia, frailty and dismobility. Biomed J Sci Tech Res. 2018;7:5776-5779.

[139] Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther. 2000;80(9):896-903.

[140] Rockwood K, Awalt E, Carver D, MacKnight C. Feasibility and measurement properties of the functional reach and the timed up and go tests in the Canadian study of health and aging. J Gerontol A Biol Sci Med Sci. 2000;55(2):M70-M73. doi:10.1093/gerona/55.2.m70

[141] Riebe D, Blissmer BJ, Greaney ML, Garber CE, Lees FD, Clark PG. The relationship between obesity, physical activity, and physical function in older adults. J Aging Health. 2009;21(8):1159-1178. doi:10.1177/0898264309350076

[142] Viccaro LJ, Perera S, Studenski SA. Is timed up and go better than gait speed in predicting health, function, and falls in older adults? J Am Geriatr Soc. 2011;59(5):887-892. doi:10.1111/j.1532-5415.2011.03336.x

[143] Wennie Huang WN, Perera S, VanSwearingen J, Studenski S. Performance measures predict onset of activity of daily living difficulty in community-dwelling older adults. J Am Geriatr Soc. 2010;58(5):844-852. doi:10.1111/j.1532-5415.2010.02820.x

[144] Lin MR, Hwang HF, Hu MH, Wu HD, Wang YW, Huang FC. Psychometric comparisons of the timed up and go, one-leg stand, functional reach, and Tinetti balance measures in community-dwelling older people. J Am Geriatr Soc. 2004;52(8):1343-1348. doi:10.1111/j.1532-5415.2004.52366.x

[145] Beauchet O, Fantino B, Allali G, Muir SW, Montero-Odasso M, Annweiler C. Timed Up and Go test and risk of falls in older adults: a systematic review. J Nutr Health Aging. 2011;15(10):933-938. doi:10.1007/s12603-011-0062-0

[146] Ansai J.H., Farche A.C.S., Rossi P.G., de Andrade L.P., Nakagawa T.H., Takahashi A.C.M. Performance of

Different Timed Up and Go Subtasks in Frailty Syndrome. J. Geriatr. Phys. Ther. 2019;42:287-293. doi: 10.1519/JPT.0000000000000162.

[147] Duncan PW, Studenski S, Chandler J, Prescott B. Functional reach: predictive validity in a sample of elderly male veterans. J Gerontol. 1992;47(3):M93-M98. doi:10.1093/geronj/47.3.m93

[148] Weiner DK, Duncan PW, Chandler J, Studenski SA. Functional reach: a marker of physical frailty. J Am Geriatr Soc. 1992;40(3):203-207. doi:10.1111/j.1532-5415.1992.tb02068.x

[149] Idland G, Rydwik E, Småstuen MC, Bergland A. Predictors of mobility in community-dwelling women aged 85 and older. Disabil Rehabil. 2013;35(11):881-887. doi:10.3109/09638288.2012.712195

[150] Isles RC, Choy NL, Steer M, Nitz JC. Normal values of balance tests in women aged 20-80. J Am Geriatr Soc. 2004;52(8):1367-1372. doi:10.1111/j.1532-5415.2004.52370.x

[151] Newton R. Review of tests of standing balance abilities. Brain Inj. 1989;3(4):335-343. doi:10.3109/02699058909004558

[152] Springer BA, Marin R, Cyhan T, Roberts H, Gill NW. Normative values for the unipedal stance test with eyes open and closed. J Geriatr Phys Ther. 2007;30(1):8-15. doi:10.1519/00139143-200704000-00003

[153] Bulbulian R, Hargan ML. The effect of activity history and current activity on static and dynamic postural balance in older adults. Physiol Behav. 2000;70(3-4):319-325. doi:10.1016/s0031-9384(00)00272-9

[154] El-Kashlan HK, Shepard NT, Asher AM, Smith-Wheelock M, Telian SA. Evaluation of clinical measures of equilibrium. Laryngoscope. 1998;108(3):311-319. doi:10.1097/00005537-199803000-00002

[155] Suni JH, Oja P, Laukkanen RT, et al. Health-related fitness test battery for adults: aspects of reliability. Arch Phys Med Rehabil. 1996;77(4):399-405. doi:10.1016/s0003-9993(96)90092-1

[156] Drusini AG, Eleazer GP, Caiazzo M, et al. One-leg standing balance and functional status in an elderly community-dwelling population in northeast Italy. Aging Clin Exp Res. 2002;14(1):42-46. doi:10.1007/BF03324416

[157] Vellas BJ, Rubenstein LZ, Ousset PJ, et al. One-leg standing balance and functional status in a population of 512 community-living elderly persons. Aging (Milano). 1997;9(1-2):95-98. doi:10.1007/BF03340133

[158] Ringsberg KA, Gärdsell P, Johnell O, Jónsson B, Obrant KJ, Sernbo I. Balance and gait performance in an urban and a rural population. J Am Geriatr Soc. 1998;46(1):65-70. doi:10.1111/j.1532-5415.1998.tb01015.x

[159] Hughes SL, Dunlop D, Edelman P, Chang RW, Singer RH. Impact of joint impairment on longitudinal disability in elderly persons. J Gerontol. 1994;49(6):S291-S300. doi:10.1093/geronj/49.6.s291

[160] Jette AM, Branch LG, Berlin J. Musculoskeletal impairments and physical disablement among the aged. J Gerontol. 1990;45(6):M203-M208. doi:10.1093/geronj/45.6.m203

[161] Bergström G, Aniansson A, Bjelle A, Grimby G, Lundgren-Lindquist B, Svanborg A. Functional consequences of joint impairment at age 79. Scand J Rehabil Med. 1985;17(4):183-190.

[162] Gibbs J, Hughes S, Dunlop D, Edelman P, Singer R, Chang R. Joint impairment and ambulation in the elderly. J Am Geriatr Soc. 1993;41(11):1205-1211. doi:10.1111/j.1532-5415.1993.tb07304.x

[163] Rikli RE, Jones CJ. Senior fitness test manual. Champaign, IL (US): Human Kinetics, 2013.

[164] Hesseberg K, Bentzen H, Ranhoff AH, Engedal K, Bergland A. Physical Fitness in Older People with Mild Cognitive Impairment and Dementia. J Aging Phys Act. 2016;24(1):92-100. doi:10.1123/japa.2014-0202

[165] Miotto JM, Chodzko-Zajko WJ, Reich JL, Supler MM. Reliability and validity of the fullerton functional fitness test: an independent replication study. J. Aging Phys Act. 1999;7:339-353. doi: 10.1123/japa.7.4.339.

[166] López-Miñarro PA, Andújar PS, Rodrñguez-Garcña PL. A comparison of the sit-and-reach test and the back-saver sit-and-reach test in university students. J Sports Sci Med. 2009;8(1):116-122.

[167] Jones CJ, Rikli RE, Max J, Noffal G. The reliability and validity of a chair sit-and-reach test as a measure of hamstring flexibility in older adults. Res Q Exerc Sport. 1998;69(4):338-343. doi:10.1080/02701367.1998.10607708

[168] Baltaci G, Un N, Tunay V, Besler A, Gerçeker S. Comparison of three different sit and reach tests for measurement of hamstring flexibility in female university students. Br J Sports Med. 2003;37(1):59-61. doi:10.1136/bjsm.37.1.59

[169] Wilson TM, Tanaka H. Meta-analysis of the age-associated decline in maximal aerobic capacity in men: relation to training status. Am J Physiol Heart Circ Physiol. 2000;278(3):H829-H834. doi:10.1152/ajpheart.2000.278.3.H829

[170] Neder JA, Jones PW, Nery LE, Whipp BJ. The effect of age on the power/duration relationship and the intensity-domain limits in sedentary men. Eur J Appl Physiol. 2000;82(4):326-332. doi:10.1007/s004210000228

[171] Lemura LM, von Duvillard SP, Mookerjee S. The effects of physical training of functional capacity in adults. Ages 46 to 90: a meta-analysis. J Sports Med Phys Fitness. 2000;40(1):1-10.

[172] Ginet J. Activités physiques et sportives et vieillissement: comment repousser la survenue de la dépendance [Physical and sports activities and aging: how to delay the state of dependence]. Bull Acad Natl Med. 1995;179(7):1493-1503.

[173] Sandvik L, Erikssen J, Thaulow E, Erikssen G, Mundal R, Rodahl K. Physical fitness as a predictor of mortality among healthy, middle-aged Norwegian men. N Engl J Med. 1993;328(8):533-537. doi:10.1056/NEJM199302253280803

[174] Paterson DH, Cunningham DA, Koval JJ, St Croix CM. Aerobic fitness in a population of independently living men and women aged 55-86 years. Med Sci Sports Exerc. 1999;31(12):1813-1820. doi:10.1097/00005768-199912000-00018

[175] Robertson RJ, Noble BJ. Perception of physical exertion: methods, mediators, and applications. Exerc Sport Sci Rev. 1997;25:407-452.

[176] Abut F, Akay MF. Machine learning and statistical methods for the prediction of maximal oxygen uptake: recent advances. Med Devices (Auckl). 2015;8:369-379. Published 2015 Aug 27. doi:10.2147/MDER.S57281

[177] American College of Sports Medicine. ACSM's health-related physical fitness assessment manual.

Philadelphia (PA): Lippincott Williams & Wilkins; 2013.

[178] Jay SJ. Reference equations for the six-minute walk in healthy adults. Am J Respir Crit Care Med. 2000;161(4 Pt 1): 1396. doi:10.1164/ajrccm.161.4.16147a

[179] Lipkin DP, Scriven AJ, Crake T, Poole-Wilson PA. Six minute walking test for assessing exercise capacity in chronic heart failure. Br Med J (Clin Res Ed). 1986;292(6521):653-655. doi:10.1136/bmj.292.6521.653

[180] Camarri B, Eastwood PR, Cecins NM, Thompson PJ, Jenkins S. Six minute walk distance in healthy subjects aged 55-75 years. Respir Med. 2006;100(4):658-665. doi:10.1016/j.rmed.2005.08.003

[181] Holland AE, Spruit MA, Troosters T, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. Eur Respir J. 2014;44(6):1428-1446. doi:10.1183/09031936.00150314

[182] Bautmans I, Lambert M, Mets T. The six-minute walk test in community dwelling elderly: influence of health status. BMC Geriatr. 2004;4:6. Published 2004 Jul 23. doi:10.1186/1471-2318-4-6

[183] Troosters T, Gosselink R, Decramer M. Six minute walking distance in healthy elderly subjects. Eur Respir J. 1999;14:270-274. doi: 10.1034/j.1399-3003.1999.14b06.x.

[184] Enright PL, Sherrill DL. Reference equations for the six-minute walk in healthy adults [published correction appears in Am J Respir Crit Care Med. 2020 Feb 1;201(3):393]. Am J Respir Crit Care Med. 1998;158(5 Pt 1):1384-1387. doi:10.1164/ajrccm.158.5.9710086

[185] Arcuri JF, Borghi-Silva A, Labadessa IG, Sentanin AC, Candolo C, Pires Di Lorenzo VA. Validity and Reliability of the 6-Minute Step Test in Healthy Individuals: A Cross-sectional Study. Clin J Sport Med. 2016;26(1):69-75. doi:10.1097/JSM.0000000000000190

[186] Cooper KH. A means of assessing maximal oxygen intake. Correlation between field and treadmill testing. Jama. 1968;203:201-204. doi: 10.1001/jama.203.3.201.

[187] Peeters P, Mets T. The 6-minute walk as an appropriate exercise test in elderly patients with chronic heart failure. J Gerontol A Biol Sci Med Sci. 1996;51(4):M147-M151. doi:10.1093/gerona/51a.4.m147

[188] Zhang Q, Lu H, Pan S, Lin Y, Zhou K, Wang L. 6MWT Performance and its Correlations with VO_2 and Handgrip Strength in Home-Dwelling Mid-Aged and Older Chinese. Int J Environ Res Public Health. 2017;14(5):473. Published 2017 Apr 29. doi:10.3390/ijerph14050473

[189] Wiacek M, Hagner W. The history and economic impact on the functional fitness of elderly in the South-Eastern region of Poland: a comparison with US citizens. Arch Gerontol Geriatr. 2008;46(2):221-226. doi:10.1016/j.archger.2007.04.002

[190] Yan T, Wilber KH, Aguirre R, Trejo L. Do sedentary older adults benefit from community-based exercise? Results from the Active Start program. Gerontologist. 2009;49(6):847-855. doi:10.1093/geront/gnp113

[191] Beck AM, Damkjaer K, Beyer N. Multifaceted nutritional intervention among nursing-home residents has a positive influence on nutrition and function. Nutrition. 2008;24(11-12): 1073-1080. doi:10.1016/j.nut.2008.05.007

[192] Rikli RE, Jones CJ. Functional fitness normative scores for

community-residing older adults, ages 60-94. J Aging Phys Activ. 1999;7:162-181.

[193] Engels HJ, Drouin J, Zhu W, Kazmierski JF. Effects of low-impact, moderate-intensity exercise training with and without wrist weights on functional capacities and mood states in older adults. Gerontology. 1998;44(4):239-244. doi:10.1159/000022018

[194] Carmelli D, Swan GE, LaRue A, Eslinger PJ. Correlates of change in cognitive function in survivors from the Western Collaborative Group Study. Neuroepidemiology. 1997;16(6):285-295. doi:10.1159/000109699

[195] Williams P, Lord SR. Effects of group exercise on cognitive functioning and mood in older women. Aust N Z J Public Health. 1997;21(1):45-52. doi:10.1111/j.1467-842x.1997.tb01653.x

[196] Fried LP, Kronmal RA, Newman AB, et al. Risk factors for 5-year mortality in older adults: the Cardiovascular Health Study. JAMA. 1998;279(8):585-592. doi:10.1001/jama.279.8.585

[197] Ferrucci L, Izmirlian G, Leveille S, et al. Smoking, physical activity, and active life expectancy. Am J Epidemiol. 1999;149(7):645-653. doi:10.1093/oxfordjournals.aje.a009865

[198] Lee BA, Kim JG, Oh DJ. The effects of combined exercise intervention on body composition and physical fitness in elderly females at a nursing home. J Exerc Rehabil. 2013;9(2):298-303. doi:10.12965/jer.130014

[199] Kang SJ. Comparison of ageing threshold and ageing coefficient in health related physical fitness on Korean and Japanese. Korea J Phys Educ 2007;46:723-736.

[200] Lin PS, Hsieh CC, Cheng HS, Tseng TJ, Su SC. Association between Physical Fitness and Successful Aging in Taiwanese Older Adults. PLoS One. 2016;11(3):e0150389. Published 2016 Mar 10. doi:10.1371/journal.pone.0150389

[201] Milanović Z, Pantelić S, Trajković N, Sporiš G, Kostić R, James N. Age-related decrease in physical activity and functional fitness among elderly men and women [published correction appears in Clin Interv Aging. clin interv aging. 2014;9:979]. Clin Interv Aging. 2013;8:549-556. doi:10.2147/CIA.S44112

[202] Vermeulen J, Neyens JC, van Rossum E, Spreeuwenberg MD, de Witte LP. Predicting ADL disability in community-dwelling elderly people using physical frailty indicators: a systematic review. BMC Geriatr. 2011;11:33. Published 2011 Jul 1. doi:10.1186/1471-2318-11-33

[203] Capranaica L, Tiberi M, Figura F, Osness W. Comparison between American and Italian older adult performances on the AAHPERD functional fitness test battery. J Ageing Phys Act. 2001; 9(1):11-18. doi: 10.1123/japa.9.1.11

[204] Jeoung BJ, Lee YC. A Study of relationship between frailty and physical performance in elderly women. J Exerc Rehabil. 2015;11(4):215-219. Published 2015 Aug 30. doi:10.12965/jer.150223

[205] Tay LB, Chua MP, Tay EL, et al. Multidomain Geriatric Screen and Physical Fitness Assessment Identify Prefrailty/Frailty and Potentially Modifiable Risk Factors in Community-Dwelling Older Adults. Ann Acad Med Singapore. 2019;48(6):171-180.

[206] von Haehling S, Morley JE, Anker SD. An overview of sarcopenia: facts and numbers on prevalence and clinical impact. J Cachexia Sarcopenia Muscle. 2010;1(2):129-133. doi:10.1007/s13539-010-0014-2

[207] Kostić R, Uzunović S, Pantelić S, Đurašković R. A comparative analysis of the indicators of the functional fitness of the elderly. Facta Univ Ser Phys Educ Sport 2011;9:161-71.

[208] Op het Veld LP, van Rossum E, Kempen GI, de Vet HC, Hajema K, Beurskens AJ. Fried phenotype of frailty: cross-sectional comparison of three frailty stages on various health domains. BMC Geriatr. 2015;15:77. Published 2015 Jul 9. doi:10.1186/s12877-015-0078-0

[209] Xue QL, Bandeen-Roche K, Varadhan R, Zhou J, Fried LP. Initial manifestations of frailty criteria and the development of frailty phenotype in the Women's Health and Aging Study II. J Gerontol A Biol Sci Med Sci. 2008;63(9):984-990. doi:10.1093/gerona/63.9.984

[210] Landers KA, Hunter GR, Wetzstein CJ, Bamman MM, Weinsier RL. The interrelationship among muscle mass, strength, and the ability to perform physical tasks of daily living in younger and older women. J Gerontol A Biol Sci Med Sci. 2001;56(10):B443-B448. doi:10.1093/gerona/56.10.b443

[211] Hawkins S, Wiswell R. Rate and mechanism of maximal oxygen consumption decline with aging: implications for exercise training. Sports Med. 2003;33(12):877-888. doi:10.2165/00007256-200333120-00002

[212] Gill TM, Williams CS, Tinetti ME. Assessing risk for the onset of functional dependence among older adults: the role of physical performance [published correction appears in J Am Geriatr Soc 1995 Oct;43(10):1172]. J Am Geriatr Soc. 1995;43(6):603-609. doi:10.1111/j.1532-5415.1995.tb07192.x

[213] Guralnik JM, Simonsick EM, Ferrucci L et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994;49(2):M85–M94. doi: 10.1093/geronj/49.2.M85.

[214] Perracini MR, Mello M, de Oliveira Máximo R, et al. Diagnostic Accuracy of the Short Physical Performance Battery for Detecting Frailty in Older People. Phys Ther. 2020;100(1):90-98. doi:10.1093/ptj/pzz154

[215] Chang SF, Yang RS, Lin TC, Chiu SC, Chen ML, Lee HC. The discrimination of using the short physical performance battery to screen frailty for community-dwelling elderly people. J Nurs Scholarsh. 2014;46(3):207-215. doi:10.1111/jnu.12068

[216] Onder G, Penninx BW, Balkrishnan R, et al. Relation between use of angiotensin-converting enzyme inhibitors and muscle strength and physical function in older women: an observational study. Lancet. 2002;359(9310):926-930. doi:10.1016/s0140-6736(02)08024-8

[217] Bandinelli S, Lauretani F, Boscherini V, Gandi F, Pozzi M, Corsi AM, Bartali B, Lova RM, Guralnik JM, Ferrucci L. A randomized, controlled trial of disability prevention in frail older patients screened in primary care: the FRASI study. Design and baseline evaluation. Ageing Clin Exp Res. 2006;18(5):359-366. doi: 10.1007/BF03324831.

[218] Vasunilashorn S, Coppin AK, Patel KV et al. Use of the short physical performance battery score to predict loss of ability to walk 400 meters: analysis from the InCHIANTI study. J Gerontol A Biol Sci Med Sci. 2009;64(2):223-229. doi: 10.1093/gerona/gln022.

[219] Freiberger E, de Vreede P, Schoene D, et al. Performance-based

physical function in older community-dwelling persons: a systematic review of instruments. Age Ageing. 2012;41(6):712-721. doi:10.1093/ageing/afs099

[220] Olsen CF, Bergland A. Reliability of the Norwegian version of the short physical performance battery in older people with and without dementia. BMC Geriatr. 2017; 17(1): 124. doi: 10.1186/s12877-017-0514-4.

[221] Gómez JF, Curcio CL, Alvarado B, Zunzunegui MV, Guralnik J. Validity and reliability of the Short Physical Performance Battery (SPPB): a pilot study on mobility in the Colombian Andes. Colomb Med (Cali). 2013;44(3):165-171.

[222] Freire AN, Guerra RO, Alvarado B, Guralnik JM, Zunzunegui MV. Validity and reliability of the short physical performance battery in two diverse older adult populations in Quebec and Brazil. J Ageing Health. 2012;24(5):863-878. doi:10.1177/0898264312438551

[223] Ostir GV, Volpato S, Fried LP, Chaves P, Guralnik JM, Women's Health and Ageing Study Reliability and sensitivity to change assessed for a summary measure of lower body function: results from the Women's health and ageing study. J Clin Epidemiol. 2002;55(9):916-921. doi: 10.1016/S0895-4356(02)00436-5.

[224] da Camara SM, Alvarado BE, Guralnik JM, Guerra RO, Maciel AC. Using the short physical performance battery to screen for frailty in young-old adults with distinct socioeconomic conditions. Geriatr Gerontol Int. 2013;13(2):421-428. doi: 10.1111/j.1447-0594.2012.00920.x.

[225] Pritchard JM, Kennedy CC, Karampatos S, et al. Measuring frailty in clinical practice: a comparison of physical frailty assessment methods in a geriatric out-patient clinic. BMC Geriatr. 2017;17[1]:264. Published 2017 Nov 13. doi:10.1186/s12877-017-0623-0

[226] Mangione KK, Craik RL, McCormick AA, et al. Detectable changes in physical performance measures in elderly African Americans. Phys Ther. 2010;90(6):921-927. doi:10.2522/ptj.20090363

[227] Perera S, Mody SH, Woodman RC, Studenski SA. Meaningful change and responsiveness in common physical performance measures in older adults. J Am Geriatr Soc. 2006;54(5):743-749. doi:10.1111/j.1532-5415.2006.00701.x

[228] Reuben DB, Siu AL. An objective measure of physical function of elderly outpatients. The Physical Performance Test. J Am Geriatr Soc. 1990;38(10):1105-1112. doi:10.1111/j.1532-5415.1990.tb01373.x

[229] Beissner KL, Collins JE, Holmes H. Muscle force and range of motion as predictors of function in older adults. Phys Ther. 2000;80(6):556-563.

[230] Rikli RE, Jones CJ. Assessing physical performance in independent older adults: issues and guidelines. J Aging Phys Act 1997; 5(3): 244-261. doi: https://doi.org/10.1123/japa.5.3.244

[231] Rikli RE, Jones CJ. The reliability and validity of a 6-minute walk test as a measure of physical endurance in older adults. J Aging Phys Act 1998; 6: 363-375.

[232] Champaign, IL: Human Kinetics, 2001.

[233] Buckinx F, Rolland Y, Reginster JY, Ricour C, Petermans J, Bruyère O. Burden of frailty in the elderly population: perspectives for a public health challenge. Arch Public Health. 2015;73(1):19. doi:10.1186/s13690-015-0068-x

[234] Morley JE. Frailty: diagnosis and management. J Nutr Health Ageing. 2011;15(8):667-670. doi:10.1007/s12603-011-0338-4

[235] Ambagtsheer RC, Beilby JJ, Visvanathan R, Dent E, Yu S, Braunack-Mayer AJ. Should we screen for frailty in primary care settings? A fresh perspective on the frailty evidence base: a narrative review. Prev Med. 2019;119:63-69. doi:10.1016/j.ypmed.2018.12.020

[236] Ambagtsheer RC, Archibald MM, Lawless M, Kitson A, Beilby J. Feasibility and acceptability of commonly used screening instruments to identify frailty among community-dwelling older people: a mixed methods study. BMC Geriatr. 2020;20(1):152. Published 2020 Apr 22. doi:10.1186/s12877-020-01551-6

[237] WHO Global Database on Child Growth and Malnutrition. The Z-score or standard deviation classification system. Available from: https://www.who.int/nutgrowthdb/about/introduction/en/index4.html [Accessed: 2020-07-18]

Chapter 5

Elderly and Polypharmacy: Physiological and Cognitive Changes

Daniela A. Rodrigues, Maria Teresa Herdeiro, Adolfo Figueiras, Paula Coutinho and Fátima Roque

Abstract

Population ageing is one of the most significant social transformations of the twenty-first century. The increase in average life expectancy was a successful challenge achieved in the modern world. However, nowadays a new challenge arises for all society: achieving a better quality of life for increasing people's life. The comorbidities associated with ageing make elderly prone to polypharmacy. On the other hand, physiological and cognitive changes interfere with drugs' pharmacodynamics and pharmacokinetics contributing to drug-related problems which have been reported to account for a large percentage of emergency treatment and hospitalizations of older people, increasing the costs with health in the most aged regions. In order to reduce the use of potentially inappropriate medicines in this population, strategies and tools have been developed in recent years to assess the appropriateness medication use in the elderly.

Keywords: polypharmacy, elderly, pharmacodynamics, pharmacokinetics, potentially inappropriate medication

1. Introduction

Ageing is an inevitable process characterized by declining functions and increased susceptibility to certain diseases. Biologically, ageing results from a variety of molecular and cellular damage over time, leading to a gradual decrease in physical and mental capacity, increasing the risk of illness and death [1]. The fragility acquired by the elderly population with ageing is related to the gradual decrease of the physiological reserve and the failure of the homeostatic mechanisms. Thus, a cumulative decline is promoted in several physiological systems, and there is an exhaustion of the body's reserves, starting to have a greater vulnerability to changes in health status [2]. The mechanisms associated with ageing are determined by environmental factors but also by genetic factors, which regulate the expression of genes that can be especially important for this process [3].

With ageing, many chronic diseases arise, requiring the use of a higher number of drugs. Polypharmacy, defined as the use of five or more drugs, is a significant public health problem, particularly in the older adults, since it is responsible for the increase of adverse drug reactions (ADR) and, frequently, for the rise of the morbidity and mortality in this population [4]. There are many other important

issues related to the problem of polypharmacy, such as the interaction between drugs, organization and adherence to treatment [4].

Through the normal ageing process, changes occur with impact on the pharmacodynamics and pharmacokinetics of drugs. These changes may be related to the function of particular organs, homeostatic mechanisms and also to the ability to respond to specific receptors, causing greater vulnerability and susceptibility to ADR in older patients [5] frequently associated with the use of potentially inappropriate medication (PIM) in this population [6]. The inappropriate prescription in older patients occurs when the risk of adverse effects exceeds the clinical benefit, especially when there are more effective alternatives available [7]. The use of PIM is a public health challenge because it has high prevalence rates in different health contexts [8].

Although older adults are the primary consumers of medicines, the truth is that clinical trials are usually carried out on younger people, and the physiological changes that occur with ageing are not considered. With the rise of older people in the world, the needs associated with the resources of health systems will continue to increase, and several challenges will arise.

Over the past few years, to reduce the use of PIM in the older population, strategies and tools of explicit and implicit criteria have been developed to evaluate the appropriateness of medication use in the older patients. These criteria are useful tools for clinical practice, as a support for clinical decision.

2. Physiological and pharmacological changes in the elderly

The normal ageing process implies the occurrence of several physiological, biological, physical and psychological changes, which can affect the elderly patient' quality of life and modify the ability to reach the best health outcomes [9]. The changes caused by ageing are associated with complex pathophysiology, variability in organ function and the presence of comorbidities, specific to this population [2]. When young, the human body has a sizeable physiological reserve to sustain the function of most organs. However, in early adulthood, the first physiological changes that can affect drug effects begin to occur, and the decline of cellular activity becomes a gradual and continuous process. In older adults, this reserve is increasingly diminished with decreasing in homeostatic mechanisms activity [10].

All of these factors contribute to the frailty of older adults making them more prone to drug-related problems. Most older people can experience significant changes in drug pharmacokinetics and pharmacodynamics due to age-related physiological changes and become more susceptible and vulnerable to adverse effects [7].

2.1 Age-related changes in pharmacokinetics

The bioavailability of a drug depends on many factors and all stages of pharmacokinetics (absorption, distribution, metabolism and excretion) and can be modified with ageing [9, 11]. A summary of the main pharmacokinetics changes can be consulted in **Table 1**.

There are several available routes of administration. However, the most common is the oral route. Although ageing is associated with decreased gastric emptying and peristalsis, in the absence of pathology, the absorption of most drugs does not decrease with age [9]. However, the presence of pathologies that affect the gastrointestinal organs can affect absorption. Furthermore, food intake can also affect drugs' absorption. The fraction of the drug dose administered that reaches the bloodstream, after oral administration, can be influenced by several other factors,

Pharmacokinetics	Physiological changes	Drug examples
Absorption	Increased gastric pH	Antacids
	Decreased gastrointestinal motility	H2-receptor antagonists
	Decreased intestinal permeability	Proton pump inhibitors
	Decreased gastrointestinal blood flow	Anticholinergic drugs
Distribution	Decreased lean body mass	Benzodiazepines
	Increased fat body mass	
	Decreased body water	
Metabolism	Decreased liver volume	Propranolol
	Decreased blood flow	Morphine
	Decreased hepatic clearance rates	
Excretion	Reduced renal blood flow	Thiazides
	Decreased glomerular filtration rates	Loop diuretics
	Increased urea excretion	ACEI
	Decreased creatinine production	ARBs
	Decreased renal clearance rates	Aliskiren
		Digoxin
		Potassium-sparing agents
		Beta-blockers
		NSAIDs

ACEI, angiotensin conversion enzyme inhibitors; ARBs, angiotensin II receptor blockers; NSAIDs, nonsteroidal anti-inflammatory drugs.

Table 1.
Impact physiological changes and pharmacokinetics in older adults [9, 11–13].

such as gastric pH, gastrointestinal motility, intestinal permeability and mucosal integrity, function and expression of drug carriers and gastrointestinal blood flow [11].

Drugs absorption after intramuscular or subcutaneous administration can be modified in older patients because there is a reduction in blood perfusion of the tissues [12].

After absorption, the drug enters the bloodstream and is distributed through the body. The distribution will influence the amount of active substance available to prosecute an effect at a specific target. Factors such as the extent of binding to tissues and plasmatic proteins, changes in body composition and protein synthesis can affect the distribution of drugs [11]. The volume of distribution can be affected by the proportions of lean body mass and fat body mass. With ageing, there is a reduction in the amount of body water and an increase in fat, so there are changes in the distribution of drugs that depend on lipid solubility. Also, the half-life of a drug increases with the volume of distribution. Thus, a decrease in the volume of distribution for hydrophilic drugs results in higher plasma concentrations and a lower half-life in older patients. Some examples are drugs such as digoxin and theophylline. As the volume of distribution increases, the half-life of liposoluble drugs increases, affecting, for example, long-acting benzodiazepines that can accumulate in the body [12].

Metabolism consists of converting an active substance in simpler and more polar substances, called metabolites. These metabolites are inactive or have modified activity. In the case of prodrugs, metabolism is necessary to convert the prodrug in an active drug. Therefore, hepatic metabolism is essential for the elimination of drugs from the body. Hepatic metabolism depends on hepatic blood flow, the transport of the drug from the blood to the hepatocytes and the ability to metabolize the drug [11]. It can be difficult to predict changes in liver metabolism for each patient. In addition to age, the nutritional status of the elderly also affects the rate of metabolism of the drug [12]. Moreover, the increase of inflammatory conditions in older adults can compromise the enzymes associated with the metabolism of many

drugs. Frailty is associated with higher inflammatory markers and a reduction in the activity of esterases (enzymes class that catalyse hydrolysis reactions) [5].

With ageing, the composition of gut microbiome also changes. Intestinal bacteria play a role in the metabolism of drugs as they, being mostly anaerobic, participate in chemical reactions of reduction and hydrolysis of molecules. The changes caused by this phenomenon occur mainly in frailty older adults and long-term nursing homes residents. They have a decreased enzyme induction capacity, which can lead to an increase in genetic silencing with age. Also, external factors such as exposure to environmental contaminants are responsible for altering gene expression. These changes reflect the differential biological ageing [5].

Most drugs are eliminated through the kidneys, and in older adults, the ability to concentrate urine is reduced, consequently, there is a need for a higher amount of urine to excrete the same amount of toxic waste compared to young adults. The decline in renal function is mainly due to the decrease in the glomerular filtration rate (GFR) and the reduction in renal blood flow. With ageing, the decline in glomerular filtration is quite evident. The decreased in renal function increases the risk of ADR, and therefore, special attention should be given when prescribing, to older patients, drugs excreted by kidneys. For drugs that have a narrow therapeutic index and are excreted through the kidneys, such as digoxin, metformin and lithium, it is especially important to adjust and monitor the treatment [12].

This decrease in GFR can be explained by an increase in urea excretion and a reduction in creatinine production in older adults. The renal plasma flow is reduced by 50%, and the kidney's ability to increase baseline GFR by at least 20% (the renal reserve) also decreases significantly with ageing [13].

Sodium reabsorption is reduced in the older adults, and drugs that promote the excretion of salt and water, such as thiazides and loop diuretics, can induce hyponatraemia, hypovolaemia and renal failure. Also, renal excretion of potassium is significantly reduced with ageing, so drugs such as angiotensin-converting-enzyme inhibitor (ACEI), angiotensin II receptor blockers (ARBs), aliskiren, digoxin, potassium-sparing agents, beta-blockers and nonsteroidal anti-inflammatory drugs (NSAIDs) can induce hyperkalaemia [13].

2.2 Age-related changes in pharmacodynamics

Age-related pharmacodynamic changes may also occur. However, these are more difficult to study than pharmacokinetic changes because there is low evidence of the mechanism underlying these changes.

Many response measures are subjective and can be influenced by several factors. These changes represent how drugs react in the body after absorption. The central nervous system (CNS) and the cardiovascular system, as well as the homeostatic mechanisms, are the most affected with the ageing process. Since most medicines used by the older adults have strong anticholinergic properties, the principal ADR that occur in this population are confusion, drowsiness and an increased risk of falls and fractures [14]. Due to all the physiological changes, an older adult's ability to recover from an illness is often diminished, and symptoms may remain partially for a long time.

Age-related pharmacodynamic changes are associated with receptors (number, activity and expression) and with the ability to signal transduction and changes in homeostatic mechanisms [15].

Thus, in the older adults, there is an impaired circulatory response, an increased risk of falls and fractures, changes in thermoregulation mechanisms, laryngeal reflexes compromised with increased risk of aspiration or pneumonia, dehydration and bleeding due to changes in vascular stability and impaired cognitive ability. Therefore, drugs with sedative effects can considerably increase the risk of ADR in older patients [16].

Considering the drugs that act in the CNS, there is an increased sensitivity to the action of benzodiazepines, which can cause a high degree of sedation and impaired psychomotor performance in older adults, making them more favourable to the occurrence of falls and fractures. With increasing age, the ability to respond to antipsychotic drugs also increases, so there is an increased risk of anticholinergic and extrapyramidal effects, orthostatic hypotension and adverse cerebrovascular effects. The increase in the response capacity to antidepressants also increases the risk of anticholinergic effects in the elderly, being responsible for causing gastrointestinal bleeding and hyponatraemia. These population also have an increased sensitivity to intravenous and inhaled anaesthetic and opioid medications, with an increased risk of respiratory depression and reduced tolerability to these drugs. Furthermore, with ageing, there is an increased sensitivity to the adverse effects caused by lithium, increasing the risk of neurotoxic effects in these population [10, 17].

Concerning drugs that act on the cardiovascular system, the main pharmacodynamic changes associated with age are related to the reduction of the baroreceptor response to low blood pressure and the increase in the sinoatrial suppressive effect, interfering with the administration of calcium channel blocker drugs, causing an effect that can lead to the occurrence of orthostatic hypotension, falls and a decrease in heart rate. With ageing, there is a change in the signal transduction of the beta receptor and negative regulation of the beta-adrenergic receptors, so that there may be a reduction in the effectiveness of beta-blocking agents at doses considered normal. The reduction in GFR causes a decrease in the capacity of diuretic and natriuretic responses. NSAIDs reduce the effects of diuretics, and there is a compromise in adaptive and homeostatic mechanisms, thus reducing the effectiveness of diuretics in doses considered normal, and a high risk of hypokalaemia, hypomagnesaemia and hyponatraemia may occur. NSAIDs can also reduce the effects of ACEI. Since older patients are more sensitive to warfarin, there is an increased risk of bleeding when taking anticoagulant drugs [10, 17].

The presence of comorbidities is also responsible for pharmacodynamic changes during the ageing process. For example, the presence of psychiatric disorders such as schizophrenia, depression and dementia can alter the function of several neurotransmitters [16].

3. Polypharmacy and inappropriate medication in older patients

Pharmacotherapy can improve the quality of life, cure, prevent and relieve the symptoms of many pathologies. However, there is a growing concern that many older people are taking an inappropriately high number of medications [18]. Polypharmacy consists of the use of several drugs by the same patient and appears as a response to the increase in health-related problems, particularly in older adults. There is no consensual definition for polypharmacy; however, most studies consider the consumption of five or more drugs per day per person [19]. In older patients, polypharmacy has been associated with a wide range of negative health outcomes, including falls, ADR effects, changes in physical and cognitive ability, hospital readmission and mortality. It has also been associated with increasing costs in health [4, 18].

Besides, older adults often self-medicate themselves to improve their quality of life. This is a concern because the use of home medicines and herbal products, as well as the diet, can interfere with their health, due to the many drug interactions that can occur [20].

The inappropriate use of medicines by older patients who suffer from multiple diseases is a public health problem due to its impact on morbidity, quality of life and the improper use of health resources. There is an increase in hospital readmissions

and the occurrence of ADR, leading the older patients to have difficulties in carrying out their daily activities, progressively losing their autonomy and, consequently, with loneliness and social isolation [4, 21]. Polypharmacy and multiple comorbidities are also associated with a lack of therapeutic compliance by older patients. The non-adherence may represent a risk because adverse health outcomes could occur like hospitalization and mortality [22].

Polypharmacy represents a challenge for health professionals, and it is essential to improve patients' knowledge about their medication because beliefs about drugs are a strong predictor of adherence. If the patient knows what medicines he is using, the reason for pharmacotherapy and believe about its benefit, the adherence problem will be improved. In practice, the main goal is to achieve an ideal pharmacotherapy by reducing the number of drug-related problems (DRP).

The probability of a drug interaction occurring also increases with ageing due to the higher number of drugs used by older patients. These interactions have negative effects on health, and therefore, health professionals must be alert to possible interactions and must prevent them from occurring [23].

Most of the medications are considered appropriate for older patients, as long as they are used in the correct dosage and for the period strictly necessary. However, since older adults are more susceptible to the adverse effects of drugs, as a result of changes on pharmacokinetics and pharmacodynamics, special care by health professionals is needed when treating older patients.

Having more than one prescriber increases the risk of inappropriate medications use. Thus, it is crucial to implement medication review procedures and that the most frailty older adults have a clinician with knowledge of all their pharmacotherapy and improve communication with caregivers [23].

Some studies have shown that some measures can be implemented to decrease polypharmacy and its adverse effects, improving the quality of the prescription, such as educational programmes for patients and professionals and the creation of multidisciplinary teams of health professionals [24].

4. Improve pharmacotherapy in older patients

To improve the pharmacotherapy in older patients, the available tools must be friendly to improve the use by the health professionals.

According to Wooten [25–27], 10 rules must be followed by the physician's when prescribing, especially in older patients: (1) know the patient and use the patient's most current medical record; (2) follow the tenets of evidence-based medicine, but understand the limitations of the evidence; (3) understand the potential pharmacokinetic and pharmacodynamic changes that can occur in older adults, and use this specific patient information to make prudent prescribing decisions; (4) recognize and investigate patient factors that may contribute to medication problems; (5) avoid the prescribing cascade, if possible; (6) prescribe and recommend only those medications/drug classes for which have a thorough understanding of the pharmacology; (7) identify, anticipate and monitor potential drug interactions before they become a problem; (8) establish a monitoring plan for each medication prescribed for both efficacy and toxicity; (9) properly counsel patients/caregivers on all of the patient's medications, and ensure that the patient understands the pharmacotherapy plan; and (10) assess and address compliance issues.

Clinical decision support includes a variety of tools and interventions that can be computerized or noncomputerized. Clinical decision support systems (CDSS) are characterized as tools for information management and include several clinical guidelines.

In the last decades, the focus has been on tools to provide specific recommendations to patients, called advanced CDSS. These may include, for example, checking interactions between drug-disease, drug-drug, individualized dosing support and advice on laboratory tests during drug treatment [28]. The creation and implementation of this type of tools are responsible for increasing the quality of care and improving health outcomes, reducing the likelihood of errors and adverse effects. Thus, it is possible to reduce uncertainty and increase the reproducibility of decisions, increasing efficiency, cost-effectiveness and the satisfaction of the patients and caregiver [29].

For reducing prescription errors in older patients, other measures can be taken, such as implementing an educational system to train prescription, especially in young doctors who have less practice, and also in hospitals, where this type of errors are more frequent [30]. In many hospitals, pharmacists are responsible for identifying errors in the prescription of medications and must report them immediately to the medical team. Sometimes, the environment involving prescribing physicians may influence the prescription process, leading to some errors. So, all the conditions must be met so that the physician can carry out the prescription in the best possible way, making simple changes such as reducing background noise and promoting more effective communication between all health professionals and with patients. Upon admission of the older patients to the hospital, it is advisable to carry out a reconciliation of the medication in which all medicines used should be checked. The importance and suitability of each medicine for the patient should be assessed, as well as the needs of adding a new list with the latest medications, explaining reasons. This list must be updated and given to the next health professional responsible for the patient [30]. There is currently a validated tool used to provide physicians with a method for obtaining their patients' medication history, the structured history taking of medication use (SHiM). The SHiM consists of 16 questions and reveals the potential to avoid discrepancies in patients' medication histories [31].

Another way to improve pharmacotherapy for older patients is to use criteria that were created to identify PIM as tools to support clinical decision support as described above.

4.1 Criteria used as tools to reduce potentially inappropriate medications in the elderly

To reduce the use of PIM in older patients, strategies and tools have been developed in recent years to assess the appropriateness of medication use in this population. The created criteria can be classified as explicit, implicit or mixed. Explicit criteria are lists of drugs that can be applied with minimal information and clinical judgement. These do not consider individual differences between patients. In contrast, the implicit criteria consider the patient's therapeutic regimen and are based on the judgement of a health professional, being specific to each patient. The mixed criteria, on the other hand, consist of a combination of the previous two, allowing to obtain advantages from both [8].

In 1991, Beers et al. [32] were the first ones to introduce the concept of PIM and to propose a list of PIM for the older adults. These criteria, developed to help healthcare professionals to assess the quality of prescription in older patients, were initially intended for psychiatric patients. In 2011, the American Geriatrics Society (AGS) assumed the responsibility for these criteria and became compromised to update them regularly, and in 2012 [33] the criteria were updated. After that, criteria have been updated, and new, improved versions appeared in 2015 [34] and recently in 2019 [35]. A consensus panel was created with several experts to define what these criteria would be and what individual aspects should be considered.

However, there are drugs not included in these criteria, and that may also be potentially inappropriate for older patients.

Many other attempts have been proposed using implicit or explicit criteria. For example, the Medication Appropriation Index (MAI) measures the appropriation of prescriptions for elderly patients [36]. That is an implicit tool that consists of making a structured assessment of the patient's medications across 10 criteria worded as questions. The 10 items are essential to evaluate the potential of DRP.

Also, according to European standards, the EURO-FORTA List was created in 2018 and is based on the FORTA List that has been validated for Germany and Austria. The EURO-FORTA List is an implicit tool and consists of 264 drugs/drug classes organized in 26 groups according to clinical diagnosis or symptoms [37].

On the other hand, explicit tools, such as the Screening Tool to Alert to Right Treatment (START) and Screening Tool of Older Person's Prescriptions (STOPP) criteria, originally created in 2008 [38], are adapted to European prescription standards. Over time, the START/STOPP criteria have been updated, with the most recent version (version 2) being published in 2015 [39]. These criteria are used as tools to help researchers and professionals to identify 81 PIM and 34 potential prescribing omissions (PPO). Although the STOPP criteria are classified as explicit, according to studies carried out recently in Portugal, for only 29 of the 81 STOPP criteria, a judgement can be made only with the patient's medication profile information. This means that 52 of the STOPP criteria require additional information (i.e., duration of treatment, previous medication, current medical conditions, medical history and laboratory data) [40].

In 2015, the EU (7)-PIM List, an explicit criteria tool, was developed by experts from seven European countries (Germany, Finland, Estonia, Holland, France, Spain and Sweden) that allows the identification and comparison of PIM in these countries [41]. The EU (7)-PIM List development process was based on the participation of several European experts in two Delphi rounds. Some PIM concepts were defined considering the dose, the time of use or the therapeutic scheme, and the final list consists of 282 PIM.

In addition to these criteria, there are many other PIM lists in several countries, such as LaRoche (France) [42, 43], the PRISCUS list (Germany) [44], the Austrian consensus panel list [45], the NORGEP criteria (Norway) [46] and the Canada national consensus panel list [47].

Figure 1 is a flowchart that represents the steps that must be taken by health professionals when prescribing medications to the elderly, including the moment when they should consult the currently available PIM identification criteria.

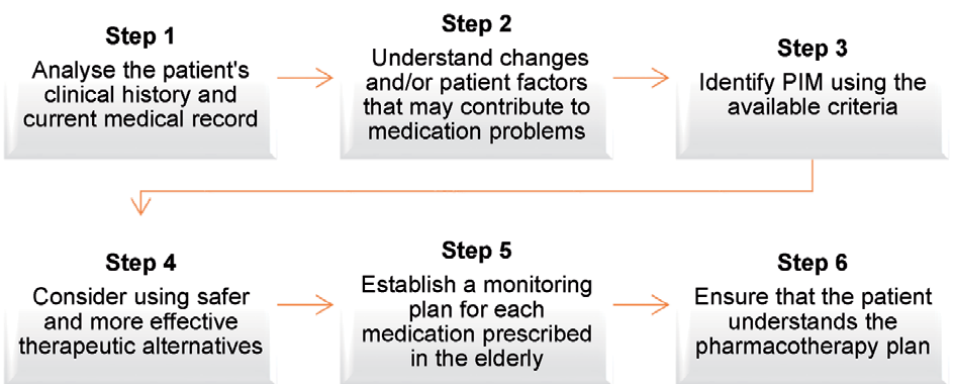

Figure 1.
Flowchart of the operating procedure of the expected steps during prescription for older patients.

5. Conclusions

There are many physiological and pathophysiological changes associated with ageing that can affect the disposition of a drug. However, there are many variations among individuals. Thus, health professionals should be more alert during a prescription to older patients and monitor their health status with individual attention.

One of the main factors responsible for variability in older patients is genetics since the structure, function and expression of most of the enzymes involved in metabolism can be affected due to genetic polymorphism, which will modify the therapeutic effect of certain drugs. Thus, the concept of individualized therapy, which analyses for each subject, genetic and non-genetic factors to optimize the treatment for each patient according to their characteristics, is increasingly common.

In general, older patients have a higher sensitivity to drug therapy, so recommendations for the appropriate prescription of drugs in the elderly population should be considered.

The incorporation of the described criteria in the CDSS has been successful in the detection of PIM. Persistent changes in medication were recorded in 8.7% of the alerts generated [48]. These data suggest that CDSS alerts are a useful tool for implementing guidelines related to the identification of PIM for older patients and for helping physicians during the prescription process, improving healthcare practices.

Acknowledgements

This work was financially supported by the project MedElderly [SAICT-POL/23585/2016], funded by Portuguese Foundation for Science and Technology (FCT/MCTES), Portugal 2020 and Centro 2020 grants, and by the project APIMedOlder [PTDC/MED-FAR/31598/2017], funded by FEDER, through COMPETE2020—Programa Operacional Competitividade e Internacionalização (POCI-01-0145-FEDER-031598), and by national funds (OE), through FCT/MCTES.

Conflict of interest

The authors declare no conflict of interest.

Abbreviations

ACEI	angiotensin conversion enzyme inhibitors
ADR	adverse drug reaction
AGS	American Geriatrics Society
ARBs	angiotensin II receptor blockers
CDSS	clinical decision support systems
CNS	central nervous system
DRP	drug-related problem
GFR	glomerular filtration rate
MAI	medication appropriation index
NSAIDs	nonsteroidal anti-inflammatory drugs
PIM	potentially inappropriate medication
PPO	potential prescribing omissions

START screening tool to alert to right treatment
STOPP screening tool of older person's prescriptions

A. Glossary

Adverse drug reactions	A response to a medicinal product which is noxious and unintended [49]
Bioavailability	The fractional extent to which a dose of drug reaches its site of action or a biological fluid from which the drug has access to its site of action [50]
Drug-related problems	An event or circumstance involving drug therapy that actually or potentially interferes with desired health outcomes [51]
Pharmacodynamic	Biochemical and physiological effects of drugs and their mechanisms of action [50]
Pharmacokinetic	The absorption, distribution, metabolism and excretion of a drug that occurs since the moment when the drug enters the body [50]
Polypharmacy	The concurrent use of multiple medications. Although there is no standard definition, polypharmacy is often defined as the routine use of five or more medications. This includes over-the-counter, prescription and/or traditional and complementary medicines used by a patient [52]
Potentially inappropriate medication	Medicines where the potential risk is greater than the potential benefit, especially when safer alternatives are available [41]
Prodrugs	Inactive drug that undergo metabolism to an active drug [50]

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References

[1] Rattan SIS. Theories of biological aging: Genes, proteins, and free radicals. Free Radical Research. 2006;**40**(12):1230-1238

[2] Picca A et al. The metabolomics side of frailty: Toward personalized medicine for the aged. Experimental Gerontology. 2019;**126**(July):110692

[3] Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;**381**(9868):752-762

[4] Davies LE, Spiers G, Kingston A, Todd A, Adamson J, Hanratty B. Adverse outcomes of polypharmacy in older people: Systematic review of reviews. Journal of the American Medical Directors Association. 2020:1-7

[5] Waring RH, Harris RM, Mitchell SC. Drug metabolism in the elderly: A multifactorial problem? Maturitas. 2017;**100**:27-32

[6] Hedna K, Hakkarainen KM, Gyllensten H, Jonsson AK, Petzold M, Hagg S. Potentially inappropriate prescribing and adverse drug reactions in the elderly: A population-based study. European Journal of Clinical Pharmacology. 2015;**71**:1525-1533

[7] Koren G, Nordon G, Radinsky K, Shalev V. Clinical pharmacology of old age. Expert Review of Clinical Pharmacology. 2019;**12**(8):749-755

[8] Motter FR, Fritzen JS, Hilmer SN, Paniz ÉV, Paniz VMV. Potentially inappropriate medication in the elderly: A systematic review of validated explicit criteria. European Journal of Clinical Pharmacology. 2018;**74**(6):679-700

[9] Corsonello A, Pedone C, Incalzi RA. Age-related pharmacokinetic and pharmacodynamic changes and related risk of adverse drug reactions. Current Medicinal Chemistry. 2010;**17**:571-584

[10] Yin D, Chen K. The essential mechanisms of aging: Irreparable damage accumulation of biochemical side-reactions. Experimental Gerontology. 2005;**40**(6):455-465

[11] Reeve E, Wiese MD, Mangoni AA. Alterations in drug disposition in older adults. Expert Opinion on Drug Metabolism & Toxicology. 2015;**11**(5):491-508

[12] McLean AJ, Le Couteur DG. Aging biology and geriatric clinical pharmacology. Pharmacological Reviews. 2004;**56**(2):163-184

[13] Musso CG, Belloso WH, Scibona P, Bellizzi V, Macías Núñez JF. Impact of renal aging on drug therapy. Postgraduate Medicine. 2015;**127**(6):623-629

[14] Curkovic M, Dodig-Curkovic K, Eric AP, Kralik K, Pivac N. Psychotropic medications in older adults: A review. Psychiatria Danubina. 2016;**28**(1):13-24

[15] Turnheim K. When drug therapy gets old: Pharmacokinetics and pharmacodynamics in the elderly. Experimental Gerontology. 2003;**38**(8):843-853

[16] Trifiro G, Spina E. Age-related changes in pharmacodynamics: Focus on drugs acting on central nervous and cardiovascular systems. Current Drug Metabolism. 2011;**12**(7):611-620

[17] Andres TM, McGrane T, McEvoy MD, Allen BFS. Geriatric pharmacology: An update. Anesthesiology Clinics. 2019;**37**(3):475-492

[18] Wastesson JW, Morin L, Tan ECK, Johnell K. An update on the clinical consequences of polypharmacy in older adults: A narrative review. Expert Opinion on Drug Safety. 2018;**17**(12):1185-1196

[19] Bushardt RL, Massey EB, Simpson TW, Ariail JC, Simpson KN. Polypharmacy: Misleading, but manageable. Clinical Interventions in Aging. 2008;**3**(2):383-389

[20] Sitar DS. Clinical pharmacology confounders in older adults. Expert Review of Clinical Pharmacology. 2012;**5**(4):397-402

[21] Naveiro-Rilo JC, Diez-Juárez D, Flores-Zurutuza ML, Javierre Pérez P, Alberte Pérez C, Molina Mazo R. La calidad de vida en ancianos polimedicados con multimorbilidad. Revista Española de Geriatría y Gerontología. 2014;**49**(4):158-164

[22] Walsh CA, Cahir C, Tecklenborg S, Byrne C, Culbertson MA, Bennett KE. The association between medication non-adherence and adverse health outcomes in ageing populations: A systematic review and meta-analysis. British Journal of Clinical Pharmacology. 2019;**2018**:1-15

[23] Midlvov P, Eriksson T, Kragh A. Drug-Related Problems in the Elderly. 1st ed. Netherlands: Springer; 2009. p. 37

[24] Sacarny A, Barnett ML, Le J, Tetkoski F, Yokum D, Agrawal S. Effect of peer comparison letters for high-volume primary care prescribers of quetiapine in older and disabled adults: A randomized clinical trial. JAMA Psychiatry. 2018;**75**(10):1003-1011

[25] Wooten JM. Rules for improving pharmacotherapy in older adult patients: Part 2 (rules 6-10). Southern Medical Journal. 2015;**108**(2):97-104

[26] Wooten JM. Rules for improving pharmacotherapy in older adult patients: Part 1 (rules 1-5). Southern Medical Journal. 2015;**108**(2):97-104

[27] Wooten JM. Appropriate pharmacotherapy in the elderly. Journal of Aging Science. 2016;**04**(01):4-6

[28] Wasylewicz ATM, Scheepers-Hoeks AMJW. Clinical decision support systems. In: Fundamentals of Clinical Data Science. 2018. pp. 153-169

[29] Berner ES. Clinical Decision Support Systems: State of the Art. Rockville, Maryland: Agency for Healthcare Research and Quality; 2009

[30] Lavan AH, Gallagher PF, O'Mahony D. Methods to reduce prescribing errors in elderly patients with multimorbidity. Clinical Interventions in Aging. 2016;**11**:857-866

[31] Maanen ACD, Spee J, van Hensbergen L, Jansen PAF, Egberts TCG, van Marum RJ. Structured history taking of medication use reveals iatrogenic harm due to discrepancies in medication histories in hospital and pharmacy records. Journal of the American Geriatrics Society. 2011;**59**(10):1976-1978

[32] Beers MH, Ouslander JG, Rollingher I, Reuben DB, Brooks J, Beck JC. Explicit criteria for determining inappropriate medication use in nursing home residents. Archives of Internal Medicine. 1991;**151**(9):1825-1832

[33] Campanelli CM, Fick DM, Semla T, Beizer J. American Geriatrics Society updated beers criteria for potentially inappropriate medication use in older adults: The American Geriatrics Society 2012 Beers Criteria Update Expert Panel. Journal of the American Geriatrics Society. 2012;**60**(4):616-631

[34] The American Geriatrics Society. American Geriatrics Society 2015 updated beers criteria for potentially inappropriate medication use in older adults. Journal of the American Geriatrics Society. 2015;**63**(11):2227-2246

[35] Fick DM et al. American Geriatrics Society 2019 updated AGS Beers Criteria® for potentially inappropriate

medication use in older adults. Journal of the American Geriatrics Society. 2019;**67**(4):674-694

[36] Hanlon JT et al. A method for assessing drug therapy appropriatness. Journal of Clinical Epidemiology. 1992;**45**:1045-1051

[37] Pazan F, Weiss C, Wehling M. The EURO-FORTA (Fit fOR The Aged) list: International consensus validation of a clinical tool for improved drug treatment in older people. Drugs and Aging. 2018;**35**(1):61-71

[38] Gallagher P, Ryan C, Byrne S, Kennedy J, O'Mahony D. STOPP (Screening Tool of Older Person's Prescriptions) and START (Screening Tool to Alert doctors to Right Treatment). Consensus validation. International Journal of Clinical Pharmacology and Therapeutics. 2008;**46**:72-83

[39] O'mahony D, O'sullivan D, Byrne S, O'connor MN, Ryan C, Gallagher P. STOPP/START criteria for potentially inappropriate prescribing in older people: Version 2. Age and Ageing. 2015;**44**(2):213-218

[40] Carvalho R et al. Patients' clinical information requirements to apply the STOPP/START criteria. International Journal of Clinical Pharmacy. 2019 0123456789

[41] Renom-Guiteras A, Meyer G, Thürmann PA. The EU(7)-PIM list: A list of potentially inappropriate medications for older people consented by experts from seven European countries. European Journal of Clinical Pharmacology. 2015;**71**(7):861-875

[42] Laroche ML, Bouthier F, Merle L, Charmes JP. Médicaments potentiellement inappropriés aux personnes âgées: Intérêt d'une liste adaptée à la pratique médicale française. La Revue de Médecine Interne. 2009;**30**(7):592-601

[43] Laroche ML, Charmes JP, Merle L. Potentially inappropriate medications in the elderly: A French consensus panel list. European Journal of Clinical Pharmacology. 2007;**63**(8):725-731

[44] Holt S, Schmiedl S, Thürmann PA. Potentially inappropriate medications in the elderly: The PRISCUS list. Deutsches Ärzteblatt. 2010;**107**(31-32):543-551

[45] Mann E et al. Potentially inappropriate medication in geriatric patients: The Austrian consensus panel list. Wiener Klinische Wochenschrift. 2012;**124**(5-6):160-169

[46] Rognstad S, Brekke M, Fetveit A, Spigset O, Wyller TB, Straand J. The norwegian general practice (NORGEP) criteria for assessing potentially inappropriate prescriptions to elderly patients. Scandinavian Journal of Primary Health Care. 2009;**27**(3):153-159

[47] McLeod PJ, Huang AR, Tamblyn RM, Gayton DC. Defining inappropriate practices in prescribing for elderly people: A national consensus panel. Canadian Medical Association Journal. 1997;**156**(3):385-391

[48] Mulder-Wildemors LGM, Heringa M, Floor-Schreudering A, Jansen PAF, Bouvy ML. Reducing inappropriate drug use in older patients by use of clinical decision support in community pharmacy: A mixed-methods evaluation. Drugs and Aging. 2020;**37**:115-123

[49] European Medicines Agency. Guideline on Good Pharmacovigilance Practices (GVP) Annex I—Definitions (Rev 4). Heads Med. Agencies; 2017 EMA/876333/2011. Available from: https://www.ema.europa.eu/en/documents/scientific-guideline/guideline-good-pharmacovigilance-practices-annex-i-definitions-rev-4_en.pdf

[50] Brunton LL. Goodman & Gilman's The Pharmacological Basis of Therapeutics. In: Brunton L, Lazo J, Parker K, editors. 11th ed. McGraw Hill, New York; 2006

[51] Pharmaceutical Care Network Europe Association. PCNE Classification for Drug-Related Problems V9.00. 2019. Available from: https://www.pcne.org/upload/files/334_PCNE_classification_V9-0.pdf

[52] World Health Organization. Medication safety in Polypharmacy. Geneva, Switzerland: World Health Organization Technical Report Series; 2019

Chapter 6

Exercise-Based Interventions as a Management of Frailty Syndrome in Older Populations: Design, Strategy, and Planning

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Abstract

Exercise-based interventions emerged as the best alternative for treating frailty syndrome (FS). Recognized as a complex phenotype, the FS is a multifaceted aging expression determined by biologic, environment, and behaviors factors. The biological theories of human development perceive aging process as an accumulation of harmful biochemical changes, whose occurrence attends the course of life. The progressive losses of functional reserves that occur in the body systems are a hallmark of this negative process. Despite the biological effects of physical and cognitive decline, more contemporary studies have identified that the environmental and behavior factors such as malnutrition and negative psychological adjustment across the life span also contribute to the early appearance of FS. Notwithstanding the latest findings that consistently demonstrate an overall positive benefit of long-term-based exercise in the decrease and/or reversal of the FS with a substantial impact on their correlated outcomes, the focus of this chapter is to present strategies for designing exercise programs for this type of population, taking into account their practical application in the field.

Keywords: physical exercise, elderly-frail, program design, physical frailty, cognitive frailty

1. Introduction

Frailty syndrome (FS) is a complex aging expression determined by ontogenetic and phylogenetic factors [1]. Chronic stress has been shown to have immunosuppressive effects, to accelerate immunosenescence, and to cause cumulative disorders in many physiological systems, resulting in a frail state [2]. This phenotype, as thus treated by the specialists, had a strong influence on the biological theories of aging [3], which explains this process as an accumulation of harmful biochemical changes, whose occurrence accompanies the course of aging [4, 5]. The progressive losses of energy and functional reserves that occur in the body are a hallmark of this negative process [6]. The vulnerability induced by these losses can lead to a

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weakening state, if he or she is exposed to more severe aggressions [2]. From a frail state, this individual tends to cycle through institutionalization, intensive care and hospitalization, often followed by early death [7].

Environmental factors such as malnutrition and negative psychological adjustment across the life span also contribute to an early appearance of frailty [8]. Nowadays, the scientific literature is identifying several sub-types of manifestation and classification of FS [9]. Fried et al. have developed a construct whose bases are the negative energy balance, low levels of physical activity, low gait speed, and hand grip strength performance called the physical frailty (PF) status [10]. Recently, some studies have identified cognitive frailty (CF) as a novel age-related concept [11], a form of pathological brain-aging, and a precursor to neurodegenerative processes, that is characterized by concurrent FS and potentially reversible cognitive impairment [12].

Despite the different frailty subtypes, there is a consensus about the sedentary lifestyle and the poor muscular resistance as powerful conditions linked to FS [13]. Regular exercise has been shown to have positive effects on several factors correlated to FS (e.g., immunity, musculoskeletal, cognitive abilities, and improve psychosocial domains) [14]. For this reason, a large number of the intervention studies with exercise in older individuals chose to investigate variables of physical, biological, and behavioral factors, also called frailty correlates [15]. These factors share biopsychological commonalities that can be explained by studying the exercise modulation simultaneous effect on some of these frailty related outcomes [16].

Evidence shows that immunological and hormonal parameters are able to mediate the effects of exercise on mucosal immunity, psychological stress, cognitive improvement, and risk of dementia in the elders who are regularly active [17]. Regular exercise may provide an effective strategy in the treatment and prevention of associated disorders due to its anti-inflammatory benefits [18] and also, in the reduction of stress and anxiety levels and on the risk of psychological diseases and emotional decline in the elders [19]. Currently, there is conflicting evidence concerning the efficacy and practicality of different types of exercise interventions to decrease FS. For this reason, some of the review articles published in the last decade, aimed to present a robust evidence supporting the use of exercise as a coadjutant treatment to frailty [20–22].

In this sense, the main purpose of the current chapter was to summarize the recent robust evidence regarding the impact of regular exercise in the decrease of several factors associated to the frailty syndrome. Specifically, our focus was to present strategies to design exercise programs for this population, taking into account their practical application in the field.

2. Benefits of exercise: recent evidences

An approach to the treatment, attenuation or reversal of the frail condition in older adults has gained some notoriety in recent years [23]. Much has been discussed about the efficacy of different physical exercise programs as an adjunct therapy capable of promoting a positive impact not only on the independent components of frailty but on their correlated domains [24]. Evidence indicates that PF-related and regular exercise research may be a 'key factor' in the study of these associations because of the important role played by regular physical exercise in neuroendocrine, immune, and hormonal modulation of several biochemical markers [25, 26]. The aging process does not affect the immune and neuroendocrine system uniformly, and there is a high degree of individual variability that may be

associated with confounding factors. These factors have the potential to either confound data interpretation or contribute to an interaction between different types of exercise and immune function, or both [27–30].

However, recent findings showed that participation in regular exercise may induce a "cascade" of cellular reactions, capable of promoting angiogenesis, neurogenesis, and synaptogenesis, and further delay immunosenescence [28, 31]. In addition, there is proven positive action in improving the quality of life related to emotional states, psychological well-being, and gains in autonomy to perform daily tasks [16]. However, scientific evidence points to different types of exercise causing distinct and specific responses in the different physiological systems in this type of population [32].

Current findings have demonstrated, for example, the beneficial effects of aerobic exercise on the increase of brain-derived neurotrophic factor (BDNF) in elderly people who practice regular exercise [33]. BDNF is an important mediator of brain neuroplasticity, differentiation, neuronal growth, learning, and memory [31]. Its unregulated expression is related to diseases such as Parkinson's, Alzheimer's, and mild cognitive impairment (MCI), a clinical condition evidenced through cognitive testing [34]. All these conditions or diseases can be diagnosed through easy-to-apply cognitive tests that are also valid and capable of revealing a possible decline in executive function and memory, among others [35]. However, MCI is often characterized as a condition or initial stage of more advanced cognitive impairments [36].

Recent findings consistently associate MCI with PF [34]. Exercise can act as a positive mediator of cognitive functioning in individuals suffering from early dementia and mental disorders, and these responses being attributed to a possible role of BDNF [12]. Cognitive functions sensitive to early dementia and mental disorders shown to undergo positive changes in response to the effects of exercise were attributed to a possible neurogenic effect of BNDF [33]. A possible regulatory effect of maintaining a satisfactory cognitive performance was also observed in studies with other markers such as testosterone and cortisol [37].

The efficacy of exercise in the prevention/attenuation of clinical manifestations of depression, stress, and chronic anxiety, whose evidences are supported by biochemical mechanisms of a similar nature was also shown [38]. In addition, the evidence that associates PF and CF with possible declines in the neuroendocrine system is increasingly robust [39]. A systematic review carried out by Hogervost et al. found that different types of exercise may affect different levels of cognition and dementia risk; aerobic programs seem to be particularly effective while there is little evidence that flexibility exercises, such as yoga, can help cognition [40].

Exercise could be a significant factor in ameliorating the deleterious effects of chronic stress but some indicators such as the type, intensity, and frequency of exercise should be controlled and defined clearly in order to effectively reduce the stress burden. However, other factors relevant to the participation of the elderly in systematic physical activity programs such as schedule, adherence strategies, health promotion and education, levels of physical function, personal wellness, and vocational dimension, should be taken in consideration when planning new successful community programs.

3. Exercise program design

An initial approach to the development of exercise programs for elderly people should include detailed description of the exercise program, as well as its information about intensity, volume, and resting intervals, taking into account the specificities of the population. Notwithstanding the influence of the fitness industry in the

offer of many types of activities, the development of new concepts and materials, and the disclosure of trends [41], the purpose of this chapter is to provide general strategies for implementation exercise program for senior populations, taking into account the current scientific evidence [42]. In this sense, a systematic search using key-terms related to the topic was conducted, and results were discussed with other exercise experts in order to prepare the final version of the exercise program. The main purpose of the systematic review was to verify the most recent scientific evidence and guidelines recommended for the type of exercise, the duration and frequency, and other elements which are crucial for an exercise program design and implementation. **Table 1** shows the examples of recommendations for the implementation of exercise programs, taking into account the duration of the exercise program.

Several books and guidelines related to exercise programs for elderly people highlight several important aspects of the program for this type of population. However, specific aspects, such as phases of implementation, schedule of activities, interruption of activities, the social calendar of the participants, and specificities of region, country, and target population are poorly referenced. The primarily relevant aspect for the development of any exercise program concerns the schedule of the program across the year. It is in this "time window" that we will organize activities, taking into account the social calendar. In sport science and exercise, this is a method called training periodization. Although it is premature to conclude that periodized exercise is superior to non-periodize exercise to increase health outcomes, periodization appears to be a feasible means of prescribing exercise to inactive adults within an intervention setting [44].

The physical activity recommendations for older adults describe the amount and type of systematic exercise that promote health and prevents, reduces or reverses the risk of getting some diseases or clinical conditions. The main benefits

Steps	General recommendations	Expected time
1	Pre-implementation	
	(a) Determine target population, program objectives, and fitness assessment model; (b) establish partnerships (i.e., schools, universities, and municipalities); (c) delimit the financial costs; (d) identifying appropriate facilities (accessibility); (e) selected sport and exercise specialists; (f) describe the types of activities, following the fitness assessment outputs	3–6 months
2	Implementation	
	(a) Organize a schedule in the periodization model, define key dates for physical-functional fitness assessment of the participants (2 or 3 times); (b) organize activities taking into account commemorative dates; (d) provide assessment, control, and feedback to the participants regarding the improvements in physical and global health	6–9 months
3	Post-implementation	
	(a) After the last moment of fitness assessment, close the season by organizing a special class; (b) communicate results and news for the next season; (c) look for some behavior indicators that provide important outcomes of improve exercise program (i.e., adherence, attractiveness by the activities and the teacher's style, motivating)	1–3 months

Note: Adapted from [24, 43].

Table 1.
Recommendations for the implementation of exercise programs in older adults.

of implementing exercise programs, not only in elderly people, but also in all other populations, is the improvement of health-related physical fitness, in its all five components (i.e., muscular endurance and strength, body composition, cardiovascular endurance, and flexibility) and others integrated physical qualities (such as balance, coordination, and reaction time), that tends to deteriorate across the aging process. In one of your innumerous paper, the American College of Sports Medicine (ACSM) makes clear the type of training and its degree of evidence in relation to its effectiveness for some markers of global health [45].

In this sense, training for cardiorespiratory fitness, muscle strength and endurance training, flexibility, and multicomponent exercise programs are strongly recommended for the improvement of different health indicators in older adults. In the next topic, these aspects will be discussed in further detail focusing on the specificity of each type of exercise and the degree of evidence for the different health-related indicators.

3.1 Participants

Frailty is considered by many authors to be a subcategory of the aging process, taking into account the level of physical functions that allow them to perform activities of daily living. This participants cannot perform several tasks evolving strength (i.e., carrying shopping bags, carrying out small tasks like sweeping or cleaning the floor) as they are unable to stand for long periods [46]. In terms of physical condition, the main characteristics of this group are the low muscular strength and cardiovascular endurance and the poor levels of dynamic and static balance [8]. This population may have a debilitating disease or condition that physically challenges them in their daily life. However, the recently created concept of frailty – decreased resistance to biological stressors [47], has been reported to modulate the risk of several types of dementia and cognitive impairment (CI) [48]. Since physical and cognitive decline have a similar outcome, a physical exercise program must take into account other methodological specificities. In this sense, chair assisted-exercise appears to be a good integrated method to promote exercise for this population [49], considering that integrated methodologies seem to be the best option for this type of population.

3.2 Physical-functional fitness assessment

There are numerous isolated tests and test batteries that can be used to assess the physical and functional capacities of the elderly [50]. Based on the assumption that exercise programs need to regularly monitor using quick, valid, and reliable tests, some test batteries such as the Short Physical Performance Battery [51] and the Senior Fitness Test Battery [52] seem to be great options to assess this population as they evaluate different components of the physical-functional and health-related fitness with low cost materials and still have numerous studies that support its use.

Although the most functional fitness tests for old adults are quite simple to use, careful planning is required including adequate use of specific strategies to overcome some critical phases that may appear during application. Thus, it is important to consider the following steps before assessment: (a) technicians team training; (b) screening of participants; (c) informed consent/assumption of liability; (d) subject some program participants to a pre-test familiarization; (e) testing equipment/supplies; (f) data recording (scorecards); (g) testing order; (h) environmental conditions; (i) observation/monitoring of signs of overextension in the participants during the tests. Considering these steps when planning the assessment

is very important to assure the participant safety, testing efficacy, and to obtain a good accuracy of the measurements [52].

As a rule, it is suggested that exercise program participants should be evaluated twice, in a pre and a post exercise intervention moment, during the same season. In long-term programs (6 months and more), it is recommended to carry out an intermediate evaluation moment, since this can provide relevant information and evidence for the hypothetical changes caused by the exercise program and about the direction of those changes, that is, if they reveal a positive or a negative progress. Many studies in the literature indicate that exercise programs with a duration between 8 and 12 weeks, in average, tend to evidence positive changes in the various components of physical fitness, although it is known that the number of weekly sessions and the participant's initial state of physical fitness are factors that will influence these variables [53].

3.3 Type of activities

The following guidelines are based on land-based group class exercise programs, which seems to be the type of format that gathers more evidence regarding its effectiveness and taking into account its epidemiological impact [43]; relatively lower costs when compared to the other types of exercise and therapies, such as water-based exercise [54]; the effect of the group environment to motivate the participants, the psychosocial needs of the group in relation to building bonds of friendship preventing social isolation and encouraging people to engage in activities and maintain an active and healthy lifestyle [55].

However, our focus is on developing specific methodologies to be used with the population affected by frailty syndrome. **Table 2** presents a set of recommendations for old adults and describes the amount and type of systematic physical activity needed to promote an improvement of general health in frail individuals. These recommendations apply to all adults aged 65+ years and to adults aged 50–64 with significant clinical chronic conditions or functional limitations that affect movement ability, functional status, and/or levels of physical activity.

Type of activities	Dose
Aerobic activity or cardiovascular Exercises	Moderate-intensity aerobic physical activity for a minimum of 30 minutes on 5 days each week or vigorous-intensity aerobic activity for a minimum of 20 minutes on 3 days each week [43]
Muscle strength and resistance	Moderate intensity for maintaining or increasing muscular strength and endurance for a minimum of 2 days each week. It is recommended that 8–10 exercises (10–20 repetitions) be performed on two or more non-consecutive days per week using the major muscle groups [53]
Type-flexibility activities	Low to moderate isolated type flexibility exercises on at least 2 days each week for at least 10 minutes each day or integrated exercises 2–3 times per week [43]
Multicomponent activities	Long-term intervention (≥5 months) performed for a minimum three times per week, for 30–45 minutes per session [24]
Body and mind interventions (BMI)	After 12 weeks and frequency of 2–3 times weekly 45–60 minutes per session, BMI interventions (i.e., Yoga, Taiichi) improve cognition related to motor tasks and functioning [56].
Balance exercises protocol	Greater effects seen from long-term exercise programs (≥6 months) that challenged balance and involved more than 3 hours/week [57].

Table 2.
Exercise recommendation statement for old adults.

3.4 Exercise class format

Several formats can be effective for senior classes. The standard format includes 45–60 minutes comprising 5–10 minutes of warm-up, 30–35 minutes of fundamental part (core of the exercise session), and 5 minutes of cooldown. Classes for beginners will have a longer warm-up and cooldown phases, but the fundamental phase must be shorter. As participants adapt and adjust to their own level of effort, classes become more regular and the duration of the fundamental phase may increase progressively, becoming closer to the main specificities and characteristics usually found in many exercise prescription manuals for older participants [43] (**Table 3**).

In order to develop a progressive exercise program aiming to improve physical fitness, in elderly participants, each exercise will be planned and performed with a specific number of sets, repetitions per set, time rest intervals, and other variables relevant to the type of exercise program. In the case of the elderly frail population, it is recommended to use an integrative approach due to the current literature which has been shown that mixed or combined training methodologies can provide improvements to one or more physical health problems that accompany these individuals.

An example of a muscle-strength exercise session with elastic resistance bands created especially for old participants with frail condition is presented below (see **Figure 1**). The use of elastic bands (EB) is an alternative method to traditional muscle strength exercise devices which reduces the risk of injury, which is cheaper and easily accessible [58], and allows individuals to perform a range of ergonomic movements and easily adjusts the training intensity to the rate of perceived exertion [59]. According to the ACSM evidence-based statement position, the systematic

Chair muscle-strength exercise group class				**Total time: 50 minutes**	
				5 minutes	
Phase 1 Warming-up: Body mobilization and dynamic flexibility exercises	**Sets***	**Reps**	**Cadence**	**Rest**	**PSE**
	2	6	1:2	20”	1–3
Phase 2 Muscle-strengthening activity: Elastic-band exercises compound (bi-sets) protocol				**30 minutes**	
Sequence of exercise*					
1. Front squat (stand or chair)	1–3	10–15	2:3	30–45”	3–5
2. Leg press with chair	1–3	10–15	2:3	30–45”	3–5
3. The calf press with chair	1–3	10–15	2:3	30–45”	3–5
4. Chest press (stand or chair)	1–3	10–15	2:3	30–45”	3–5
5. Seated row	1–3	10–15	2:3	30–45”	3–5
6. Lateral raiser with chair (or stand)	1–3	10–15	2:3	30–45”	3–5
7. The triceps press	1–3	10–15	2:3	30–45”	3–5
8. The biceps curl	1–3	10–15	2:3	30–45”	3–5
Phase 3 Cool-down: Body mobilization and static flexibility exercises				**5 minutes**	
	1	10	2:1	10”	1–2

Table 3.
Overview of single session chair elastic-band muscle resistance exercises program.

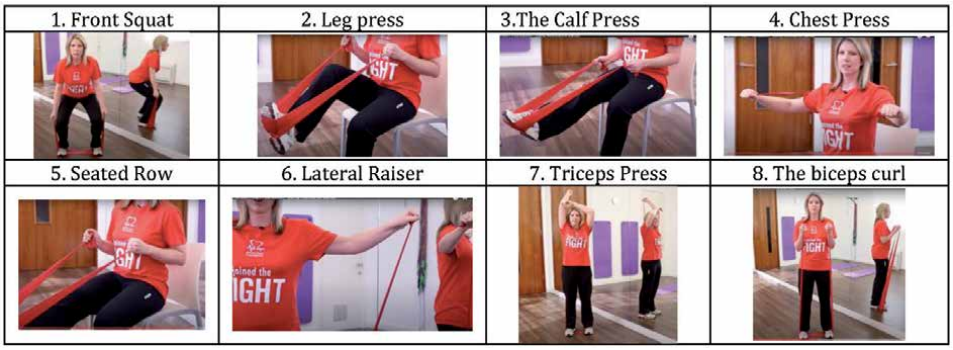

Figure 1.
Illustration of each elastic band exercise of the single session elastic-band muscle resistance exercises program, authorized by British Heart Foundation (adapted from: https://wwwyoutube.com/watch?v=mka5ZLE2RI0).

muscle-strength exercise has an evidence category A. The materials used in EB exercise programs are relatively inexpensive and provide a practical form of strength training that could be considered in exercise programs designed for older adults with mobility limitations [60].

3.5 Control of exercise effort

Some methods can be used by exercise participants to check their own response to intensity. A target heart rate range to be achieved and maintained during aerobic exercise can be calculated for monitoring the heart rate response to exercise. Karvonen's formula is an example of how to calculate an age-specific target heart rate zone [61]. The Borg Rating of Perceived Exertion Scale (PSE), which consists of a 10-point category/proportion scale, is another method used to monitor exercise intensity [62]. It is a subjective method that allows exercise participants to assess how well they are working during the exercise.

Stress assessment can be a primary way of measuring exercise intensity when a patient is not experiencing typical heart rate responses to exercise. On a scale of 0–10, patients assess how they are feeling while exercising, in terms of body fatigue and how they are feeling physically and mentally. In addition to the Borg Scale, other methods using scales are widely used, for example, the OMNI scale (OMNI-S) during resistance exercise [63].

In the case of the EB exercise program, intensity was measured through the OMINI-S that consists of an arbitrary scale ranging from 0 to 10 points, with identical intervals and with reference to the quality of effort: (PSE = 0) extremely easy; (PSE = 1–2) easy; (PSE = 3–4) somewhat easy; (PSE = 5–6) somewhat hard; (PSE = 7–8) hard; (PSE = 9–10) extremely hard [63].

In terms of periodization, considerate is suggested that these programs may last 9 months. During the first 12 weeks of periodization, participants will develop their stabilization and implement their endurance strength training program using an intensity somewhat easy [PSE = 3–4]. For this effect, the level one (yellow color) of EB was used. In the next 12 weeks, participants were encouraged to develop their resistance strength level, increasing their intensity load perception level to somewhat hard (PSE = 5–6).

They were also induced to change the elastic-band levels for 2 and 3 (red and green color). In the last 12 weeks, participants were stimulated for training their resistance and muscular strength level and increasing their intensity load (PSE = 7–8) [49]. In this way, we have a periodization divided into 3 periods (mesocycles), determined by controlling the intensity of the training over a season.

3.6 Music and materials

According to the current evidence, music plays a significant role in the success of an exercise class. Exercise with music increases participation in the class, when compared to the controls without music [64]. Exercise combined with music helps to determine and maintain the rhythm of the motor tasks and the dual-tasks involving upper and lower limbs and to improve balance [65]. Music can also match or transmit vibrations, rhythms, and vocalizations consistent with the different moments of the class. After moderate exercise (cooldown), listening to a favorite piece of music might decrease the influence of stress caused by fatigue thus increasing the level of "comfort" to perform the exercise [66]. Besides that, music plus exercise appears to maintain older participants' positive moods, motivate them to exercise, and help them to continue high involvement [67]. Over time music may encourage participants to realize a more challenge exercises.

Considering that the classic format of an exercise group class presents three parts (warming-up, fundamental part of class, and cooling down), specific songs should be selected to help us to create an adequate environment to those three moments. When choosing the type of music, professionals should take into account some cultural aspects of the group or try to identify the musical preference of the participants. According to experts, the ideal number of beats per minute (bpm) used in exercise programs for the elderly should vary between 100 and 140 bpm, and for muscle strength and endurance training between 120 and 140 bpm. For relaxation (or cooldown), music close to 100 bpm recommended [68]. However, pay attention for some specific aspects, such as: (a) choose distinct music without over powering vocals; (b) consider the appropriate volume of the music taking into account that some of the participants may have some level of hearing impairment.

3.7 Quality of fitness instructors

Fitness instructors play an important role in helping their participants to acquire and maintain a healthy lifestyle [69]. Exercise leaders must give safety and high priority as well as to be able to match exercise programming to physical fitness and functional abilities. Generally, these professionals have degrees in physical education and sports, with extra training in specific fitness activities for each type of population. For example, the laws in some European countries require that professionals, in addition to specific fitness courses, present additional cardiopulmonary and basic or intermediate first aid certification.

In some countries, researcher surveys show that instructors usually stay in continuous training education, combined with their work routine [70]. However, it is still unclear how they impart practical knowledge based on scientific evidence to their students and this needs to be improved. The senior exercise certifications offer extensive information on special conditions and clinical settings and circumstances relevant to conduct exercise programs for old people. It is recommended that the professional is constantly undergoing in training and updating, as knowledge about the benefits of exercise for health and well-being is evolving exponentially and participants can highly benefit from this [69].

4. Conclusions

The growth of the physically and cognitively elderly frail population leads to the creation of specific guidelines for the prescription of exercise programs aiming to target this audience. Nowadays, the knowledge base of research and practice is

growing; however, more information is needed to provide adequate exercise programming for this populations, and this is a challenging task. Some factors such as motivation, global health status, and other psychosocial aspects can influence the participant adherence. In this sense, the organization of the program and the quality of the professionals involved may be one of the determining factors for the involvement and regular participation of the elderly. Currently, exercise science seeks what is the best type of exercise to prevent, mitigate, and to a certain extent, reverse this condition, taking into account the close relationship between physical and cognitive decline.

Cognitive frailty represents a great challenge for public health. Recent findings support causal evidence of regular exercise effects in older frail individuals not only in motor skills, but in others important CS, such as visuospatial function, executive function, and memory. In this sense, maintaining an active, healthy lifestyle and including a regular exercise program in everyday life habits can have protective and lasting effects on physical and mental health. For this reason, to meet the specifics of this elderly sub-clinical population, professionals need specific education training and reviewing research in the area to be able to provide adequate answers to the needs of those looking for this specific type of service.

Acknowledgements

We would like to thank the British Heart Foundation for authorizing the use of elastic-band exercises videos to capture some images. Thanks to Professor Juan Colado for sharing experience with elastic bands exercise prescription over the past few years.

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References

[1] Lang P-O, Michel J-P, Zekry D. Frailty syndrome: A transitional state in a dynamic process. Gerontology. 2009;**55**(5):539-549. DOI: 10.1159/000211949

[2] Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;**381**(9868):752-762. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23395245

[3] Walston JD, Bandeen-Roche K. Frailty: A tale of two concepts. BMC Medicine. 2015;**13**:1-3

[4] Gruver AL, Hudson LL, Sempowski GD. Immunosenescence of ageing. The Journal of Pathology. 2007;**211**(2):144-156. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1931833&tool=pmcentrez&rendertype=abstract

[5] Morley JE. Frailty: Diagnosis and management. The Journal of Nutrition, Health & Aging. 2011;**15**(8):667-670. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21968862

[6] Yao X, Li H, Leng SX. Inflammation and immune system alterations in frailty. Clinics in Geriatric Medicine. 2011;**27**(1):79-87. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0749069010000765

[7] de la Rica-Escuín M, González-Vaca J, Varela-Pérez R, Arjonilla-García MD, Silva-Iglesias M, Oliver-Carbonell JL, et al. Frailty and mortality or incident disability in institutionalized older adults: The FINAL study. Maturitas. 2014;**78**(4):329-334. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24929996

[8] Lally F, Crome P. Understanding frailty. Postgraduate Medical Journal. 2007;**83**(975):16-20. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2599957&tool=pmcentrez&rendertype=abstract

[9] Clegg A, Rogers L, Young J. Diagnostic test accuracy of simple instruments for identifying frailty in community-dwelling older people: A systematic review. Age and Ageing. 2015;**44**:148-152

[10] Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: Evidence for a phenotype. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences. 2001;**56**(3):M146-M156. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11253156

[11] Ruan Q, Yu Z, Chen M, Bao Z, Li J, He W. Cognitive frailty, a novel target for the prevention of elderly dependency. Ageing Research Reviews. 2015;**20**:1-10

[12] Panza F, Solfrizzi V, Barulli MR, Santamato A, Seripa D, Pilotto A, et al. Cognitive frailty: A systematic review of epidemiological and neurobiological evidence of an age-related clinical condition. Rejuvenation Research. 2015;**18**(5):389-412. DOI: 10.1089/rej.2014.1637

[13] Peterson MJ, Giuliani C, Morey MC, Pieper CF, Evenson KR, Mercer V, et al. Physical activity as a preventative factor for frailty: The health, aging, and body composition study. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences. 2009;**64**(1):61-68. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2913907&tool=pmcentrez&rendertype=abstract

[14] Silva RB, Aldoradin-Cabeza H, Eslick GD, Phu S, Duque G. The Effect of Physical Exercise on Frail Older Persons: A Systematic Review.

The Journal of Frailty & Aging. 2017;**6**(2):91-96. DOI: 10.14283/jfa.2017.7. Available from: http://www.jfrailtyaging.com/all-issues.html?article=524

[15] Rodriguez-Larrad A, Arrieta H, Rezola C, Kortajarena M, Yanguas JJ, Iturburu M, et al. Effectiveness of a multicomponent exercise program in the attenuation of frailty in long-term nursing home residents: Study protocol for a randomized clinical controlled trial. BMC Geriatrics. 2017;**17**(1):60. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28231827

[16] Tarazona-Santabalbina FJ, Gómez-Cabrera MC, Pérez-Ros P, Martínez-Arnau FM, Cabo H, Tsaparas K, et al. A multicomponent exercise intervention that reverses frailty and improves cognition, emotion, and social networking in the community-dwelling frail elderly: A randomized clinical trial. Journal of the American Medical Directors Association. 2016;**17**(5):426-433. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26947059

[17] Guerreiro RJ, Santana I, Brás JM, Santiago B, Paiva A, Oliveira C. Peripheral inflammatory cytokines as biomarkers in Alzheimer's disease and mild cognitive impairment. Neurodegenerative Diseases. 2007;**4**(6):406-412. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17934323

[18] Aguirre LE, Villareal DT. Physical exercise as therapy for frailty. Nestle Nutrition Institute Workshop Series. 2015;**83**:83-92

[19] Chodzko-Zajko W, Schwingel A. Successful aging: The role of physical activity. American Journal of Lifestyle Medicine. 2008;**3**(1):20-28. Available from: http://ajl.sagepub.com/cgi/doi/10.1177/1559827608325456

[20] Chou C-H, Hwang C-L, Wu Y-T. Effect of exercise on physical function, daily living activities, and quality of life in the frail older adults: A meta-analysis. Archives of Physical Medicine and Rehabilitation. 2012;**93**(17):237-244

[21] Liu CKCK, Fielding RARA. Exercise as an intervention for frailty. Clinics in Geriatric Medicine. 2011;**2013**:101-110

[22] Anthony K, Robinson K, Logan P, Gordon AL, Harwood RH, Masud T. Chair-based exercises for frail older people: A systematic review. BioMed Research International. 2013;**2013**:1-9

[23] Lopez P, Pinto RS, Radaelli R, Rech A, Grazioli R, Izquierdo M, et al. Benefits of resistance training in physically frail elderly: A systematic review. Aging Clinical and Experimental Research. 2017;**30**(8):1-11. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29188577

[24] Theou O, Stathokostas L, Roland KP, Jakobi JM, Patterson C, Vandervoort AA, et al. The effectiveness of exercise interventions for the management of frailty: A systematic review. Journal of Aging Research. 2011;**2011**:569194. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3092602&tool=pmcentrez&rendertype=abstract

[25] Coelho FGDM, Gobbi S, Andreatto CAA, Corazza DI, Pedroso RV, Santos-Galduróz RF. Physical exercise modulates peripheral levels of brain-derived neurotrophic factor (BDNF): A systematic review of experimental studies in the elderly. Archives of Gerontology and Geriatrics. 2013;**56**(1):10-15. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22749404

[26] Norman B, Esbjörnsson M, Rundqvist H, Österlund T, Glenmark B, Jansson E. ACTN3 genotype and modulation of skeletal muscle response

to exercise in human subjects. Journal of Applied Physiology. 2014;**116**(9):1197-1203. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24651987

[27] Senchina DS, Kohut ML. Immunological outcomes of exercise in older adults. Clinical Interventions in Aging. 2007;**2**(1):3-16. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2684080&tool=pmcentrez&rendertype=abstract

[28] Kohut ML, Senchina DS. Reversing age-associated immunosenescence via exercise. Exercise Immunology Review. 2004;**10**:6-41. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15633584

[29] Schober-Halper B, Hofmann M, Oesen S, Franzke B, Wolf T, Strasser E-M, et al. Elastic band resistance training influences transforming growth factor-ß receptor I mRNA expression in peripheral mononuclear cells of institutionalised older adults: The Vienna active ageing study (VAAS). Immunity & Ageing. 2016;**13**(1):22. Available from: http://www.ncbi.nlm.nih.gov/pubmed/27375767

[30] Hall-López J, Ochoa-Martínez P, Teixeira AMMB, Moncada-Jiménez JA, Dantas EM. Effect of hydrogymnastics physical exercise on serum level of immunoglobulin a in elderly women. Revista Chilena de Infectología. 2015;**32**(3):272-277. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26230432

[31] Gomez-Pinilla F, Hillman C. The influence of exercise on cognitive abilities. Comprehensive Physiology. 2013;**3**(1):403-428. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3951958&tool=pmcentrez&rendertype=abstract

[32] Walsh NP, Gleeson M, Shephard RJ, Jeffrey MG, Woods A, Bishop NC, et al. Position statement part one: Immune function and exercise. 2011;**7**:6-63

[33] Carlson MC, Erickson KI, Kramer AF, Voss MW, Bolea N, Mielke M, et al. Evidence for neurocognitive plasticity in at-risk older adults: The experience corps program. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences. 2009;**64**(12):1275-1282. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2781785&tool=pmcentrez&rendertype=abstract

[34] De Jager CA, Hogervorst E, Combrinck M, Budge MM, De Jager C. Sensitivity and specificity of neuropsychological tests for mild cognitive impairment, vascular cognitive impairment and Alzheimer's disease. Psychological Medicine. 2003;**33**(6):1039-1050. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12946088

[35] Petersen RC. Mild cognitive impairment as a clinical entity and treatment target. Archives of Neurology. 2004;**62**(7):1160-1163; discussion 1167. Available from: http://doi.wiley.com/10.1111/j.1365-2796.2004.01388.x

[36] Petersen RC, Doody R, Kurz A, Mohs RC, Morris JC, Rabins PV, et al. Current concepts in mild cognitive impairment. Archives of Neurology. 2001;**58**(12):1985-1992. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11735772

[37] Verdelho A, Madureira S, Moleiro C, Santos CO, Ferro JM, Erkinjuntti T, et al. Self-perceived memory complaints predict progression to Alzheimer disease. The LADIS study. Journal of Alzheimer's Disease. 2011;**27**(3):491-498. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21841255

[38] Hogervorst E, Clifford A, Jennifer Stock XX. Exercise to prevent

cognitive decline and Alzheimer's disease: For whom, when, what, and (most importantly) how much? Journal of Alzheimers Disease & Parkinsonism. 2012;**2**(3):e117. Available from: http://www.omicsonline.org/exercise-to-prevent-cognitive-decline-and-alzheimers-disease-for-whom-when-what-and-most-importantly-how-much-2161-0460.1000e117.php&&aid=7477

[39] Erickson KI, Kramer AF. Aerobic exercise effects on cognitive and neural plasticity in older adults. British Journal of Sports Medicine. 2009;**43**(1):22-24. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2853472&tool=pmcentrez&rendertype=abstract

[40] Hogervorst E. Exercise to prevent cognitive decline and Alzheimer's disease: For whom, when, what, and (most importantly) how much? Journal of Alzheimers Disease & Parkinsonism. 2012;**02**(03):1-3. Available from: https://www.omicsonline.org/exercise-to-prevent-cognitive-decline-and-alzheimers-disease-for-whom-when-what-and-most-importantly-how-much-2161-0460.1000e117.php?aid=7477

[41] Thompson WR. Worldwide survey of fitness trends for 2020. ACSM's Health & Fitness Journal. 2019;**23**:10-18

[42] Murphy MH, McNeilly AM, Murtagh EM. Session 1: Public health nutrition: Physical activity prescription for public health. The Proceedings of the Nutrition Society. 2010;**69**(1):178-184. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19954570

[43] Nelson ME, Rejeski WJ, Blair SN, Duncan PW, Judge JO, King AC, et al. Physical activity and public health in older adults: Recommendation from the American College of Sports Medicine and the American Heart Association. Medicine and Science in Sports and Exercise. 2007;**39**(8):1435-1445. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17762378

[44] Strohacker K, Fazzino D, Breslin WL, Xu X. The use of periodization in exercise prescriptions for inactive adults: A systematic review. Preventive Medicine Reports. 2015;**2**:385-396

[45] Kraemer WJ, Adams K, Cafarelli E, Dudley GA, Dooly C, Feigenbaum MS, et al. Progression models in resistance training for healthy adults. Medicine and Science in Sports and Exercise. 2002;**34**(2):364-380

[46] Furtado GE, Letieri R, Caldo A, Patricio M, Loureiro M, Hogervorst E, et al. The role of physical frailty independent components on increased disabilities in institutionalized older women. Translational Medicine @ UniSa. 2019;**19**:17-26

[47] Morley JE, Vellas B, van Kan GA, Anker SD, Bauer JM, Bernabei R, et al. Frailty consensus: A call to action. Journal of the American Medical Directors Association. 2013;**14**(6):392-397. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4084863&tool=pmcentrez&rendertype=abstract

[48] Robertson DA, Savva GM, Kenny RA. Frailty and cognitive impairment--a review of the evidence and causal mechanisms. Ageing Research Reviews. 2013;**12**(4):840-851. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23831959

[49] Furtado GE, Carvalho HM, Loureiro M, Patrício M, Uba-Chupel M, Colado JC, et al. Chair-based exercise programs in institutionalized older women: Salivary steroid hormones, disabilities and frailty changes. Experimental Gerontology. 2020;**130**:1-11

[50] Varela S, Ayán C, Cancela JM. Batteries assessing health related fitness in the elderly: A brief review. European Review of Aging and Physical Activity. 2008;**5**:97-105

[51] da Câmara SMA, Alvarado BE, Guralnik JM, Guerra RO, ACC M. Using the short physical performance battery to screen for frailty in young-old adults with distinct socioeconomic conditions. Geriatrics & Gerontology International. 2013;**13**(2):421-428. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22882512

[52] Rikli RE, Jones CJ. Development and validation of criterion-referenced clinically relevant fitness standards for maintaining physical independence in later years. The Gerontologist. 2013;**53**(2):255-267

[53] Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee I-M, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. Medicine and Science in Sports and Exercise. 2011;**43**(7):1334-1359. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21694556

[54] Sherrington C, Fairhall N, Kirkham C, Clemson L, Howard K, Vogler C, et al. Exercise and fall prevention self-management to reduce mobility-related disability and falls after fall-related lower limb fracture in older people: Protocol for the RESTORE (recovery exercises and STepping on afteR fracturE) randomised controlled trial. BMC Geriatrics. 2016;**16**(1):34. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4739405&tool=pmcentrez&rendertype=abstract

[55] Mehra S, Dadema T, Kröse BJA, Visser B, Engelbert RHH, Van Den Helder J, et al. Attitudes of older adults in a group-based exercise program toward a blended intervention; a focus-group study. Frontiers in Psychology. 2016;**7**(NOV):1-7

[56] Farhang M, Miranda-Castillo C, Rubio M, Furtado G. Impact of mind-body interventions in older adults with mild cognitive impairment: A systematic review. International Psychogeriatrics. 2019;**31**(5):643-666

[57] Sherrington C, Michaleff ZA, Fairhall N, Paul SS, Tiedemann A, Whitney J, et al. Exercise to prevent falls in older adults: An updated systematic review and meta-analysis. British Journal of Sports Medicine. 2017;**51**:1749-1757

[58] José A, Dal Corso S. Inpatient rehabilitation improves functional capacity, peripheral muscle strength and quality of life in patients with community-acquired pneumonia: A randomised trial. Journal of Physiotherapy. 2016;**62**(2):96-102. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26996093

[59] Colado JC, Triplett NT. Effects of a short-term resistance program using elastic bands versus weight machines for sedentary middle-aged women. Journal of Strength and Conditioning Research. 2008;**22**(5):1441-1448. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00124278-200809000-00009

[60] Webber SC, Porter MM. Effects of ankle power training on movement time in mobility-impaired older women. Medicine and Science in Sports and Exercise. 2010;**42**(7):1233-1240. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20019625

[61] Karvonen J, Vuorimaa T. Heart rate and exercise intensity during

sports activities: Practical application. International Journal of Sport, Exercise and Health Research. 1988;**5**:303-311

[62] Borg GAV. Psychophysical bases of perceived exertion. Medicine and Science in Sports and Exercise. 1982;**14**(5):377-381

[63] Robertson RJ, Goss FL, Rutkowski J, Lenz B, Dixon C, Timmer J, et al. Concurrent validation of the OMNI perceived exertion scale for resistance exercise. Medicine and Science in Sports and Exercise. 2003;**35**(2):333-341. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12569225

[64] Johnson L, Deatrick EJ, Oriel K. The use of music to improve exercise participation in people with dementia: A pilot study. Physical & Occupational Therapy in Geriatrics. 2012;**30**(2):102-108

[65] Trombetti A, Hars M, Herrmann FR, Kressig RW, Ferrari S, Rizzoli R. Effect of music-based multitask training on gait, balance, and fall risk in elderly people: A randomized controlled trial. Archives of Internal Medicine. 2011;**171**(6):525-533

[66] Yamashita S, Iwai K, Akimoto T, Sugawara J, Kono I. Effects of music during exercise on RPE, heart rate and the autonomic nervous system. The Journal of Sports Medicine and Physical Fitness. 2006;**46**(3):425-430

[67] Clark IN, Taylor NF, Baker FA. Music interventions and physical activity in older adults: A systematic literature review and meta-analysis. Journal of Rehabilitation Medicine. 2012;**44**:710-719

[68] Harmon NM, Kravitz L. The beat goes on: The effects of music on exercise. WebEbscohostCom. 2011;**4**(8):1-5. Available from: http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=25&hid=127&sid=36bd8415-6f13-4337-b23d-fce970d39dca%40sessionmgr112%5Cnpapers2://publication/uuid/26A30506-6D1F-4178-9774-F8F109368C7F%5Cnpapers2://publication/uuid/5D1DA2AB-3273-4892-95F8-529F339924F

[69] Skrastins O, Tsotsos S, Aqeel H, Qiang A, Renton J, Howe JA, et al. Fitness coordinators' and fitness instructors' perspectives on implementing a task-oriented community exercise program within a healthcare-recreation partnership for people with balance and mobility limitations: A qualitative study. Disability and Rehabilitation. 2019;**2019**:1-9

[70] Stacey D, Hopkins M, Adamo KB, Shorr R, Prud'homme D. Knowledge translation to fitness trainers: A systematic review. Implementation Science. 2010;**5**:1-9

Chapter 7

The Complexity of Frailty: Psychological Mechanism and Therapeutic Interventions in Old People - A Narrative Review

Francesca Romana Greco and Grazia D'Onofrio

Abstract

Aging is a complex and dynamic process. Senses become less sophisticated and negative life events increase. These factors combined with medical conditions contribute to develop a degenerative functional autonomy of the elderly. This clinical condition is known as frailty. However, there is a difference in the way people live their silver years in terms of happiness and their sense of autonomy. Both being and feeling frail represent two different drives of cognitive representations concerning how the elderly live their lives. In addition, other factors such as cognitive stimulation, assistive technology and physical activity can support frail people to achieve independence. This chapter aims to provide an overview on how the psychological environment may affect frailty, suggesting a possible role of new technology's solutions and physical activity as therapeutic interventions.

Keywords: aging, frailty, emotion, assistive technology, psychology

1. Introduction

Aging is commonly defined as the accumulation of many deleterious changes in cells and tissues with advancing age that are responsible for the increased risk of disease and death (see **Table 1**) [1]*.

As a consequence of the extended life expectancy, older population is rapidly increasing all over the world [2].

Older adults may experience reduced mobility, chronic pain, frailty, major neurocognitive disorder and many other health problems affecting the quality of their life.

Furthermore, all these factors can lead to social isolation, loneliness or physical distress that may require long-term care [3]*.

To date, a great amount of data exists on frailty in older people, but few and conflicting data exist about the psychological mechanism of frailty and its preventability.

This narrative review aimed to analyze to which extent the psychological setting may improve frailty condition in elderly people.

This chapter also aimed to present a brief description of the main psychological models and interventions used in the clinical practice for the elderly.

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Frailty: Frailty can be defined as a 'clinically recognizable state of increased vulnerability resulting from aging associated decline in reserve and function across multiple physiologic systems such that the ability to cope with everyday or acute stressors is compromised
Comprehensive Geriatric Assessment (CGA): It is defined as a multidisciplinary diagnostic and treatment process that identifies medical, psychological and functional limitations of a frail person in order to develop a coordinated plan to maximize overall health with aging.
Cognitive impairment: Cognitive impairment is when a person has trouble remembering, learning new things, concentrating, or making decisions that affect their everyday life. Cognitive impairment ranges from mild to severe. With mild impairment, people may begin to notice changes in cognitive functions, but still be able to do their everyday activities. Severe levels of impairment can lead to losing the ability to understand the meaning or importance of something and the ability to talk or write, resulting in the inability to live independently.
Emotions: biological states associated with the nervous system brought on by neurophysiological changes variously associated with thoughts, feelings, behavioral responses, and a degree of pleasure or displeasure. There is currently no scientific consensus on a definition. Emotion is often intertwined with mood, temperament, personality, disposition, creativity and motivation.
Positive technology approach: is a scientific and applied approach to the use of technology for improving the quality of our personal experience through its structuring, augmentation and replacement

Table 1.
Definitions.

Furthermore, we proposed a positive technology approach in order to assist elderly people using new technology solutions [4].

2. Methodology

We searched for publications dated between January 2015 and January 2020 (see **Table 2**) using keywords and medical subject headings termed as psychology of frailty in the elderly. We searched PubMed, Medline and Google Scholar database.

Figure 1 shows the flow chart selection process. From the 1648 papers initially selected, 20 were found suitable to be included in the present review (**Table 3**).

2.1 Possible limits of the review

Some possible limits of this narrative review can be found in the low prevalence of randomized clinical trial that has investigated classical or innovative psychological intervention for the frailty in elderly people.

3. Discussion

3.1 The complexity of frailty syndrome

Life expectancy has rapidly increased worldwide, from 461 million people older than 65 years in 2004 to an estimated of 2 million people by 2050 [5].

This has a severe impact on social care.

In addition, frailty is the most problematic expression of population aging because it is strictly interrelated to the physical system such as the endocrine, muscle, cognitive and respiratory.

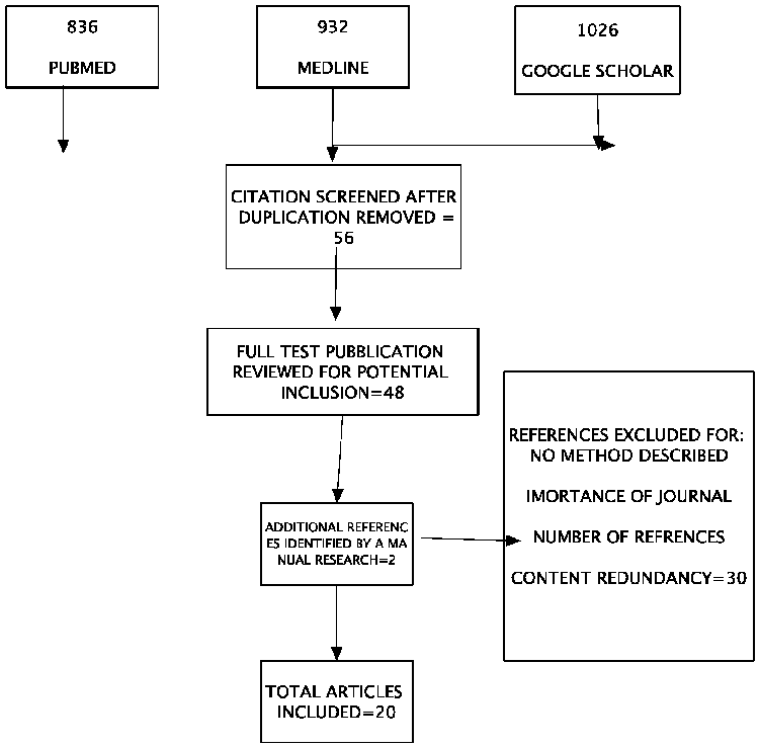

Table 2.
Flow chart of the literature selection.

Figure 1.
Examples of casual and hardcore video games.

*Ref.	Title	Authors	Therapeutic approach	Duration of intervention	Characteristic of the sample	Succes/failure of the intervention
1*	*Frailty measurement in research and clinical practice: A review*	Elsa Dent, Paul Kowal, Emiel O. Hoogendijk, 2016.	Review	January 2009-July 2015	422 studies were identified. From these studies, 29 different frailty measurements were included.	The CHS index is the most robust assessment tools for use by clinicians and researchers today.
3*	*Interventions aimed at loneliness and fall prevention reduce frailty in elderly urban population*	Sanja Ožic et al; 2020	Prospective interventional study	January 2015-September 2017	410 persons aged 75 to 95	Public health interventions to prevent falls and to prevent loneliness have a positive effect on the frailty and independent living of the elderly living in their own homes in an urban community.
37*	*Which one came first: movement behavior or frailty? A cross-lagged panel model in the Toledo Study for Healthy Aging*	Asier Mañas, Borja del Pozo-Cruz, Irene Rodríguez-Gómez,et al; 2020	Longitudinal study	Over 4 years	186 older people aged 67 to 90	MVPA/SB and frailty is unidirectional: individuals who spent less time on moderate to vigorous physical activity are more likely to increase their frailty score, and individuals who are more frail are more likely to spent more time on sedentary behaviour.
23*	*Frailty is associated with early hospital readmission in older medical patients*	Gary R. Stillman, Andrew N. Stillman and Michael S. Boodher. 2019	Retrospective analysis	Between September 2017 and June 2018	435 patients over 65 years	Frailty as measured by the Reported Edmonton Frailty Scale was a significant predictor of hospital readmission and length of stay.
13*	*Incidence and Predictors of Cognitive Frailty Among Older Adults: A Community-based Longitudinal Study*	Nurul Fatin Malek Rivan et al: 2020	Community-based longitudinal study	5 years follow-up	Out of 490 older adults participating in the Malaysian Towards Useful Aging (TUA) study, 282 were successfully followed-up at five-years for an analysis of the CF incidence.	The incidence rate of Cognitive Frailty was 7.1 per 100 person-years. Advancing age, depression, decreased processing speed, assessed by a lower digit symbol score decreased functional mobility measured using Timed-Up-and-Go (TUG) low vitamin D intake and physical frailty were predictors for CF incidence
17*	*Anticipatory care planning intervention for older adults at risk of functional decline: study protocol for a primary care cluster feasibility randomised trial*	Kevin Brazil et al; 2020	Cluster randomised controlled trial	The study started in April 2019.	A total of 64 patients > 70 years	Evaluation of the implementation and outcomes of an ACP intervention to identified the risk of functional decline.
33*	***Functional Ability, Frailty and Risk of Falls in the Elderly: Relations with Autonomy in Daily Living***	Inmaculada Torncro-Quiñones, Jesús Sáez-Padilla, Alejandro Espina Díaz, Manuel Tomás Abad Robles and Ángela Sierra Robles. 2020	Cross-sectional investigation study	Not specified	A total of 139 elderly	Functional capacity is a significant predictive variable of autonomy in instrumental activities of daily living, while fragility and the risk of falls are significant predictors of autonomy in activities of basic daily life.

38*	*Association between frailty and the combination of physical activity level and sedentary behavior in older adults*	Venicius Dantas da Silva et al; 2019	Cross-sectional study	Data collection for the present study occurred from July to October 2015	457 older adults (age range = 60 to 96 years old)	Frailty is more prevalent among older adults who exhibit insufficient levels of physical activity combined with a great amount of time spent in sedentary behavior, even when adjusted for socio demographic factors.
30*	*The relationship between basic, instrumental, and advanced activities of daily living and executive functioning in geriatric patients with neurocognitive disorders*	Elise Cornelis,Ellen Gorus, Nele Van Schelvergem, Patricia De Vriendt. 2018	Correlational study	Not specified	One hundred twenty participants (80 female and 40 male) were included	This study recommends using the TMT-A, CDT, and AFT as screening tools to indicate the need for profound evaluation of ADLs in older persons with neuro cognitive disorders.
43*	*"Homeless in life" loneliness experienced as existential suffering by older adults living at home: a caring science perspective*	Jessica Hemberg, Fredrica Nyqvist, and Marina Nasman. 2018	A qualitative study	Not specified	A total of 17 participants (12 females and five males) aged 72–95 years in different life situations	Enhancing the quality of life for vulnerable individuals by supporting older adults in strengthening their health, communion with others and engaging them in meaningful social activities in daily life. This study also sheds light on the complexity of loneliness; being socially lonely does not automatically mean suffering from loneliness.
11*	*Frailty predicts mortality in all emergency surgical admissions regardless of age. An observational study*	J. Hewitt, B. Carter, K. MC Carthy et al. 2019	multi-centre prospective cohort study	The study was carried out during 2015 and 2016	2,279 patients	Worsening frailty at any age is associated with significantly poorer patient outcomes, including mortality in unselected acute surgical admissions.
24*	*Depression in older adults*	Amy Fiske, Julie Loebach Wetherell, and Margaret Gatz. 2009	Review	Not specify	Older adults	Depression is less prevalent among older adults than younger adults. Older adults are more likely to display cognitive changes, somatic symptoms than younger adults. Support the use of psychological and somatic interventions to prevent the onset of depression in later life.
16*	*Multicomponent Frailty Assessment tools for older people with psychiatric disorder: A systematic review*	Jennifer L. Sutton. Rebecca L. Gould, Mark C. Coulson et al. 2019	A Systematic Review	2017	Adults aged 60 years or older	No frailty assessment tool identified in this review was developed for use with, nor had its reliability or validity been tested in older adult psychiatric populations.
52*	*Virtual enactment effect on memory in young and aged populations: A systematic review*	Cosimo Tuena, Silvia Serino, Léo Dutriaux, Giuseppe Riva and Pascale Piolino. 2019	A Systematic Review	25 January 2019	Majority of the experiments included healthy participants, mainly young adults (YA), but also older adults (OA)	The present review sheds light on the key role of the sensorimotor and cognitive systems for memory rehabilitation by means of a more ecological tool such as virtual reality and stresses the importance of the body for cognition, endorsing the view of an embodied mind.

44*	*A Social Virtual Reality Based Application for the Physical and Cognitive Training of the Elderly at Home.*	Sara Arlati, Vera Colombo, Daniele Spoladore, et al. 2019	A validation study that provides frails elderly with a dual task training program	2019	Frail elderlies	The final aims are reducing the risk of falling, through the improvement of the clinical outcomes of frailty, and promoting their social participation.
9*	*Frailty Clinical Phenotype: A Physical and Cognitive Point of View*	M Aubertin-Leheudre, AJ Woods, S Anton, R Cohen, and M Pahor. 2015	Manuscript based on the definition of frailty	Not specified	Frailty and elderly people	Frailty can present in different stages of severity (from mild to severe), and there appears to be a dynamic relationship between these stages. Despite these challenges, a consensus on an international definition of frailty including physical and cognitive criteria is essential in order to advance research and treatment of this condition.
31*	*Depression, frailty, and all-cause mortality: a cohort study of men older than 75 years.*	Almeida OP, Hankey GJ, Yeap BB, Golledge J, Norman PE, Flicker L. 2015	Prospective longitudinal cohort study	2008	2565 men aged 75 years	Current, but not past, depression is associated with increased mortality, and this excess mortality is strongly associated with frailty. Interventions designed to decrease depression-related mortality in later life may need to focus on ameliorating frailty in addition to treating depression.
21*	*Expert opinion on the management of pain in hospitalised older patients with cognitive impairment: a mixed methods analysis of a national survey.*	Rodger KT, Greasley-Adams C, Hodge Z, Reynish E. 2015	A mixed methods analysis of a national survey	Not specified	consultant Geriatricians/Dementia Leads identified in the National Dementia Audit from the British Geriatrics Society	The need for evaluation of the whole individual (a Comprehensive Geriatric Assessment approach), including their family and care- givers and the environment are promoted rather than an approach that would just simply treat the pain.
32*	*Social vulnerability and survival across levels of frailty in the Honolulu-Asia*	Joshua j. Armstrong, Melissa k. Andrew, Arnold Mitnitski, Lenore j. Launer, Lon R. White, Kenneth Rockwood. 2015	Self report approach	From 1991	Sample of 3,271 older men	- Changes in the health of individuals result from both intrinsic and extrinsic factors, such as social vulnerability. -The impact of social vulnerability on mortality differed across frailty groups. -For frail individuals, intrinsic factors influenced mortality risk more than extrinsic factors.
19*	*Fried phenotype of frailty: cross-sectional comparison of three frailty stages on various health domains.*	Linda P. M. Op het Veld, Erik van Rossum, Gertrudis I. J. M.Kempen et al; 2015	Cross-sectional study	2012	8,684 community-dwelling older people (65−)	This study indicated that the Fried frailty criteria could help healthcare professionals identify and treat frail older people in an efficient way, and provide indications for problems in other domains.

Table 3.
Summary of the included studies.

From this background, two models were proposed in order to identify the concept of frailty in elderly patients.

Rockwood and colleagues have defined frailty as an accumulation of deficits.

One such example is the risk to develop dementia which increases in relation to problems with hypertension or diabetes in older adults [6].

It is becoming clear that a range of subclinical and clinical age-related deficits, which are themselves not recognized as disease-specific risks, are associated with a greater chance of common age-related illness in older adults [7].

On the other hand, the phenotype model suggests that five factors (weight loss, self-reported exhaustion, low-energy expenditure, slow gait speed, and weak grip strength) are associated with frailty [8].

What does it means being frail? And what characteristic defines a frail person?

Aging is arguably the most familiar yet least well-understood aspect of human biology, and it can be present in different stages of severity: From mild to severe [9]*.

It is characterized by a progressive impairment of functions, difficulties in environmental challenges, and a growing risk of death.

Clinicians suggest that frailty is a state of vulnerability in front of a stressful situation, and the consequences are a decline in health status [10].

Therefore, the risk of developing other negative life events including falls, delirium (a temporary condition characterized by the rapid onset of fluctuating confusion and impaired awareness) and disability could increase.

To date, the concept of frailty is well analyzed in the clinical setting, where it is considered as a potential negative factor of the patient's clinical condition.

J. Hewitt and colleagues suggested that frail patients are likely to stay in the hospital longer than those that are not frail.

In fact, there is a linear relationship between the increase of clinical frailty index at admission and increase odds of day 90 mortality [11]*.

Frailty in old people becomes also evident in many complex physiological systems including cognitive functions.

Aging is characterized by structural and physiological changes in the brain.

The loss of individual neurons in most cortical regions is low, but neurons with high metabolic demands, such as the hippocampal pyramidal neurons, could be affected disproportionally by changes in synaptic function.

The hippocampus has been identified as an important mediator in the pathophysiology of cognitive decline and Alzheimer's disease, and it is a key component of the stress response.

The aging brain is also characterized by structural and functional changes to microglial cells, which have an important role in the pathophysiology of delirium [12].

Accumulated evidence supports an association between frailty, cognitive impairment, dementia and Alzheimer's disease [13]* [14].

In a prospective, observational cohort study, Boyle et al. show the hypothesis that physical frailty is associated with an increased risk of mild cognitive decline in aging [15].

In this study, more than 700 older people without mild cognitive impairment were involved.

Physical frailty, based on four components (grip strength, timed walk, body composition and fatigue) was assessed at baseline and cognitive function was assessed annually.

Proportional hazard models were used to examine the association of physical frailty with the risk of incident MCI, and mixed effect models were used to examine the association of frailty with the rate of change in cognition.

During up to 12 years of annual follow-up, 305 of 761 persons developed MCI. Moreover, a higher level of physical frailty was associated with an increased rate of decline in global cognition and five systems (episodic memory, semantic memory, working memory, perceptual speed and visual spatial abilities).

In addition, Jennifer and colleagues have evaluated the use of multicomponent frailty assessment tools in assessing frailty also in elderly patients with psychiatric

disorders, comparing the items of each frailty assessment tool with the *Diagnostic and Statistical Manual of Mental Disorder 5th Edition* (DSM-5) criteria to assess the overlap.

The results suggested that there is a significant overlap between the indicators of frailty as conceptualized in frailty assessment tools and DSM-5 diagnostic criteria for a common psychiatric disorder including major depression episode and generalized anxiety disorder that has the potential to confound frailty assessment results [16]*.

3.1.1 Evaluation tool

In order to establish frailty, reliable models should be assessed for their success in predicting therapeutic interventions [17]*.

As we previously described above, there are two main geriatric models: The phenotype model [8] and the cumulative deficit model, which form the basis of the Canadian study of health and aging (CSHA) frailty index [18].

This chapter aims to go deep under the knowledge of these models and explore how do these models are used in the clinical practice.

A frailty phenotype was established with five variables: Unintentional weight loss, self-reported exhaustion, low-energy expenditure, slow gait speed and weak grip strength.

The Fried frailty criteria could help healthcare professionals to identify and efficiently treat frail older people in an efficient way and also contribute to provide indications for other related problems (social, psychological and physical functioning).

In a study of 5210 men and women aged 65 years and older, Fried and colleagues conducted a famous study that is known as the milestone study of the phenotype model [19]*.

A frailty phenotype was established with the five variables: Unintentional weight loss, self-reported exhaustion, low-energy expenditure, slow gait speed and weak grip strength.

People with Parkinson's disease, previous stroke, cognitive impairment or depression were excluded.

Those with three or more of the five factors were judged to be frail, those with one or two factors as pre-frail and those with no factors as not frail.

This work is important because it suggests that a frailty phenotype can be defined and might be a basis for detection of frailty in routine care.

However, how the variables can be reliably translated into clinical practice is not clear.

Furthermore, other important factors such as cognitive impairment, a prevalent condition associated with functional decline, were not included as part of this model.

Despite the criticism, the general approach of clusters of variables to define frailty phenotype has been independently validated.

The frailty index was developed as part of the CSHA study [18].

10,263 people were involved, and it was designed to investigate the epidemiology and burden of dementia in elderly people in Canada.

92 baseline variables of symptoms (e.g. low mood), signs (e.g. tremor), disabilities and abnormal laboratory values (referred to as deficits) were used to define frailty.

The frailty index was a simple calculation of the presence or absence of each variable.

The frailty condition is defined as the cumulative effect of individual deficits.

Additionally, the cumulative deficit model expresses the theory of a gradation of frailty with progressive accumulation of deficits.

This model is clinically attractive because it presents frailty as gradable, rather than present or absent.

3.2 Comprehensive geriatric assessment

Clinicians and researchers need valid and accurate methods to assess and identify frailty.

Comprehensive geriatric assessment (CGA) [20] (see **Table 1**) has become an internationally established method to assess elderly people in clinical practice.

This method is the goal standard to assess frailty.

It is a process that specializes the elderly care delivered by a multidisciplinary team (psychologists, nurses, occupational therapists, and geriatricians) to establish functional psychological functions and a plan of treatment [21]*.

Besides, as aging is a process that leads to conditions of vulnerability to mortality and severe stress, also for the caregiver's multidisciplinary approach, programs of prevention should be proposed.

How do clinicians identify frailty in the clinical practice?

More specifically, many types of test are used to evaluate the state of frailty in elderly people.

Among them, the timed up and go test (TUG) and the Edmonton Frail Scale are commonly used for screening the evaluation of frailty.

The TUG test is a simple and specific method to test functional mobility.

This test is easily included as part of the routine medical examination.

This test assesses many dimensions of frailty and requires no specific equipment or training.

Each singular patient is observed and timed, while he/she rises from an armchair, walks 3 m, turns, walks back, and sits down again.

The results indicate that the "up and go" test is a valid test to quantify frailty [22].

Moreover, the Edmonton Scale is a multidimensional scale assessment instrument that includes the timed up and go test and many other tests in order to evaluate cognitive impairment (see **Table 1**).

The test lasts less than 5 minutes and is a valid instrument.

To underlie the negative effects of frailty and the use of Edmonton Frail scale as a multidimensional assessment, an original study was conducted.

Beecher MS and colleagues conducted a retrospective analysis based on 435 elderly patients.

This study aimed to evaluate the probability of early readmission and length of hospital stay, using the Edmonton Scale and the age-adjusted Charlson comorbidity index.

The results suggest that the Edmonton Scale was a significant instrument to predict hospital readmission and length of stay [23]*.

4. Emotion and frailty

Social isolation or being socially lonely could have a severe impact on the psychological health of the elderly.

Therefore, it is necessary to support the elderly in order to prevent them from mood disorders.

Importantly, depression merits special attention because it can have negative consequences, including increased burden of physical illness, cognitive impairment and risk of suicide [24]*.

Living alone, not having a friend to confide in and not spending time with others could have a severe impact on psychological well-being.

Being both active and socially involved are very important for frail patients; therefore, emotions (see **Table 1**) and affective recognitions may play a crucial role during aging.

Moreover, neuropsychological functions are strictly connected with perceptions of satisfaction of life and emotion recognition.

To date, existing literature suggests that age affects emotion recognition.

Does aging affect emotion detection during their life span?

Being socially involved in a relationship, cooperating with others, understanding and reacting appropriately to the social signals sent out by other people determine social perception abilities.

Being able to decode emotional expressions is an important and essential skill to navigate through the social world and to guide appropriate behavior.

Meyer and colleagues propose that social perception is a powerful dimension of emotional intelligence as mental ability including personal and social intelligence [25].

Prosocial behavior is involved in being able to establish a social relationship [26].

However, old people respond differently to emotional stimuli in everyday life.

Little is still known about the emotion recognition of the elderly and how these are linked with the changes in social life during the life span of people.

Ruffman and colleagues examined 60 young and 61 older adults' recognition of emotions in facial, vocal, bodily expression and when matching faces and bodies to voices.

Older adults were worse than young adults, reporting difficulties in recognizing both positive and negative vocal and bodily expression.

In addition, they found that older adult's difficulty in matching emotions was explained by an additional problem of integration [27].

Social perception is a key factor to understand and react at the social signal sent out by other people.

Also, as people grow older, they prioritize close social relationships and focus more on achieving emotional well-being; therefore, the elderly became more selective in what and in where they invest their emotional resources.

It should be noted that most emotions that are decoded from people are not static but dynamic.

Dynamic facial cues improved recognition of facial emotions for both younger and older adults.

In addition, these results could also explain why many elderly have difficulties to recognize emotion which appear stable [28].

Neuroscientists suggest that also gender differences could be involved in emotional regulation and recognition of emotions.

More specifically, the amygdala is essential for enhanced long-term memory associated with emotional events.

There is a strong relationship between men and women in the activity of the right hemispheric of the amygdala and memory functions regarding emotional material [29].

4.1 Cognitive compensatory strategies in ageing

During aging, the old people could be affected by cognitive impairment and dementia disease.

This means that many cognitive domains like attention, memory and also mood state could be affected [30]*.

The relationship between depression and frailty remains one of the common problems of the elderly [31]*.

Besides, many changes in the health of elderly result from both intrinsic and extrinsic factors, such as social vulnerability [32]*.

However, cognitive declines take place over a long time, and during this lapse of time, the elderly can adopt to many cognitive strategies to manage stressful

situations (e.g. cooking, providing self-care, etc.), while fragility and risk of fall are two negative predictors of well-being [33]*.

Many researchers from France conducted an innovative study on this topic, comparing the drivers' performances on a driving simulator between 12 elderly (between 65- and 78-year-olds) and 18 younger people (between 21- and 35-year-olds) [34].

They compared their self-assessment of driving as well as their visual and cognitive strategies.

Finally, they assessed their driving competencies and self-regulation practice using a simulator.

This research sheds some additional point on the ability to self-regulate the behaviors of the elderly, which could reduce the risk of being injured and to prevent from social isolation, for example, increasing the safety distance from the vehicle in front when reflexes decrease.

Previous research on this matter found that elderly drivers self-regulate by engaging less frequently in secondary tasks (singing or talking) when the driving task is more difficult.

In this way, they reduce the cognitive cost of sharing attention between two tasks [35].

More specifically, in older people, cognitive strategies are used to solve problems of daily life living.

Being able to self-regulate our mood state and cognitive functions is essential to make sense and meaning of life.

Furthermore, the ability to reflect on how important it is to live these silver years in terms of happiness and quality of life could have a great impact on the subject of well-being.

Therefore, understanding and enhancing these cognitive strategies could be crucial to support people in developing many coping methods.

In addition, a positive technology approach could be useful to identify and solicit cognitive competencies.

5. Positive technology for healthy living and active ageing

"Positive technology" (see **Table 1**) approach is a scientific and applied approach to the use of technology for improving the quality of our personal experience through its structuring, augmentation and replacement [36].

Aging is associated with a decline in mental, physical, functional activity and well-being; therefore, it is necessary to promote active behavior in contrast to sedentary behaviors [37]*, [38]*.

However, promoting well-being in old people lifestyle interventions is commonly used to improve their quality of life.

Furthermore, technology could have an important role in supporting elderly living and healthy and active aging.

Developing technological systems and applications to promote personal growth, creativity and social support should be done by psychology.

Specifically, positive psychology is a psychological approach, which focuses on the biopsychological aspects of cognitions, emotions and positive experiences [39].

Martin Seligman is considered as the pioneer of positive psychology.

He identified "three pillars" of the good life in his book titled *Authentic Happiness* [40]*:

- The pleasant life: Achieved through the presence of positive emotions.

- The engaged life: Achieved through pleasant activity.
- The meaningful life: Achieved through the ability to discover meaning and a purpose in life.

According to positive psychology, positive technologies are classified in three dimensions [41]:

- Hedonic dimension: Technologies are used to induce positive experiences.
- Eudaimonic dimension: Technologies are used to support people in reaching engaging and personal experiences.
- Social/interpersonal dimension: These types of technologies are used to improve social integration and be part of a social group providing relational well-being.

The use of positive technology brings an advantage in cognitive stimulation technologies beyond traditional healthcare.

In virtual reality, the serious game could engage the attention of the elderly.

In addition, thanks to a positive technology approach, it is possible to change from a "disease-centered" to a "citizen-client" model, based on the engagement of the elderly [42].

5.1 The effect of technology interventions on reducing social isolations

Social isolation is one of the major risk factors of mental and physical health for the elderly [43]*.

However, many authors have investigated the role of technology as a new potential intervention to prevent social isolation.

Assistive technology could contribute to improving their quality of life, living independently at home.

Assistive technology includes many devices, which support people in their independent living [44]*.

To date, smartphone and smart applications are the most common device involved in assistive technology [45].

Using smartphone includes many advantages: Flexibility, user friendly, various built-in sensors and connectivity options.

These technological devices make possible the development of new solutions for the elderly.

Going deep under the use of technology, several studies proposed the role of video games as powerful tools for cognitive training and well-being of the old people.

In fact, during the past years, video games were not designed to support people or for specific improvements on cognitive domains, but recent research finds out that they could be a valid instrument to help people with specific cognitive training and brain exercise.

Generally, there are two types of video games: Hardcore and casual video games (CVGs).

Hardcore video games are harder to play; they are usually played for a long time period.

However, hardcore action video games were mostly used in most research during the past years to study the improvement of perceptual and cognitive abilities in the younger audience.

Furthermore, the interaction between old people and this type of video games could be very difficult.

First, learning how to play an action video game could be very difficult and challenging for the elderly, and secondly, as many authors suggested, the elderly usually dislike action video games, especially when they have violent content [46].

To sum up, all these results suggest that the elderly could be less motivated to be involved trough action video game interventions which are less attractive.

On the other side, casual video games (CVGs) have short play session and are an easy task to be played, and this is the reason why they are mainly a target for old people improving cognitive functions and emotional well-being [47].

Different CVG genres engage different perpetual and cognitive functions, and it is important to understand the logical process under these video games to improve specific cognitive abilities [48].

In order to understand better which CVGs are more suitable and enjoyed by the elderly, many authors from Switzerland have studied what older people like to play [49].

In this study, Chesham and coworkers [48] have evaluated 16 healthy older adults (5 females and 11 males) aged between 65- and 84-year olds coping with games.

All the participants have no deficit vision, and exclusion criteria were a diagnosis of dementia, mild cognitive impairment, and motor impairments leading to inability to manage a tablet computer.

Finally, all participants were informed about the procedure of the study and signed for the informed consent.

We examined casual game enjoyment and game characteristics across a range of four genres (casual action, casual puzzle, casual simulation and casual strategy games) based on different cognitive functions in healthy older adults.

The results of this study suggest that tablet-based casual games have been enjoyed by the elderly.

A possible limitation of the study was that all the subjects were healthy and well-motivated to participate in the research.

No prior game experience was considered as possible bias in the obtained results.

5.2 A social virtual reality-based applications: The physical and cognitive training of the elderly

Virtual reality is an interactive and immersive experience that can be used to transport patients to a place beyond the clinical setting.

Patients can experience realistic, three-dimensional worlds that aim to not just reduce the stress and anxiety of a clinic visit but also teach patients' and the clinicians' new skills [50].

Generally, virtual reality is usually used to enhance many cognitive abilities (attention) in clinical disease.

Because virtual reality is an interactive method, it is mostly involved in rehabilitation and education in children [51].

It leads the opportunity to work on creating a new virtual world.

There have been several numbers of software created to deflect the minds of patients and focus more on virtual reality worlds that can help them to relieve stress and to stimulate cognitive functions.

Virtual reality-based cognitive stimulation can also be used to improve cognitive functions in critically ill patients, and most research involved the elderly population [52]*.

This tool could be a valid instrument to prevent the patients from the overload of disturbing extra-stimuli, especially during the hospitalization period.

Furthermore, thanks to virtual reality, it is possible to select natural restorative environments with neutral content.

Generally, there is a distinction between virtual environments (VE) and virtual world (VW).

In virtual environments, people could see characters and objects interacting with them in a realist way in real time.

On the other hand, virtual worlds consist of a social world that is more stable, where people could interact with other users using an artificial avatar [53].

One challenge in using VR stimulation in old people especially in a critical situation is to engage their attention in a suitable and relaxing scenario [54].

Many authors suggested that visual exposure to the natural environment (e.g. landscapes, vegetation and water) has a protective role against stress, restoring physiological, emotional and attention functions [55].

The attention restoration theory suggests that exposure to natural environments combined with sounds has a relaxing effect.

The attention request from the clinical setting is lower, and this promotes a sense of being away, stimulating less cognitive domains.

This has a crucial role in cognitive abilities because it allows the attention capacity to be restored [56].

Chirico et al. focused on the level of immersion given by this experience.

They found out that exposure of VR nature environment stimuli can trigger a parasympathetic activation, inducing strong emotion and a vivid sense of scene [57].

Gerber and colleagues [58] conducted an interesting study in order to investigate how virtual reality could help to relax in the intensive care unit.

In this study, three different nature VR videos (landscape, water worlds and animals) were presented.

To measure the visual exploration behavior (e.g. where the patient "looks at" and whether the eyes are open), the video-oculography was used.

Furthermore, to measure participant's reactions to the virtual reality stimuli, many vital parameters (heart rate, blood pressure, etc.) were recorded while the videos were presented to the patients.

The results suggest that in line with previous studies, the exposure to virtual nature environments produced a relaxing effect.

In fact, all vital sign measurements (heart frequency, respiratory frequency) significantly decreased during the session of virtual reality.

This could show a positive link between VR and the reduction of psychological stress.

In addition, no fatigue in visual exploration task and target stimulus has affected the visual exploration behavior.

Finally, the VR scenario was accepted by all the participants of the study and the possibility to be adapted for use in frailty patients.

6. Future perspective of research and the potential benefit of the use of the proposed model in the clinical setting

The aging population is increasing, making a critical impact on social care.

Therefore, from our point of view, it is necessary to consider new potential solutions as a therapeutic instrument to help frailty people.

A potential benefit solution comes from positive technology.

The aim of this approach is contributing to the development of well-being for the elderly and allows them to maintain their autonomy in their activities of daily living.

It is necessary to consider that positive technology could have a positive effect on the psychological well-being of the elderly in an alternative way from the classical therapeutic intervention which has already been used.

Also, taking together the main geriatrics models and deep comprehension of the cognitive and emotional functions of the older gives the clinicians an opportunity to embrace multiple disciplines.

It is crucial to consider many different aspects of the aging process from a different point of view (medical, psychological and engineering).

This multidisciplinary approach gives the clinicians the opportunity to develop and implement an innovative cognitive rehabilitation program providing to the elderly strategies to increase motivation and social relationship in every clinical setting.

In conclusion, future research should be focused on the importance of technology as an instrument that could be used by the clinicians, the elderly patients and especially their family to reduce the distance between them.

It has to be considered that most of the frailty elderly are in critical conditions and live in nursing homes away from their family.

Positive technology could represent a bridge of hope between them and their families, contributing to keeping alive a sense of community and the joy of sharing their emotions.

7. Conclusion

The basic objective of this book chapter is to briefly describe the complexity of aging, the impact of cognitive representation on emotions and life events, and the role of new technology's solution and physical activity as therapeutic interventions.

These results confirm the importance of considering multidimensional aspects of the aging process (psychological mechanism and physical structures).

Taking together there are really good changes that in the near future will be possible to help many humans to live healthy aging.

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References

[1] Dent E, Kowal P, Hoogendijk EO. Frailty measurement in research and clinical practice: A review. European Journal of Internal Medicine. 2016;**31**: 3-10

[2] Bennett JE et al. The future of life expectancy and life expectancy inequalities in England and Wales: Bayesian spatiotemporal forecasting. Lancet. 2015;**386**:163-170

[3] Ožić S et al. Interventions aimed at loneliness and fall prevention reduce frailty in elderly urban population. Medicine (United States). 2020;**99**

[4] Ge S, Zhu Z, Wu B, McConnell ES. Technology-based cognitive training and rehabilitation interventions for individuals with mild cognitive impairment: A systematic review. BMC Geriatrics. 2018;**18**

[5] Kinsella K, Phillips DR, Butz WP, Bentzen MP, Hokenson RF. Global aging: The challenge of success Population Reference Bureau (PRB). Population Reference Bureau. 2005;**60**:1-44

[6] Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;**381**:752-762

[7] Rockwood K et al. A frailty index based on deficit accumulation quantifies mortality risk in humans and in mice. Scientific Reports. 2017;**7**:1-10

[8] Fried LP et al. Frailty in older adults: Evidence for a phenotype. The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences. 2001;**56**: M146-M157

[9] Aubertin-Leheudre M, Woods AJ, Anton S, Cohen R, Pahor M. Frailty clinical phenotype: A physical and cognitive point of view. Nestle Nutrition Institute Workshop Series. 2015;**83**:55-63. DOI: 10.1159/000382061.FRAILTY

[10] Kirkwood TBL. Understanding the odd science of aging. Cell. 2005;**120**: 437-447

[11] Hewitt J et al. Frailty predicts mortality in all emergency surgical admissions regardless of age. An observational study. Age and Ageing. 2019;**48**:388-394

[12] Eeles EMP, White SV, O'mahony SM, Bayer AJ, Hubbard RE. The impact of frailty and delirium on mortality in older inpatients. Age and Ageing. 2012;**41**:412-416

[13] Rivan NFM et al. Incidence and predictors of cognitive frailty among older adults: A community-based longitudinal study. International Journal of Environmental Research and Public Health. 2020;**17**:1-17

[14] Buchman AS, Boyle PA, Wilson RS, Tang Y, Bennett DA. Frailty is associated with incident Alzheimer's disease and cognitive decline in the elderly. Psychosomatic Medicine. 2007; **69**:483-489

[15] Boyle PA, Buchman AS, Wilson RS, Leurgans SE, Bennett DA. Physical frailty is associated with incident mild cognitive impairment in community-based older persons. Journal of the American Geriatrics Society. 2010;**58**:248-255

[16] Sutton JL, Gouldon RL, Coulson MC, Ward EV, Butler AM, Smith M, et al. Multicomponent frailty assessment tools for older people with psychiatric disorder: A systematic review. Journal of the American Geriatrics Society. 2018;**67**:1085-1095

[17] Brazil K et al. Anticipatory care planning intervention for older adults at risk of functional decline: Study protocol for a primary care cluster feasibility randomised trial. Trials. 2020; **21**:1-10

[18] Rockwoo K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, et al. A global clinical measure of fitness and frailty in elderly people. Canadian Medical Association Journal. 2005;**173**: 489-495

[19] Op Het Veld LPM et al. Fried phenotype of frailty: Cross-sectional comparison of three frailty stages on various health domains. BMC Geriatrics. 2015;**15**:1-11

[20] Ellis G, Gardner M, Tsiachristas A, Langhorne P, Burke O, Harwood RH, et al. Comprehensive geriatric assessment for older adults admitted to hospital (review). Cochrane Library Database of Systematic Reviews. 12 September 2017;**9**(9). DOI: 10.1002/14651858.CD006211.pub3

[21] Rodger KTM, Greasley-Adams C, Hodge Z, Reynish E. Expert opinion on the management of pain in hospitalised older patients with cognitive impairment: A mixed methods analysis of a national survey. BMC Geriatrics. 2015;**15**:1-5

[22] Mathias S, Nayak US, Isaacs B. Balance in elderly patients: The 'get-up and go' test. Archives of Physical Medicine and Rehabilitation. 1986;**67**: 387-389

[23] Stillman GR, Stillman AN, Beecher MS. Frailty is associated with early hospital readmission in older medical patients. Journal of Applied Gerontology. 2019;**6**:1-9. DOI: 10.1177/0733464819894926

[24] Wilkinson P, Ruane C, Tempest K. Depression in older adults. BMJ. 2018; **363**:363-389

[25] Mayer JD, Caruso DR, Salovey P. The ability model of emotional intelligence: Principles and updates. Emotion Review. 2016;**8**:290-300

[26] Beadle JN, Sheehan AH, Dahlben B, Gutchess AH. Aging, empathy, and prosociality. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences. 2015;**70**:213-222

[27] Ruffman T, Halberstadt J, Murray J. Recognition of facial, auditory, and bodily emotions in older adults. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences. 2009;**64**:696-703

[28] Grainger SA, Henry JD, Phillips LH, Vanman EJ, Allen R. Age deficits in facial affect recognition: The influence of dynamic cues. The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences. 2017;**72**: 622-632

[29] Cahill L, Uncapher M, Kilpatrick L, Alkire MT, Turner J. Sex-related hemispheric lateralization of amygdala function in emotionally influenced memory: An fMRI investigation. Learning & Memory. 2004;**11**:261-266

[30] Cornelis E, Gorus E, Van Schelvergem N, De Vriendt P. The relationship between basic, instrumentals, and advanced activities of daily living and executive functioning in geriatric patients with neurocognitive disorders. International Journal of Geriatric Psychiatry. 2019;**34**:889-899

[31] Almeida OP et al. Depression, frailty, and all-cause mortality: A cohort study of men older than 75 years. Journal of the American Medical Directors Association. 2015;**16**:296-300

[32] Armstrong JJ et al. Social vulnerability and survival across levels of frailty in the Honolulu-Asia aging study. Age and Ageing. 2015;**44**:709-712

[33] Tornero-Quiñones I, Sáez-Padilla J, Díaz AE, Robles MTA, Robles ÁS. Functional ability, frailty and risk of falls in the elderly: Relations with autonomy in daily living. International Journal of Environmental Research and Public Health. 2020;**17**:1-12

[34] Isabelle MP, Simon M. Comparison between elderly and young drivers' performances on a driving simulator and self-assessment of their driving attitudes and mastery. Accident; Analysis and Prevention. 2020;**135**: 105317

[35] Baldock MRJ, Mathias JL, McLean AJ, Berndt A. Self-regulation of driving and its relationship to driving ability among older adults. Accident; Analysis and Prevention. 2006;**38**: 1038-1045

[36] Riva G. What is positive technology and it's impact on cyber psychology. Studies in Health Technology and Informatics. 2012;**181**:37-41

[37] Mañas A et al. Which one came first: Movement behavior or frailty? A cross-lagged panel model in the Toledo Study for Healthy Aging. Journal of Cachexia, Sarcopenia and Muscle. April 2020;**11** (2):415-423. DOI: 10.1002/jcsm.12511

[38] Da Silva VD et al. Association between frailty and the combination of physical activity level and sedentary behavior in older adults. BMC Public Health. 2019;**19**:1-6

[39] Riva G et al. Positive technology for healthy living and active ageing. Studies in Health Technology and Informatics. 2014;**203**:44-56

[40] Seligman MEP. Authentic Happiness: Using New Positive Psychology to Realize Your Potential for Lasting Fulfillment. New York: Atria Books; 5 January 2004. pp. 150-336

[41] Graffigna G, Barello S, Wiederhold BK, Bosio AC, Riva G. Positive technology as a driver for health engagement. Annual Review of CyberTherapy and Telemedicine. 2013; **191**:9-17

[42] Keyes CLM, Lopez SJ. Toward a science of mental health: Positive directions in diagnosis and interventions. Handbook of Positive Psychology. Chapter 4. Oxford University Press; 2002. p. 45

[43] Hemberg J, Nyqvist F, Näsman M. 'Homeless in life'—Loneliness experienced as existential suffering by older adults living at home: A caring science perspective. Scandinavian Journal of Caring Sciences. 2018;**33**: 446-456

[44] Arlati S et al. A social virtual reality-based application for the physical and cognitive training of the elderly at home. Sensors (Switzerland). 2019;**19**: 1-17

[45] Doughty K. SPAs (smart phone applications)—A new form of assistive technology. Journal of Assistive Technologies. 2011;**5**:88-94

[46] De Schutter B, Malliet S. The older player of digital games: A classification based on perceived need satisfaction. Communications. 2014;**39**:67-88

[47] Blocker KA, Wright TJ, Boot WR. Gaming preferences of aging generations. Geron. 2014;**12**:174-184

[48] Zelinski EM, Reyes R. Cognitive benefits of computer games for older adults. Geron. 2009;**8**:220-235

[49] Chesham A, Wyss P, Müri RM, Mosimann UP, Nef T. What older people like to play: Genre preferences and acceptance of casual games. JMIR Serious Games. 2017;**5**:e8

[50] Szekley G, Satava RM. Virtual reality in medicine. The BMJ (British Medical Journal). 1999:1-4

[51] Nijhof SL et al. Healthy play, better coping: The importance of play for the development of children in health and disease. Neuroscience and Biobehavioral Reviews. 2018;**95**:421-429

[52] Tuena C, Serino S, Dutriaux L, Riva G, Piolino P. Virtual enactment

effect on memory in young and aged populations: A systematic review. Journal of Clinical Medicine. 2019;**8**:620

[53] Triberti S, Chirico A. Healthy avatars, healthy people: Care engagement through the shared experience of virtual worlds. Transforming Healthcare through Patient Engagement. 2016:247-275. DOI: 10.4018/978-1-5225-0663-8.ch010

[54] Chirico A et al. Effectiveness of immersive videos in inducing awe: An experimental study. Scientific Reports. 2017;7:1-11

[55] Valtchanov D, Barton KR, Ellard C. Restorative effects of virtual nature settings. Cyberpsychology, Behavior and Social Networking. 2010;**13**:503-512

[56] Gamble KR, Howard DV. Attention in older adults. Experimental Aging Research. 2016;**40**:1-16

[57] Ulrich RS et al. Stress recovery during exposure to natural and urban environments. Journal of Environmental Psychology. 1991;**11**:201-230

[58] Gerber SM et al. Visuo-acoustic stimulation that helps you to relax: A virtual reality setup for patients in the intensive care unit. Scientific Reports. 2017;7

Chapter 8

Crime against Elderly Women in India

Avanish Bhai Patel

Abstract

The cases of crime against the elderly women are rising fast in India. Today, elderly women are facing many problems such as murder, theft, hurt, cheating and bag snatching by the both known and unknown persons. These problems have certainly affected the way of life and sense of well-being of the elderly women. They are also deprived to live a dignified life due to these problems. The study has two objectives; first objective understands the nature of crime against the elderly women and second objective examines relationship between elderly women victims and their offenders and also examines the impact of crime on physical and emotional well-being of elderly women. This study is based on content analysis. The data have been collected through two national newspapers, namely, Amar Ujala and Dainik Jagran from March 2012 to March 2013. Findings indicate that the elderly women have been victimised due to property and lack of proper adjustment. The study has also found in many cases that elderly women have been targeted by known persons.

Keywords: content analysis, crime, elderly women, socio-ecological paradigm, India

1. Introduction

There is a sad reality for the elderly women in contemporary time because they are facing the problem of victimisation in this phase of life. The victimisation of the elderly women is the most concerning and emerging social issue in later life. Today, they are being targeted for murder, attempt to murder, hurt, abuse, chain snatching, cheating. It is difficult to find any specific cause behind victimisation. But it can be supposed that the changing social and family structure is responsible for victimisation of elderly women in current times because it has given rise to many problems such as abusive behaviour, neglect and exploitation against the elderly women in Indian society. The changing social and family structures also breach the social order. The way of life and sense of wellbeing of the elderly women has been affected the most due to changing social and family structure [1–3]. Increased longevity of the elderly population has raised a number of problems on households with limited resources, particularly in the absence of formal social support systems [4]. Consequently, it may increase social rejection, broken family ties and embarrassment. The crime does not only make worse and disabling conditions of the elderly women, but it also makes the elderly women more dependent, vulnerable and marginalised.

With the steady rise in elderly population, the rate of their problems is also increasing. The problem of crime against the elderly and elder abuse is one of them. Crime against the elderly and elder abuse has never been considered as a problem

in India. It has been found in many studies [1, 2, 5] that the roots of the traditional social structure are being undermined ushered in by the processes of change such as industrialisation, urbanisation and modernisation. In such changing situations, the majority of the elderly, who have spent most part of their lives with their joint families, are on the verge of isolation in old age. When they need family and social support the most they are living alone and are feeling neglected. These changes have certainly affected the way of life and sense of well-being of the elderly to a large extent causing fracture in their social bonds. As a result of which problems like criminal activities and abusive behaviour faced by the elderly are on the rise.

According to, National Crime Record Bureau Report [6] has found its nation-wide survey that 41,942 elderly have been murdered, hurt and robbed in India from 2015 to 2016. This survey has also explored that the family members, neighbours and strangers are involved in committing murder against the elderly. HelpAge India [5, 7] conducted a study on elder abuse in 20 major cities of India. This study reported that the daughter-in-law (61%) and son (59%) emerged as the topmost perpetrators. The most common form of abuse experienced by the elderly is disrespect followed by verbal abuse and neglect and elderly are beaten in the family as well as in neighbourhood. This study has also identified the major reasons behind the elder abuse such as lack of adjustment, economic dependence of the abused, increasing longevity and economic dependence of abuser. Similarly, Group for Economic and Social Studies [8] studied nature of crime against elderly in four metro cities such as Chennai, Kolkata, Mumbai and New Delhi. This study pointed out various types of crime such as crime against the body, which are committed against the elderly. These crimes are recognised as crime against the body, crime against the property and economic crime. This study found that those who are rich elderly, they are more vulnerable to exploitation and physical threats for property and financial gain from their family members, relatives and antisocial elements. The survey shows that overall 48.6% elderly in our country are not being respected by their family members, relatives and society [9].

Mallick [10] has pointed out in a study that the elderly women are discriminated in the society on the basis of gender and age. He has mentioned that "the negative connotations of ageism and ideas of dependency and impairment aggregate in the negotiations of power within the society. Ageism and structural divisions combines to create power imbalances that are predicated on the notion of women as being of inferior status". The gender dimension of ageing reflects that both elderly men and women face discrimination, violence and abuse due to age but elderly females have more experience differently due to the subordinate status and stereotyped attitude towards elderly females. The gender relations structure the entire life cycle from birth to old age, influence access to resources and opportunities and shape life choices at every stage. Often elderly women suffer more from elder abuse and they are treated as a burden on the family because it is considered that they are not reproductive and income generating person in the family they [11]. Therefore, elderly women are subject to harmful practices in the society which can involve in both family and society. The position of elderly women has affected due to socio-technological changes, loss of joint families, changing norms and values and dual career families [12].

2. Socio-ecological paradigm of crime against elderly women

Socio-ecological paradigm shapes perception and practices within the disciplines according its subject matter. It shapes what we look at, how we look things, what we label as a problem, and what problem we consider for worth investigation and what methods are preferred for the investigation. Basically, socio-ecological paradigm

states the level of interaction and relationship between individual, family members and neighbourhood members in a particular social setting and how these interactions and relationships influence the way of life and well-being of the individuals [13, 14]. Bronfenbrenner [13] has discussed the system of interactions and relationships under socio-ecological paradigm. The relationship and interaction between the elderly and individuals within their immediate settings such as their family and social networks. It also talks about the social structures and social systems that do not directly contain the elderly but which impact upon the immediate micro system in which the elderly are situated and can include health policy, social welfare system and adult protection services. It also centralises on the overarching beliefs and dominant social values around ageing, such as ageist attitudes towards elderly.

The nature and problem of crime against elderly women can be understood and analysed with reference to Indian society by using above discussed socio-ecological paradigm. The respect and honour for the elderly (women) is deeply rooted into Indian value system and way of life since the ages. The elderly women have always enjoyed a respectable place in family matters and decision making of Indian society. They have provided the entire fabric of the social reality with proper care and concern which have played a nurturing role in the family and society. But the advent of changing socio-economic scenario has weakened the fabrics of social bonding between elderly and their family members. Hence, these have not only affected the respect for and decision making power of elders and elderly women but they have contributed its role in bringing a number of problems before elderly parents and elderly women in India. Today, the elderly (women) are being abused physically, emotionally, verbally by known and unknown persons and sometimes crimes are committed against them in family and society. Aforementioned problems of abuse and crime in various forms have brought social, physical and cognitive frailty among the elderly women in the society as well as family.

2.1 Objective of the study

The study has two objectives; first objective understands the nature of crime against the elderly women and second objective examines relationship between elderly women victims and their offenders and also examines the impact of crime on physical and emotional well-being of elderly women.

3. Sources of data

3.1 Content analysis

The present study is based on content analysis. Content analysis is a method of qualitative and quantitative data analyses which aim is to analyses the content of documents, books, newspapers, magazines and other forms of written material. Berelson [15] has defined that "content analysis is a research technique for the objective and systematic description of the manifest content of communication (verbal and non-verbal materials)". The researcher applied this method for the study due to unavailability of specific data on crime against elderly women. The research found newspaper as a best source for data collection related to crime against elderly women. The researcher saw the patterns and nature of crime against elderly with the help of every day news papers' analysis and observation and based on this he made contents for his study such as age group of elderly women, crime rate in rural–urban areas, nature of crime and victim-offender relationship. For this task, researcher went through two national newspapers like *Amar Ujala* and *Dainik Jagran* from

March 2012 to March 2013. The data have been collected both urban and rural areas. The researcher collected 103 cases of crime against the elderly women from five places, namely, Delhi, Kanpur, Lucknow, Roorkee and Unnao through newspapers.

3.2 Result and discussion

Newspapers have shown that crime against the elderly women is an emerging social problem in Indian society. A total of 103 cases have been collected from March 2012 to March 2013.

3.3 Age group

Looking at the age group of the victims, we find that the elderly in the 60–65 year age category have been victimised the most. There are 38 (36.8%) such cases in that age group. The study reveals that 33 (32.0%) case of crime against elderly women belong to 66–70 year age group and 18 (17.4%) case of crime against elderly women belong to 71 and above age group. Moreover, the study indicates that the age of victims has not been found in 14 (13.8%) cases of crimes (**Figure 1**).

3.4 Rural–urban ratio of crime rate

A total of 39 (37.1%) cases of crimes against the elderly women have been reported in rural area as compared to 64 (62.9%) cases of crimes reported in urban area. The crime rate of an area decides level of fear of crime. The crime rate of an area reveals anxiety about crime and it is also found that crime rate is higher in urban areas and urban people are more fearful than rural areas [16] (**Figure 2**).

3.5 Nature of crime

The break-up of 103 cases of crime shows that there are 23 (22.4%) cases of murder, 12 cases of attempt to murder, eight (7.7%) cases of cheating, six (5.8%) cases of robbery and 10 cases of theft, 13 (12.6%) cases of hurt, 10 cases of mis-treatment and 14 (13.6%) cases of chain snatching. The remaining seven (6.7%) cases pertain to accidents and suicides (**Figure 3**).

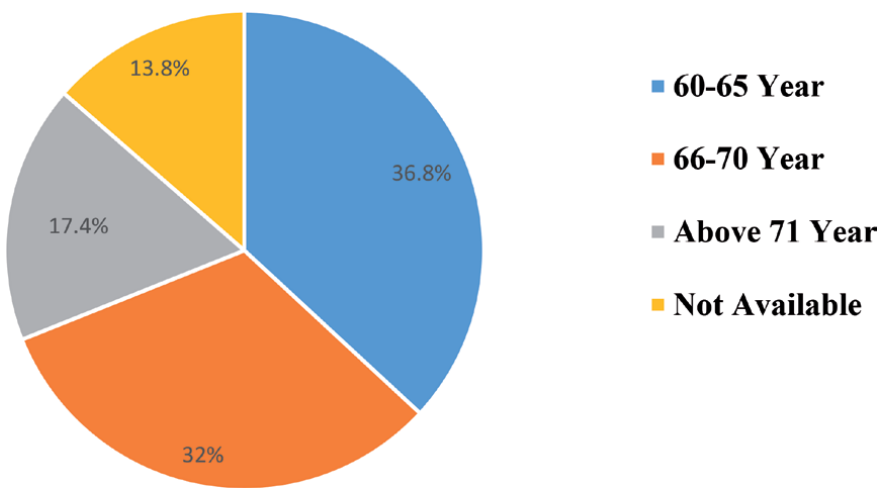

Figure 1.
Age group number of cases.

Figure 2.
Rural–urban ratio of crime rate.

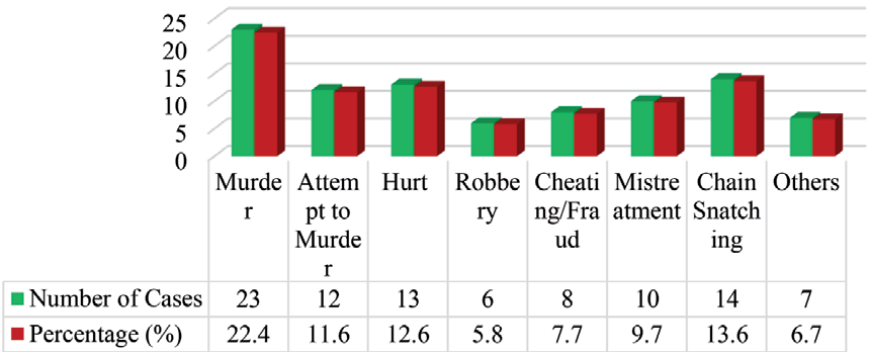

Figure 3.
Nature of crime against elderly women.

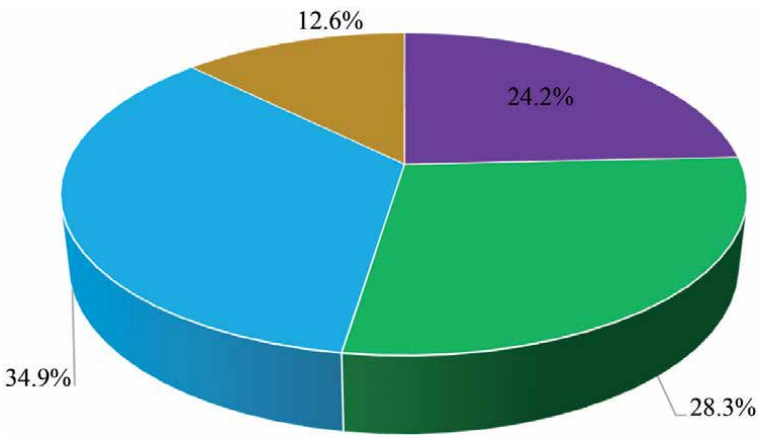

Figure 4.
Victim-offender relationship.

3.6 Victim-offender relationship

Figure 4 reveals that 25 (24.2%) cases of crime against elderly women have been committed by known persons such as family members and relatives. The study has also found that 29 (28.3%) incidents of victimisation have been committed by the neighbours of the elderly. Thus, it can be said that elderly women are insecure in their families and neighbourhood. Similarly, some researchers have pointed out this trend in their studies that the family members, relatives and neighbours abuse and victimised the elderly which brings many frailty such as physical, emotional

and social frailty among them [17, 18]. The study has found that found that 36 (34.9%) cases of crime have been committed by strangers. Furthermore, 13 (12.6%) incidents of crime have occurred as accidents. In these incidents, criminals are not involved but these incidents points to the negligence of village as well as town municipal administrators [19].

The nature of crime which is directed specifically against the elderly women and in which only elderly women are victims are considered as crime against the elderly women [20, 21]. The crime against the elderly women is known as abuse and includes any sort of physical aggression or misbehaves. The crimes against the elderly women may involve different means such as hitting, kicking, biting, shoving, and restraining, throwing objects. In broad terms, it includes threats, sexual abuse, and emotional abuse, controlling or domineering intimidation, stalking, passive/covert abuse and economic deprivation, rape, abduction, kidnapping, murder against the elderly women [20, 21]. Similarly, present study has found some specific crimes which have been committed against the elderly women. These crimes are murder (22.4%), attempt to murder (11.6%), hurt (12.6%), robbery (5.6%), cheating (7.7%), mistreatment (9.7%) chain snatching (13.6) and other crimes (6.7%).

Victim-offender relationship is the most important finding in the study of crime against the elderly because victim-offender relationship plays an important role in effecting of wellbeing of the elderly women. The study has found that in many cases elderly women have been victimised due property. These elderly women were staying with their family members because their husbands were no more and they had property and bank account. Known persons victimised the elderly women for occupying their property and bank account. The study has pointed out that elderly women are not victimised only for property reasons but also economic dependency on the family members. Similarly, a study has quoted that familial relationship is no more based on love, affection and care. Instead there is an emergence of contractual and utilitarian relationship. Sons look after their aged mothers not out of sense of respect but out of selfish motives to get hold of their property and money [22].

A glimpse of crime against the elderly women can be had from the newspapers. These cases of crime are such: "*A son murdered his mother because she was not giving money him for drinking. Being aggressive he murdered his mother and immediately ran away outside the home* (Dainik Jagran: New Delhi, March 18, 2013)." Similarly, "*a drunkard killed his blind grandmother because she got pension and forbade giving him* (Dainik Jagran: Lucknow, February 19, 2013)." Further, "*in other case an elderly woman was victimised by her drunkard son. In this case son knifed her eye at night. When police reached for enquiry, she was so fearful and not able speak something* (Amar Ujala: Kanpur, April 11, 2013)." "*A son shot his old mother and threw her on the road because he wanted to occupy her property* (Amar Ujala: Kanpur, July 10, 2012)." In another case, "*an elderly woman told the police that her son bothers her son and discards her from house* (Amar Ujala: Kanpur, April 25, 2013)." Moreover, "*an elderly woman was killed by her neighbour. This elderly woman forbade her neighbour to throw the filthy water* (Amar Ujala: Dehradun, April 18, 2013)." In another case it was found that "*an advocate cheated an elderly woman. She told police that advocate borrowed money sometime ago. Now when I asked for money, he abused me and threatens to kill me* (Dainik Jagran: Kanpur, July 24, 2012)." This is a significant finding as the elderly women have, in general, relied upon the family members and relatives for physical and mental support. The dependence of elderly women on family members is based on trust and attachment. But these cases of crime against elderly women indicate that in many cases elderly have been victimised in the families. The different forms of crime have been pointed out in present study such as mistreatment, cheating, hurt, theft, murder, attempt to murder which highlight the social, physical and cognitive frailty experienced by the elderly women [19]. Similarly, Madhurima [22]

has examined in her study that family members especially sons beat their elderly mothers they do not show any kindness to their elderly parents. She has reported in her study that often elderly parents' physical victimisation is not reported and in many cases they are isolated from the mainstream of the society [22].

Moreover, the study has pointed out through news items that technological innovation, urbanisation and migration have significantly affected our value based social system because these changes have brought the technological innovation. This technological innovation has exposed individual to all kinds of violent behaviours and abusive behaviours which are the major factors behind the crime against elderly women [23, 24]. Further, the study has found that that economic growth has brought to India problems inherent to rapid urbanisation and migration which have affected the contemporary way of life. Urbanisation and migration have resulted in loosening of social controls and widening of social gap between the privileged and the disadvantaged. Security and violence have not been regarded as core issues of urban management. This is one of the major reasons for increased crime (against elderly women) in the society. Separation from family, lack of identity and possible anonymity of the migrants is also a possible explanation of the increasing rate of crime against the women (elderly women) [23–25].

This study found that victimisation affects the well-being of elderly women which lead many other problems before the elderly women. The study has found that the mistreatment is more common among the elderly women, which raise the feeling of insecurity, depression and isolation. The mistreatment leads to physical ill-health and lack of emotional bonding with family members and other individuals. The present research has pointed out that the family members do not give proper attention and provide basic needs such as food, cloth and medical facilities in rural areas which brings cognitive, physical and social frailty among the elderly women. The study has found that most of rural elderly women are not economically strong and are also widow and due to it they are dependent on their children and other family members for their basic needs. Most of times children and other family members do not fulfil their demand and they behave rudely with elderly women on their any demand. These ignorance and rude behaviour emotionally weakens them and brings many problems to them such as feeling of negligence, isolation and fear of abuse. Many researchers [26, 27] have also discussed in their studies that when elderly women are not able to care themselves due to growing age, then they have hope for caring, for activities of daily living and for the financial support from the children and other members of the family. As a result, their hope and dependence on the children and other family members become the source of abuse. Moreover, HelpAge India [7] has also pointed out in its report that emotional dependence on the abuser' and economic dependence on the abuser are the major reasons for them being abused. In the case of urban elderly people, it is seen that when they need care the most, they are living alone and are dependent on the caretakers and neighbours because their family members have migrated to other towns for job [28]. Their caretakers and neighbours take advantage of their helplessness and abuse them. This abusive behaviour affects their well-being and raises the feeling of insecurity.

The Researcher has also focused on frailty to examine its impact on the physical and emotional well-being of the elderly women with the help of news items. The researchers has found during the analysis of news items that in many cases elderly women have expressed that they are physically and socially weak and are not able to protect themselves. The researcher has found that many of the elderly women are suffering from multiple diseases such as paralysis, eye sight problem and diabetes. The elderly women have become weak due to these diseases and these diseases have reduced their physical capability. Due to such physical frailty, they are not able to protect themselves from any mishappening or criminal assault. The researcher has

also analysed hat many elderly women think that they are emotional weak because in old age they are less engaged in social activities and consequently, feel isolated. The news items indicated that children and other family members do not have time for the elderly women and they do not have 'we feeling' like people of past. They are of the view that materialistic way of life has affected Indian social structure a lot and has contributed its share in bringing emotional frailty among the elderly women. Similarly, Patel and Mishra [29] has found in their study related fear of crime among the elderly that the nuclear families, working couples, changes in neighbourhood behaviour have left the elders neglected, uncared for and lonely. The social support of the elderly has weakened. Due to this many elderly are frail, vulnerable and cannot help themselves [14, 30].

4. Conclusion

The paper implies that crime against the elderly women is an emerging social problem in India. In this paper researcher has tried to highlight the nature of crime against the elderly women through news items. The news items show that occurrence of crime in neighbourhood affects the way of life and sense of wellbeing of the elderly women because those who were victimised, they expressed their fear and said that they are not safe anywhere. Findings have found that maximum crimes against the elderly women have been committed due to money and property and mostly these incidents of crime against the elderly have been committed by known persons such as family members and neighbours. Finally, Government should implement abuse preventive and elder supportive mechanism for the safety and security of the elderly women. Moreover, the paper suggests about the police accountability for the protection of the elderly women from crime as well as fear of crime. Police should implement neighbourhood watch programs through community policing. Police Friendly Mobile System should be implemented by police, which motive is to solve the public problems and the problems of elderly women. The paper also suggests that elderly women should follow some guidelines for their safety and security. These guidelines such as elderly women should have telephone numbers of police helpline and neighbours so that in case of any mishap immediate help could be sought. The elderly women should install good locks, auto locks on doors and windows and use door chains, magic eye and strong grills on the doors and windows.

5. Limitations of the study

There are certain limitations of this study. The present study is based on secondary data which have been collected through newspapers of few places. These secondary data do not reveal clear picture of crime against elderly women. Whatever cases related to crime against elderly women have been collected from newspapers, they are very few and focus only on the crime of a particular area. It would be difficult to make generalisations from this study considering that there is great diversity of experience and difference in perception and nature of crime against elderly women in the society.

DOI: http://dx.doi.org/10.5772/intechopen.91173

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References

[1] Jain UC. Elder abuse: Outcome of changing family dynamics. Indian Journal of Gerontology. 2008;**22**(4):447-455

[2] Khan AM. Decay in family dynamics of interaction, relation and communication as determinant of growing vulnerability amongst elders. Indian Journal of Gerontology. 2004;**18**(2):173-186

[3] Sankardass MK. Critical understanding of prevalence of elder abuse and the combating strategies with specific reference to India. Indian Journal of Gerontology. 2008;**22**(4):422-446

[4] HelpAge India. Elder Abuse in India. New Delhi: HelpAge India; 2013

[5] Jamuna D. Ageing in India: Some key issues. Ageing International. 2000;**25**(4):16-31

[6] National Crime Record Bureau. Crime in India Report. New Delhi: National Crime Record Bureau (Government of India); 2016

[7] HelpAge India. Elder Abuse in India. New Delhi: HelpAge India; 2014

[8] Group for Economic and Social Studies. Rising Crime against the Elderly People and Responsibility of Police in Metros. New Delhi: Bureau of Police Research and Development; 2009

[9] Agewell Foundation. Study on Perceptions towards Human Rights of Older Persons. New Delhi: Agewell Foundation; 2013

[10] Mallick A. Narratives of aged widows on abuse. Indian Journal of Gerontology. 2008;**22**(3&4):480-500

[11] Begum FA. Elder abuse and wellbeing of older women. HelpAge India Research and Development Journal. 2014;**20**(2):33-40

[12] Ramamurthy M. Empowering the older persons in India. Research and Development Journal. 2003;**9**(2):5-8

[13] Bronfenbrenner U. The Ecology of Human Development: Experiments by Nature and Design. Cambridge: Harvard University Press; 1979

[14] Schiamberg LB, Gans D. Elder abuse by adult children: An applied ecological framework for understanding contextual risk factors and the intergenerational character of quality of life. International Journal of Aging & Human Development. 2012;**50**:329-359

[15] Berelson B. Content Analysis in Communication Research. New York: The Free Press; 1952

[16] Miethe TD, Lee GR. Fear of crime among older people: A reassessment of the predictive power of crime- related factors. The Sociological Quarterly. 1984;**25**:397-415

[17] Patel M. Crimes against the elderly. Indian Journal of Gerontology. 2010;**24**(3):395-402

[18] Rufus D, Shekhar B. A study on victims of elder abuse: A case study of residents of old age homes in Tirunelveli District. HelpAge India Research and Development Journal. 2011;**17**(3):29-39

[19] Mishra AJ, Patel AB. Crimes against the elderly in India: A content analysis on factors causing fear of crime. International Journal of Criminal Justice Sciences. 2013;**8**(1):13-23

[20] Goel A. Violence and Protective Measures for Women Development and Empowerment. New Delhi: Deep and Deep Publications; 2004

[21] Singh AK, Choudhury J. Violence Against Women and Children-Issues and Concerns. New Delhi: Serial Publications; 2012

[22] Madhurima. Elderly widows as victims of physical abuse: A qualitative study in the State of Punjab. Indian Journal of Gerontology. 2008;**22**(3&4):501-514

[23] Nalla MK, Joseph JD, Smith RH. Prior victimisation, region and Neighbourhood effects on fear of crime in Mumbai, India. Asian Criminology. 2011;**6**:141-159

[24] Sharma RR, Pardasani R, Nandram S. The problem of rape in India: A multi-dimensional analysis. International Journal of Managing Projects in Business. 2014;**7**(3):1-28

[25] International Crime Victim Survey (ICVS). Criminal Victimisation in the Developing World. 1995

[26] Khan AM, Handa S. Exploring older persons' perception about old age and different forms of elder abuse. HelpAge India Research and Development Journal. 2011;**17**(2):7-19

[27] Sanwal T, Kumar S. Elder abuse. HelpAge India Research and Development Journal. 2011;**17**(3):40-48

[28] Patel AB, Mishra AJ. An empirical study of elder abuse in the state of Uttar Pradesh of India. Journal of Quality in Ageing and Older Adults. 2018;**19**(2):106-116

[29] Patel AB, Mishra AJ. A study of the factors triggering fear of crime among the elderly in Northern India. Indian Journal of Gerontology. 2015;**29**(4):456-470

[30] National Crime Record Bureau. Crime in India Report. New Delhi: National Crime Record Bureau (Government of India); 2015

Edited by Sara Palermo

The progressive growth in the number of older adults worldwide has led to a modification of the current healthcare scenario and a parallel increase in the use of public resources. In this book, we propose a conceptual framework within which aging, frailty, and care are analyzed through the lens of complexity medicine. Therefore, we present a multidimensional perspective that takes into account biomedical, (neuro) psychological, and socio-ecological vulnerability. The theses presented are the result of an inductive approach, based on many years of experience in the field, which has made it possible to identify strategies for frailty recognition and effective responses even in complicated clinical settings. The book is intended to be a tool of concrete and easy consultation, rich in reflections and suggestions.

Published in London, UK
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ISBN 978-1-83968-220-9